HOW TECHNOLOGY-BASED START-UPS SUPPORT U.S. ECONOMIC GROWTH

J. John Wu and Robert D. Atkinson | November 2017

ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

How Technology-Based Start-Ups Support U.S. Economic Growth

BY J. JOHN WU & ROBERT D. ATKINSON | NOVEMBER 2017

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

INTRODUCTION

Technology-based start-ups have long been an important driver of America's economic growth and competitiveness.[1] But while these firms provide outsized contributions to employment, innovation, and productivity growth, many policymakers focus more broadly on helping all business start-ups without regard to type. Such a broad-based focus will do little or nothing to spur economic growth for three key reasons: First, most owners of new firms have no intention of growing beyond just a few employees; second, small, non-technology-based firms on average have much lower productivity and wage levels than larger firms; and third, most non-tech start-ups are in local-serving industries (e.g., retail) and as such create few net new jobs.[2]

Rather, policymakers should focus on spurring high-growth, technology-based start-ups. These firms, by definition, seek to grow; they offer better-paying jobs; and they are almost always in export-based industries that help U.S. competitiveness. While they account for less than 1 percent of all U.S. businesses, if the share of these firms could be increased by just a fraction, the result would be greater job creation, productivity growth, global competitiveness, innovation, and a stronger U.S. economy.[3] Yet, to formulate good policy in this area, it is important for policymakers to first understand the state of technology-based start-ups in the United States. This report quantifies entrepreneurship in 10 technology-based industries over the last decade (2007-2016) at the national, state, and congressional district levels.

Policymakers should focus on spurring high-growth, technology-based start-ups. These firms, by definition, seek to grow; they offer better-paying jobs; and they are almost always in export-based industries and help U.S. competitiveness.

The first section discusses what differentiates a technology-based start-up from the typical new business. It then details the former's importance in terms of job creation, wages, research and development (R&D), and competitiveness. The second section provides data on technology-based entrepreneurship at the national and state levels. We analyze trends in the number of start-ups for a total of 10 technology-based industries from 2007 to 2016. In addition, we provide data on: 1) early stage start-ups (companies that report annual sales generally lower than $2 million, with this "threshold" value differing by industry) to identify the share of technology-based start-ups in their pre-revenue/pre-commercialization phase; 2) start-ups that display high growth rates (companies that increase employment more than 25 percent in a year); 3) first-year and fifth-year survival rates to illustrate the share of firms that stay in business year-after-year; and 4) a more in-depth analysis of start-ups in one industry—pharmaceutical and medicine manufacturing, which includes biotechnology.

The third section provides policy recommendations to support the formation and growth of technology-based start-ups. For additional analysis, Appendix C presents sectoral start-up trends for each of the technology-based industries from 2007 to 2016; Appendix D contains an analysis of venture-capital-backed technology-based start-ups in 2016; Appendix E contains tables on state-level technology-based start-up activity in each of the 10 industries for 2016; and, Appendix E contains analysis of technology-based start-up activity in each of the 435 congressional districts for 2016.

In contrast to the prevailing narrative that U.S. business start-up rates are low and that this represents a serious problem, when it comes to technology-based entrepreneurship the situation is much more positive. Scott Stern of the Massachusetts Institute of Technology (MIT) finds that around 5 percent of all start-ups are "high-quality"—start-ups that have significant innovation and growth potential. Stern also finds that these start-ups have grown in number over the last decade. Our analysis supports this finding. From 2007 to 2016, the number of technology-based start-ups has grown 47 percent. Moreover, wage growth among technology-based start-ups has been higher than U.S. wage growth overall (20 percent versus 3 percent), and the average share of high-growth start-ups among all technology-based start-ups was higher from 2012 to 2016 than from 2007 to 2011 (6 percent versus 10 percent). This suggests that start-ups in recent years have been creating more jobs that remain in the economy. Early stage, pre-revenue start-ups account for 12.6 percent of technology-based firms and 10 percent of technology-based jobs. Early-stage start-ups as a share of all technology-based firms decreased from 15 percent in 2007 to 10 percent in 2016. This trend was driven by the number of early-stage technology-based service start-ups decreasing in firm share, and was only partially offset by early-stage technology-based manufacturing start-ups increasing in firm share. Lastly, in examining survival rates over a longer period, from 1998 to 2016, we find that firm survival rates have increased since 1998 (first-year survival rates increased from 70 percent to 90 percent), but have declined slightly from their peak in the past few years. In other words, technology-based start-ups have been getting better at staying in business. (The decrease in survival rates in recent years could possibly be due to more start-ups entering the economy, thus raising competition between them.)

DEFINING TECHNOLOGY-BASED START-UPS

There is no hard and fast rule as to what is or is not a technology-based industry. The U.S. Bureau of Labor Statistics (BLS) classifies an industry as technology-based if its share of science, technology, engineering, and mathematics (STEM) workers is twice the national average. The Organization for Economic Co-operation and Development (OECD) identifies technology-based industries as ones with a high R&D-to-sales ratio (e.g., R&D intensity). For this analysis, the Information Technology and Innovation Foundation (ITIF) uses a combination of measures, including both R&D intensity and whether the industry appears on selections of technology-based industries published by the BLS, OECD, or the European Union's Eurostat. This led us to focus on 10 technology-based industries in manufacturing and services: pharmaceutical manufacturers, medical device manufactures, computer and electronic manufacturers, semiconductor machinery manufacturers, semiconductor component manufacturers, aerospace manufacturers, data processing services, computer systems and design services, software publishing services, and R&D-performing services.

Although firms in these 10 industries make up less than 5 percent of U.S. businesses, they make outsized contributions to income, employment, innovation, competitiveness, and

productivity.[4] Therefore, a slowdown in entrepreneurial activity in this sector would likely result in a reduction of these positive economic contributions over the moderate term.

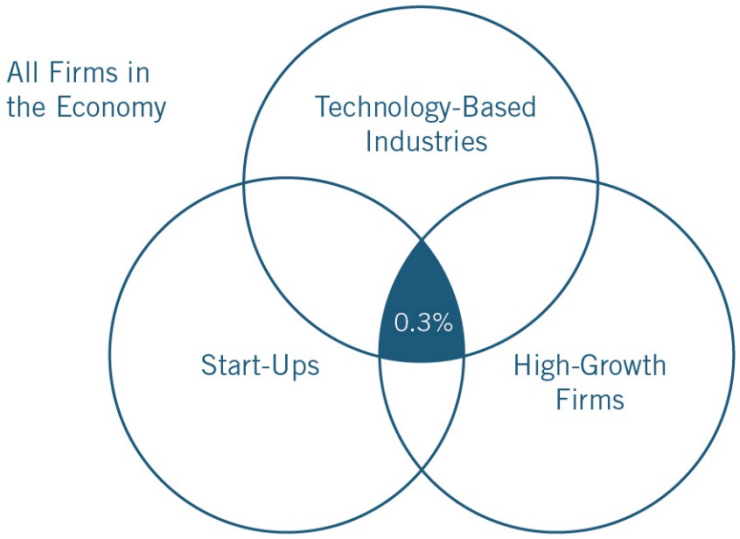
How does a start-up in the technology industry (referred to as a technology-based start-ups) differ from a new business in other industries? In general, technology-based start-ups have high growth potential, in both employment and revenue, as a result of them seeking to develop innovations that have a clear competitive advantage in the global market.[5] They often experience accounting losses for several years because they undertake heavy initial R&D and prototyping and testing investments, often many years before developing a significant revenue stream.[6] Many fail somewhere along this process, but if their technology and business models succeed, they often experience robust growth rates, hiring skilled and semi-skilled workers and paying well above the median wage. This contrasts with the typical new business in other industries, such as a restaurant or local service firm, which does not invest in R&D, has little intention to grow, creates a small number of jobs often at low wages, and usually goes out of business in under 10 years. Even when these businesses survive, they tend to follow a slower growth trajectory until they peak at just a few employees.[7]

In general, technology-based start-ups have high-growth potential, in both employment and revenue, as a result of them seeking to develop innovations that have a clear competitive advantage in the global market.

These key differences mean that, to succeed, technology-based start-ups face a set of challenges different from that of the typical start-up. They must find a way to grow before being able to make sizeable and sustainable revenue. They must be able to cope with significant global competition. They need to be able to develop and protect their intellectual property. And they need to be able to attract talent skilled in technology development.

By understanding where this group of firms fits into the economy, policymakers will be better able to craft effective policies that enable firms in these industries, and their workers, to more fully succeed. In figure 1, the *rectangle* represents all firms in the economy; the circle *Start-ups* represents all firms 10 years or younger; the circle *Technology-Based Industries* represents all firms in industries with technology-based characteristics (e.g., higher share of STEM workers and higher investments in R&D than the economy average); and the circle *High Growth Firms* represents firms that grow fast in employment or output. Not all technology-based firms are start-ups or high-growth; not all high-growth firms are start-ups or in technology-based industries.[8] And not all start-ups are high-growth or in technology-based industries.

Figure 1: Technology-Based, High-Growth Start-Ups in the Economy



Successful technology-based start-ups lie at the intersection of these three circles; these are the start-ups that usually grow into larger, successful businesses or are acquired by other companies to accelerate their growth. They currently make up approximately 0.3 percent of U.S. businesses. To overly simplify firm dynamics, firms in technology-based industries have an outsized role in increasing innovation and competitiveness, while high-growth firms overall have an outsized role in increasing net employment and productivity.[9] Growing and empowering the number of firms in this sweet spot of high-growth, technology-based start-ups will be a key driver for boosting U.S. innovation, competitiveness, productivity, and job-creation.

THE ROLE OF TECHNOLOGY-BASED START-UPS IN U.S. ECONOMIC GROWTH

Start-ups in technology-based industries benefit the economy in a number of ways: they create many high-paying jobs; they invest heavily in R&D; and they are more likely to export their goods and services.

Technology-Based Start-Ups Create Good Jobs

Technology-based start-ups provide outsized contributions to overall employment growth. They create jobs at faster rates than other start-ups, with a greater share of these jobs remaining in the economy year-after-year; pay high wages; and, indirectly create many more jobs in other sectors.

High-Growth Technology-Based Start-Ups' Outsized Employment Effects

Two dynamics work in tandem to produce outsized employment effects among these start-ups. First, firms in technology-based sectors are better at translating their R&D investments into job growth. Second, technology-based start-ups account for a higher share of net job creation than other start-ups.

Firms in technology-based industries are better than those in other industries at translating their R&D investments into jobs. In a discussion paper from the Institute of Labor Economics in Bonn, Germany, economists analyze the relationship between employment growth and R&D investments in high-tech, medium-tech, and low-tech firms across the European Union. The study found that firms in high-tech industries create 30 percent more jobs than firms in medium-tech industries for the same percentage increase in R&D investment.[10] A study that analyzed the employment effects of technology-based firms in Belgium from 2001 to 2008 found that technology-based firms grow employment faster than did other firms. In other words, when looking at the top 10 percent of technology-based firms in terms of employment growth and comparing that to the equivalent top 10 percent of other firms in the economy, technology-based firms have higher employment growth rates (approximately 10 percentage points higher). This trend remains consistent across the rest of the employment growth range, with the slowest-growing 10 percent of technology-based firms growing employment 7 percentage points higher than the slowest-growing 10 percent of all other firms.[11] An analysis of Spanish firms that invested in R&D between 2004 to 2010 returned similar findings: R&D intensity has an effect on employment growth, but only for high-growth and start-up firms.[12]

Growing and empowering the number of firms in this sweet spot of high-growth, technology-based start-ups will be a key driver for boosting U.S. innovation, competitiveness, productivity, and job-creation.

On average, technology-based start-ups increase their employment much faster than do start-ups generally.[13] Ian Hathaway of the Kauffman Foundation analyzed the employment growth rates of start-ups in 14 technology-based industries compared to other new businesses from 1990 to 2011.[14] He found that technology-based firms from one to five years old created twice as many net jobs as all firms in the same age group. While all of these young firms economy-wide increased employment by just under 6 percent year-after-year, the young technology-based firms increased employment by almost 12 percent.[15] Examining technology-based firms aged from six to ten, this magnitude increased to a factor of three, in part because so many start-ups in non-technology-based sectors don't survive to year ten. Strong job creation by technology-based start-ups is likely to continue due to the fact that technology-based industries have increased their share of the economy's output year-after-year. In 1980, technology-based industries comprised 10 percent of U.S. GDP, with this share increasing to just above 14 percent by 2016.[16]

Technology-based start-ups' greater-than-average employment growth is not just a U.S. phenomenon. An analysis of firms in Portugal from 1983 to 2000 finds that technology-based start-ups created more employment in the long run than typical new businesses.[17] In a more recent study, economists Dirk Czarnitzki and Julie Delanote analyze the performance of 3,500 Belgian firms from 2001 to 2008. They find that technology-based start-ups increase their employment faster than other new businesses by 5 percentage points.[18]

High-Growth Technology-Based Start-Ups Pay Higher Wages

While the number of jobs that businesses create matter, the number of "good" jobs (jobs that pay higher-than-average wages) matters even more. An independent personal or business-services company may employ a few workers at relatively low wages, but firms in

technology-based industries on average pay much higher wages. In fact, as our analysis finds, technology-based start-ups pay an average of $102,000, more than double the U.S. average wage of $48,000. Beyond creating better paying jobs, technology-based start-ups tend to create jobs that last longer.[19]

In a study of 19,000 MIT graduates from 2006 to 2014, Daniel Kim finds that those who joined a venture-capital-backed start-up (which tend to be in technology-based industries) earned 8 to 13 percent higher wages than their fellow graduates at other types of firms.[20] Although not sub-analyzing technology-based start-ups, economists Diane Burton, Michael Dahl, and Olav Sorenson in analyzing Danish firm data from 1991 to 2006 found that as start-ups grew rapidly, they passed that success on as higher wages for their workers. They estimate that one-quarter of these high-growth start-ups pay a wage premium over older firms.[21] And, as we find in our analysis, technology-based start-ups do pay a higher wage than other start-ups and the economy average.

Technology-Based Start-Ups Create Jobs in Other Economic Sectors

Alongside outsized contributions to direct employment growth, firms, including start-ups, in technology-based industries enable high levels of indirect job creation. These are jobs created in other firms that technology-based firms conduct business with—for example, manufacturing jobs in production supply chains, laboratory technicians in third-party laboratories, hospital workers where biotech firms conduct trails, and lawyers and accountants that help firms. They are also responsible for induced job creation—the jobs created by the spending of their employees on everything from groceries and financial services to entertainment.

These indirect and induced job creation effects—known as the job multiplier effect—arise because the lion's share of technology-based industries operate in traded sectors: sectors that sell most of their output outside their local region or even nation. This contrasts with non-traded sectors, such as dry cleaners and barber shops, which sell their output to local residents. These local sectors have very low job multipliers because their expansion normally comes at the expense of market share of another local business, rather than bringing new spending into the local economy.

Technology-based traded sectors have the highest employment multipliers, followed by other industries in traded sectors, while non-traded sectors show the lowest multiplier.[22] Economist Enrico Moretti estimates that technology-based start-ups have a job multiplier of five—for every direct job created by a technology-based enterprise, five additional jobs are created elsewhere.[23] A Massachusetts Biotechnology Council white paper estimated that each new bio-tech job created in and around Boston's strong bio-tech start-up ecosystem generated five indirect jobs in the region.[24] For comparison, each job in manufacturing (a traded sector) supports three indirect jobs, while each job in the food and beverage industry (a non-traded sector) supports up to one indirect job.[25]

Technology-Based Start-Ups Invest in R&D

Technology-based start-ups invest in R&D to create new products and implement better production processes.[26] In contrast, fewer than 5 percent of U.S. businesses invest in R&D, with this figure differing by less than half a percentage point when looking only at businesses under two years of age.[27] Jorge Guzman and Scott Stern find a similar figure: from 1988 to 2014 just 5 percent of U.S. start-ups were technology-based and had high growth potential.[28] Other advanced economies are similar. Erik Stam and Karl Wennberg studied 12,000 Dutch start-ups from 1994 to 2000. They found that only 9 percent of these start-ups engaged in R&D activities.[29]

Furthermore, start-ups in technology-based sectors tend to be more R&D-intensive (R&D spending as a share of sales) than older firms in their industries.[30] For example, in the bio-tech industry, the average R&D intensity is around 20 percent, but a survey of bio-tech start-ups found that the average R&D intensity was 62 percent, while over one-third of surveyed start-ups had R&D intensities higher than 75 percent.[31] In part, this is because at this stage in their life cycle they are investing to create and perfect products and have fewer sales than more mature firms. Nonetheless, not investing heavily enough into R&D is likely a liability for start-ups in technology-based sectors. David Deeds, in an analysis of technology-based start-ups, concludes, "our findings are that R&D intensity restricts the growth of technology-based SMEs at lower levels of R&D intensity and stimulates their growth at higher levels."[32]

Technology-based traded industries have the highest employment multipliers: one technology-based job creates five jobs in other industries.

But investing heavily into R&D in itself isn't a guarantee of success; too often start-ups that invest in R&D fail. Because innovation is inherently risky, not all R&D investments result in either technical innovations or market success, and thus there is a huge dispersion in the economic outcomes for the same level of R&D intensity.[33] Dirk Czarnitzki and Julie Delanote analyze the performance of 3,500 Belgium firms from 2001 to 2008.[34] They find that after controlling for R&D intensity, the fastest growing 10 percent of technology-based start-ups grew their revenues 30 percent more than the fastest growing 10 percent of all other firms in the economy; the slowest growing 10 percent of technology-based start-ups grew their revenues 10 percent less than the slowest growing 10 percent of all other firms in the economy. But, on average, they find that technology-based start-ups increase their revenues 10 percentage points greater than all other firms in the economy.

Technology-Based Start-Ups Support Competitiveness

A strong U.S. competitive position internationally will depend in large part on U.S. firms introducing and exporting a steady stream of high-value-added technological innovations. Technology-based start-ups do just that, investing in R&D to develop technologically advanced goods and services, usually for global markets.

Indeed, a study reviewing 38 economic analyses of international-orientated start-ups found that investment in R&D is a key determinant of success in international markets.[35] Firms that compete in international markets invest more in R&D than firms with only domestic ambitions.[36] In an analysis of U.S. firm behavior, Foster, Grim, and Zolas find that

approximately 50 to 60 percent of all R&D performing firms have at least one annual international transaction. In contrast, only 7 to 8 percent of all U.S. firms have one annual international transaction.[37]

Investment in R&D is a strong indicator that a start-up will compete in international markets. A study of Danish firms, "Do R&D Investments Affect Export Performance," finds that as start-ups that invest in R&D grow, they are likely to export more. The authors conclude that "the answer to the question asked in the title of the paper is yes. Export is affected positively if the firm has decided to engage in R&D activities."[38] Similarly, in a survey of 75 Canadian technology-based start-ups, the larger they grew, the greater their export intensity and export diversity.[39] This means that as these firms grew, exports became a larger share of their sales revenue and the number of countries they exported to increased. In a British economic analysis that merged 2004 trade data with an innovation survey, the authors found that technology-based start-ups were up to 40 percent more likely to be an exporter than start-ups not engaged in innovation.[40] One reason technology-based firms in general and technology-based start-ups in particular export more is because of the unique economics they confront, namely the high up-front fixed costs associated with developing innovative products and services followed by marginal incremental production costs. For instance, there is high fixed cost associated with developing a new software program, but once developed, creating an additional copy of that software costs virtually zero dollars. Similarly, developing the first new biologic or pharmaceutical drug can cost billions in upfront research, development, and clinical trials, but incremental copies can be produced at the marginal production cost. This means that the larger markets that international trade affords become critical for the success of technology-driven firms since they enable those high fixed costs to be recouped over many more sales in the global marketplace.

Venture Capital Supports Technology-Based Start-Ups

Venture capital (VC) investment funds have an important role in funding and supporting technology-based start-ups.[41] VC accelerates the growth of technology-based start-ups, by providing these young companies funds to hire more workers and the professional business guidance to push their innovations to market sooner. Therefore, VC serves as a catalyst for technology-based start-up activity.

But VC's catalyzing effect for economic growth isn't as simple as increasing the supply of funds. This is because when a technology sector has a sufficient number of entrepreneurs with high growth potential, venture capitalists will seek out these entrepreneurs and invest in them. If there is a lack of potential high-growth, technology-based entrepreneurs, venture capital funds will be drawn to other, better investment opportunities. Economists Masayuki Hirukawa and Masako Ueda reported on this chain of causality after analyzing venture capital investment in the U.S. manufacturing industry from 1958 to 2001.[42] Therefore, the quantity of venture capital invested in technology-based start-ups across the economy should not be the main focal point for policymakers, but rather a key yard stick to measure how effective other innovation policies have been in supporting the demand for venture funding through technology-based innovation.

The better VC investors are at selecting potential high-growth companies in which to invest and help to succeed, the more the economy stands to benefit. These investors often look at the patenting activity of start-ups as an indicator of potential future high growth to gauge their returns on investment. In a European study, British start-ups that patented their technologies grew 8 to 27 percent per annum faster than start-ups that did not patent their technology.[43] Economists at the National Bureau of Economic Research estimate that when a U.S. start-up receives a patent, it hires an average of 16 more workers and generates $10.6 million more sales over the next five years.[44] This is why VCs tend to invest more in start-ups that hold more patents. Furthermore, start-ups that display greater potential are able to attract larger VC investment. For example, an economic paper analyzed 332 VC-backed firms in the nanotechnology sector worldwide from 1985 to 2006 and found highly significant statistical results indicating that start-ups with a greater number of patents in their "core technologies" prior to accepting VC bids receive higher levels of VC investment.[45] As a result, VC investors have, at the aggregate, made good investments in start-ups with valuable technologies. A recent economic analysis finds that for the same dollar invested in R&D, a VC-backed firm produces nine times the return than that of a typical business.[46]

VC-backed start-ups grew employment and sales 40 percent faster than non-VC-backed firms on average.

By obtaining VC investment, start-ups accelerate their own growth and can attract additional economic activity into their surrounding regions. In an Italian study that analyzed 538 technology-based start-ups over ten years, the authors find that VC-backed start-ups grew employment and sales 40 percent faster than non-VC-backed start-ups on average.[47] Technology-based entrepreneurs, lured by the prospect of obtaining VC investments, may choose to open their start-ups in regions with a high density of firms with VC backing, creating more jobs for the region. In a study that analyzed start-up activity across the 329 U.S. metropolitan regions from 1993 to 2002, the authors find that the average number of VC-backed start-ups per metro region was four. And they estimate that doubling this number would increase the number of start-ups by 2.2 percent, increase employment by 1.2 percent, and increase aggregate income by 3.8 percent in the average metro region.[48]

Federal policies can help firms in advanced technology sectors attract VC investment, as evidenced by the Small Business Innovation Research (SBIR) program. Economist Sabrina Howell found that by providing seed capital to small energy-technology companies, SBIR grants doubled the chances of these companies receiving venture capital in the future.[49] This increase in likelihood arises for two reasons. First, as Howell explains, "the [SBIR] funds proof-of-concept work that reduces investor uncertainty about the technology." Second, a project that passes the SBIR's robust project criteria and peer-review process serves as a good indicator of the project's potential to private investors.

THE STATE OF TECHNOLOGY-BASED START-UPS

A critical question for the future of the U.S. economy is the current state of technology-based start-ups. ITIF attempted to assess this by examining data on firms in technology-based industries from 2007 to 2016 (and data from 1998 to 2016 on firm tenure). This

section first discusses the methodology used and the 10 industries chosen. It then illustrates the current economic contribution of technology-based industries and start-ups to the U.S. economy. It goes on to examine trends on technology-based start-ups from 2007 to 2016 (including early-stage companies and high-growth companies); wage growth among technology-based start-ups from 2007 to 2016; firm tenure rates among technology-based start-ups from 1998 to 2016; state-level breakdowns of technology-based start-ups; and industry-level trends (using the pharmaceutical industry as an example). Appendix C contains trend analyses for each of the remaining 10 technology-based industries from 2007 to 2016; Appendix D analyzes the state of VC-backed, technology-based start-ups in 2016; Appendix E contains tables on state-level technology-based start-up activity in each of the 10 industries for 2016; Appendix F contains analysis on technology-based start-up activity in each of the 435 Congressional districts for 2016.

Methodology

ITIF classified 10 industries as technology-based; of these, six are goods-producing industries and four are service-providing industries. This multi-step selection process involved, first, identifying industries based on their R&D intensity above the national average based on U.S. National Science Foundation (NSF) data; second, cross-referencing these industries; and, finally, selecting those that also appear on currently established lists of technology-based industries published by the U.S. BLS, OECD, and the European Union's Eurostat.

On average, firms in these industries invest between 4.4 percent and 28.4 percent of their revenue in R&D. For comparison, the average firm across the entire economy invests only 3.3 percent of its revenues in R&D.[50] Appendix A presents additional technical details on how we defined technology-based sectors. Do note that through our selection, the technology-based R&D-intensive sector strictly consists of nine industries. For ease of presentation, we count the semiconductor and other electronic components industry as a tenth industry even though it is a sub-industry of the computer and electronic component manufacturing industry within our analysis. ITIF included the former industry because it has the second-highest R&D intensity among all manufacturing industries, and thus it is important to understand the trends within it.

Table 1: Technology-Based Sectors Analyzed

Industry	NAICS Code	R&D Intensity
Pharmaceuticals and medicines	3254	10.3%
Semiconductor machinery	333295	28.4%
Computer and electronic products	334	10.6%
Semiconductor and other electronic components	3344	18.5%
Aerospace products and parts	3364	7.6%
Medical equipment and supplies	3391	4.4%
Software publishers	5112	9.0%
Data processing, hosting, and related services	518	8.1%
Computer systems design and related services	5415	8.4%
R&D in the physical, engineering, and life sciences	54171	19.4%

To analyze start-up trends in these industries, ITIF used a private, firm-level dataset available through the Business Dynamics Research Consortium (BDRC) of the University of Wisconsin Extension Service and supplemented this analysis with the publicly available Longitudinal Employer-Household Dynamics (LEHD) database published by the U.S. Census Bureau. Pitchbook, a firm that compiles data and research on private capital markets, provided supplemental proprietary data on VC-backed start-up activity. The BDRC database is a time-series dataset that catalogues individual establishments by location, employment, sales, and industry from 1997 to 2016. Our sample of firms in the 10 industries contains more than a million establishments over these two decades. The LEHD database provides time-series data, aggregated at the industry-level and state-level, on employment, payroll, firm age, and firm size. Pitchbook data provides the number of VC-backed start-ups by firm age and industry. Appendix B provides a more technically detailed discussion on the sampling methodology and inherent biases for these datasets and further methodological considerations.

This slightly slower rate of growth among older firms (compared to start-ups) resulted in start-ups making up a slightly larger firm share of the technology-based sector in 2016 than in 2007.

We classify a start-up as a business 10 years or younger in age. Within technology-based start-ups we also look at early-stage start-ups (i.e., start-ups in the pre-product-revenue or pre-commercial phase), which we define as firms with generally less than $2 million in sales in that year of operation (this threshold value differs by industry and additional details are provided in Appendix A), and high-growth start-ups (firms that increased employment by greater than 25 percent over the previous year). We also consider first-year and fifth-year firm tenure, which represents the share of start-ups that survive past their first and fifth years of operations.

Analysis

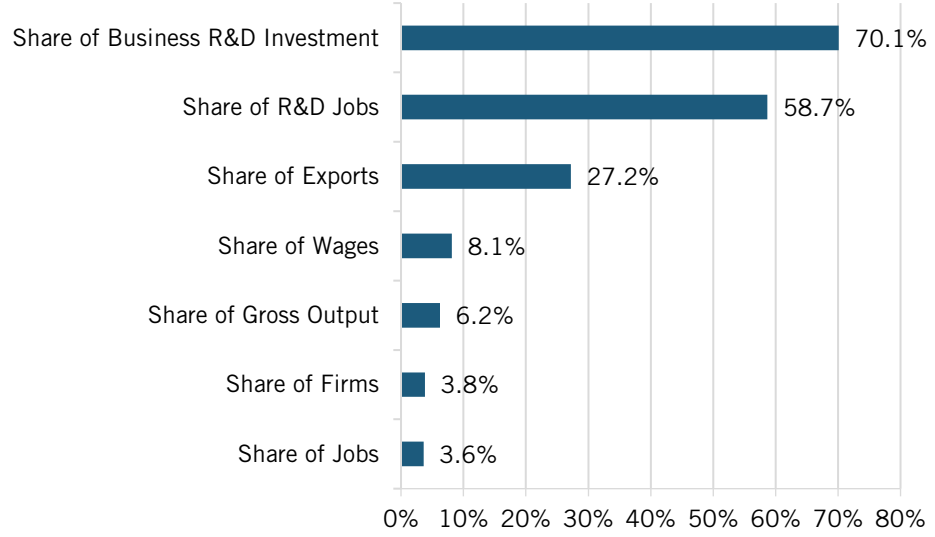
This section provides our findings at the national, state, and for illustration, industry level. Our analysis is organized as follows: first, the economic contributions the technology-based sector provides the economy; second, the share of the economy made up of technology-based start-ups; third, trends in technology-based start-up activity from 2007 to 2016 (which includes early-stage firms, high-growth firms, and wage growth); fourth, firm tenure of technology-based start-ups from 1998 to 2016; fifth, a detailed breakdown of start-up activity in the pharmaceutical manufacturing industry from 2007 to 2016 (as an example for illustrating industry-specific trends); and, sixth, technology-based start-up activity specific to each of the 50 states in 2016.

Technology Industries

The 10 technology-based industries consist of 230,000 firms—young and old—that employ 4.5 million workers (of which 900,000 are in R&D-specific occupations); pay half a trillion dollars in wages; invest $226 billion in R&D; export $600 billion in goods and services; and generate $2 trillion in gross output.[51] To put that into context, these firms account for 3.8 percent of all firms in the United States and employ 3.6 percent of the workforce. But they generate 6.2 percent of gross output; pay 8.1 percent of total wages;

generate 27.2 percent of exports; account for 58.7 percent of R&D-related jobs; and are responsible for 70 percent of private R&D investment (figure 2).

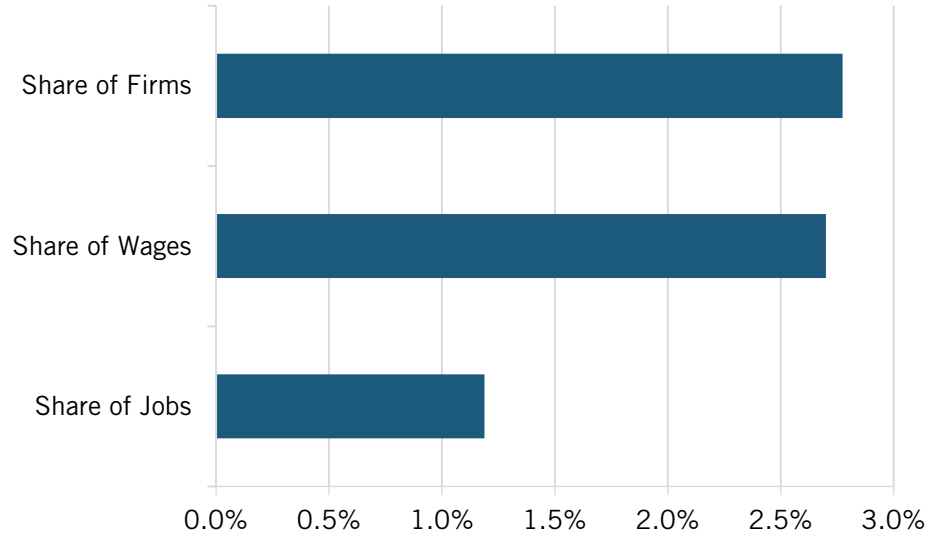
Figure 2: The Ten Technology-Based Industries' Contributions to the U.S. Economy



Technology-Based Start-Ups

For 2016, we find that start-ups (firms 10 years old or less) in these ten industries consist of 171,000 firms that employ 1.5 million workers and pay $150 billion in wages. As a share of the U.S. economy, technology-based start-ups account for 2.8 percent of all firms, employ 1.2 percent of the workforce, and pay 2.7 percent of total wages (figure 3). In other words, on average, start-ups employ workers making significantly above the median wage.

Figure 3: Technology-Based Start-Ups' Contributions to the U.S. Economy



Technology-Based Start-Up Trends

Over the last few years a widely held narrative has emerged that new business formation is down and that this has been a significant contributing factor to the recent underperformance of the U.S. economy.[52] There is a parallel narrative that holds that large technology firms are crushing technology-based start-ups, using their power to enter markets that otherwise start-ups would occupy. As it turns out, neither claim is true. While it is true that fewer "mom and pop" start-ups are forming, technology-based start-up formation appears robust. In fact, from 2007 to 2016, the number of technology-based start-ups has grown, and these firms have increased their overall share of U.S. employment. Moreover, inflation-adjusted wages have increased faster among start-ups than across the technology-based sector overall. Start-up firm tenure has increased, with start-ups more able to stay in business. And start-ups have grown as a share of all technology-based firms.

Number of Start-Ups

Over the past 10 years, technology-based start-ups have increased steadily. Since 2007, the number of start-ups has increased 47 percent, from 116,000 firms in 2007 to 171,000 in 2016, while start-ups as a share of all technology-based firms have increased from 72 percent to 73 percent.

Over the past 10 years, technology-based start-ups have increased steadily. Since 2007, the number of start-ups has increased 47 percent, from 116,000 firms in 2007 to 171,000 in 2016 (figure 4), while start-ups as a share of all technology-based firms have increased 1 percentage point from 72 percent to 73 percent (figure 5). The number of start-ups remained stable through the recession, started to recover from 2011 to 2013, decreased slightly in 2014, and increased over the past two years. To be specific, the total number of start-ups in 2007 is the sum of the total number of firms that launched operations between 1998 and 2007 and were still in business in 2007; while the total number of start-ups in 2016 is the sum of the total number of firms that launched operations between 2007 and 2016 and were still in business in 2016.

Start-ups also increased in number by 47 percent from 2007 to 2016, while older firms (firms more than 10 years old) increased by 40 percent. This slightly slower rate of growth (compared to start-ups) resulted in start-ups making up a slightly larger share of this sector in 2016 than in 2007.

Figure 4: Number of Firms in the Technology-Based Sector, 2007 to 2016

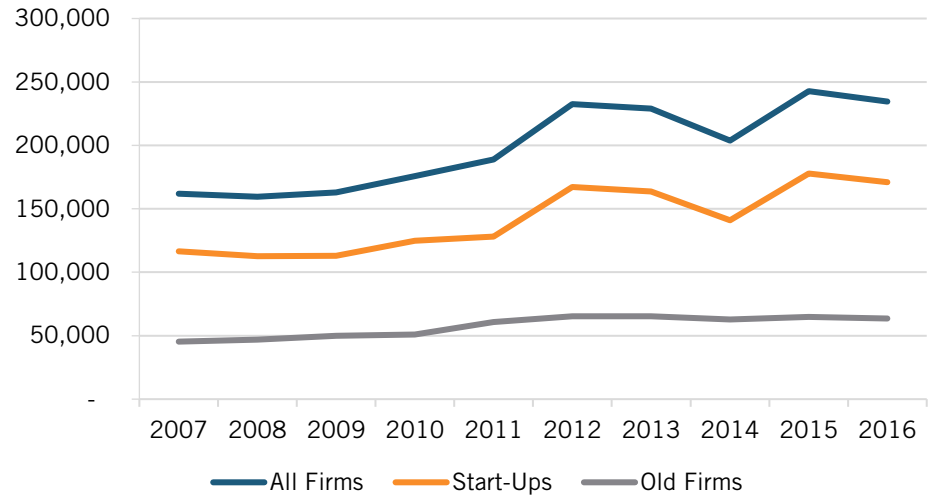
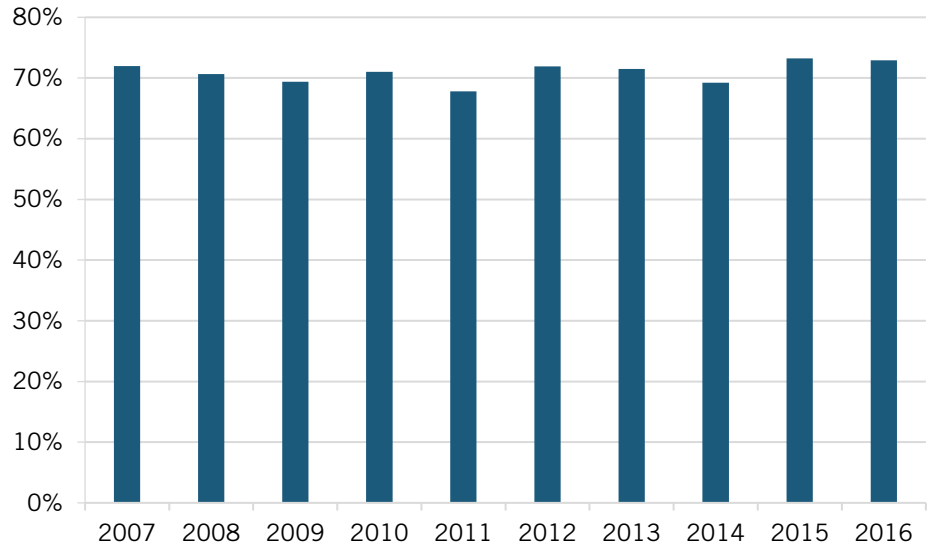
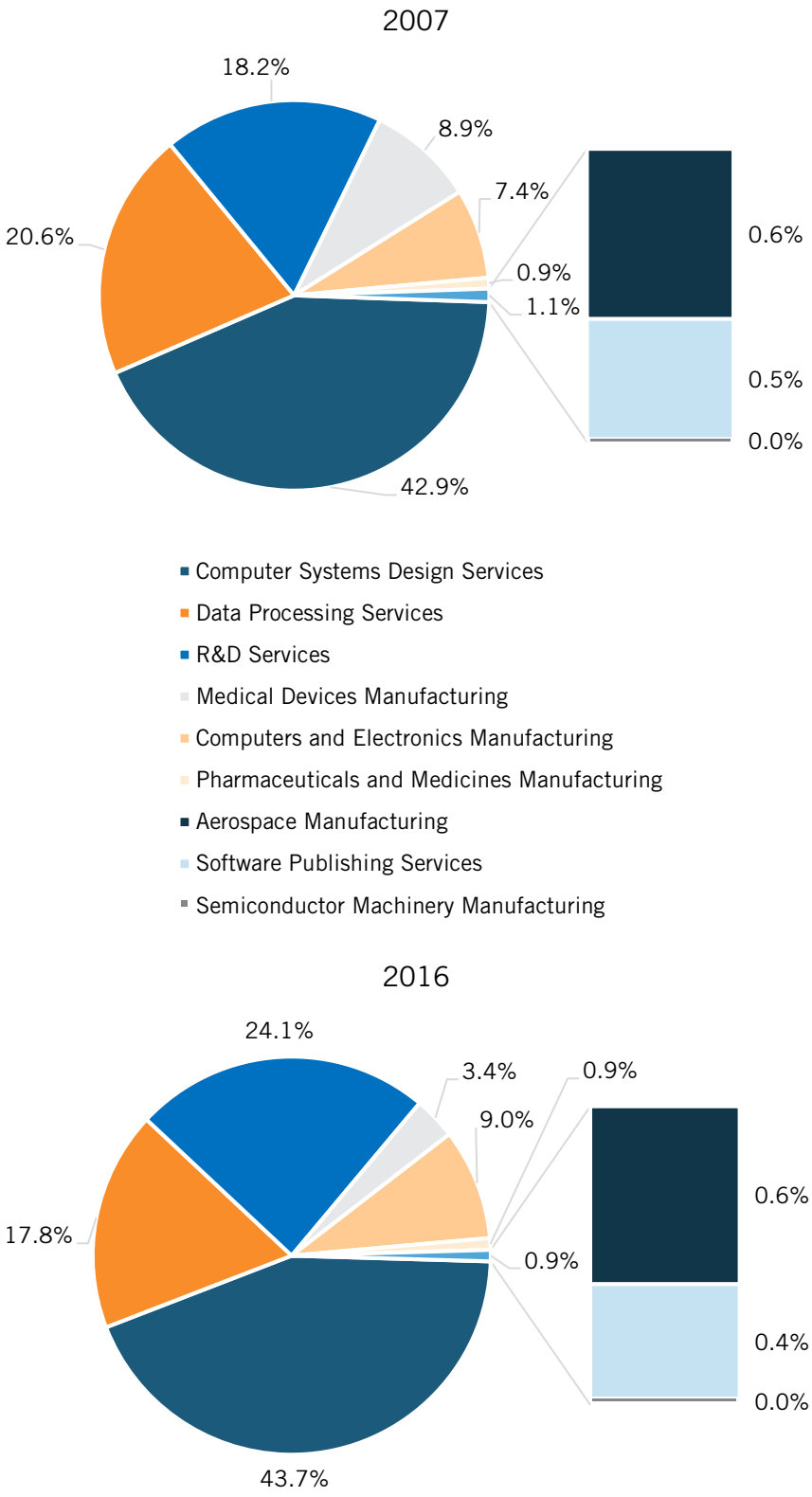


Figure 5: Start-Ups as a Share of Total Firms in the Technology-Based Sector, 2007 to 2016



Although the overall number of technology-based start-ups increased from 2007 to 2016, certain technology-based industries increased their number of start-ups much faster than others. Computer systems design service start-ups make up 40 percent of all technology-based start-ups, and have increased in both number and share of all technology-based start-ups from 2007 to 2016 (figure 6). Manufacturing technology-based start-ups make up less than 20 percent of technology-based start-ups, and from 2007 to 2016, their share of all technology-based start-ups decreased to less than 15 percent. This reduced firm share of manufacturing technology-based start-ups is not due to a decrease in manufacturing technology-based start-ups, but a result of the fact that the number of service technology-based start-ups increased much faster. This may be because service technology-based start-ups tend to be smaller in size and have much lower average sales than manufacturing technology-based start-ups. In other words, it may take less investment to scale up a service technology-based start-up into a successful enterprise, and so it is "easier" to launch such start-ups.

Figure 6: Start-Ups by Technology-Based Industries as a Share of All Technology-Based Start-Ups, 2007 and 2016



Employment in Start-Ups

In 2007, technology-based start-ups employed 1.2 million workers, with this figure decreasing to 1.1 million by 2011, then increasing to 1.5 million by 2016 (figure 7). Because technology-based start-up employment grew much faster than older technology-based firms (20 percent versus 7 percent employment growth), technology-based start-up employment as a share of total technology-based employment increased by 2 points from 31 percent to 33 percent (figure 8). In part reflecting the dynamic nature of technology industries, tech-based start-ups account for a larger share of technology-based sector employment than do overall start-ups across the entire economy (33 percent to 19 percent).[53]

In 2007, technology-based start-ups employed 1.2 million workers, with this figure decreasing to 1.1 million by 2011, then increasing to 1.5 million by 2016.

Figure 7: Employment in the Technology-Based Sector, 2007 to 2016

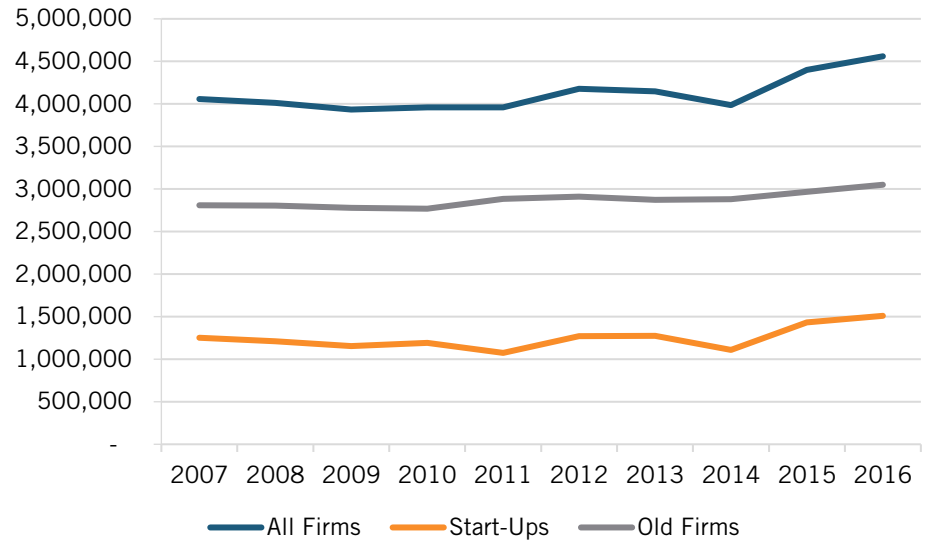
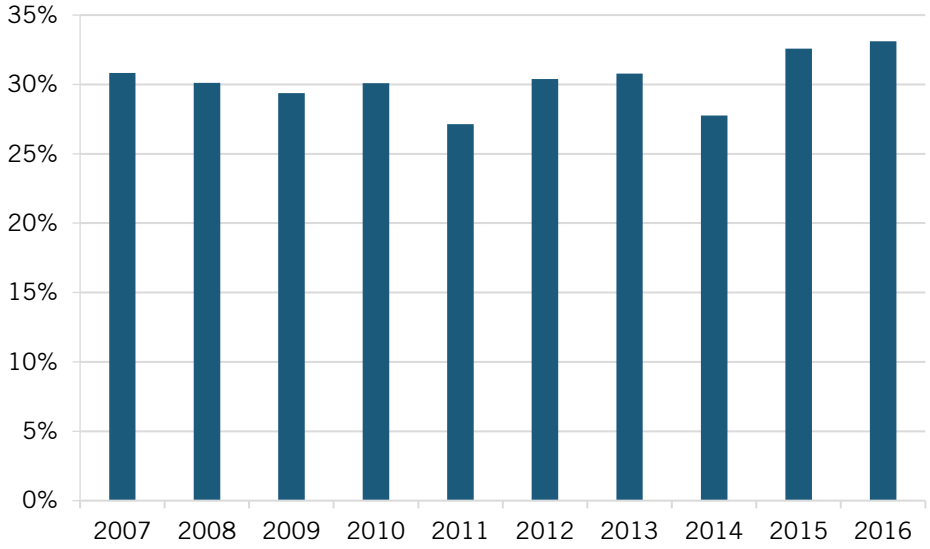
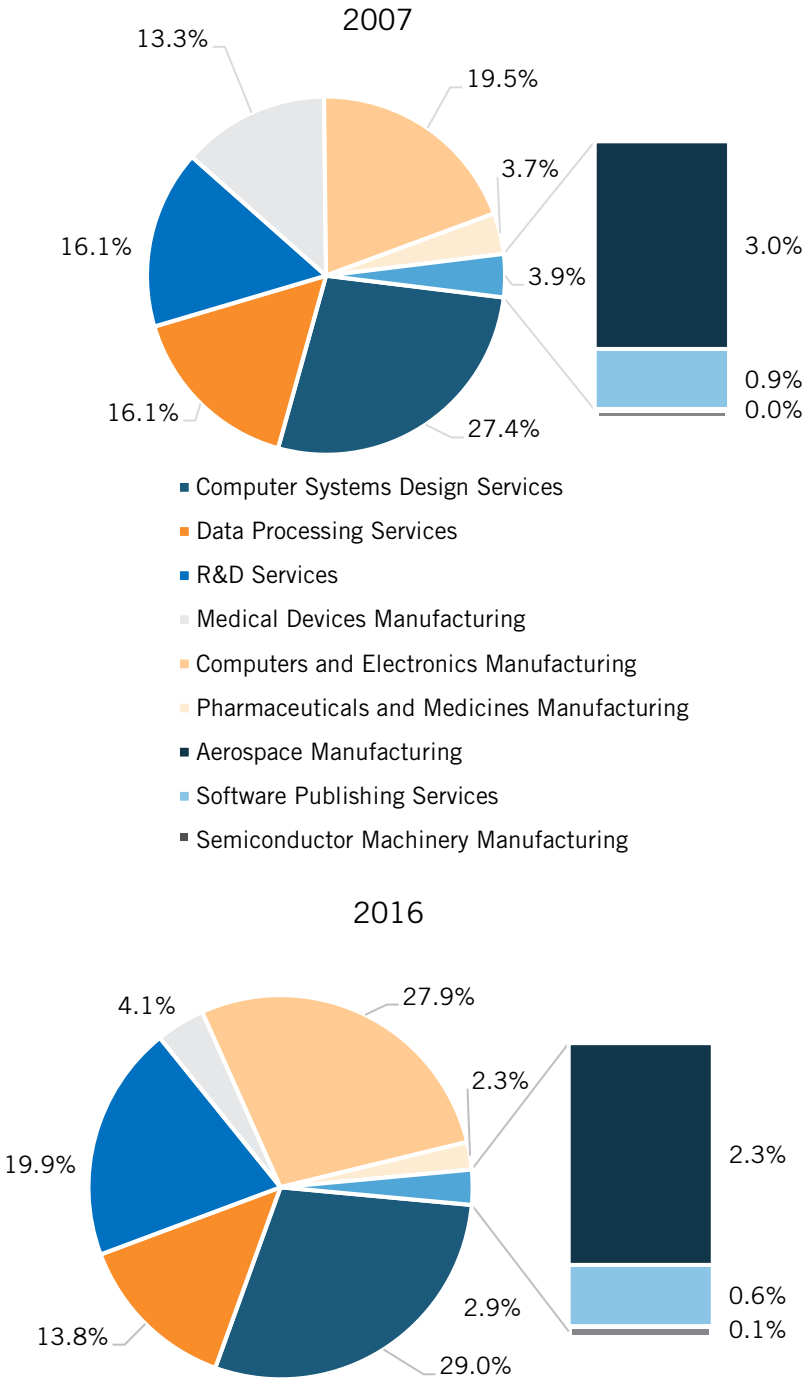


Figure 8: Employment in Start-Ups as a Share of Total Employment in the Technology-Based Sector, 2007 to 2016



Examining the breakdown of technology-based start-up employment by industry, service-providing technology-based start-ups employed 60 percent of the technology-based start-up workforce in 2007, with this figure increasing to 64 percent in 2016. Computer electronics manufacturing start-ups have absorbed a large share of technology-based start-up employment. In 2007, start-ups in the computer and electronics manufacturing industry employed 20 percent of all those working for technology-based start-ups, and by 2016, this share had increased to 28 percent. In general, four industries increased their start-up employment share between 2007 and 2016, while the remaining five industries decreased in employment share. This figure also shows that manufacturing technology-based start-ups tend to employ more workers per start-up than do service providing technology-based start-ups.

Figure 9: Technology-Based Start-Up Employment by Industry and as a Share of Total Technology-Based Start-Up Employment, 2007 and 2016



Early-Stage Start-Ups

Early-stage start-ups are firms that have yet to bring their product to the market in a significant way, often because they are in the midst of research and development or, in the case of pharmaceutical firms, for example, in the process of seeking Food and Drug Administration approval. In some industries, these start-ups are termed pre-revenue start-ups as most of their revenue does not come from the sale of their products, but from contracts or marketing deals. Because some industries, such as the pharmaceutical industry, face much higher product development costs than others, we defined early-stage start-ups as those that generate roughly less than a tenth of their industry's average sales. These "threshold" values are provided in Appendix A.

Early-stage start-ups account for 12.6 percent of all firms in the technology-based sector and 18 percent of technology-based start-ups.

Early-stage start-ups from 2007 to 2016 accounted for 12.6 percent of all firms in the technology-based sector and 18 percent of technology-based start-ups (figure 10). In 2007, early-stage start-ups made up 15 percent of all technology-based firms; by 2016, they had decreased to 10 percent. Over this 10-year period, early-stage start-ups accounted for 10 percent of the technology-based sector's employment and a smaller share of total employment in 2016 than in 2007 (figure 11). In fact, early-stage start-ups have become smaller enterprises over time. In 2007, the average early-stage firm employed 11 workers, but by 2016, they employed only 4. As a result, the number of gross jobs that early-stage start-ups have provided the economy has decreased. In 2007, these start-ups contributed 160,000 jobs to the economy. This figure remained stable until 2011 when gross employment by early-stage start-ups decreased to 100,000 workers; it has remained at that value since (figure 12).

Figure 10: Early-Stage Start-Ups as a Share of All Firms in the Technology-Based Sector, 2007 to 2016

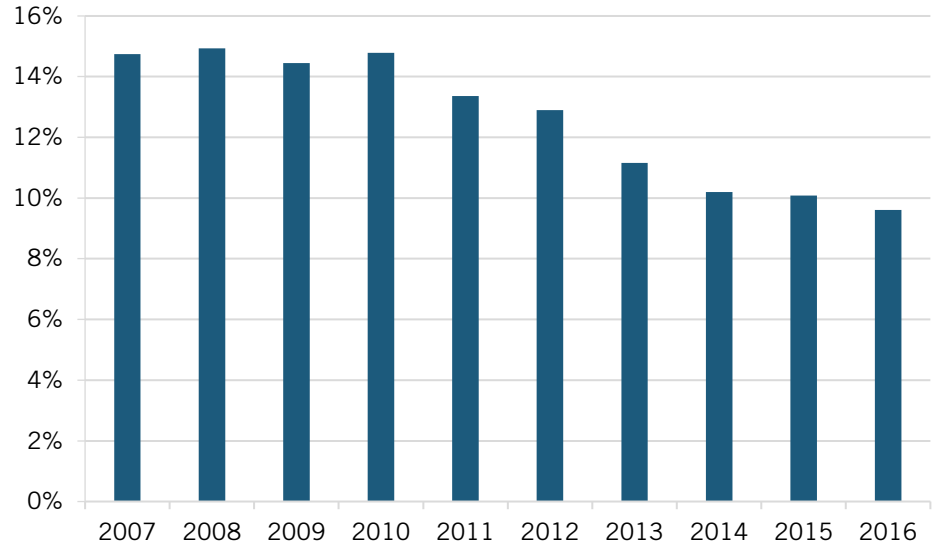


Figure 11: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Technology-Based Sector, 2007 to 2016

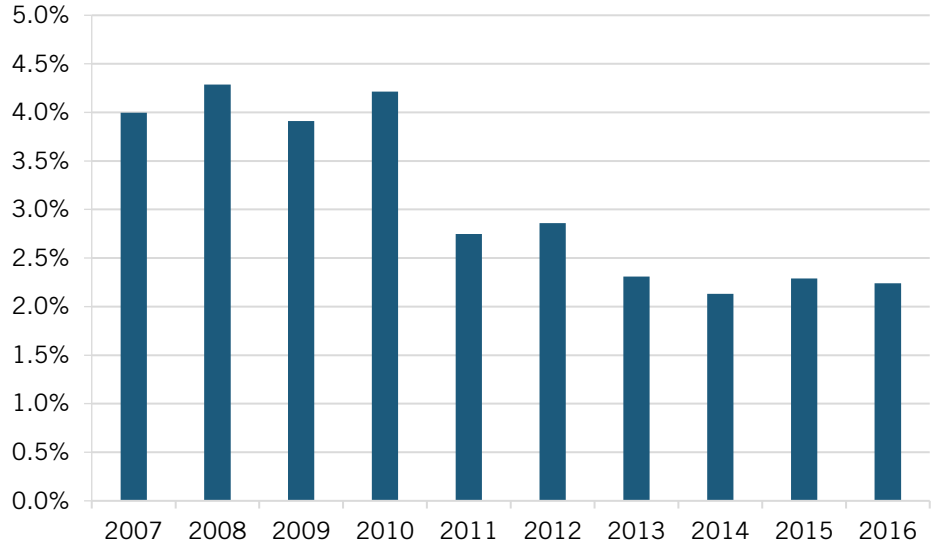
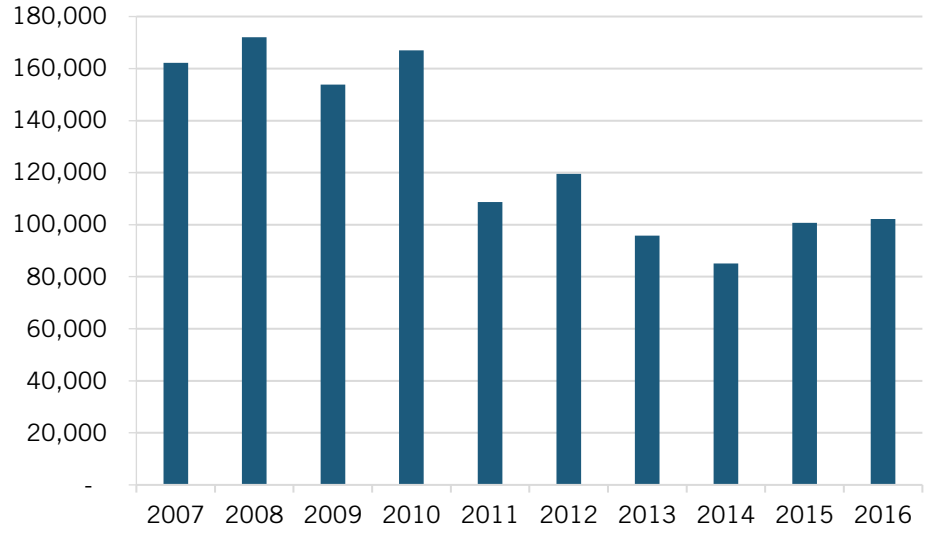
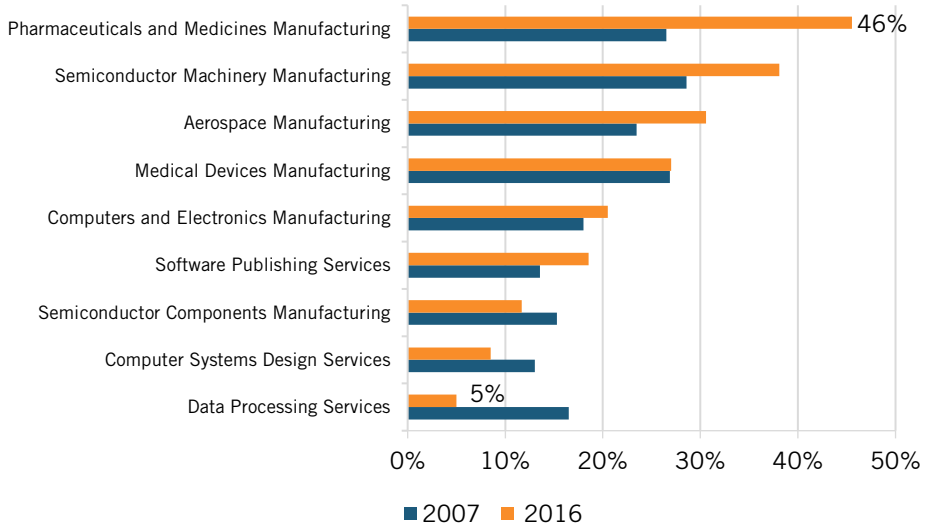


Figure 12: Gross Employment of Early-Stage Technology-Based Start-Ups, 2007 to 2016



This decrease in early-stage start-ups is driven by industry differences. Service-providing technology-based start-ups (which make up the majority of technology-based start-ups) may be taking a shorter time to commercialize their services, and so there are fewer of them in the early-stage phase. In contrast, among the manufacturing technology-based start-ups, the share of early-stage start-ups among all firms has increased. For example, the firm share of early-stage pharmaceutical manufacturing start-ups increased from 26 percent to 46 percent from 2007 to 2016; whereas computer system design services start-ups (which make up about 40 percent of all technology-based start-ups) experienced a decrease in firm share for early stage start-ups from 2007 to 2016 (figure 13).

Figure 13: Early Stage Start-Ups as a Share of All Firms in Each Technology-Based Industry, 2007 and 2016



In 2007, high-growth start-ups employed 150,000 workers, with the gross number of workers employed by these firms decreasing to 41,000 in 2011, then increasing to 116,000 workers in 2016.

High-Growth Start-Ups

High-growth start-ups are defined as firms that are 10 years or younger and that have increased their employment by greater than 25 percent over the previous year. This group of firms has increased in share over the past ten years (figure 14). In 2007, 6.2 percent of start-ups grew fast, with this share of firms decreasing to a low of 2.3 percent in 2012 in the wake of the financial crisis. However, by 2016 over one in ten firms (10.6 percent) grew rapidly. High-growth start-ups employ 100,000 workers a year on average (figure 15). In 2007, these start-ups employed 150,000 workers, with the gross number of workers employed by these firms decreasing to 41,000 in 2011, then increasing to 116,000 workers in 2016.

Figure 14: Share of Start-Ups in the Technology-Based Sector With High Employment Growth, 2007 to 2016

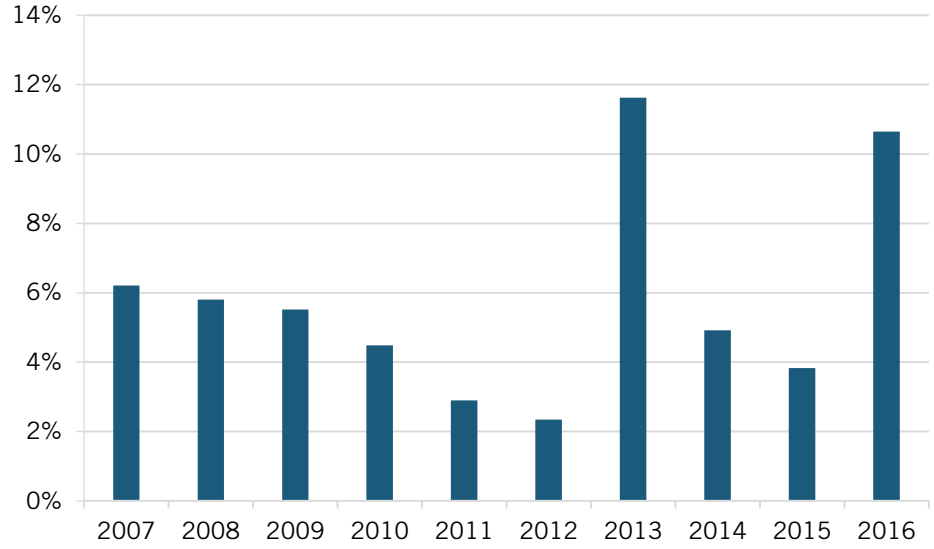
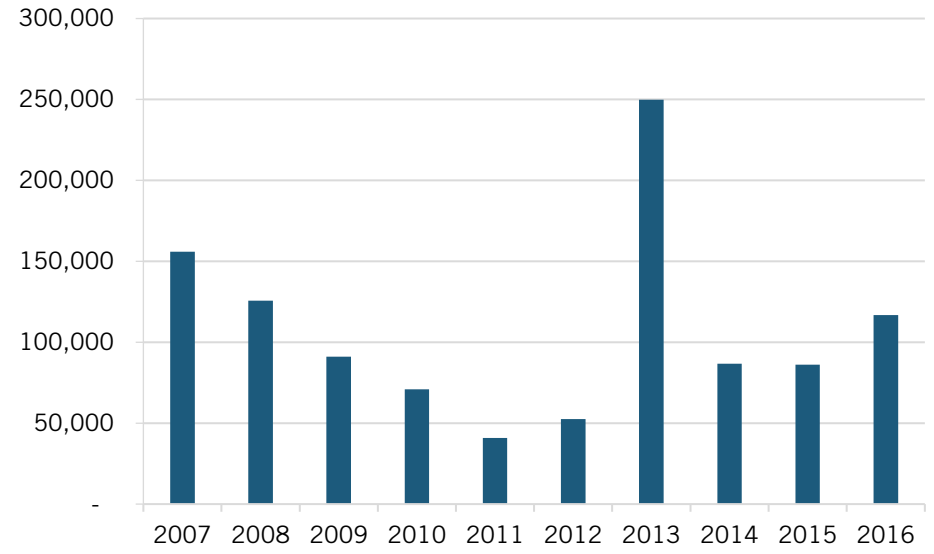
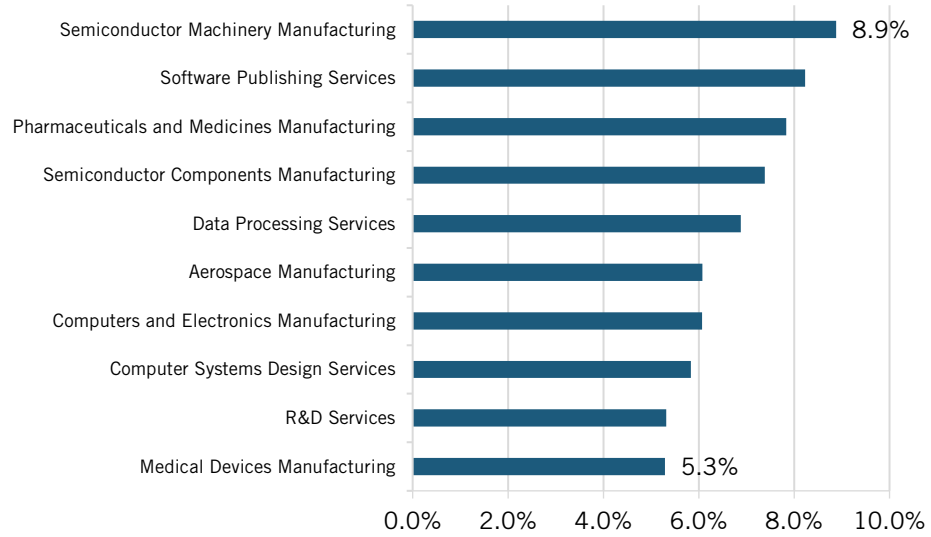


Figure 15: Gross Employment Across High-Growth Technology-Based Start-ups, 2007 to 2016



Some technology-based industries tend to have a higher share of high-growth firms as compared to other industries. From 2007 to 2016, approximately 9 percent of semiconductor machinery manufacturing start-ups experienced high employment growth, the largest share among the 10 technology-based industries. This contrasts with the medical devices industry, where only 5.3 percent of start-ups experienced high employment growth (figure 16). In three of the ten technology-based industries, less than 6 percent of start-ups experienced high employment growth; five industries had high employment growth in 6 to 8 percent of their start-ups, while two industries had high employment growth in more than 8 percent of their start-ups.

Figure 16: Share of Start-Ups With High Employment Growth by Technology-Based Industry, 10-Year Average

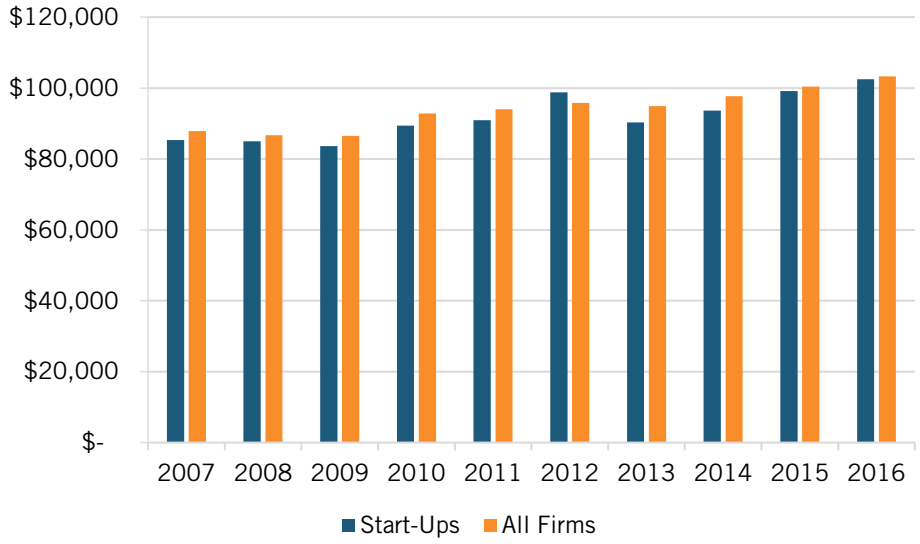


By 2016, the average technology-based start-up paid almost triple that of the average start-up wage and double that of the national average wage.

Wages

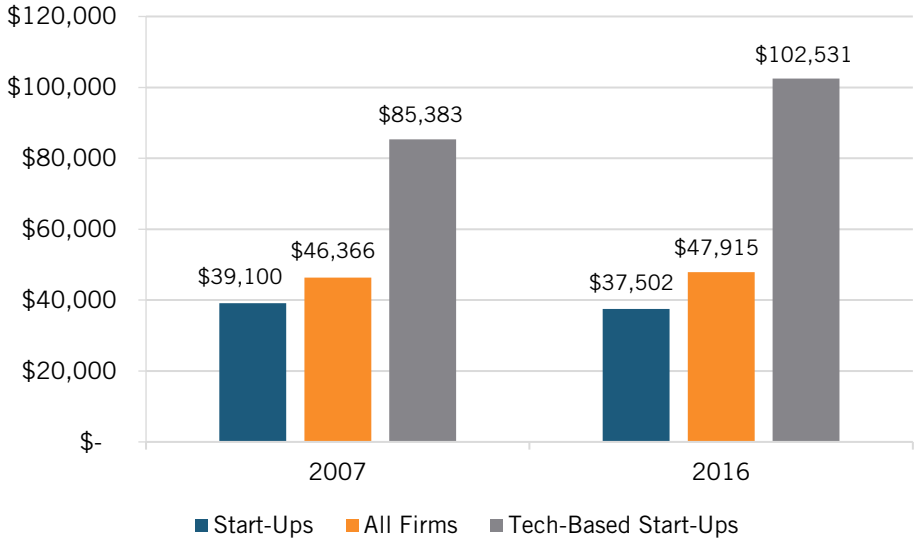
Technology-based start-ups paid their workers 2 percent less than the technology-based sector average over the past ten years. In 2007, technology-based start-ups paid an average wage of $85,000, compared with the $88,000 technology-based sector average—a 3 percent gap (figure 17). By 2016, this gap had decreased to 1 percent, with technology-based start-ups paying an average wage of $102,000 as compared to the technology-based sector average of $103,000. This is because the average wage has increased slightly faster among technology-based start-ups than across the technology-based sector over this period—20 percent as compared to 17 percent.

Figure 17: Average Annual Wage (Real 2009 $) in the Technology-Based Sector, 2007 to 2016



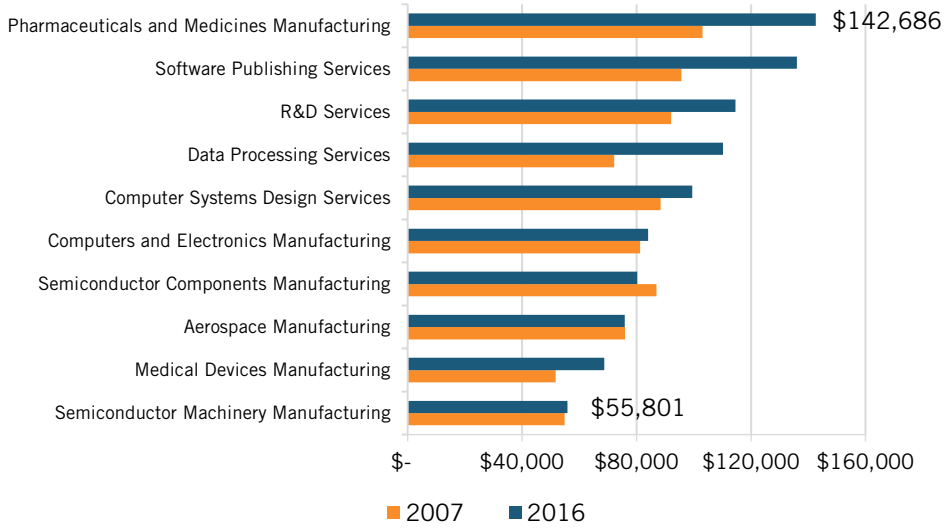
Technology-based start-ups offer higher wages than other firms in the rest of the economy. In 2007, technology-based start-ups paid an average wage more than twice that of the average start-up and almost double the national average wage. By 2016, the average technology-based start-up paid almost triple that of the average start-up wage and double that of the national average wage. This sizable wage premium developed due to the average start-up decreasing its real wages by 4 percent while the national average wage only increased by 3 percent—as compared to the 20 percent growth in wages among technology-based start-ups (figure 18).

Figure 18: Comparison of Average Annual Wages (Real 2009 $) Between Start-Ups, All Firms in the Economy, and Technology-Based Start-Ups, 2007 and 2016



The average wage among technology-based start-ups also differs by industry (figure 19). In 2016, pharmaceutical and medicines manufacturing start-ups offered the highest wage rate, $140,000 on average. Besides pharmaceutical and medicines manufacturing start-ups, start-ups in all four service-providing technology-based industries offered the highest wages across the 10 industries, with annual wages at $100,000 or higher. Comparing wages from 2007 to 2016, the average annual wage offered by start-ups increased in all but two industries, the aerospace manufacturing sector, and the semiconductor component manufacturing sector.

Figure 19: Average Start-Up Annual Wages (Real 2009 $) by Industry, 2007 and 2016[54]



From 1998 to 2015, 78 percent of new technology-based firms survived past their first year in business; 41 percent survived through their fifth year.

Firm Tenure

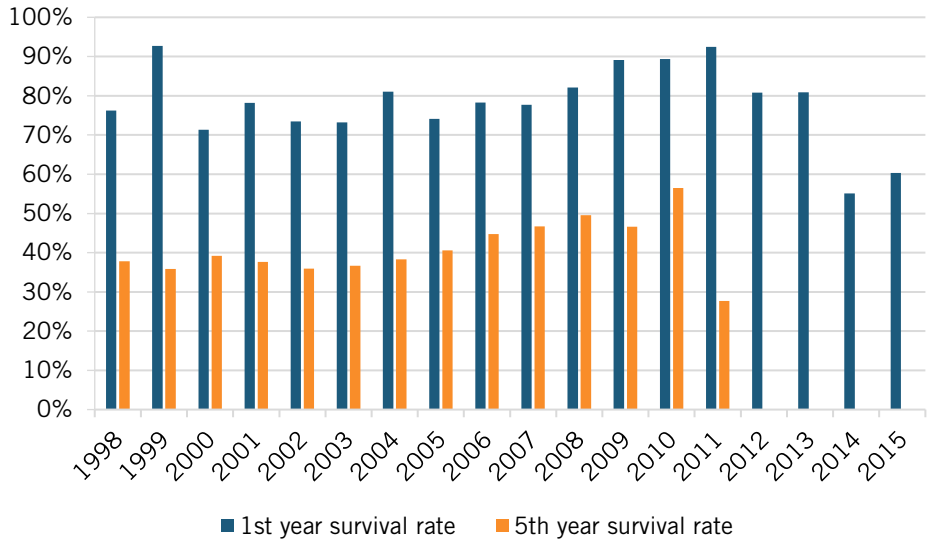
Compared to older firms, technology-based start-ups are more likely to go out of business. From 1998 to 2015, 78 percent of new technology-based firms survived past their first year in business; 41 percent survived through their fifth year (figure 20).

These rates are similar to the survival rate of start-ups across the entire economy. The U.S. Small Business Association found that 78.5 percent of new businesses established between 1994 and 2013 survived past their first year and the survival rate decreased to 48.2 percent past their fifth year.[55] Comparing first-year survival rates, technology-based start-ups do as well as start-ups across the economy, but comparing fifth-year survival rates, technology-based start-ups have lower survival rates than the average start-up.

Start-up survival rates, both first year and fifth year (i.e., the percent of firms that remained in business past their first year and fifth year, respectively), increased from 1998 until the late 2000s, and have decreased in recent years. This decrease could possibly be attributable to increased domestic competition (i.e., there are more technology-based start-ups in the economy than 10 years ago) or perhaps to stiffer international competition.

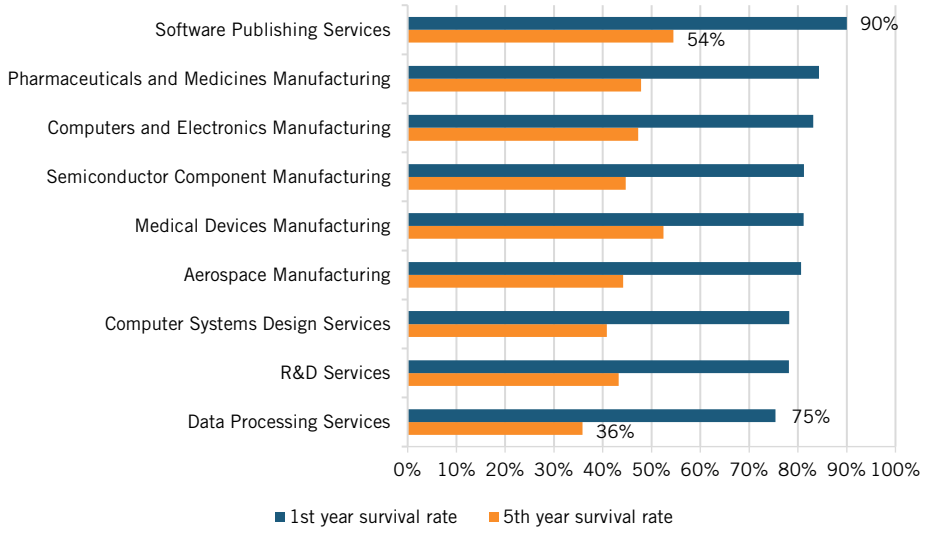
First-year survival rates averaged 75 percent from 1998 to 2007, increased to a high of 90 percent for firms started in 2011, and have decreased since. Fifth-year survival rates have demonstrated a more gradual increase (with survival rates for firms started in 2011 an exception). In other words, 40 percent of firms established in 1998 still operated in 2003, while 55 percent of firms established in 2010 still operated in 2015.

Figure 20: Survival Rate of Start-Ups in the Technology-Based Sector, 1998 to 2015



Industry differences also mean that start-ups in some technology-based industries are more likely to succeed than those in other technology-based industries. For example, 90 percent of software publishing service businesses survive past their first year of business, making this the industry with the highest firm survival rate. Meanwhile, data processing service businesses are the least likely to survive, with 75 percent of new businesses in this industry surviving past their first year of operations. Examining fifth year survival rates, half of software publishing firms survive past their fifth year of business, while only a third of data processing firms survive past this same duration. Additionally, besides the software publishing service industry, technology-based manufacturing start-ups have slightly higher firm survival rates than technology-based service start-ups.

Figure 21: Survival Rate of Technology-Based Start-Ups by Industry, Averaged from 1998 to 2015



Technology-Based Start-Ups in the Pharmaceutical Manufacturing Industry

To understand dynamics more deeply at the sectoral level, this section presents some findings on start-up activity and trends from the pharmaceutical manufacturing industry. Appendix C provides similar detailed sectoral analyses for each of the remaining nine industries.

Businesses in the pharmaceutical and medicine manufacturing sector develop and produce pharmaceutical products such as biologic compounds, medical substances used in diagnostic tests, and base medicinal chemicals used to produce medicines or other chemical compounds.

Since 2007, the number of pharmaceutical and medicine manufacturing start-ups has increased 56 percent, from 1,000 firms in 2007 to 1,600 firms in 2016.

The sector employs 300,000 workers, consists of 2,500 firms, and accounts for less than 1 percent of gross U.S. output.[56] In terms of R&D investment, the sector invests $52 billion in domestic R&D, which translates to an R&D intensity of 10 percent and represents 16 percent of U.S. business R&D investments.[57] The average firm employs 137 workers that are paid an average annual wage of $140,000. Additionally, approximately one-fifth of the sector's workforce is in R&D-related occupations.[58]

Start-ups employ 35,000 workers across 1,600 firms. Overall, the state of technology-based entrepreneurship in the pharmaceutical and medicine manufacturing industry is positive, especially in recent years. Start-ups have entered the industry in greater numbers than before, accounting for 66 percent of all firms in 2016, a ten-year high. Among start-ups, the share of early stage start-ups has steadily increased over the decade and the share of high-growth firms has increased year-after-year since 2014. Furthermore, start-ups offer wages higher than the industry average. But, start-ups appear less able to succeed in this industry. The rate of new businesses surviving past their fifth year has gradually decreased from 70 percent for firms started in 1998 to 40 percent for firms started in 2011.

Over the past ten years, pharmaceutical start-ups have increased steadily, in both gross figures and as a share of all firms. Since 2007, the number of start-ups has increased 56 percent, from 1,000 firms in 2007 to 1,600 firms in 2016 (figure 22), while start-ups as a share of all firms have increased 10 percentage points from 56 percent to 66 percent (figure 23). Start-up growth has mirrored overall industry trends, remaining stable during the recession years then slowly growing in the recovery years. The industry has experienced a substantial increase in entrepreneurship in recent years. From 2007 to 2014, the number of new firms to enter the industry each year averaged 200. In 2015, 700 new firms entered the industry, and in 2016, 500 firms entered the industry.

Figure 22: Number of Firms in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016

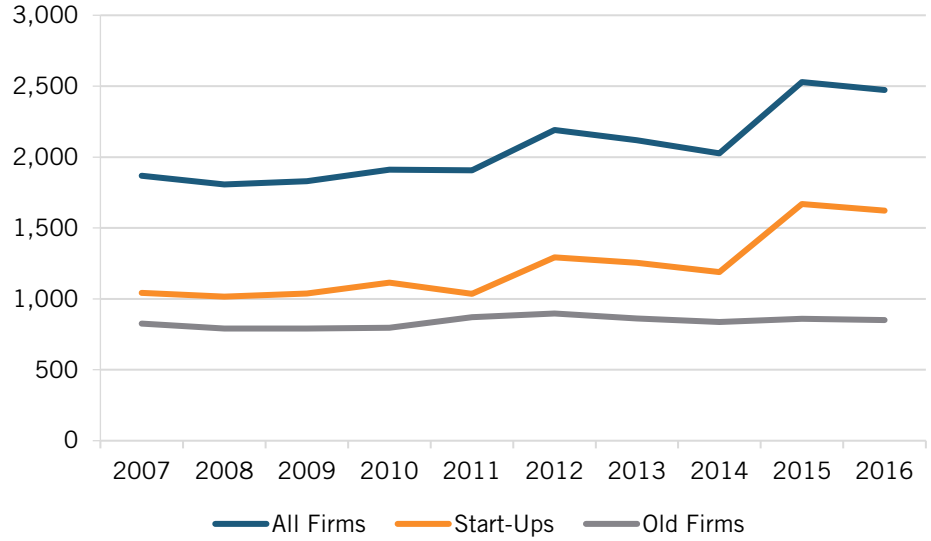
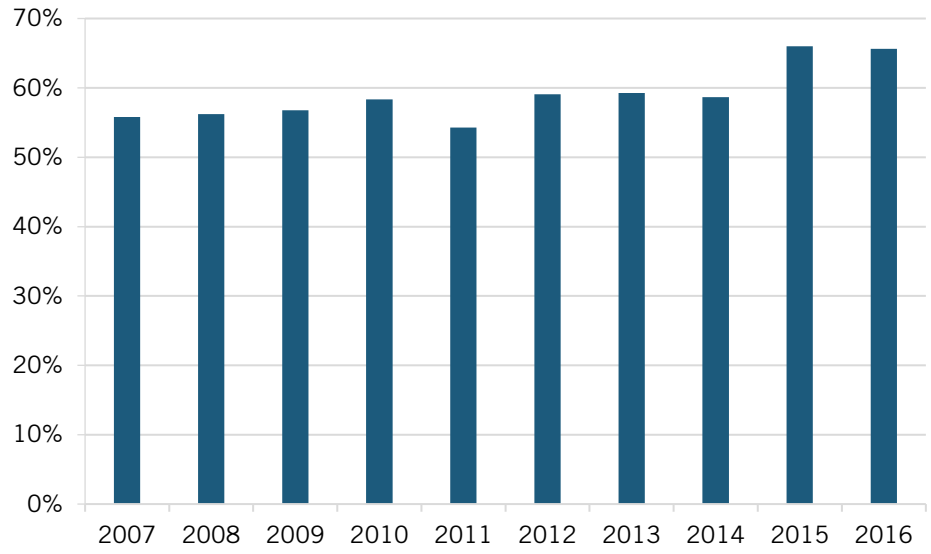
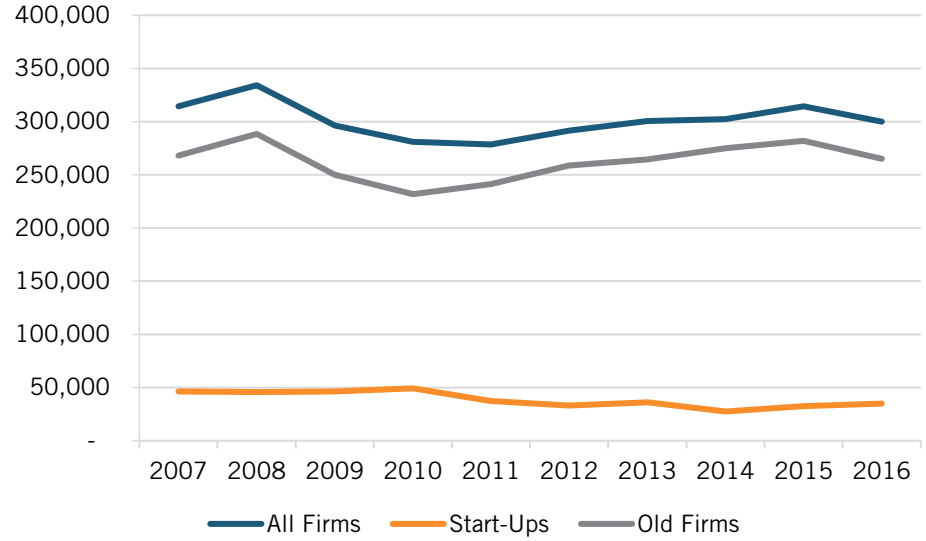


Figure 23: Start-Ups as a Share of Total Firms in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016



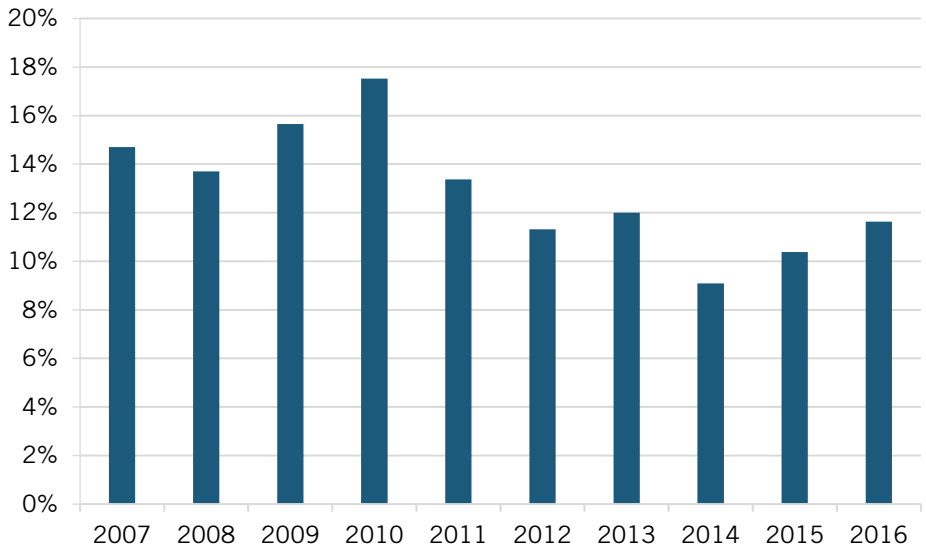
While the number of start-ups has increased over the past decade, employment among start-ups has decreased. In 2007, start-ups employed 46,000 workers, with this figure decreasing by 24 percent to 35,000 in 2016 (figure 24). Meanwhile, across the industry, employment decreased by only 5 percent. While the industry experienced a sharp decrease in employment over the recession (2008 to 2010), employment among start-ups remained stable. During the recovery years, as employment across the industry started to pick up, employment among start-ups decreased slowly. Start-ups are also responsible for a smaller share of total industry employment in 2016 than in 2007, 12 percent as compared to 15 percent (figure 25). Start-ups' employment share reached a decade low of 9 percent in 2014 before increasing to 12 percent in 2016.

Figure 24: Employment in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016



Early-stage pharmaceutical manufacturing start-ups account for 33 percent of all firms and 57 percent of all start-ups; and 2.3 percent of industry employment and 18.8 percent of start-up employment.

Figure 25: Employment in Start-Ups as a Share of Total Employment in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016



Early-stage start-ups (those that generate less than $8 million in sales), account for 33 percent of all firms, and 57 percent of all start-ups, and these figures have increased steadily from 2007 to 2016 (figure 26). In 2016, early-stage start-ups accounted for 45 percent of all firms, up from 26 percent in 2007. Most early-stage start-ups are small, with an average of 10 workers. They account for 2.3 percent of industry employment and 18.8 percent of start-up employment (figure 27). In 2016, early-stage start-ups employed 3.3 percent of all workers, up from 2.4 percent in 2007.

Figure 26: Early-Stage Start-Ups a as a Share of All Firms in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016

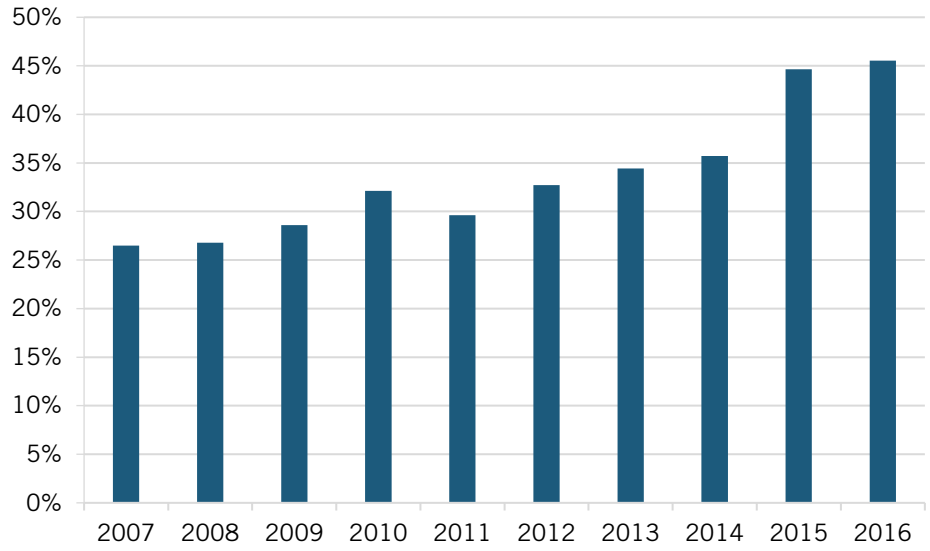
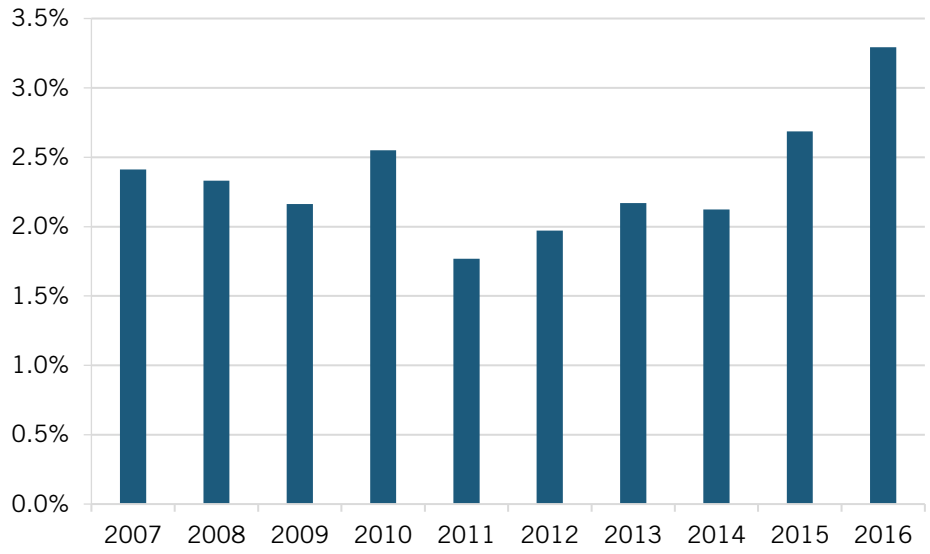
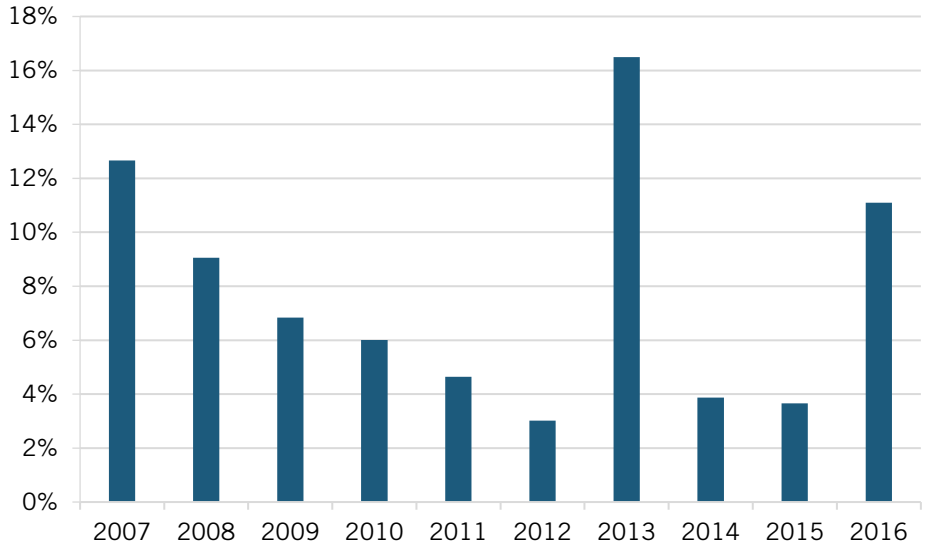


Figure 27: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016



High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past ten years. On average, 8 percent of start-ups demonstrate high growth annually (figure 28). In 2007, 13 percent of start-ups grew fast, with this share of firms decreasing to a low of 3 percent in 2012 before increasing to 16 percent in 2013 then decreasing to 11 percent in 2016. This group of firms makes outsized contributions to employment. For example, in 2016, high-growth start-ups made up 11 percent of start-ups but employed 15 percent of all those employed by start-ups.

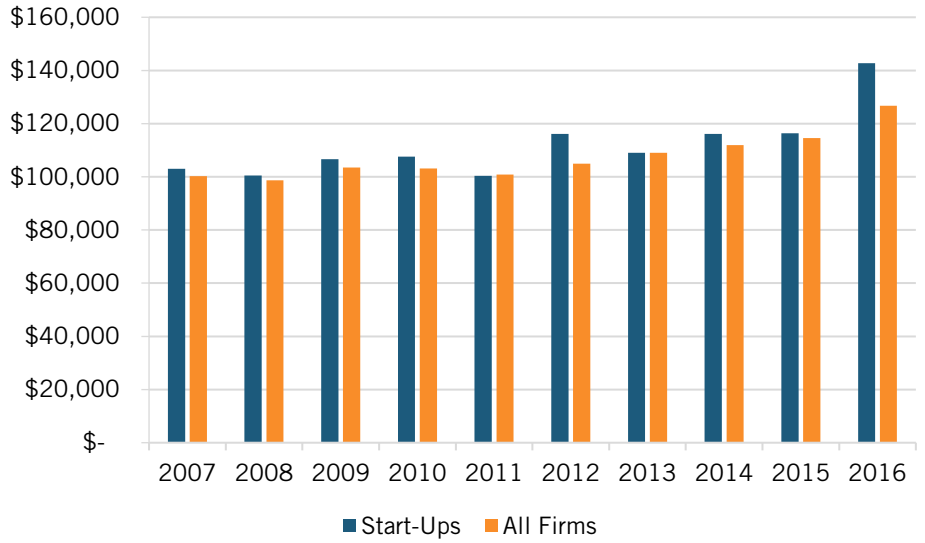
Figure 28: Share of Start-Ups With High Employment Growth in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016



In nine of the past ten years, average annual wages paid by pharmaceutical manufacturing start-ups were greater than the industry average.

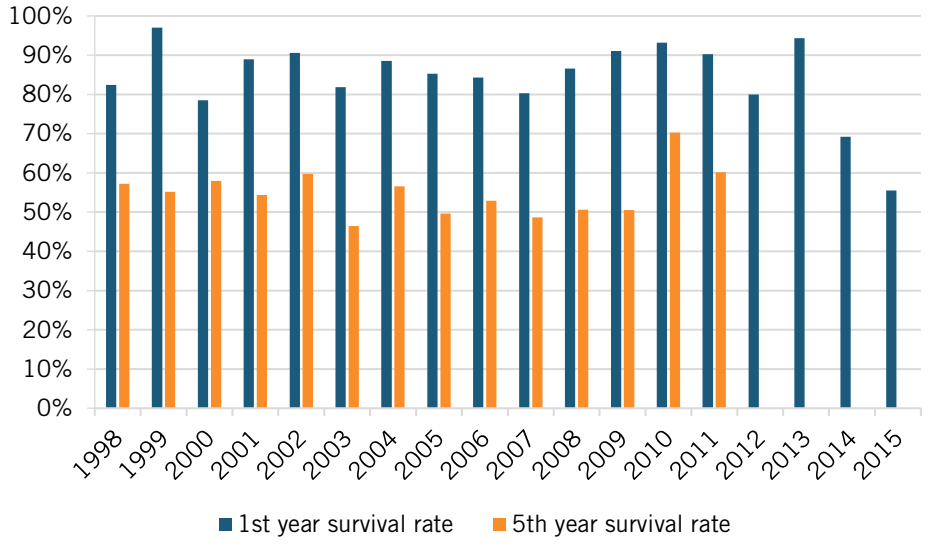
Examining real wages, start-ups paid their workers 4 percent more than the industry average over the past ten years. In nine of these ten years, average annual wages paid by start-ups were higher than the industry average (figure 29). In 2007, start-ups paid an average wage of $103,000, in contrast to the $100,000 industry average. Real wages have also grown faster among start-ups than across the industry. From 2007 to 2016, real wages grew by 39 percent among start-ups, as compared to 26 percent across the industry. In 2016, start-ups paid an average wage of $142,000, in contrast to the $127,000 industry average. Real wages among start-ups grew particularly fast in recent years—from 2015 to 2016 real wages increased 23 percent among start-ups. It should be noted that real wages held steady over the recession, and even increased slightly among start-ups.

Figure 29: Average Annual Wage (Real 2009 $US) in the Pharmaceutical and Medicine Manufacturing Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 15 percent of new firms did not survive their first year in business; only 55 percent survived through their fifth year (figure 30). First-year survival rates have remained generally stable, but were lower than average in the past two years. In other words, firms are having a more difficult time succeeding past their first year in the industry. However, fifth-year survival rates have ranged from 50 to 60 percent between 1998 and 2009, and were higher than average in 2010 and 2011. To elaborate, 57 percent of firms established in 1998 were still in business by 2003, while 60 percent of firms that were established in 2011 were still in business by 2016.

Figure 30: Survival Rate of Start-Ups in the Pharmaceutical and Medicine Manufacturing Industry, 1998 to 2015



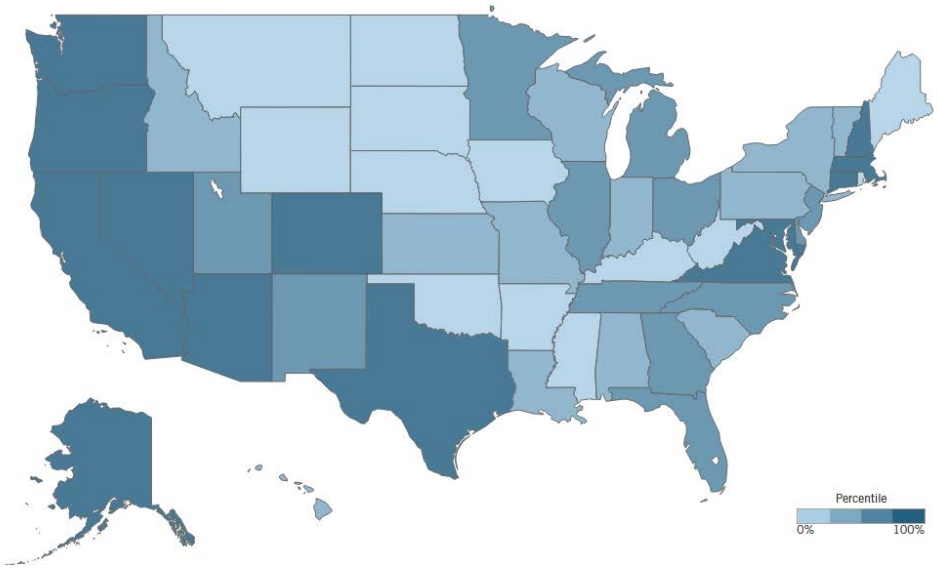
Technology-Based Start-Ups by State

Technology-based start-up activity differs by geography. This section offers an analysis of this activity by state in 2016. The median state contains 1,800 start-ups that employ 17,000 workers. Put in context, the median state's economy is home to 76,000 firms that employ 1.6 million workers. In other words, technology-based start-ups in the median state account for 2.4 percent of all businesses and employ 0.9 percent of the workforce. Appendix E provides additional state-level tables on technology-based start-up activity disaggregated into the ten technology-based industries.

Figure 31 segments the United States into four quartiles based on a state's share of firms that are technology-based start-ups. Western and northeastern states, as well as Colorado and Texas, have high levels of technology-based start-up activity.

Technology-based start-ups, in the median state, account for 2.4 percent of all businesses and employ 0.9 percent of the workforce.

Figure 31: Technology-Based Start-ups as a Share of All Firms by State, Sorted into Quartiles, 2016



Not surprisingly, states that are "new" economy states with higher levels of knowledge workers, globalization, R&D, economic dynamism, and usage of information technology have much higher levels of technology-based start-up activity. In fact, a state's level of technology-based start-up activity has a strong correlation of 0.75 with ITIF's "2017 State New Economy Index" overall score—an index where ITIF measures how well a state's economic structure fits the "new" economy.

Table 2 summarizes key statistics on technology-based start-ups by state: number of start-ups, number of workers employed, and the number of young establishments (one firm always consists of at least one establishment, but one firm can also be made up of multiple establishments), and the average firm size.[59] To contextualize the size of technology-based start-up activity, table 2 also contains data on the total number of firms, establishments, and workers in a state.

Table 2: Technology-Based Start-Ups Statistical Snapshot by State, 2016

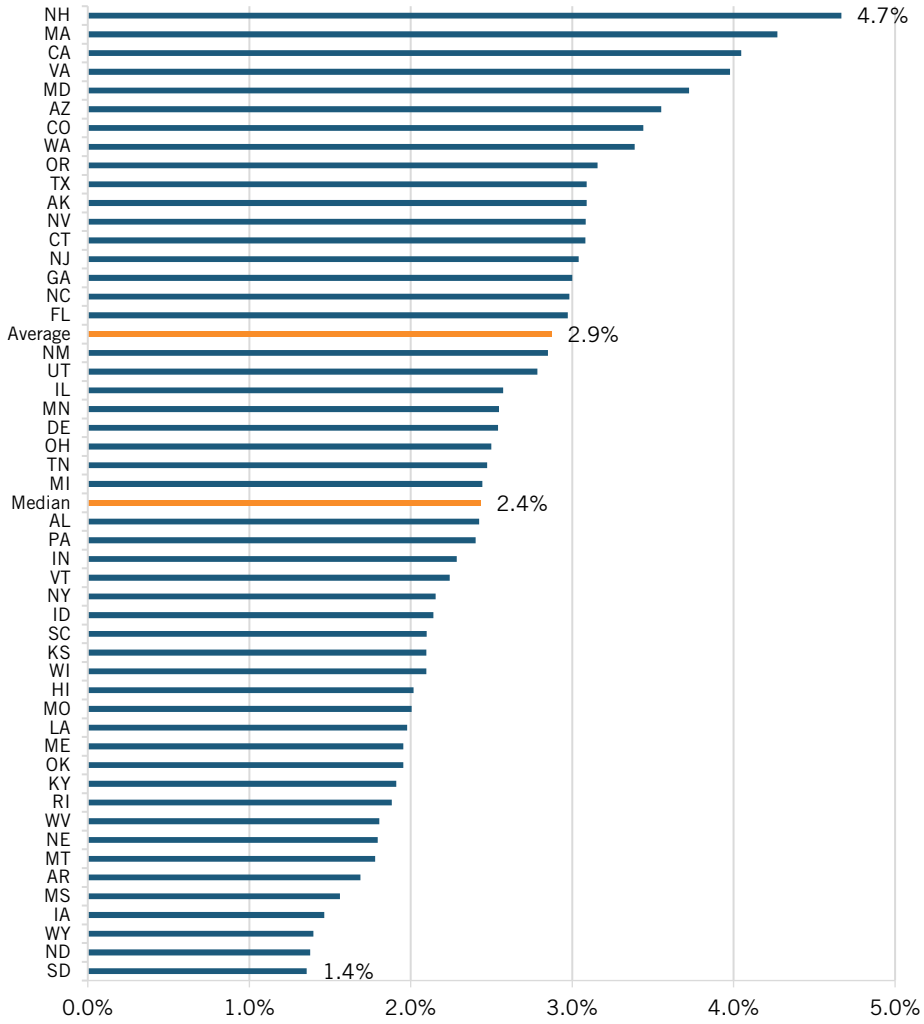
State	Tech-Based Start-Ups (Firms)	Tech-Based Start-Ups (Estabs)	Tech-Based Start-Ups (Employ)	Total Firms	Total Estabs	Total Employ	Tech-Based Start-ups Average Size	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Estab. Share)	Tech-Based Start-Ups (Emp. Share)
AL	1,761	1,927	24,336	72,651	97,491	1,622,524	18	2.4%	2.0%	1.5%
AK	526	528	3,153	17,028	21,082	275,910	6	3.1%	2.5%	1.1%
AZ	3,746	3,994	26,402	105,463	137,564	2,353,343	10	3.6%	2.9%	1.1%
AR	842	906	7,048	49,891	64,525	1,006,129	11	1.7%	1.4%	0.7%
CA	30,261	31,584	300,676	747,800	915,097	14,785,189	12	4.0%	3.5%	2.0%
CO	4,647	4,941	42,937	135,050	163,179	2,337,670	13	3.4%	3.0%	1.8%
CT	2,204	2,335	18,247	71,536	88,902	1,507,442	11	3.1%	2.6%	1.2%
DE	510	556	3,648	20,065	24,772	421,797	10	2.5%	2.2%	0.9%
FL	13,091	13,592	82,700	440,297	537,944	7,988,545	8	3.0%	2.5%	1.0%
GA	5,242	5,546	39,955	174,642	224,991	3,719,439	10	3.0%	2.5%	1.1%
HI	506	537	3,458	25,071	32,109	547,675	9	2.0%	1.7%	0.6%
ID	806	859	5,213	37,640	44,754	569,930	12	2.1%	1.9%	0.9%
IL	6,561	6,983	50,183	255,036	318,053	5,511,997	10	2.6%	2.2%	0.9%
IN	2,458	2,640	23,274	107,520	143,679	2,696,105	16	2.3%	1.8%	0.9%
IA	907	961	9,127	61,966	80,283	1,339,600	12	1.5%	1.2%	0.7%
KS	1,222	1,343	12,149	58,279	74,167	1,223,631	28	2.1%	1.8%	1.0%
KY	1,333	1,468	9,250	69,769	93,070	1,591,487	14	1.9%	1.6%	0.6%
LA	1,616	1,741	13,137	81,687	105,901	1,794,633	10	2.0%	1.6%	0.7%
ME	655	765	4,163	33,507	40,620	498,625	10	2.0%	1.9%	0.8%
MD	4,081	4,360	36,719	109,578	138,733	2,283,206	13	3.7%	3.1%	1.6%
MA	6,069	6,528	75,544	142,091	175,902	3,130,926	16	4.3%	3.7%	2.4%
MI	4,231	4,456	30,333	173,206	219,126	3,758,824	9	2.4%	2.0%	0.8%
MN	3,016	3,232	25,489	118,458	149,211	2,654,481	13	2.5%	2.2%	1.0%
MS	690	810	4,621	44,198	58,439	928,519	17	1.6%	1.4%	0.5%
MO	2,561	2,735	22,372	127,666	161,654	2,492,258	12	2.0%	1.7%	0.9%
MT	574	606	2,816	32,256	37,349	384,635	6	1.8%	1.6%	0.7%
NE	772	830	8,044	42,991	53,697	885,310	14	1.8%	1.5%	0.9%
NV	1,574	1,660	9,686	51,041	63,916	1,171,207	7	3.1%	2.6%	0.8%
NH	1,412	1,480	10,116	30,257	37,580	578,071	10	4.7%	3.9%	1.7%
NJ	5,940	6,299	49,235	195,413	232,938	3,615,148	12	3.0%	2.7%	1.4%
NM	980	1,037	6,413	34,389	43,615	610,514	8	2.8%	2.4%	1.1%
NY	10,093	10,610	82,434	468,528	546,966	8,172,433	10	2.2%	1.9%	1.0%
NC	5,067	5,453	48,440	169,879	222,419	3,782,048	14	3.0%	2.5%	1.3%
ND	291	325	2,534	21,122	25,901	393,354	13	1.4%	1.3%	0.6%
OH	4,605	4,909	36,727	184,218	250,230	4,727,281	12	2.5%	2.0%	0.8%
OK	1,446	1,564	11,147	74,000	93,930	1,416,841	11	2.0%	1.7%	0.8%
OR	2,898	3,029	17,988	91,808	112,252	1,529,348	8	3.2%	2.7%	1.2%
PA	5,517	6,069	49,901	229,616	299,729	5,343,254	13	2.4%	2.0%	0.9%
RI	450	485	3,280	23,906	28,230	441,073	13	1.9%	1.7%	0.7%
SC	1,665	1,774	11,627	79,361	103,378	1,689,033	10	2.1%	1.7%	0.7%
SD	302	324	1,800	22,293	26,630	359,499	8	1.4%	1.2%	0.5%
TN	2,380	2,592	26,263	96,192	132,423	2,568,008	15	2.5%	2.0%	1.0%
TX	13,452	14,270	103,749	435,470	578,338	10,524,387	11	3.1%	2.5%	1.0%
UT	1,783	1,897	15,461	64,047	76,417	1,231,145	12	2.8%	2.5%	1.3%
VT	403	429	2,718	17,979	20,922	256,731	13	2.2%	2.1%	1.1%
VA	6,007	6,514	48,850	151,015	198,592	3,233,499	12	4.0%	3.3%	1.5%
WA	5,095	5,323	34,347	150,397	182,540	2,707,885	9	3.4%	2.9%	1.3%
WV	491	546	4,014	27,209	36,810	570,909	16	1.8%	1.5%	0.7%
WI	2,258	2,417	18,681	107,734	138,196	2,513,376	12	2.1%	1.7%	0.7%
WY	250	269	1,339	17,901	20,981	225,715	10	1.4%	1.3%	0.6%
Average	3,505	3,721	29,635	121,982	153,505	2,519,412	11	2.9%	2.4%	1.2%
Median	1,772	1,912	16,725	76,681	100,434	1,607,005	12	2.4%	2.0%	0.9%

Firm Distribution of Technology-based Start-ups by State

In 2016, the median state contained 1,800 technology-based start-ups, with 10 states home to more than 5,000 start-ups each, and 17 states containing fewer than 1,000 start-ups. Not surprisingly, given its size and its technology-based economy, California had 30,000 technology-based start-ups, the highest number of any state. In contrast, Wyoming had 250 technology-based start-ups. As expected, states with larger economies are more likely to have larger numbers of technology-based start-ups. Therefore, once we control for the number of total businesses in a state, different trends emerge.

Controlling for the number of technology-based start-ups by a state's total firms, the median state has 2.4 percent of its businesses classified as technology-based start-ups. Three states have shares greater than 4 percent (New Hampshire, Massachusetts, and California); 14 states have shares greater than 3 percent; while 15 states have shares less than 2 percent. South Dakota has the lowest firm share, with technology-based start-ups only making up 1.4 percent of its business (figure 32).

Figure 32: Technology-Based Start-Ups as a Share of the State's Total Firms, 2016



Employment Distribution of Technology-based Start-ups by State

In 2016, technology-based start-ups in the median state employed 16,700 workers; such start-ups in 19 states employed more than 20,000 workers; in 11 states, they employed fewer than 5,000 workers. Technology-based start-ups in California employ the most workers—300,000—while Wyoming's start-ups employ only 1,300 workers.

In the median state, 0.9 percent of the workforce is employed in technology-based start-ups. Some states have a larger share of their workforce employed among technology-based start-ups. Massachusetts has the highest share at 2.4 percent. Mississippi has the lowest share at 0.5 percent. This distribution in employment share between states is particularly "top-heavy." To illustrate, there is a 0.8-point difference between Massachusetts (2.4 percent) and Maryland (1.6 percent), the first and fifth state as arranged by the state's share of its workforce in technology-based start-ups; in contrast, a 0.8-point difference separates North Carolina (1.3 percent) and Mississippi (0.5 percent), the ninth and fiftieth states (figure 33).

Because technology-based start-ups differ in size according to state, there isn't a one-to-one correlation between the firm share and employment share of technology-based start-ups. In fact, there is only a 0.7 correlation between the number of technology-based start-ups and the number of workers they employ in a state.

Because technology-based start-ups differ in size according to state, there isn't a one-to-one correlation between the firm share and employment share of technology-based start-ups. In fact, there is only a 0.7 correlation between the number of technology-based start-ups and the number of workers they employ in a state. For example, although New Hampshire has the highest share of technology-based start-ups, it ranks fourth in technology-based start-up employment as a share of the workforce. To further elaborate, in the median state, a technology-based start-up employs 12 workers; Kansas' technology-based start-ups are the largest, employing 28 workers per start-up, while Alaskan technology-based start-ups are the smallest, employing 6 workers each (figure 34). A state's industry mix also affects this correlation, as some states have a greater share of start-ups in technology-based industries that employ more workers per firm than in other industries. For example, the average computer systems and design start-up employs 6 workers, whereas the average computer and electronic manufacturing start-up employs 25 workers (Appendix E).

Figure 33: State's Technology-Based Start-Up Employment as a Share of the State's Total Employment, 2016

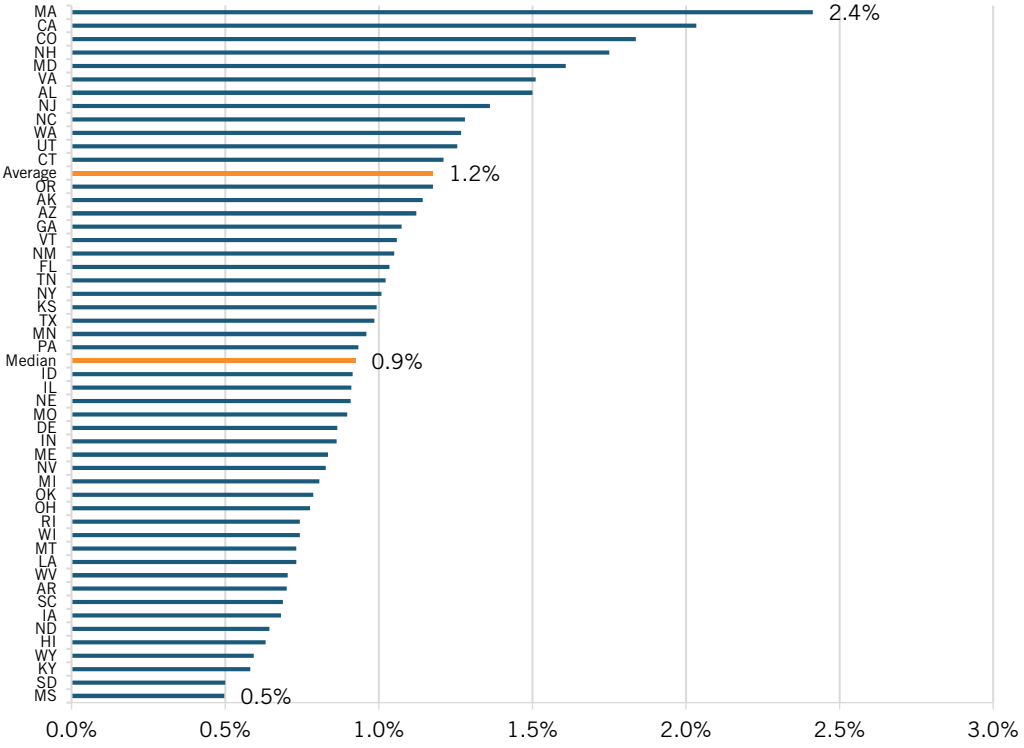
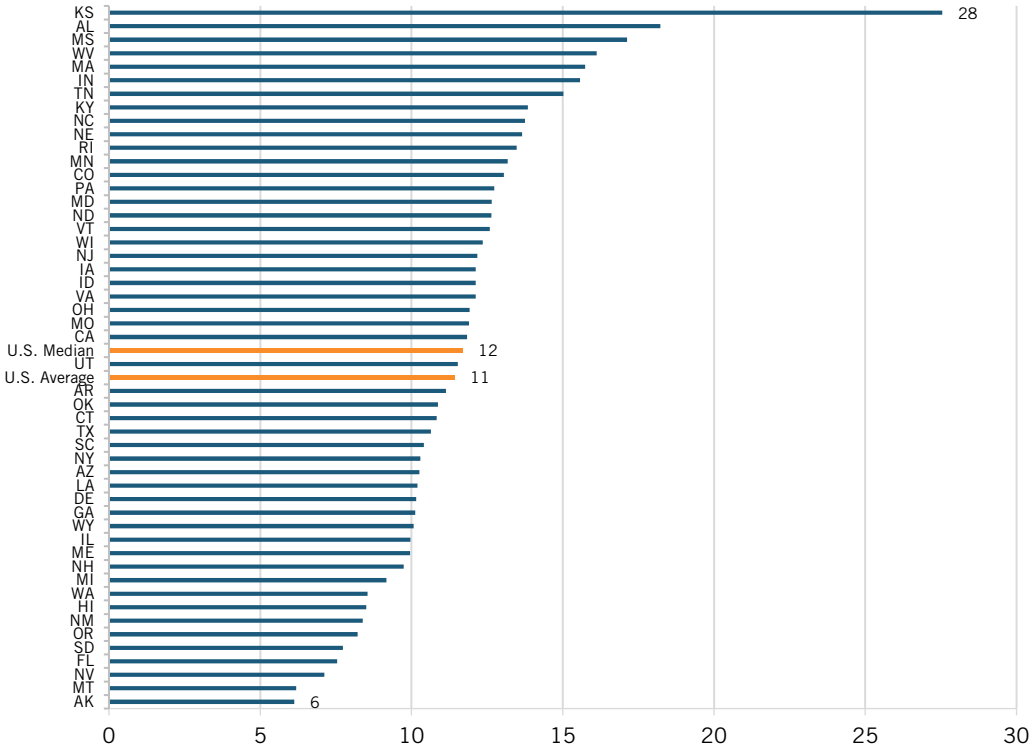


Figure 34: State's Technology-Based Start-Up Size (Average Workers Employed Per Start-Up), 2016



POLICIES TO INCREASE TECHNOLOGY-BASED ENTREPRENEURSHIP

All levels of government—local, state, and federal—have a role in implementing policies that can bolster technology-based start-ups. They can do so by crafting policies that accomplish three objectives: 1) encourage individuals to create or join technology-based start-ups; 2) increase survival and success rates of technology-based start-ups; and 3) enable technology-based start-ups to scale their growth faster and become larger.

To support these three objectives, ITIF has detailed policy solutions listed in its "Tech Policy To-Do List."[60] It's beyond the scope of this report to thoroughly list all these policies, but to accomplish these three objectives, policy needs to focus on a few key areas which include tax reform, regulatory reform, improving STEM skills, and improved federal technology-transfer policies.

Tax Reform

One key area is the tax code. As Congress considers a rewrite of the corporate tax code it will be important that it not only maintain, but strengthen, the R&D tax credit. In particular, Congress should expand the rate of the Alternative Simplified Credit to at least 25 percent from 14 percent. ITIF has calculated that expanding the R&D tax credit would pay for itself from the additional revenue growth after 15 years.[61]

While the R&D tax credit is effective at spurring more R&D, it is less useful for early-stage, pre-revenue, technology-based start-ups because it requires tax liability, which requires income. In other words, the tax credit is designed more for established innovators, not so much for research-intensive, pre-revenue companies. The PATH Act (Protecting Americans From Tax Hikes) of 2015 made the R&D tax credit at least partially refundable for small businesses (i.e., it allowed small businesses to take the credit against their payroll taxes). But two additional tax reform proposals could further address these challenges.[62]

The first proposal would amend Section 469 of the tax code to permit passive investors to take advantage of the net operating losses and research tax credits of companies in which they invest. (The Tax Reform Act of 1986 severely limited this ability because it was seen as a way for high-income individuals to reduce their taxes by investing in operations that were never meant to be profitable.) Under this reform, investors could immediately use their share of net operating losses, as well as any credits, for research and development. The percentage of losses or credits that could be passed through would be limited to the portion of investment that was specifically targeted for qualified research activities. In order to qualify, a company would have to devote at least half of its expenses to research and development. The company would also have to have fewer than 250 employees and less than $150 million in assets.[63]

The second change would make it easier for small companies to carry net operating losses forward even as they continue to attract new investors. Small, research intensive companies often go through several rounds of financing as they rack up expenses in pursuit of profitability. Unfortunately, Section 382 of the tax code prevents companies from carrying net operating losses forward if they undergo an ownership change. This rule eliminates an

attraction to investors. It also means that the company will start paying taxes on its revenue long before its total revenues exceed it total expenses. Under the proposed change, Section 382 would not apply to net operating losses generated by qualifying research and development activities conducted by a small business.[64]

Regulatory Reform

Smart regulation is increasingly important for productivity and growth, especially when technology is developing rapidly.[65] The federal government must draw a delicate balance between protecting public safety and allowing innovation to flourish. If regulators are too cautious they can easily retard the development of new industries such as drones and new products such as breakthrough drugs. Burdensome regulations have a disparate effect on young firms in two ways. First, regulations are naturally more burdensome for smaller companies because they have fewer revenues to spread the costs over. Second, by favoring existing technology, rules may protect incumbents from disruptive innovation by new entrants.

Several industries, including biopharmaceuticals, transportation, and financial services are undergoing significant changes caused by new technologies. In each of these, at least a portion of the newest technology is being developed by younger companies. Intelligent regulation requires regulators to follow a set of principles that sound simple in practice but can be difficult to apply in real life.[66] These include ensuring that rules are technology neutral and making timely decisions.

Congress and the Trump Administration have already made progress in rolling back costly regulations and directing agencies to do a better job of reducing the total regulatory burden. But more could be done. Congress should create a new Office of Innovation Policy within the Office of Management and Budget (OMB).[67] OMB already plays a major role in reviewing agency regulations. The new office would specifically review the impact major regulations would have on future innovation. It could also force agencies to consider policies that would more effectively promote innovation. At the same time, Congress should charge the Office of Advocacy in the Small Business Administration with focusing solely on advocating for and reviewing federal regulations that affect new firms in technology-based industries.

STEM Skills

A key enabler of technology-based start-ups is technology talent: individuals with advanced skills in math, science, engineering, and computer science. ITIF has laid out a number of proposals to boost STEM talent domestically.[68]

Many proposals made regarding STEM are focused on K-12 education. While important, this overlooks the fact that America could graduate significantly more STEM students if only more colleges and universities made it a priority, which too many do not. To give them incentives to do so, Congress should appropriate approximately $325 million over five years for the NSF to award prizes to colleges and universities that dramatically increase the rate at which freshmen STEM students graduate with STEM degrees, and that

demonstrably sustain the increase.[69] Awards could be sized in tiers for small, mid-sized, and large universities. Alternatively, Congress could require NSF to consider an institution's record on STEM "switch-outs" and dropouts, especially among women and minority students, in fields such as engineering and computer science, as a factor in awarding research grants.

At the same time, Congress should create a NSF-industry Ph.D. fellows program. Doctoral fellowships are key factors in producing more Ph.D. degrees in STEM fields. But compared with the number of science and engineering graduates, NSF now awards less than half as many research fellowships as it did in the 1960s. Rather than expanding the existing NSF Graduate Research Fellowship program (currently funded at $102 million), Congress should appropriate $21 million per year for a new program, where NSF and industry match funds on a dollar-for-dollar basis to support an additional 1,000 STEM Ph.D. fellows.[70]

Finally, as ITIF has shown, a significant share of America's best STEM talent is comprised of immigrants or children of immigrants.[71] As such, Congress should enact more generous immigration rules regarding STEM workers wanting to move to the United States, including by shifting more permanent resident slots away from family-based and other related programs toward workers with advanced STEM skills.

Technology Transfer

A not insignificant share of technology-based start-ups can trace their origins in one way or another to federal support of R&D, either at universities, in firms, or even national laboratories and other research institutions. While that system works well in some cases, it is in need of significant reform.[72]

For instance, Congress should allocate a share of federal research funding to promote technology transfer and commercialization, such as through a Spurring Commercialization of Our Nation's Research (SCNR) Program.[73] The current federal system for funding research pays too little attention to commercializing technology and is still based on the linear model that assumes basic research gets easily translated into commercial activity. To address this, the administration should work with Congress to establish an automatic set-aside program that allocates a modest percentage of federal research budgets to technology-commercialization activities. For instance, Congress could allocate 0.15 percent of agency research budgets to fund university, federal laboratory, and state government technology-commercialization and innovation efforts. The funds could be used to provide: 1) "commercialization capacity-building grants" to institutions of higher education pursuing specific initiatives to improve their capacity to commercialize faculty research, and 2) "commercialization-accelerator grants" to support institutions of higher education pursuing initiatives that allow faculty to directly commercialize research in an effort to accelerate research breakthroughs.

Related to this, Congress should develop a proof-of-concept, or "Phase Zero," individual and institutional grant award program within major federal research agencies.[74] The Small

Business Innovation Research and Small Business Technology Transfer (STTR) programs both support innovation, but their approval processes are high bars to clear for very early-stage companies. Too often, there is insufficient funding available at universities (or from other sources) to push nascent technologies to the point where these companies can receive SBIR or STTR grants. A national "Phase Zero" proof-of-concept program would address this problem by helping more projects cross the so-called "valley of death" from early-stage research to commercialization, by providing infrastructure (e.g., expertise, personnel, and small business and venture capital engagement), and by facilitating the cultural change necessary for universities, federal laboratories, and other nonprofit research organizations to better support these kind of commercialization activities. Kentucky and Louisiana, among other states, have developed such "Phase Zero" grants to help firms apply for SBIR grants and support early proof-of-concept research. One way Congress could implement such a proof-of-concept program would be through a grant program to states that agree to match funds on a dollar-for-dollar basis.

The federal government should also do more to spur more universities to be more focused on and better at technology transfer. One step would be for Congress to direct the National Science Foundation (NSF) to establish stronger university entrepreneurship metrics and to use them to provide stronger incentives for commercializing research.[75] In particular, Congress should direct NSF to partner with the National Institute of Standards and Technology (NIST) to develop a metric for universities to report entrepreneurship and commercialization information annually, including data on new business starts by faculty, spin-offs, license agreements, patenting, and industrial funding of research. Congress should further direct agencies to factor these metrics into their decisions to award research funds. At the same time, Congress should provide funds for NSF to expand its I-Corps program so that it also works with universities seeking to become better at commercialization.

CONCLUSION

Technology-based start-ups have an integral role in supporting U.S. economic growth. Over the past decade, they have become an even greater part of the U.S. economy. Contrary to the decline in overall start-ups, technology-based start-ups—those that policymakers should pay most attention to—have increased. But policymakers should not accept the recent increases in technology-based start-up activity as the "new normal." Instead, they should promote policies that will help current and future technology-based start-ups succeed and scale into large firms that will generate long-lasting, high-paying jobs, increase innovation and productivity, and improve the global competitiveness of the U.S. economy.

APPENDIX A: INDUSTRY SELECTION METHODOLOGY

This study selected 10 technology-based industries through developing a matrix that first identified industries that have an above-average level of R&D intensity then cross referenced this list of industries against classifications of technology-based industries published by various statistical agencies. As stated earlier in the report, statistical agencies employ different methodologies to define an industry as technology-based. And although these methods may differ, there is general congruence in the industries identified as technology-based (for example: aerospace, pharmaceuticals, electronic manufactures, etc.). For industry classification, ITIF defaults to the North American Industry Classification System (NAICS). The NAICS, at its broadest definitions, classifies industries into two digits, and at its most detailed definition, six digits.

ITIF's first step in identifying technology-based industries used U.S. National Science Foundation data on industry R&D intensities. R&D intensity—the share of an industry's sales/revenue invested in R&D—is often used as a strong measure of how "innovative" an industry is. The NSF's "2013 Business R&D and Innovation Survey" (the most recent release) surveys approximately 45,000 U.S. firms with at least five employees annually on their R&D activities and uses that sample to construct multiple industry-level innovation-related variables—one of which is R&D intensity. One major limitation is that the NSF does not provide R&D data at every industry-level. To elaborate, the NSF reports R&D data for all industries at the NAICS 2-digit level, reports R&D intensities of mainly manufacturing industries at the three-digit level, and a handful of industries at the six-digit level. In addition, the NSF aggregates R&D data for certain industries (e.g., NAICS 313-316 textiles, apparel, and leather products manufacturing).

For the first step, ITIF identified 32 industries (at various NAICS digit-levels) from the NSF raw data as industries with an R&D intensity higher than that of the economy-wide average of 3.3 percent (Table 3).

Next, we matched these 32 industries against classifications of technology-based industries from the U.S. BLS, OECD, and Eurostat. Elaborating upon how these three classifications differ:

The U.S. BLS classifies an industry as "high-tech" if that industry's share of science, technology, engineering, and mathematics (STEM) workers is twice the national average. Through its definition, it classifies 33 of the 206 industries at the NAICS four-digit level into either high-tech manufacturing or high-tech services. Eurostat classifies an industry as "high-tech/medium-high tech/knowledge intensive" according to its "technological intensity"—an industry's R&D investment expressed as a share of industry value added. In a similar vein, the OECD classifies an industry as "high-tech/medium-high-tech" according to its R&D intensity—an industry's R&D investment expressed as a share of industry sales. Eurostat and OECD industry classifications use a different system than the United States. ITIF made its best effort to map their industry classifications onto the NAICS system.

ITIF considered an industry as technology-based if any of these three agencies identified any of the 32 industries in table 3 as high-tech or knowledge-intensive. Therefore, ITIF's final ten selected technology-based industries is a mix of industries aggregated at different levels of classification (two industries at the 3-digit level; six industries at the 4-digit level, one industry at the 5-digit level, and one industry at the 6-digit level).

There were some exceptions to our selection matrix. ITIF excluded: chemical manufacturing (325) as its R&D intensity is inflated by the technology-based pharmaceutical manufacturing industry (3254); pesticide manufacturing (3253) as its R&D intensity is almost equal to the economy average; transportation manufacturing (336) as its R&D intensity is inflated by the technology-based aerospace manufacturing industry (3364); "other information" (other 51) as it appears to be a residual category although it has a high R&D intensity (this category mixes non-R&D-performing libraries with internet-based start-ups, preventing an accurate analysis); and, architectural, and engineering services (5413) as its R&D intensity is almost equal to the economy average.

Table 3: Industry Selection Matrix[76]

Industry	NAICS Code (As listed by NSF)	NSF (R&D Intensity %)	BLS Classification	Eurostat Classification	OECD Classification
All industries	21–23, 31–33, 42–81	3.3			
Manufacturing industries	31–33	3.8			
Chemicals	325	4.5	High-Tech Manuf.	Medium-High-Tech	Medium-High-Tech
Pesticide, fertilizer, and other agricultural chemicals	3253	3.5	High-Tech Manuf.		
Pharmaceuticals and medicines	3254	10.3	High-Tech Manuf.	High-Tech	High-Tech
Machinery	333	3.4	High-Tech Manuf.	Medium-High-Tech	Medium-High-Tech
Semiconductor machinery	333295	28.4	High-Tech Manuf.		
Computer and electronic products	334	10.6	High-Tech Manuf.	High-Tech	High-Tech
Communications equipment	3342	9.0	High-Tech Manuf.		
Semiconductor and other electronic components	3344	18.5	High-Tech Manuf.		
Navigational, measuring, electromedical, and control instruments	3345	8.3	High-Tech Manuf.		
Electromedical, electrotherapeutic, and irradiation apparatus	334510, 334517	9.5	High-Tech Manuf.		
Search, detection, navigation, guidance, aeronautical, and nautical system and instrument	334511	9.4	High-Tech Manuf.		
Other measuring and controlling device	other 3345	6.2	High-Tech Manuf.		
Other computer and electronic products	other 334	5.2	High-Tech Manuf.		
Transportation equipment	336	4.1		Medium-High-Tech	Medium-High-Tech
Aerospace products and parts	3364	7.6	High-Tech Manuf.		High-Tech

Other transportation	other 336	3.4			
Miscellaneous manufacturing	339	4.0			
Medical equipment and supplies	3391	4.4			High-Tech
Information	51	5.5			
Publishing	511	8.6			
Software publishers	5112	9.0	High-Tech Serv.	Knowledge Intensive	
Data processing, hosting, and related services	518	8.1	High-Tech Serv.	Knowledge Intensive	
Other information	other 51	9.0	High-Tech Serv.	Knowledge Intensive	
Lessors of nonfinancial intangible assets (except copyrighted works)	533	15.4			
Professional, scientific, and technical services	54	8.4			
Architectural, engineering, and related services	5413	3.4	High-Tech Serv.		
Computer systems design and related services	5415	8.4	High-Tech Serv.	Knowledge Intensive	
Scientific research and development services	5417	20.1	High-Tech Serv.	Knowledge Intensive	
Biotechnology research and development	541711	19.3	High-Tech Serv.		
Physical, engineering, and life sciences (except biotechnology) research and development	541712	19.4	High-Tech Serv.		
Social sciences and humanities research and development	541720	61.1	High-Tech Serv.		
Other professional, scientific, and technical services	other 54	4.5			

APPENDIX B: ADDITIONAL DETAILS FOR METHODOLOGY

This report had two major methodological challenges: 1) technical challenges in adjusting the raw firm-level data; and 2) methodological decisions to identify various sub-groups of technology-based start-ups. This appendix details what these technical challenges were and how we addressed them.

Raw Data Adjustments

Several technical challenges exist in classifying businesses into specific industries. For the purposes of this report, we used NAICS 2012 codes. The NAICS system is a joint classification system developed to facilitate data standardization and trade as part of the North American Free Trade Agreement between the U.S., Canada, and Mexico. This classification system was implemented in the late 1990s to supersede the previous industry classification system (the Standard Industrial Classification—implemented by the U.S. in 1937). Because industries evolve over time, the NAICS is revised approximately every five years, with cross-reference tables provided by the U.S. Census Bureau to map an older classification system onto a newer one (i.e., biotechnology R&D service firms appear in the 2007 classification but did not exist in the 2002 classification). Due to these bi-decade

revisions to the NAICS, some unavoidable error is introduced when working with time-series data that covers more than a decade.

But when is a "business" a part of an "industry?" A few technical issues surround this issue. First, businesses self-report their industry code. This leads to both unintentional and intentional "wrong" reporting. With over 1,000 industry codes, business owners may not know which industry best represents their business activities. Anecdotally, this happens frequently among small businesses that lack employees trained in reporting data to government agencies.[77] In some cases, businesses intentionally report themselves as part of a different industry to secure industry-specific incentives, such as government procurement or state tax benefits.[78] Second, because most businesses conduct activities that crisscross multiple industries (for example, auto manufacturers that also perform auto maintenance or auto retail sales), but can only have one industry code associated to it, this leads to some constraint as to which industry a business may choose to associate with. Third, each establishment can have one industry code; therefore, multi-establishment firms have multi-industry codes tied to them. Typically, the main firm is associated with the industry code from which it draws the majority of its revenue. Although point two and three appear similar, these two points result in two different sources of error or uncertainty. To elaborate, with the second point, the error lies on the side of the reporting firm deciding which industry best represents them; with the third point, the error lies on the side of a researcher deciding which industry best applies to the entirety of a multi-establishment firm.

Due to these three technical issues, various statistical products published by the U.S. Census Bureau do not agree with each other in terms of firm counts and establishments by each industry. Accordingly, our firm count aggregates by industry derived from our BDRC dataset also differ vastly from Census Bureau firm count aggregates by industry in statistical products such as the Statistics of U.S. Businesses. BDRC data deviates in the industry classification in two major ways. First, BDRC uses an industry classification built upon the older Standard Industrial Classification system but updated with more detailed industry categories, then cross references these categories into NAICS codes. Second, some degree of BDRC establishment data has their industry code modelled in (using in-house modeling estimates) with these industry codes additionally verified by phone. BDRC data also goes through measures such as third-party auditing and validation to ensure that data provided is accurate.

The following data adjustments were made to the dataset before performing the analysis. Because NAICS industry codes are self-reported by firms, a firm may "change" industry over its years of operation. For example, a pharmaceutical manufacturing firm may start off producing medicines, but after a number of years, reorganize its business activities toward biotechnology R&D (i.e., changing from NAICS 3254 to 51711). As this analysis is not interested in the movement of firms between industries, we attach a single NAICS industry code to each firm over its entire lifespan. ITIF selected the most frequently reoccurring NAICS code a firm identified as, and in some outlying cases, the second-most frequently

reoccurring NAICS code. For firms that existed for only two years, the NAICS code for the most recent year was used. In very extreme cases where a firm had a different NAICS code in each year of existence, ITIF attached the most recent NAICS code to that firm.

This next adjustment concerned multi-establishment firms, which made up approximately 10 percent of our entire sample. Often, subsidiary establishments do not have the same NAICS code. For example, a technology-based manufacturer may have retail outlets across the country, but we still want to factor the employment and sales of their entire firm into our analysis. Therefore, at the industry-level analysis, we attributed data on employment and sales from subsidiary establishments to their parent establishment by matching their business identification codes. For the geographic-level analysis, we gave subsidiary-establishments the NAICS code of their parent company. Since most start-ups are single establishment firms, this adjustment does not overly affect start-up trends.

LEHD data on employment and payroll is reported quarterly. Wages were estimated by summing total payroll over four quarters and dividing that by the average employment of those four quarters.

Analytical Section Methodology Considerations

Often, there is no hard and fast rule for classifying start-ups, and the various sub categories of start-ups. In examining various studies on start-ups, we found that depending on industry and author, a start-up may range from anywhere between a firm less than one year in age, to a firm less than sixteen years in age. ITIF landed on defining a start-up as a firm 10 years or younger in age partially due to the limitations of the LEHD dataset.

Early-stage start-ups were trickier to define, mainly because we did not find any prior studies that provide a clear technical description to identify these firms. This is in part because qualitative measures rather than quantitative measures are often used to define this category of firms, and these qualitative measures also differ by industry. ITIF settled on creating a "revenue threshold" by industry. In other words, if a start-up generated less than a certain dollar value in sales, it would be placed under the early-stage category. To determine this "revenue threshold," we took an industry's average sales in 2016, divided it by ten, and rounded this value to the nearest million for manufacturing industries, and nearest quarter million for service industries. This resulted in nine unique "revenue thresholds" as listed in table 4. (The R&D service providing industry was excluded from this sub-analysis). As we analyzed start-up trends from 2007 to 2016, ITIF adjusted the "revenue threshold" for inflation using the GDP-deflators provided by U.S. Bureau of Economic Analysis.

Table 4: Early-Stage Start-Ups Revenue Threshold Values

Industry	NAICS	Revenue Threshold
Medical Devices	3391	$1M
Pharmaceuticals	3254	$8M
Computer and Electronics	334	$2M
Aerospace	3364	$3M
Semiconductor Components	3344	$2M
Semiconductor Machinery	333242	$2M
Data Processing	518	$250K
Software Publishing	5112	$750K
System Designs	5415	$250K

For high-growth firms, quite a substantial amount of economic work has been done. The fundamental economic dynamic in the study of high-growth firms points out that such firms have outsized long-term impacts on employment and productivity (as typically observed through quantile regressions). There is no common consensus on the definition of a high-growth firm. Economist John Haltiwanger has published a number of articles in this area using U.S. firm data, and he uses an annualized 25 percent growth rate (be it employment, output, or productivity) as the benchmark for a high-growth firm.[79] Economic studies from the OECD use an annualized 20 percent employment growth over three years, and exclude firms with fewer than 10 employees.[80] Meanwhile, the U.S. Bureau of Labor Statistics conducted a broad analysis using threshold values from 5 to 25 percent, and at 5 percent increments.[81] The differences in these methodologies highlight certain measurement pros and cons. For example, using one-year annualized growth as compared to three-year average annualized growth captures a larger sample of firms (as it would contain firms that failed within two to three years), but doing so also discounts net jobs that such firms have in the economy. As an additional example, some analysts only include firms above a certain size within their sample. The rationale is simple: it is much easier for a firm with five employees to hire three more people (and by definition fall into the high-growth category) than a firm with 500 employees looking to hire an additional 100 employees. But in settling on a firm size threshold, we used a simple 25 percent annualized employment growth for ease of communication and presentation.

APPENDIX C: SUPPLEMENTARY ANALYSIS

This appendix contains sectoral trend analyses for start-up activity in each of the other technology-based industries from 2007 to 2016. For each industry, we analyze trends in the number of start-ups, start-up employment, early-stage start-ups, high-growth start-ups, wages, and firm tenure. On the first page for each industry, we provide an overall description of the technology-based industry, describe the overarching state of entrepreneurship in the industry, and provide a summarized list of key empirical findings. This appendix is arranged by technology-based industry, as follows:

1. Computer and electronic products manufacturing
2. Semiconductor and electronic components manufacturing
3. Semiconductor machinery manufacturing
4. Aerospace products and parts manufacturing
5. Medical equipment and supplies manufacturing
6. Software publishing services
7. Data processing, hosting, and related services
8. Computer systems design and related services
9. Science and technology R&D services

Computer and Electronic Products

Businesses in the computer and electronics manufacturing sector develop and produce computers, communication equipment, audio and visual equipment, semiconductor components, navigational electronics, electro-medical equipment (i.e., hearing aids), and optical media (i.e., compact discs).

The sector employs almost 1.5 million workers, is comprised of 25,000 firms, and accounts for a bit less than 1.2 percent of gross U.S. output.[82] In terms of R&D investments, the sector invests $67 billion in domestic R&D, which translates to an R&D intensity of 10 percent and represents 21 percent of U.S. business R&D investments.[83] The average firm employs 59 workers that are paid an average annual wage of $101,000. Additionally, approximately one-fifth of the sector's workforce is in R&D-related occupations.[84]

Start-ups employ 420,000 workers across 15,500 firms. Overall, the state of technology-based entrepreneurship in the computer and electronics manufacturing industry has been mixed, especially in recent years. Start-ups have entered the industry in greater numbers than before, accounting for 62 percent of all firms in 2016, a ten-year high. The share of early-stage start-ups has increased slightly since 2007 and the share of high-growth start-ups is almost back to pre-recession levels. Real wage growth among start-ups has remained sluggish when compared to the rest of the industry. While first-year survival rates in 2015 and 2016 were lower than average, this could be an outcome of increased competition due to more start-ups in the industry rather than a sign of struggling entrepreneurship levels.

From 2007 to 2016 in the computer and electronics manufacturing industry:

- Start-ups increased from 8,600 firms to 15,500 firms, a 78 percent increase.
  - As a share of all firms, an increase from 44 percent to 62 percent.
- Employment among start-ups increased from 240,000 to 420,000, a 75 percent increase.
  - As a share of total employment, a decrease from 18 percent to 28 percent.
- Early-stage start-ups account for 19 percent of firms in the industry and employ 1.5 percent of workers.
- Six percent of start-ups experience high growth annually, i.e., the firm increases employment by more than25 percent over the previous year
  - For example, in 2015, high-growth start-ups made up 3 percent of start-ups and employed 6 percent of all start-up employees.
- Start-ups provide an annual wage 14 percent less than the industry average.
  - From 2007 to 2016, real annual wages grew by 4 percent among start-ups, as compared to 17 percent across the industry.

Over the past ten years, computer and electronic manufacturing start-ups have increased steadily, in both gross figures and as a share of all firms. Since 2007, the number of start-ups has increased 78 percent, from 8,600 firms in 2007 to 15,500 firms (figure 35), while start-ups as a share of all firms have increased 18 percentage points from 44 percent to 62 percent (figure 36). Start-up growth has mirrored overall industry trends, remaining stable during the recession years then slowly growing in the recovery years. The industry has experienced a substantial increase in entrepreneurship in recent years. From 2007 to 2014, the number of new firms to enter the industry each year averaged 2,600. In 2015, 7,700 new firms entered the industry, and in 2016, 5,000 firms entered the industry.

Figure 35: Number of Firms in the Computer and Electronics Manufacturing Industry, 2007 to 2016

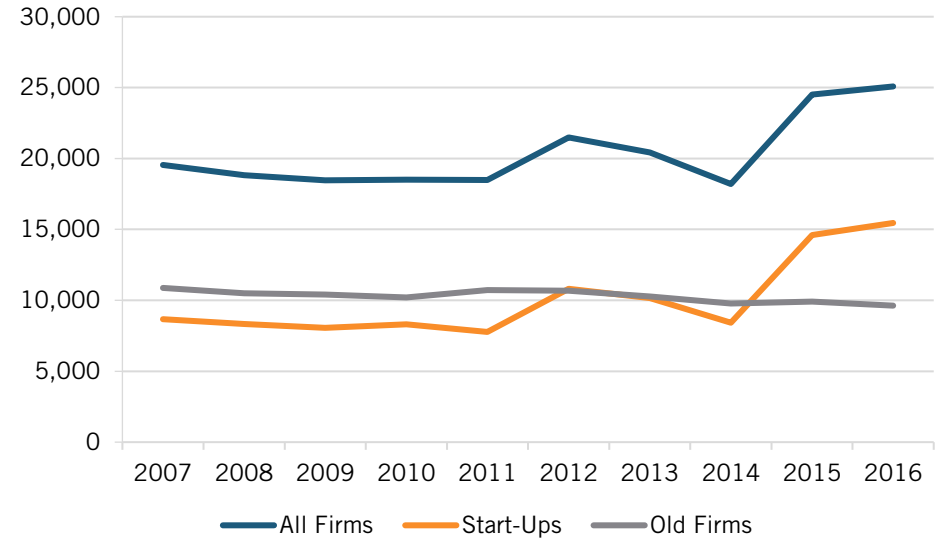
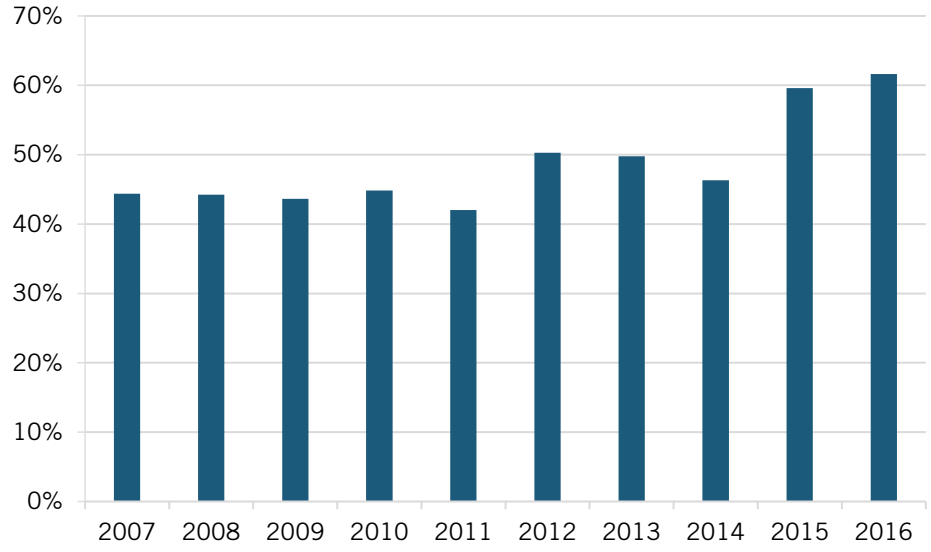


Figure 36: Start-Ups as a Share of Total Firms in the Computer and Electronics Manufacturing Industry, 2007 to 2016



Start-ups have been responsible for the uptick in employment across the industry in recent years. While older firms have both decreased in number and employees, start-ups have maintained a stable number of workers through the recession years, and increased employment in the past two years. In 2007, start-ups employed 240,000 workers, with this figure almost doubling to 420,000 in 2016 (figure 37). Meanwhile, across the industry, employment decreased by 6 percent over the same period. Start-ups were also responsible for a larger share of total industry employment in 2016 than in 2007, 28 percent as compared to 18 percent (figure 38). This 10 percentage point increase has been driven by start-up activity in the past two years, with the share of start-up employment averaging only 17 percent over the previous eight years.

Figure 37: Employment in the Computer and Electronics Manufacturing Industry, 2007 to 2016

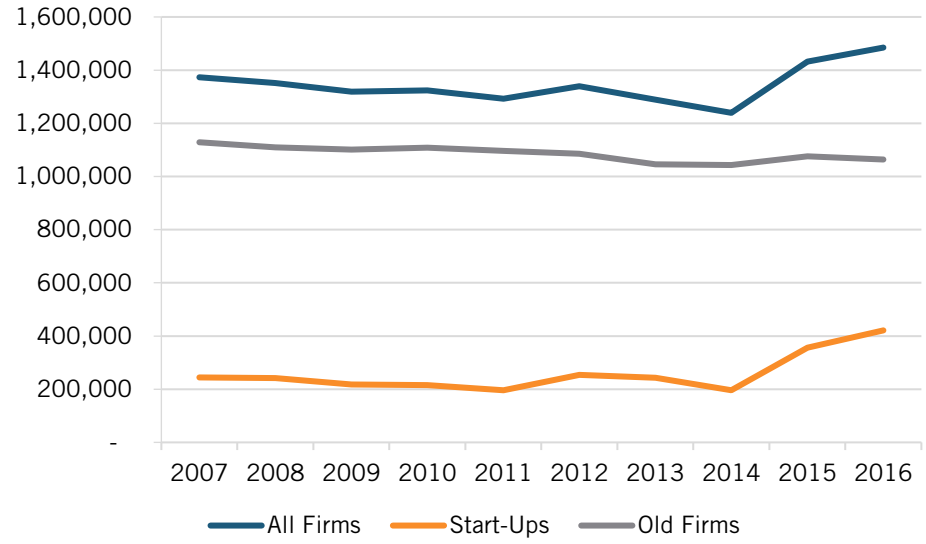
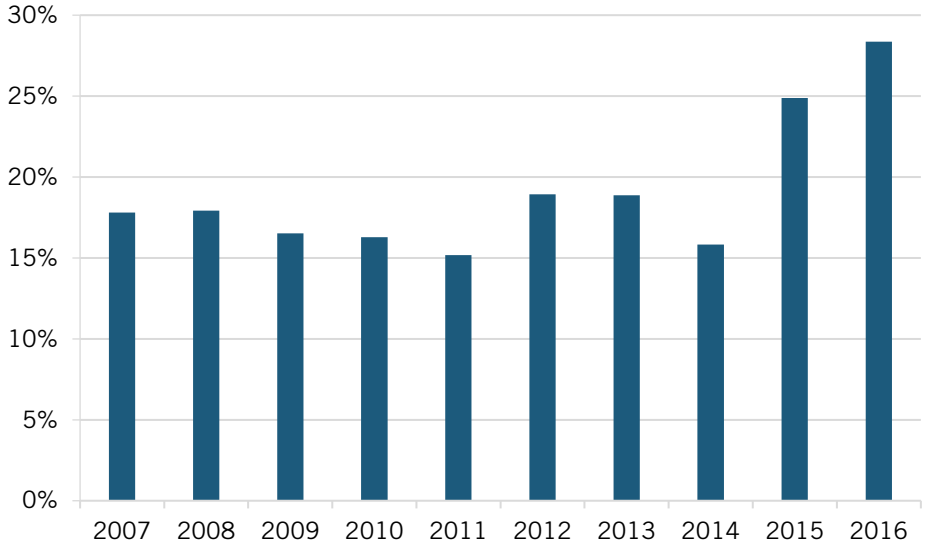


Figure 38: Employment in Start-ups as a Share of Total Employment in the Computer and Electronics Manufacturing Industry, 2007 to 2016



Early-stage start-ups, start-ups that generate less than $2 million in revenue, account for 19 percent of all firms, and 39 percent of all start-ups, and these figures have increased slightly from 2007 to 2016 (figure 39). In 2016, early-stage start-ups accounted for 20 percent of all firms, up from 18 percent in 2007. Most early-stage start-ups are small, with an average of five workers, and have grown smaller over the last decade. From 2007 to 2016, they accounted for 1.5 percent of industry employment and 8.3 percent of start-up employment (figure 40). In 2016, early-stage start-ups employed 1.5 percent of all workers, down from 1.7 percent in 2007.

Figure 39: Early-Stage Start-Ups as a Share of All Firms in the Computer and Electronics Manufacturing Industry, 2007 to 2016

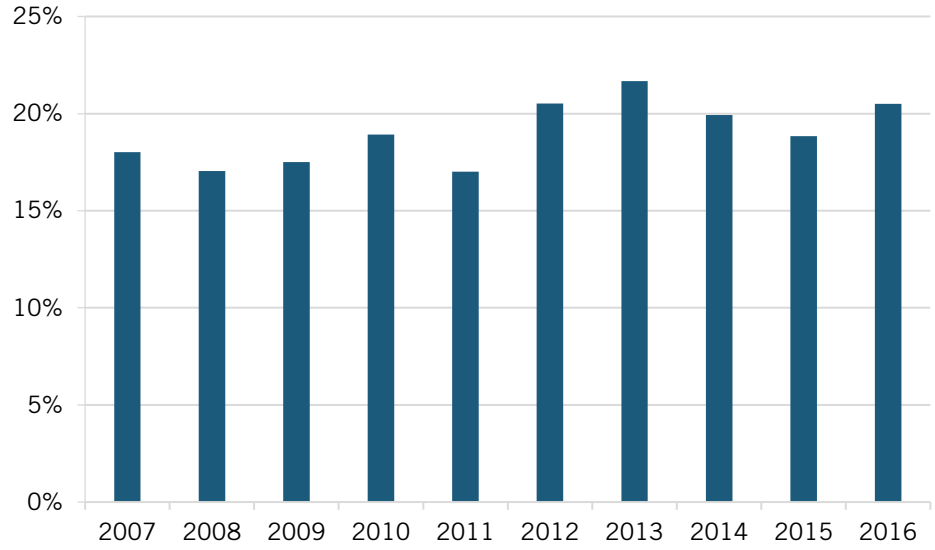
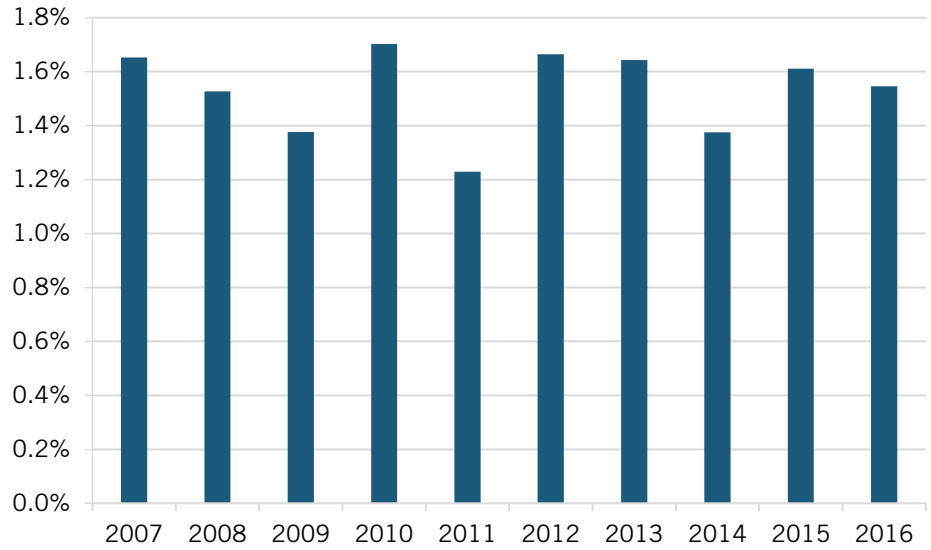
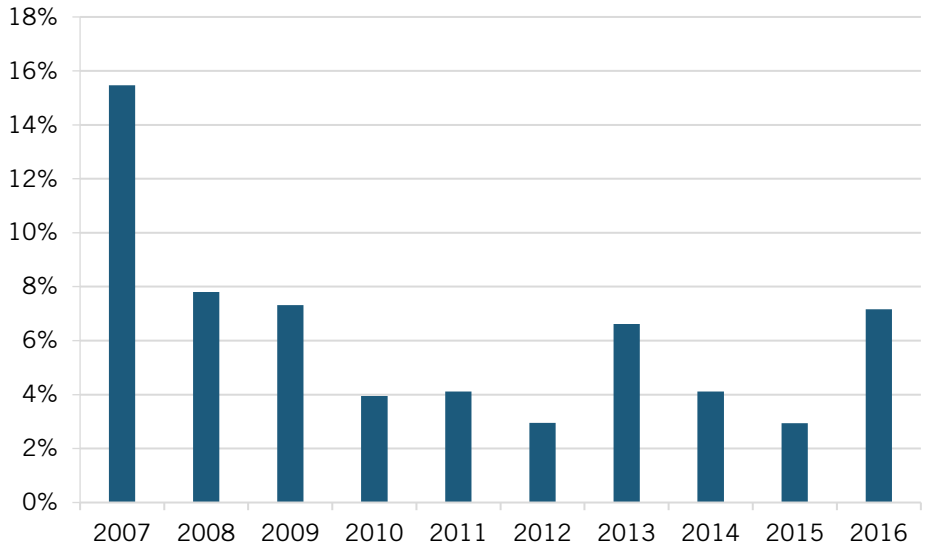


Figure 40: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Computer and Electronics Manufacturing Industry, 2007 to 2016



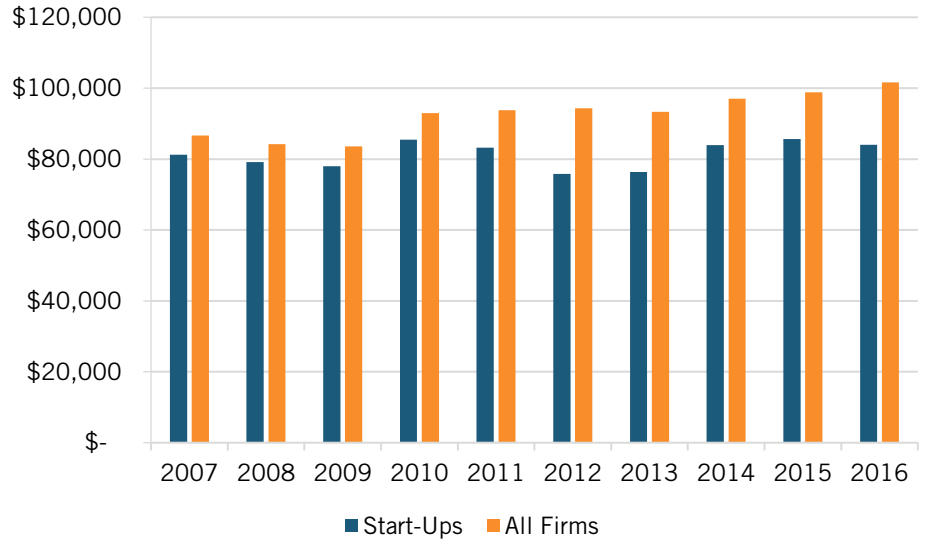
High-growth start-ups generate long-term employment and have the potential to make large economic contributions to an industry. The economic performance of this group of firms has been stable over the past decade. On average, 6 percent of start-ups experience high growth annually (figure 41). In 2007, 15 percent of start-ups grew fast, with this share of firms decreasing to a low of 3 percent in 2012 before increasing to 16 percent in 2013 then decreasing over the recession to a low of 3 percent in 2012. Fast-growing start-ups have increased since, with 7 percent of all start-ups demonstrating high-growth in 2016. This group of firms has outsized contributions to employment. For example, in 2015, high-growth start-ups made up 3 percent of start-ups but employed 6 percent of all those employed by start-ups.

Figure 41: Share of Start-ups With High Employment Growth in the Computer and Electronics Manufacturing Industry, 2007 to 2016



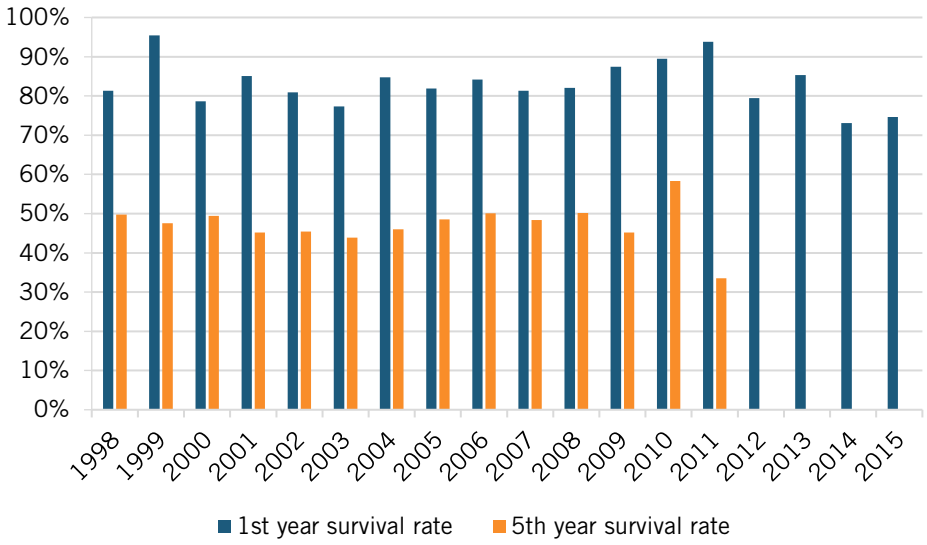
Examining real wages, start-ups paid their workers 14 percent less than the industry average over the past ten years. In fact, the industry average wage has increased by 17 percent while the average wage among start-ups has grown at a much slower rate of 4 percent (figure 42). In 2007, start-ups paid an average wage of $81,000, in contrast to the $86,000 industry average—a 7 percent gap. By 2016, this gap had increased to 21 percent, with start-ups paying an average wage of $84,000 as compared to the industry average of $101,000. It should be noted that real wages decreased slightly during the recession, and while the industry recovered, the average wage among start-ups reached a decade low of $76,000 in 2012.

Figure 42: Average Annual Wage (Real 2009 $) in the Computer and Electronics Manufacturing Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2015, 17 percent of new firms did not survive their first year in business; only 47 percent survived through the fifth year(figure 43). First-year survival rates have remained generally stable, but were lower than average in the past two years. However, fifth-year survival rates have remained stable at 50 percent since 1998, increasing to 60 percent in 2010, then decreasing to 34 percent in 2011. In other words, 50 percent of firms established in 1998 still operated in 2003, while 34 percent of firms established in 2011 still operated in 2016.

Figure 43: Survival Rate of Start-Ups in the Computer and Electronics Manufacturing Industry, 1998 to 2015



Semiconductor and Electronic Components

Businesses in the semiconductor and electronic components manufacturing industry are a sub-industry of the computer and electronics manufacturing sector. These businesses develop and produce semiconductors, printed circuit boards, circuit assemblies, and capacitors.

The sector employs almost 500,000 workers, is comprised of 6,600 firms, and accounts for 0.4 percent of gross U.S. output.[85] In terms of R&D investments, the sector invests $31 billion in domestic R&D, which translates to an R&D intensity of 19 percent and represents 9.5 percent of U.S. business R&D investments.[86] The average firm employs 73 workers who are paid an average annual wage of $101,000. Additionally, approximately a third of the sector's workforce is in R&D-related occupations.[87]

Start-ups employ 85,000 workers across 3,200 firms. Overall, the state of technology-based entrepreneurship in the semiconductor and electronic components manufacturing industry is negative. The number of start-ups has remained stable, averaging 45 percent of all firms over this period. The share of early-stage start-ups has been decreasing since 2007 and the share of high-growth start-ups has remained stable. Unfortunately, start-ups offer wages lower than the industry average, with the real wage offered in 2016 lower than that of the overall industry wage rate in 2007. Start-up survival rates have also remained quite stable over the past ten years (although first-year survival rates for firms started in 2014 and 2015 appear below average).

From 2007 to 2016 in the semiconductor and electronic components manufacturing industry:

- Start-ups remained unchanged at 3,200 firms.
  - As a share of all firms, an increase from 45 percent to 48 percent.
- Employment among start-ups remained unchanged at 85,000 workers.
  - As a share of total employment, an increase from 16 percent to 17 percent.
- Early-stage start-ups account for 14 percent of firms in the industry and employ 1.1 percent of workers.
- Seven percent of start-ups experience high-growth annually, i.e., the firm increased employment by over 30 percent over the previous year
- Start-ups provide an annual wage 10 percent higher than the industry average.
  - From 2007 to 2016, real annual wages decreased by 8 percent among start-ups, as compared to a 28 percent increase across the industry.

Over the past ten years, semiconductor and electronic components manufacturing start-ups have remained stable, in both gross figures and as a share of all firms. Since 2007, the number of start-ups has hovered around 3,000 firms (figure 44), while start-ups as a share of all firms increased modestly, from 45 percent to 48 percent, due in part to a gross decrease in older firms over this period (figure 45). Start-up growth decreased during the recession, but has recovered since. The number of older firms has decreased since 2007. As a result, there are fewer semiconductor and electronic components manufacturing firms in the industry as of 2016 than in 2007. If older firms continue to decrease while start-ups continue to grow, start-ups as a share of all firms will make up more than half of all firms in the industry within the next few years.

Figure 44: Number of Firms in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016

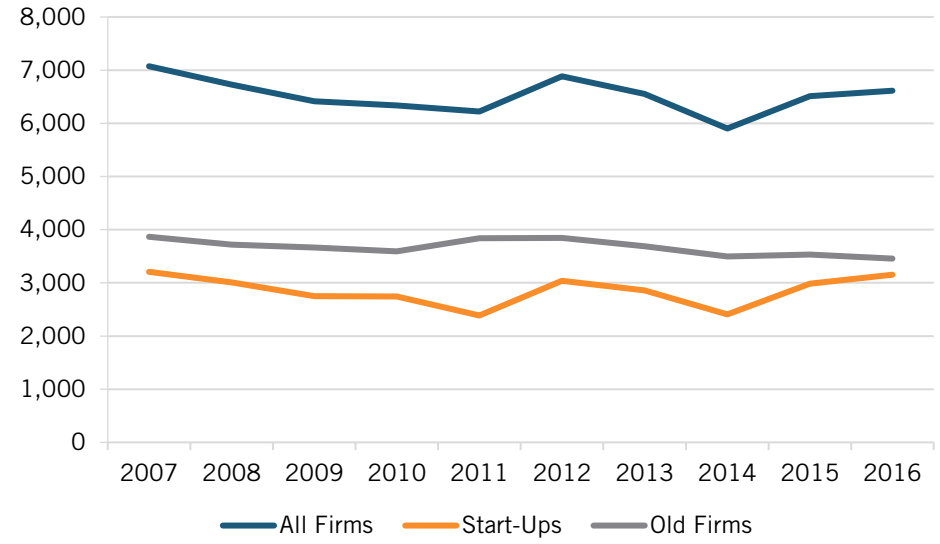
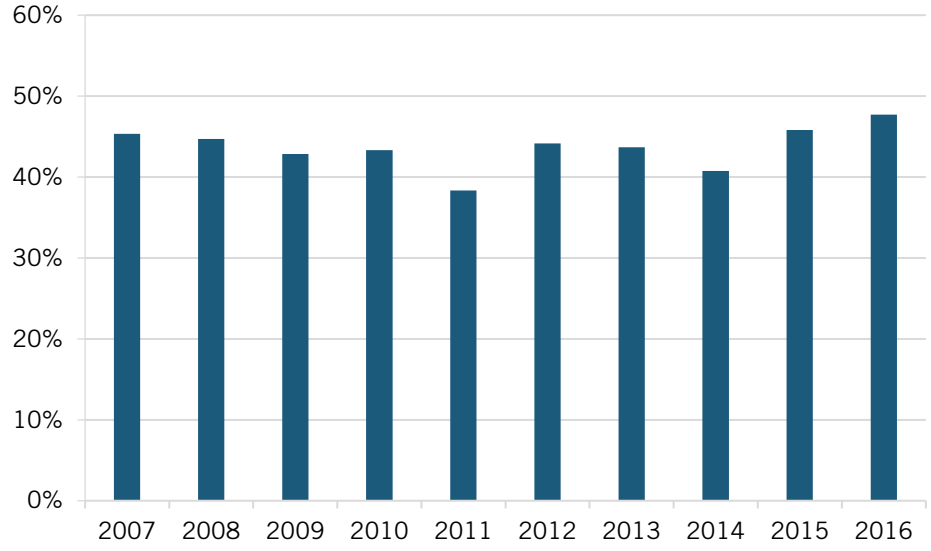


Figure 45: Start-Ups as a Share of Total Firms in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016



Similar to firm growth trends, employment among start-ups has remained stable at 85,000 workers over the past ten years, while employment among older firms has decreased from 450,000 in 2007 to 400,000 in 2016 (figure 46). Employment in start-ups decreased over the recession years and only started to recover from 2014 onwards. In 2016, start-ups employed 16 percent of all workers in the industry, a one point increase since 2007 (figure 47). This one point increase is mainly due to employment among older firms decreasing.

Figure 46: Employment in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016

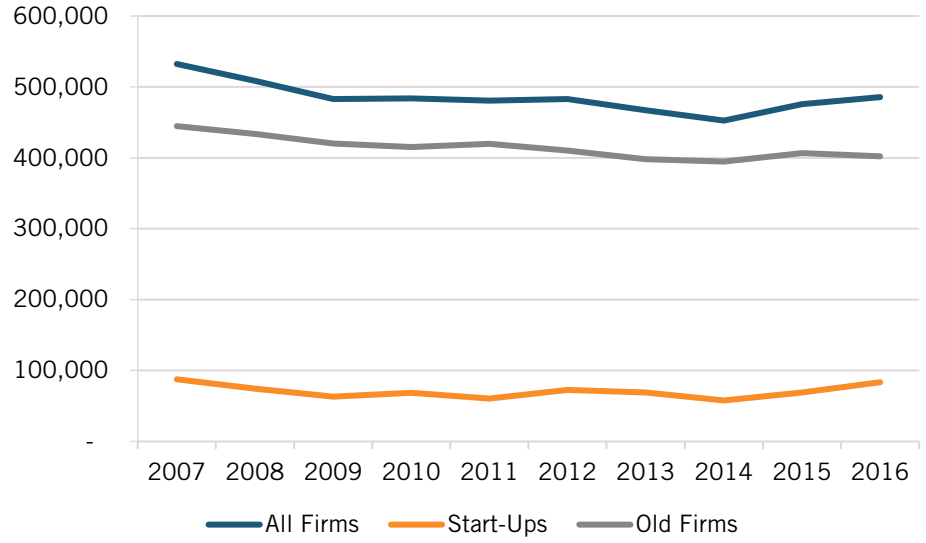
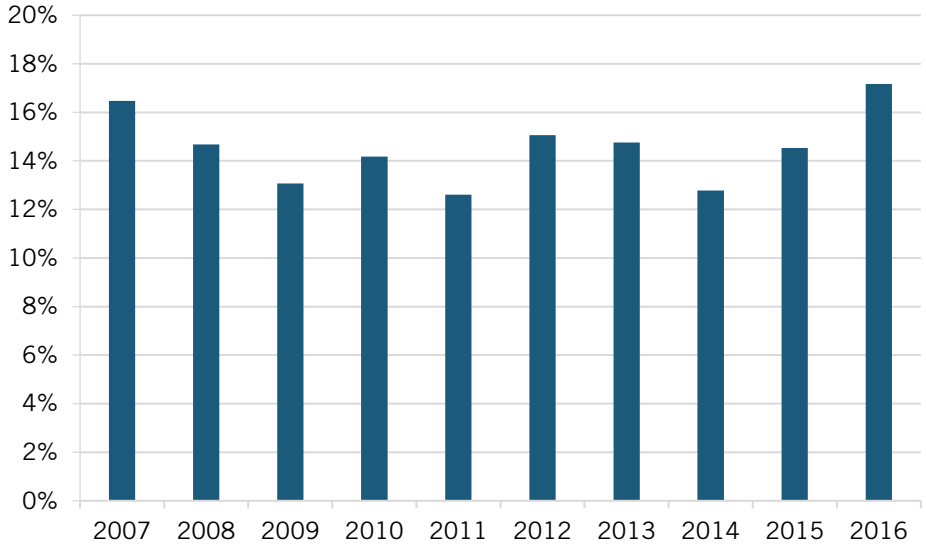


Figure 47: Employment in Start-Ups as a Share of Total Employment in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016



Early-stage start-ups, those that generate less than $2 million in revenue, account for 14 percent of all firms, and 32 percent of all start-ups, and these figures have decreased slightly from 2007 to 2016 (figure 48). In 2016, early-stage start-ups accounted for 12 percent of all firms, down from 15 percent in 2007. Most early-stage start-ups are small, with an average of six workers. From 2007 to 2016, they accounted for 1.1 percent of industry employment and 7.7 percent of start-up employment (figure 49). In 2016, early-stage start-ups employed 1.0 percent of all workers, down from 1.8 percent in 2007.

Figure 48: Early Stage Start-Ups as a Share of All Firms in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016

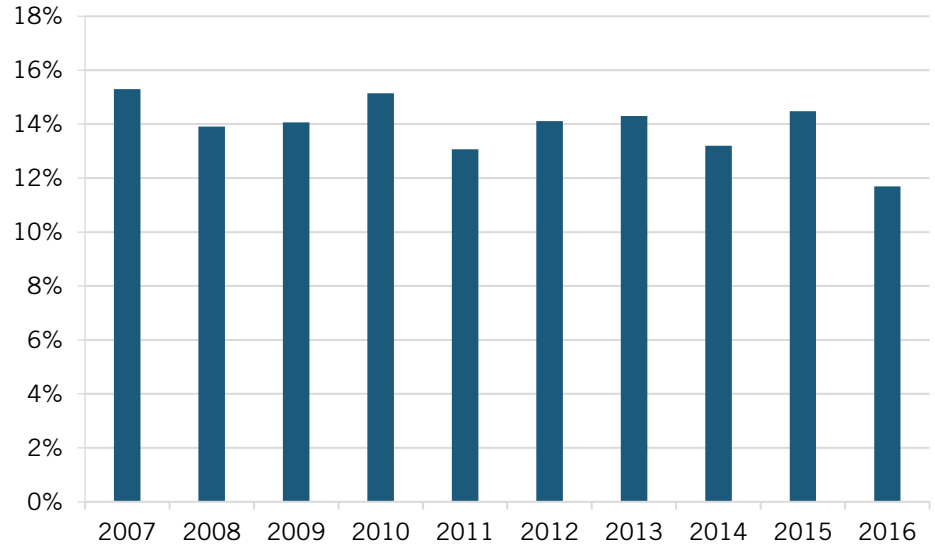
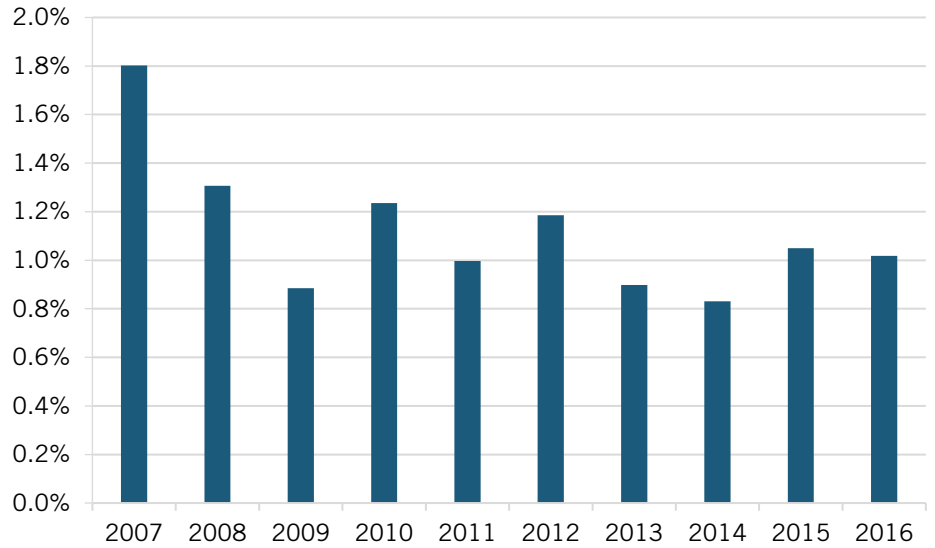
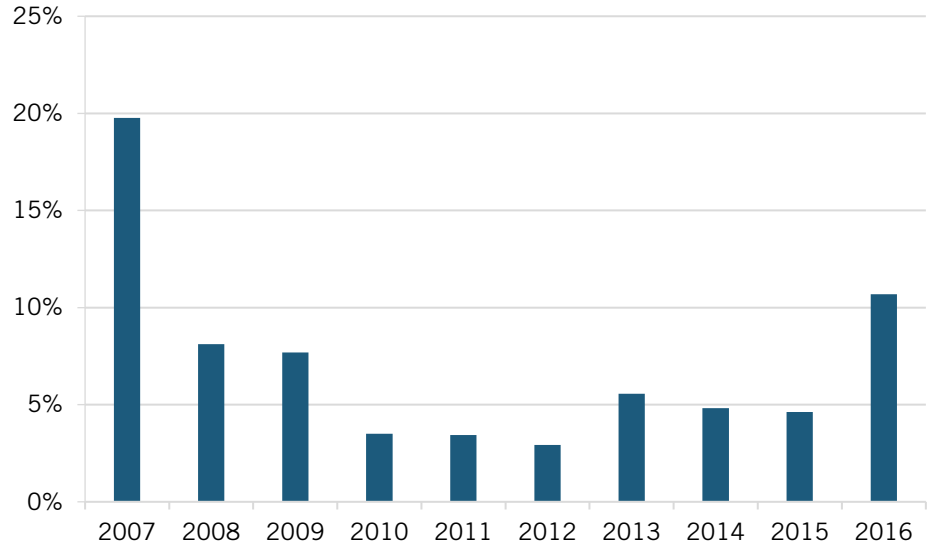


Figure 49: Employment in Early Stage Start-Ups as a Share of Total Employment in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016



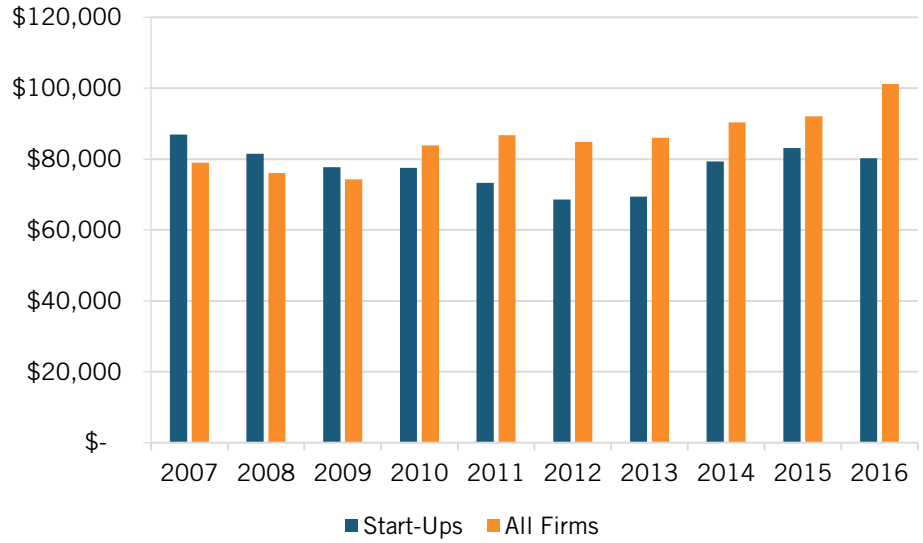
High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied substantially over the past decade. On average, 7 percent of start-ups experience high growth annually (figure 50). In 2007, 20 percent of start-ups grew fast, with this share of firms decreasing to a low of 3 percent in 2012 before increasing to 11 percent in 2016; 2007 and 2016 are the only two years in the past decade when the share of high-growth start-ups exceeded 10 percent of all start-ups.

Figure 50: Share of Start-Ups with High Employment Growth in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016



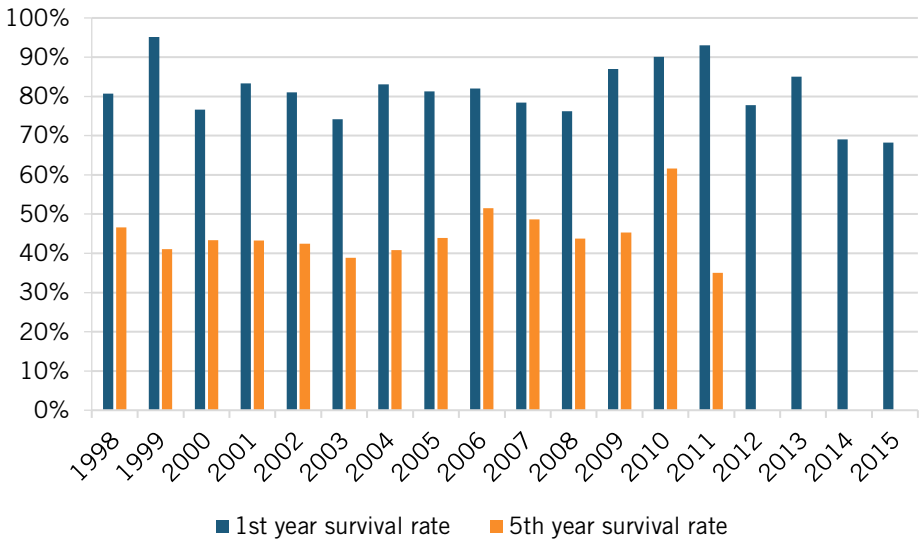
Examining real wages, start-ups paid their workers 10 percent less than the industry average over the past ten years. In fact, the industry average wage has increased by 28 percent while the average wage among start-ups has decreased by 8 percent (figure 51). In 2007, start-ups paid an average wage of $87,000, in contrast to the $79,000 industry average—a 9 percent premium. By 2016, this gap had reversed, with industry average wages 11 percent higher than start-up wages (average industry wage of $101,000 as compared to the start-up average of $80,000). While industry wages have gradually increased over the past decade, start-up's wages decreased over the recession and have yet to recover fully.

Figure 51: Average Annual Wage (Real 2009 $) in the Semiconductor and Electronic Components Manufacturing Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2015, 19 percent of new firms did not survive their first year in business; only 45 percent survived through the fifth year(figure 52). First-year survival rates have remained generally stable, increasing over the recession years, but were lower than average in the past two years. Fifth-year survival rates remained stable from 1998 to 2004, increasing slightly before the recession, and have been on a decreasing trend since 2006 (except for a high of 60 percent in 2010). In other words, 45 percent of firms established in 1998 were still in business by 2003, but only 35 percent of firms that were established in 2011 were still in business by 2016.

Figure 52: Survival Rate of Start-Ups in the Semiconductor and Electronic Components Manufacturing Industry, 1998 to 2015



Semiconductor Machinery

Businesses in the semiconductor machinery manufacturing industry develop and produce the processing equipment (i.e., robots) used in the production of semiconductors and electronic wafers (i.e., silicon or solar wafers).

The sector employs almost 3,000 workers, is comprised of 40 firms, and accounts for 0.02 percent of gross U.S. output.[88] In terms of R&D investments, the sector invests $3.2 billion in domestic R&D, which translates to an R&D intensity of 28 percent (making it the manufacturing industry with the highest R&D intensity). It represents 1 percent of U.S. business R&D investments.[89] The average firm employs 77 workers that are paid an average annual wage of $73,000. Additionally, approximately a third of the sector's workforce is in R&D-related occupations.[90]

Start-ups employ 800 workers across 34 firms. Overall, the state of technology-based entrepreneurship in the semiconductor machinery manufacturing industry is positive. Although this sector has few firms, start-up growth has been significant in the past ten years. Even with a moderate decrease in start-ups in recent years, start-ups still accounted for more than 80 percent of all firms in 2016. Employment in start-ups has also increased steadily over the past ten years. Unfortunately, real wages in start-ups have stagnated over the past ten years, growing by only 2 percent.[91]

From 2007 to 2016 in the semiconductor machinery manufacturing industry:

- Start-ups increased from 12 firms to 34 firms, a 183 percent increase.
  - As a share of all firms, a decrease from 86 percent to 81 percent.
- Employment among start-ups decreased from 200 to 800, a four-fold increase.
  - As a share of total employment, an increase from 11 percent to 25 percent.
- Early-stage start-ups account for 32 percent of firms in the industry and employ 2.2 percent of workers.
- Ten percent of start-ups experience high-growth annually, i.e., the firm increased employment by over 30 percent over the previous year
- Start-ups provide an annual wage 17 percent less than the industry average.
  - From 2007 to 2016, real annual wages grew by 2 percent among start-ups, as compared to 10 percent across the industry.

From 2007 to 2011, semiconductor machinery manufacturing start-ups increased steadily, in both gross figures and as a share of all firms, but they have decreased since 2011. Because this is a small-sized industry, the 183 percent increase in start-ups over the past decade translates into an increase from 12 start-ups in 2007 to 34 start-ups in 2016 (figure 53). However, the industry has experienced a substantial decrease in new firm entrants in recent years. From 2012 to 2016, start-ups decreased by 19 percent. Expressed as a share of all firms, start-ups decreased 5 percentage points from 86 percent in 2007 to 81 percent in 2016 (figure 54). In fact, start-ups reached a decade high in 2010, making up 93 percent of all firms.

Figure 53: Number of Firms in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016

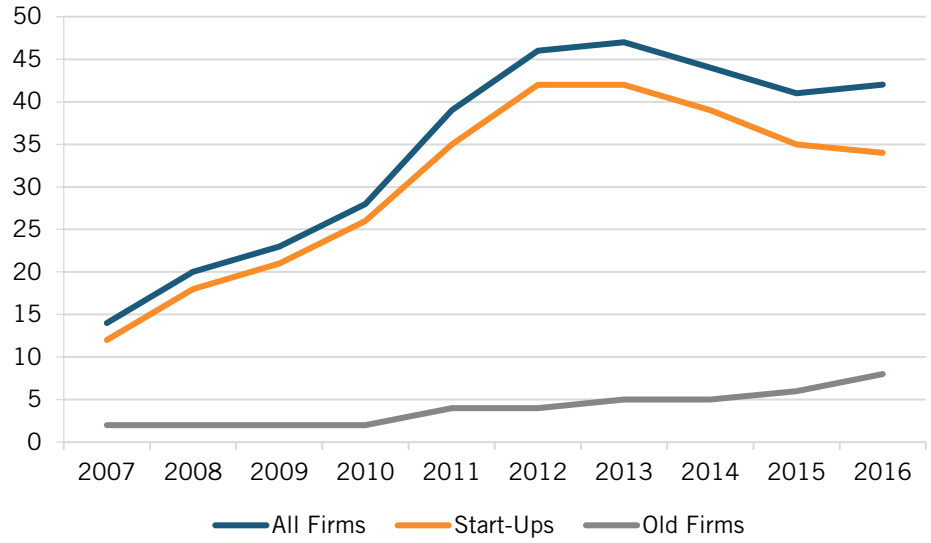
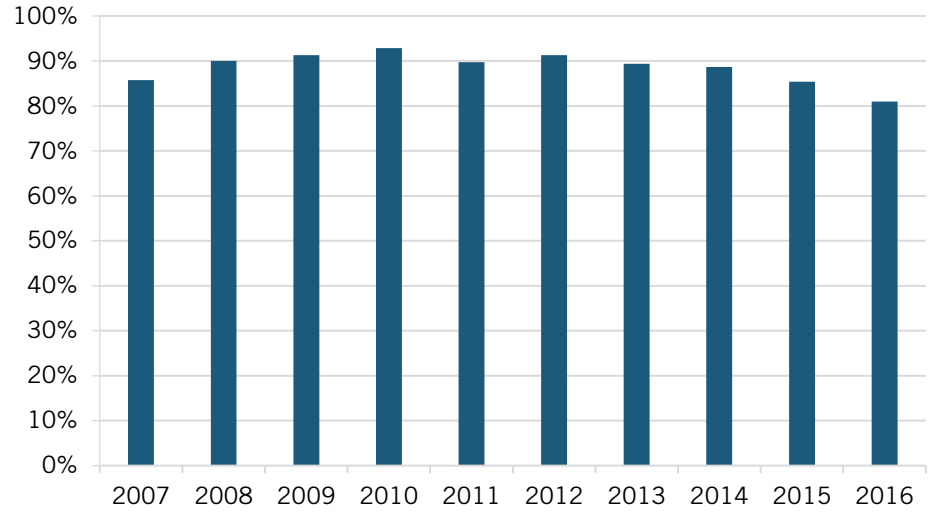


Figure 54: Start-Ups as a Share of Total Firms in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016



Start-ups have increased in both gross employment and employment share over the past decade. While older firms experienced a slight decrease in employment post-recession, they have since recovered. In 2007, start-ups employed just under 200 workers, with this figure quadrupling to 800 in 2016 (figure 55). Meanwhile, across the rest of the industry, employment increased by an average 6 percent per year. Start-ups are also responsible for a larger share of total industry employment in 2016 than in 2007, 25 percent as compared to 11 percent, a 14 percentage point difference (figure 56). In fact, start-ups have, on average, accounted for 25 percent of total industry employment since 2013.

Figure 55: Employment in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016

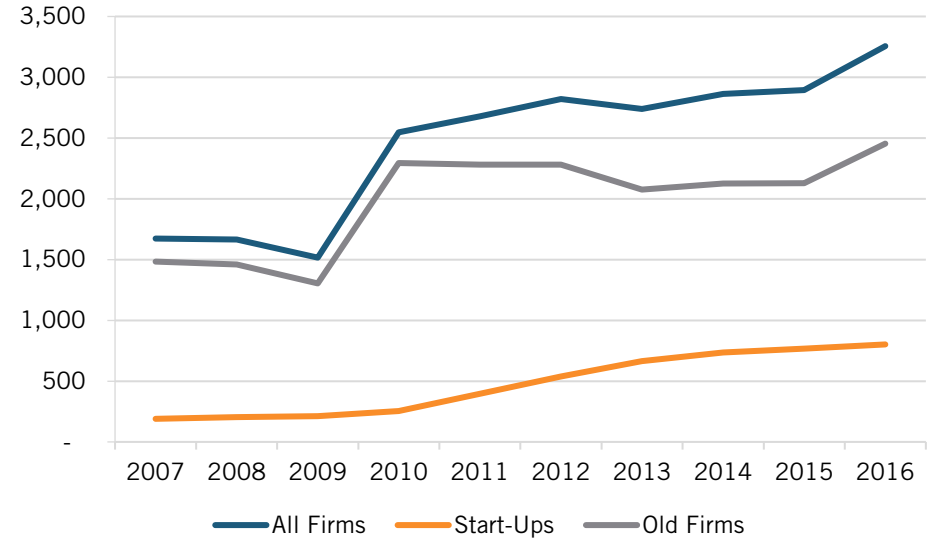
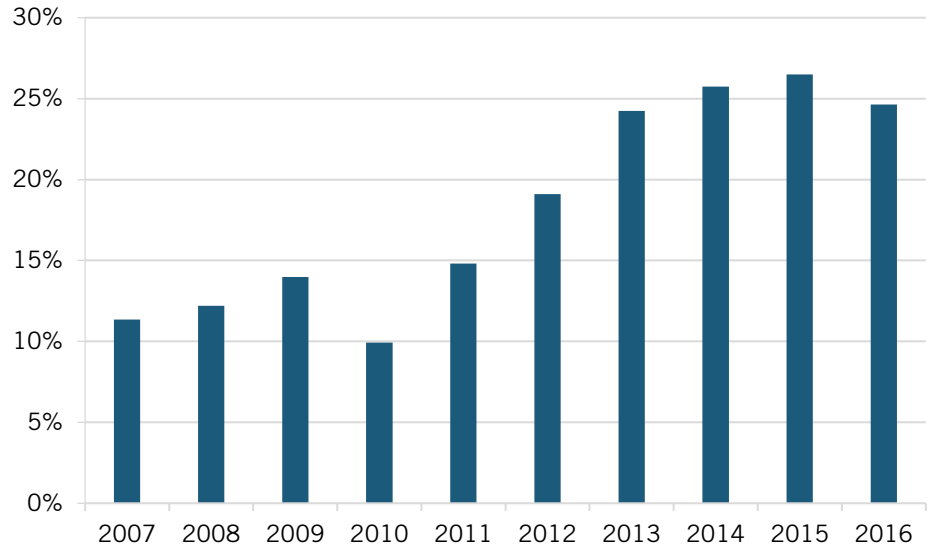


Figure 56: Employment in Start-Ups as a Share of Total Employment in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016



Early-stage start-ups, those that generate less than $2 million in revenue, account for 32 percent of all firms, and 37 percent of all start-ups; these percentages have been erratic from 2007 to 2016, mainly due to the small size of this industry (figure 57). In 2016, early-stage start-ups accounted for 38 percent of all firms, up from 29 percent in 2007. Most early-stage start-ups are small, with an average of five workers. From 2007 to 2016, they accounted for 2.2 percent of industry employment and 12.7 percent of start-up employment (figure 58). In 2016, early-stage start-ups employed 4.1 percent of all workers, up from 1.1 percent in 2007.

Figure 57: Early-Stage Start-Ups as a Share of All Firms in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016

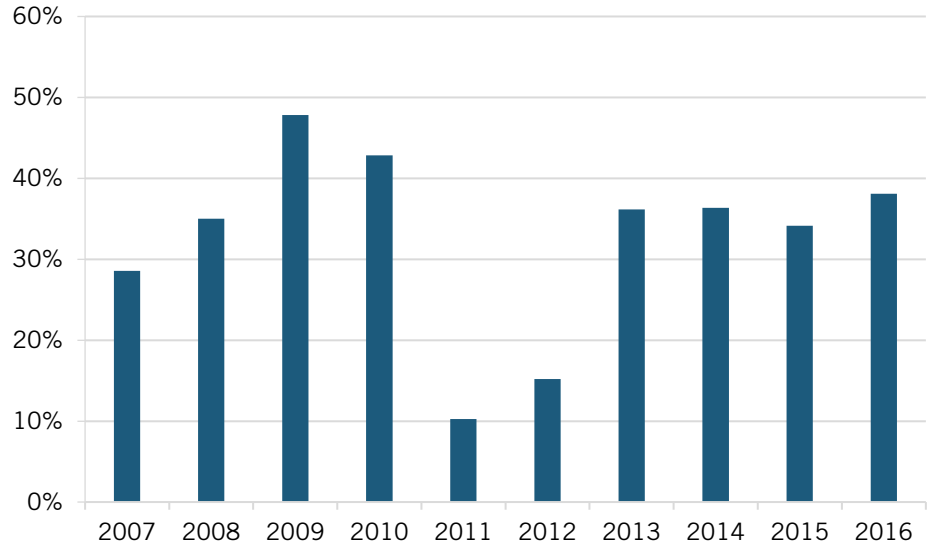
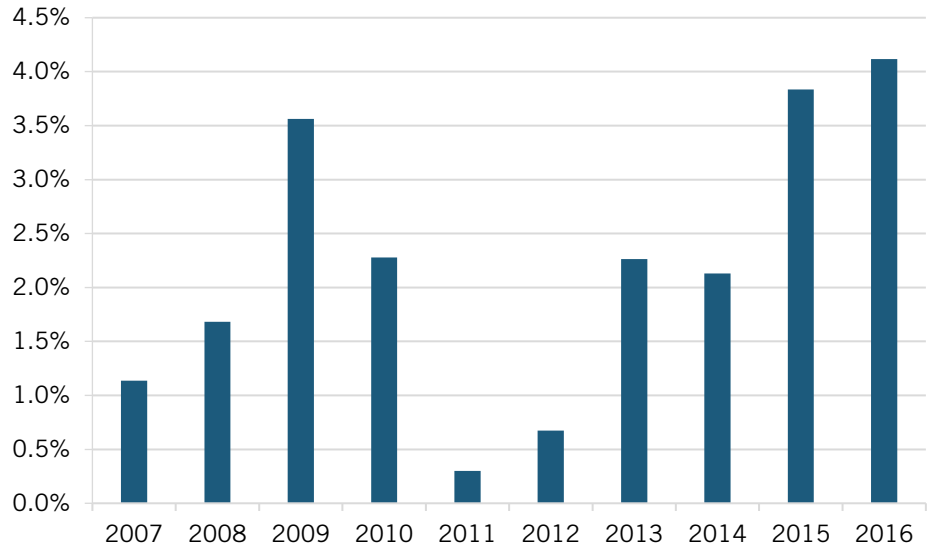
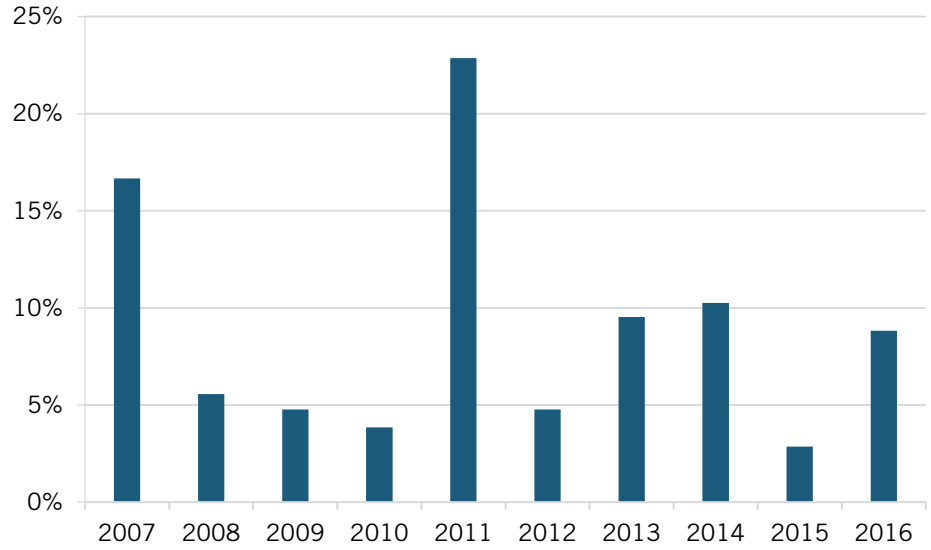


Figure 58: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016



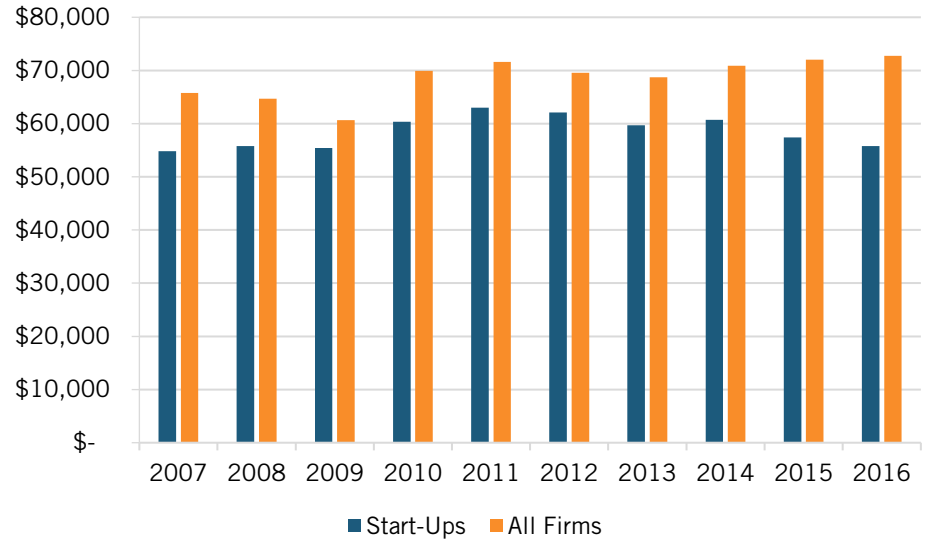
High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. Due to few firms in this industry, strong performance by some firms in some years may lead to a few outlying data points. But on average, 10 percent of start-ups experience high growth annually (figure 59).

Figure 59: Share of Start-Ups with High Employment Growth in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016



Examining real wages, start-ups paid their workers 17 percent less than the industry average over the past ten years. In fact, the industry average wage has increased by 10 percent while the average wage among start-ups has grown at a much slower rate of 2 percent (figure 60). In 2007, start-ups paid an average wage of $55,000, in contrast to the $66,000 industry average—a 20 percent gap. By 2016, this gap had increased to 30 percent, with start-ups paying an average wage of $56,000 as compared to the industry average of $73,000. In fact, real wages among start-ups have been decreasing since 2011.

Figure 60: Average Annual Wage (Real 2009 $) in the Semiconductor Machinery Manufacturing Industry, 2007 to 2016[92]



Aerospace Products and Parts

Businesses in the aerospace products and parts manufacturing sector develop and produce airplanes and parts, spacecraft and parts, and advanced weapons.

The sector employs 250,000 workers, is comprised of 2,000 firms, and accounts for less than 1 percent of gross U.S. output.[93] In terms of R&D investments, the sector invests $27 billion in domestic R&D, which translates to an R&D intensity of 7.6 percent and represents 8 percent of U.S. business R&D investments.[94] The average firm employs 136 workers who are paid an average annual wage of $89,000. Additionally, 8.5 percent of the sector's workforce is in R&D-related occupations.[95]

Start-ups employ 34,000 workers across 900 firms. Overall, the state of technology-based entrepreneurship in the aerospace products and parts manufacturing industry is mixed. The number of start-ups has increased in both gross number and as a share of all firms. Employment among start-ups has been unchanged. The start-up share of early-stage start-ups has increased slightly. Start-ups offer lower wages than the industry average, with real wages among start-ups stagnating over the past ten years.

From 2007 to 2016 in the aerospace manufacturing industry:

- Start-ups increased from 700 firms to 900 firms, a 26 percent increase.
  - As a share of all firms, an increase from 42 percent to 50 percent.
- Employment among start-ups decreased from 37,000 to 34,000, an 8 percent decrease.
  - As a share of total employment, remaining stable at 13 percent.
- Early-stage start-ups account for 27 percent of firms in the industry and employ 0.9 percent of workers.

- Six percent of start-ups experience high growth annually, i.e., these firms increased employment by over 30 percent compared to the previous year
- Start-ups provide an annual wage 11 percent lower than the industry average.
    - From 2007 to 2016, real annual wages did not grow, while the industry average increased by 10 percent.

Over the past ten years, aerospace products and parts start-ups have increased steadily, in both gross figures and as a share of all firms. Since 2007, the number of start-ups has increased 26 percent, from 700 firms in 2007 to 900 firms (figure 61), while start-ups' share of all firms has increased 8 percentage points from 42 percent to 50 percent (figure 62). This increase in firm share by start-ups is mainly due to start-ups increasing gradually as the number of older firms decreased slightly over this period. Of note, 2015 was the only year in the past decade where start-ups outnumbered older firms.

Figure 61: Number of Firms in the Aerospace Products and Parts Manufacturing Industry, 2007 to 2016

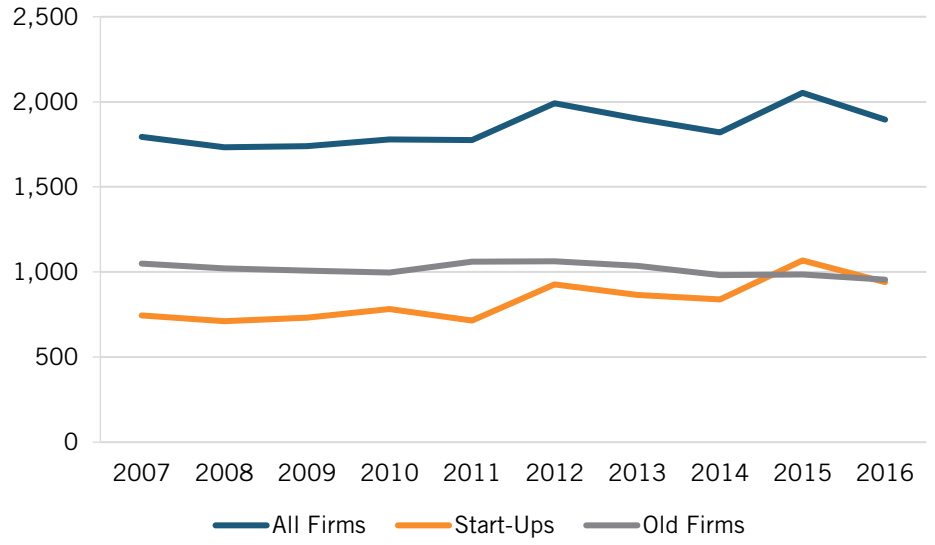
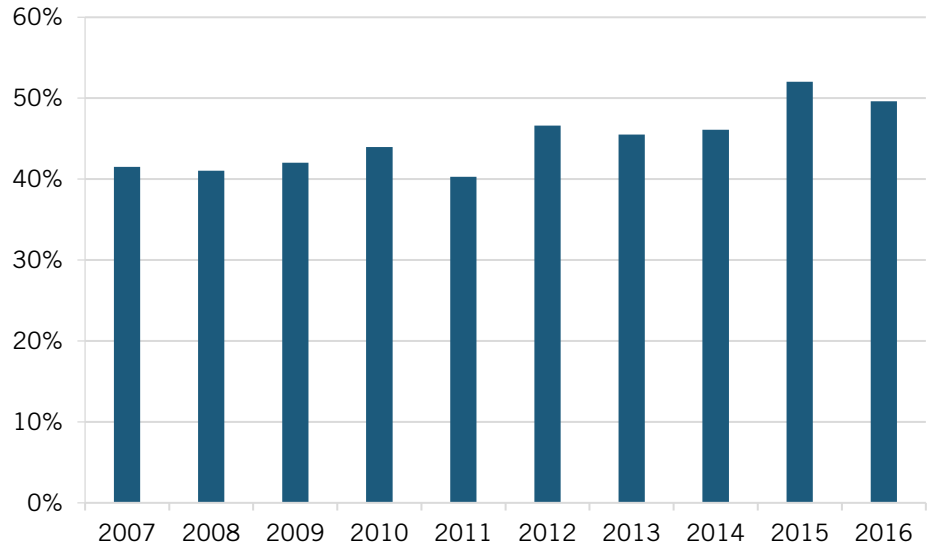


Figure 62: Start-Ups as a Share of Total Firms in the Aerospace Products and Parts Manufacturing Industry, 2007 to 2016



While the number of start-ups has increased over the past decade, employment among start-ups remained stable. In 2007, start-ups employed 37,000 workers, with this figure decreasing by 8 percent to 34,000 in 2016 (figure 63). Meanwhile, across the industry, employment decreased by 16 percent. This decreasing employment trend across older firms is why start-ups have increased their share of workers employed in this industry. In 2008, start-ups employed 6 percent of the industry's workers, but by 2016, they employed 13 percent of all workers, a 6-point difference (figure 64).

Figure 63: Employment in the Aerospace Products and Parts Manufacturing Industry, 2007 to 2016

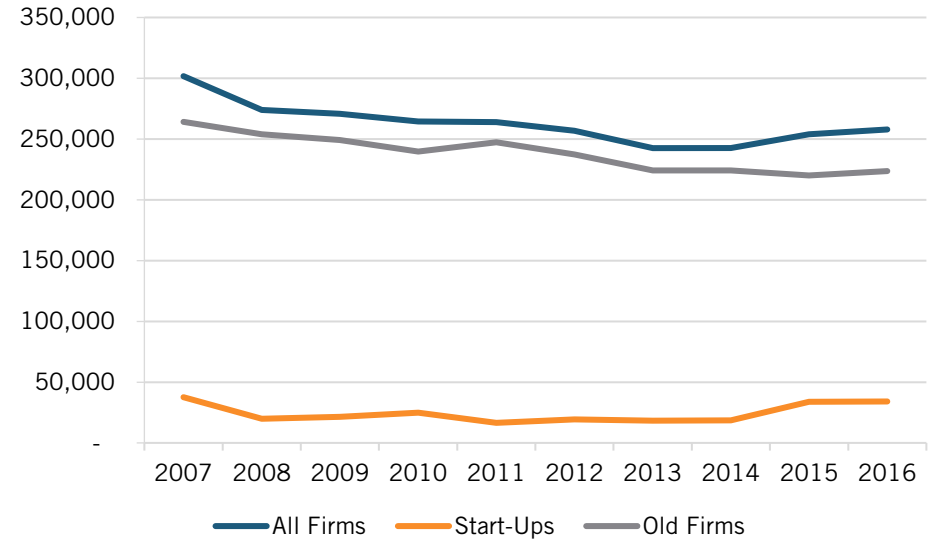
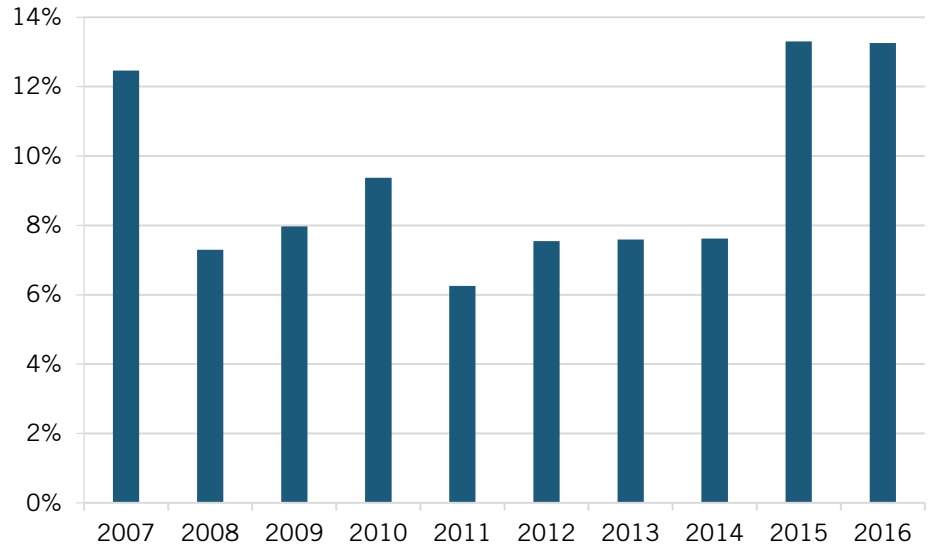


Figure 64: Employment in Start-Ups as a Share of Total Employment in the Aerospace Products and Parts Manufacturing Industry, 2007 to 2016



Early-stage start-ups, those that generate less than $3 million in revenue, account for 26 percent of all firms, and 60 percent of all start-ups; these figures have increased gradually from 2007 to 2016 (figure 65). In 2016, early-stage start-ups accounted for 31 percent of all firms, up from 23 percent in 2007. Most early-stage start-ups are small, with an average of five workers. From 2007 to 2016, they accounted for 0.9 percent of industry employment and 9.5 percent of start-up employment (figure 66). In 2016, early-stage start-ups employed 1.8 percent of all workers, up from 0.5 percent in 2007.

Figure 65: Early-Stage Start-Ups as a Share of All Firms in the Aerospace Products and Parts Industry, 2007 to 2016

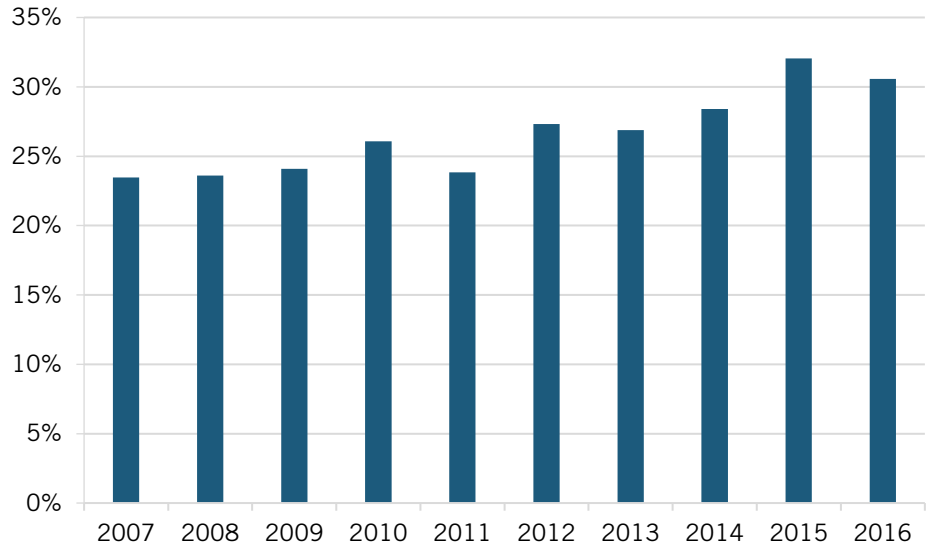
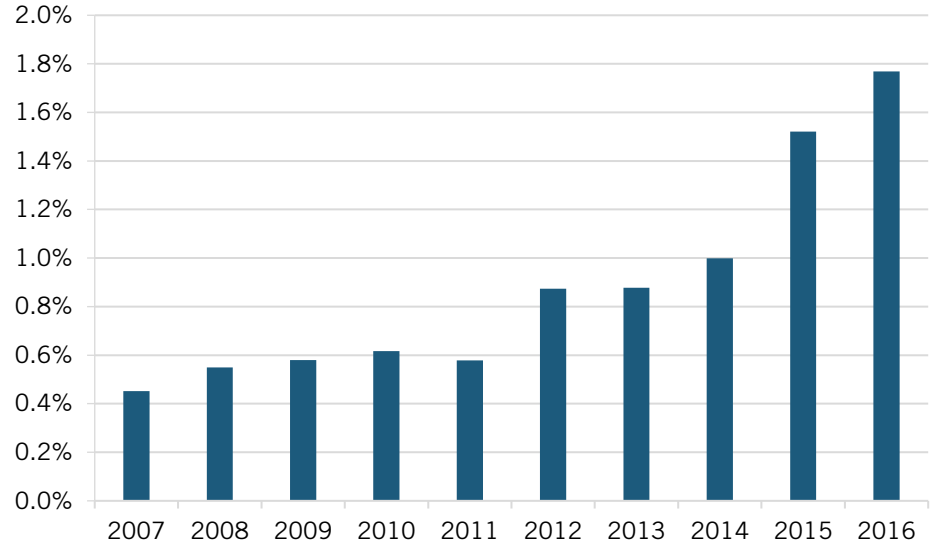
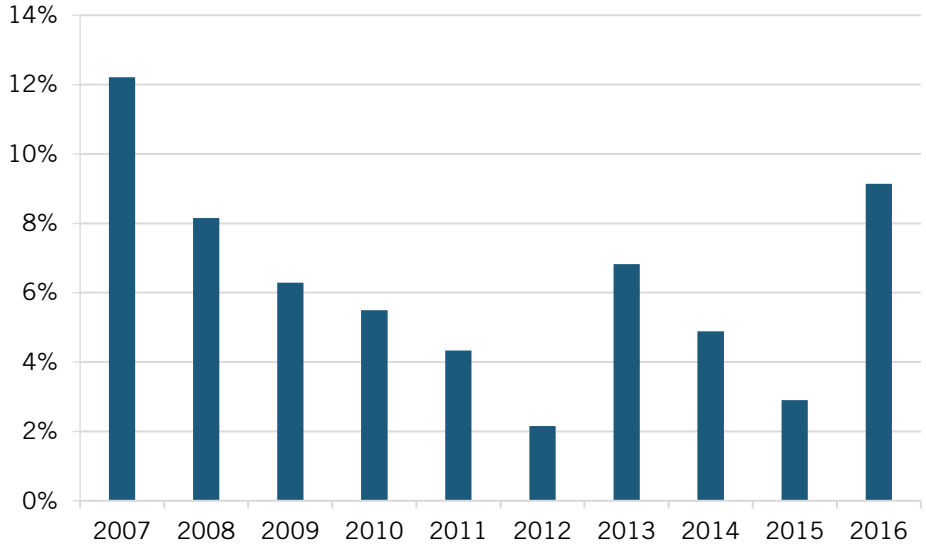


Figure 66: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Aerospace Products and Parts Manufacturing Industry, 2007 to 2016



High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past ten years. On average, 6 percent of start-ups demonstrate high growth annually (figure 67). In 2007, 12 percent of start-ups grew fast, with this share of firms decreasing to a low of 2 percent in 2012 before increasing to 9 percent in 2016.

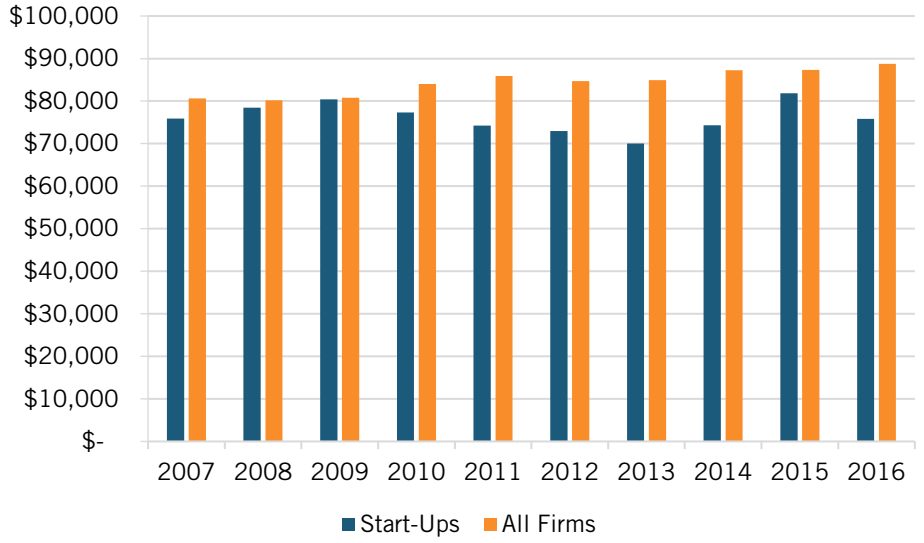
Figure 67: Share of Start-Ups With High Employment Growth in the Aerospace Products and Parts Industry, 2007 to 2016



Examining real wages, start-ups paid their workers 11 percent less than the industry average over the past ten years, and the average start-up wage was lower in 2016 than in 2007 (figure 68). In 2007, start-ups paid an average wage of $76,000, in contrast to the $80,000

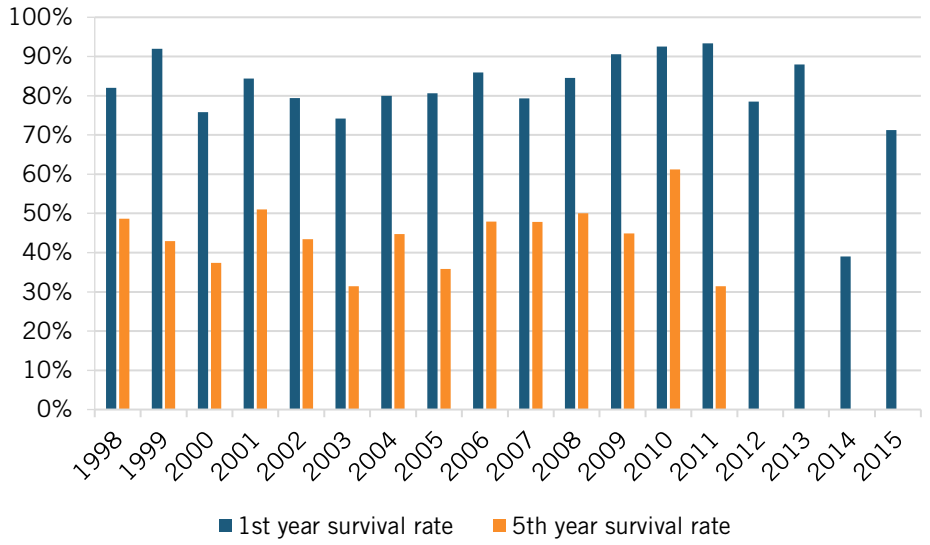
industry average—a 6 percent gap. From 2007 to 2016, real wages paid by start-ups stagnated while the industry average wage increased by 10 percent. In 2016, start-ups paid an average wage of $76,000, in contrast to the $89,000 industry average—a 7 per cent gap. In the post-recession years, wages in start-ups decreased while the industry average increased. And it is only in recent years that the average start-up wage has recovered to its pre-recession level.

Figure 68: Average Annual Wage (Real 2009 $) in the Aerospace Products and Parts Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 19 percent of new firms did not survive their first year in business; only 44 percent survived through the fifth year (figure 69). First-year survival rates have remained generally stable, increasing over the recession and falling since. Firms established in 2014 had the lowest first-year survival rate (40 percent) of the past decade. However, fifth-year survival rates have remained stable since 1998, increasing to a high of 60 percent in 2010 before decreasing to a low of 30 percent in 2011. In other words, fifty percent of firms established in 1998 were still in business by 2003, whereas thirty percent of firms established in 2011 were still in business by 2016.

Figure 69: Survival Rate of Start-Ups in the Aerospace Products and Parts Manufacturing Industry, 1998 to 2015



Medical Equipment and Supplies

Businesses in the medical equipment and supplies manufacturing sector develop and produce surgical, medical, optical, and dental instruments, devices, and supplies.

The sector employs 500,000 workers, is comprised of 17,000 firms, and accounts for 0.3 percent of gross U.S. output.[96] In terms of R&D investments, the sector invests $11 billion in domestic R&D, which translates to an R&D intensity of 4.4 percent; it represents 3 percent of U.S. business R&D investments.[97] The average firm employs 30 workers who are paid an average annual wage of $69,000. Additionally, approximately a tenth of the sector's workforce is in R&D-related occupations.[98]

Start-ups employ 35,000 workers across 1,600 firms. Overall, the state of technology-based entrepreneurship in the medical devices manufacturing industry is mixed, especially in recent years. Start-ups have decreased steadily over the past ten years, and so too has employment among them. However, the share of early-stage start-ups has remained unchanged while high-growth firms have increased in recent years. Wages have also increased much faster among start-ups and are almost at parity with the industry average.

From 2007 to 2016 in the medical devices manufacturing industry:

- Start-ups increased from 1,000 firms to 1,600 firms, a 56 percent increase.
  - As a share of all firms, an increase from 56 percent to 66 percent.
- Employment among start-ups decreased from 46,000 to 35,000, a 24 percent decrease.
  - As a share of total employment, a decrease from 15 percent to 12 percent.
- Early-stage start-ups account for 29 percent of firms in the industry and employ 3.7 percent of workers.

- Eight percent of start-ups experience high growth annually, i.e., these firms increased employment by over 30 percent compared to the previous year
    - For example, in 2016, high-growth start-ups made up 11 percent of start-ups and accounted for 15 percent of all start-up employees.
- Start-ups provide an annual wage 4 percent higher than the industry average.
    - From 2007 to 2016, real annual wages grew by 39 percent among start-ups, as compared to 26 percent across the industry.

Over the past ten years, medical equipment start-ups have decreased steadily in both gross figures and as a share of all firms. Since 2007, the number of start-ups has decreased 43 percent, from 10,000 firms in 2007 to 5,800 firms (figure 70), while start-ups as a share of all firms have decreased 15 percentage points from 49 percent to 34 percent (figure 71). Start-up growth slightly declined during the recession, and recovered by 2012, before decreasing year-after-year since. Over this same period, the number of mature firms remained constant.

Figure 70: Number of Firms in the Medical Equipment Manufacturing Industry, 2007 to 2016

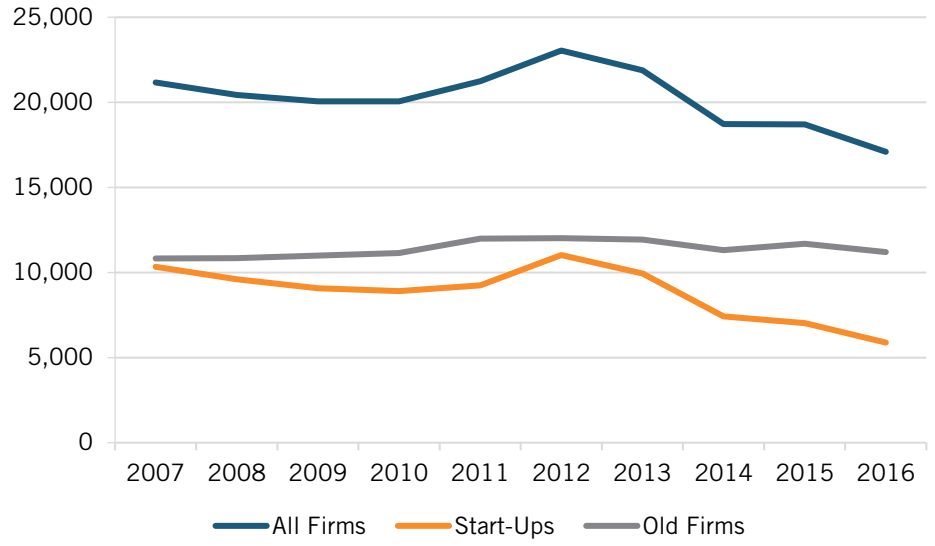
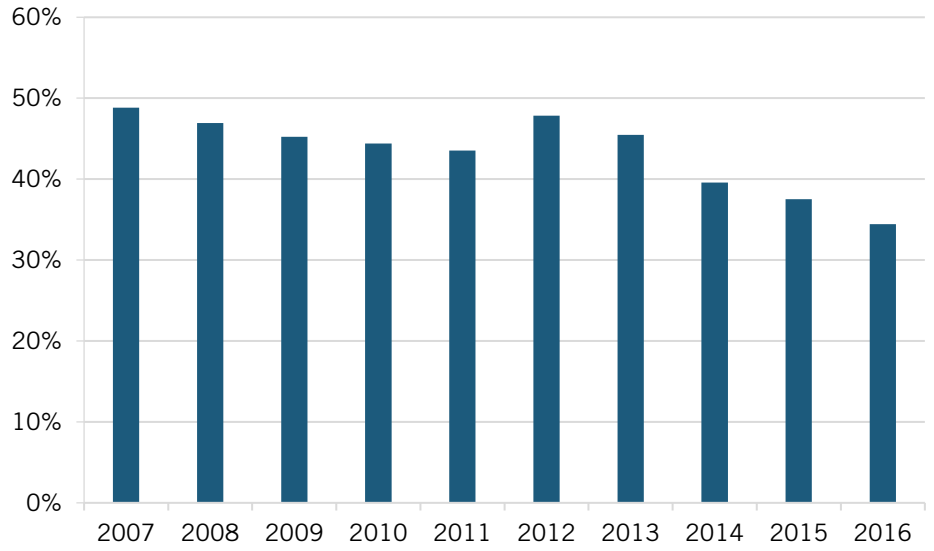


Figure 71: Start-Ups as a Share of Total Firms in the Medical Equipment Manufacturing Industry, 2007 to 2016



Employment across the industry has decreased since 2007, with start-ups the main contributor to this decrease (gross employment in older firms increased over this period). In 2007, start-ups employed 166,000 workers, with this figure decreasing by 63 percent to 62,000 in 2016 (figure 72). Meanwhile, across the industry, employment increased by 9 percent. The recession may have had a particularly large impact on start-ups in this industry, with both the number of new start-ups and employment among start-ups showing no signs of recovery. Due to the decrease in start-ups, they also account for a smaller share of total industry employment in 2016 than in 2007, 12 percent as compared to 28 percent, a 16 percentage point difference (figure 73).

Figure 72: Employment in the Medical Equipment Manufacturing Industry, 2007 to 2016

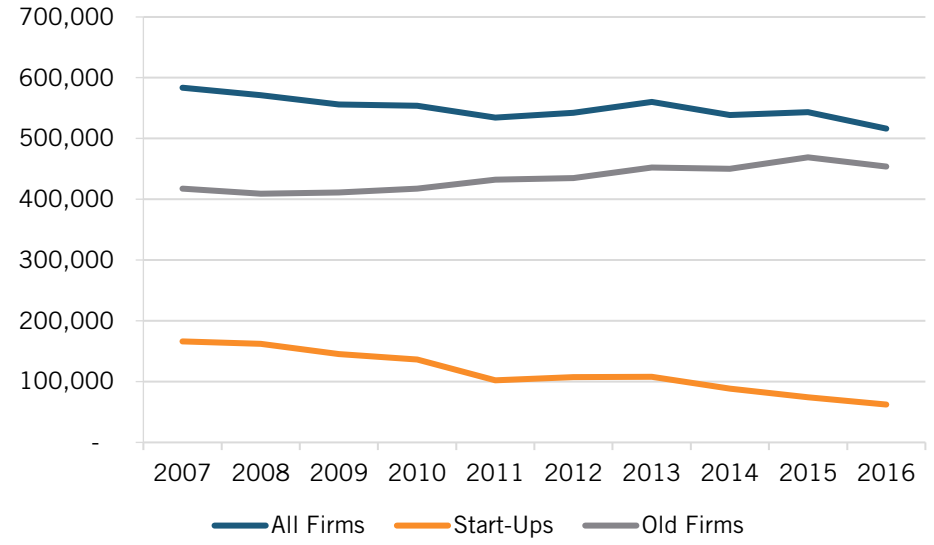
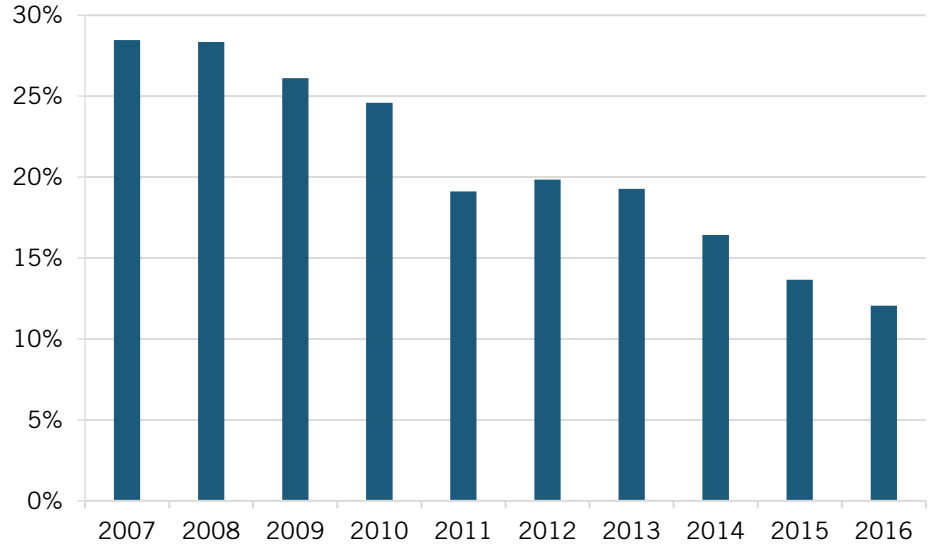


Figure 73: Employment in Start-Ups as a Share of Total Employment in the Medical Equipment Manufacturing Industry, 2007 to 2016



Early-stage start-ups, those that generate less than $1 million in revenue, account for 29 percent of all firms, and 68 percent of all start-ups; this firm share increased then decreased from 2007 to 2016 (figure 74). In both 2007 and 2016, early-stage start-ups accounted for 27 percent of all firms. Most early-stage start-ups are small, with an average of three workers. From 2007 to 2016, they accounted for 3.7 percent of industry employment and 19.2 percent of start-up employment (figure 75). In 2016, early-stage start-ups employed 4.0 percent of all workers, up from 3.7 percent in 2007.

Figure 74: Early-Stage Start-Ups as a Share of All Firms in the Medical Equipment Manufacturing Industry, 2007 to 2016

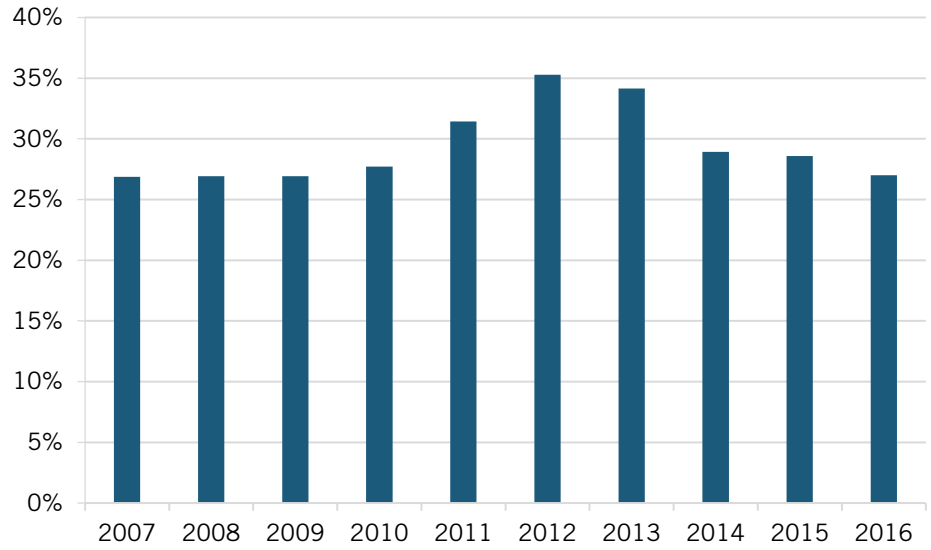
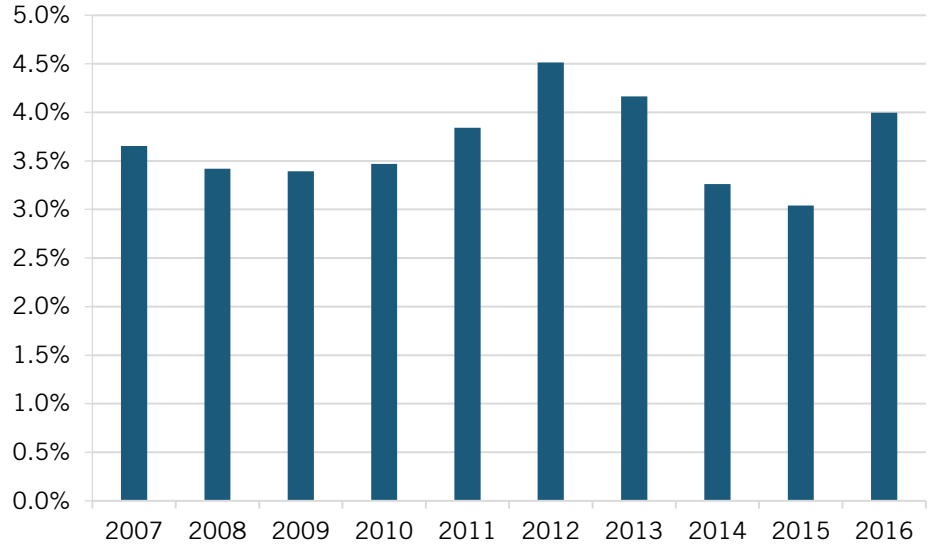
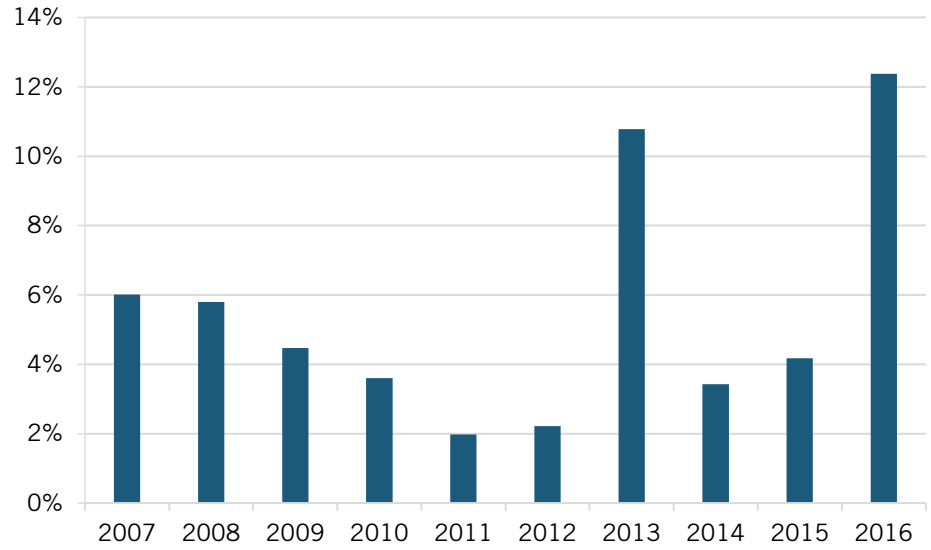


Figure 75: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Medical Equipment Manufacturing Industry, 2007 to 2016



High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past ten years. On average, 5 percent of start-ups demonstrate high-growth annually (figure 76). In 2007, 6 percent of start-ups grew fast, with this share of firms decreasing to a low of 2 percent in 2011 before increasing to 12 percent in 2016. With fewer start-ups in the industry, it is a strong positive that a larger share of them are growing fast in recent years.

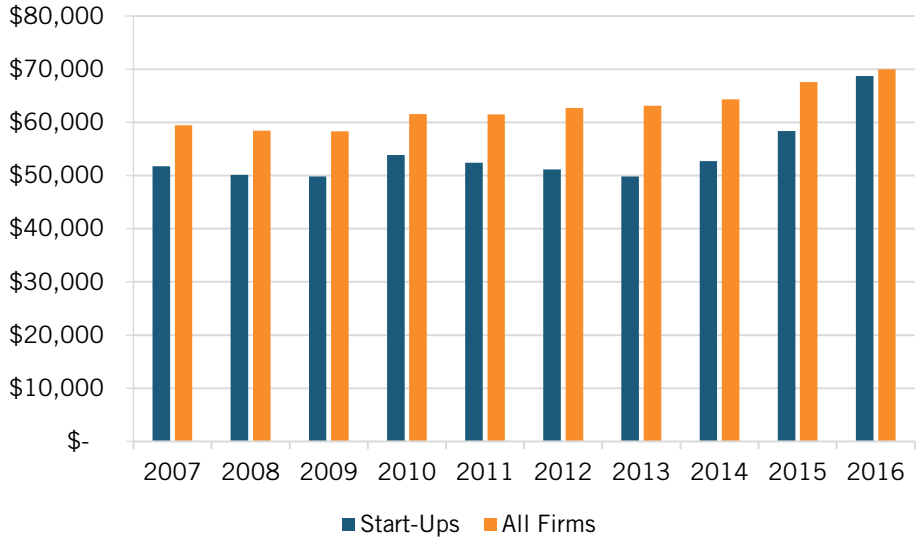
Figure 76: Share of Start-Ups With High Employment Growth in the Medical Equipment Manufacturing Industry, 2007 to 2016



Examining real wages, start-ups paid their workers 16 percent less than the industry average over the past ten years (figure 77). In 2007, start-ups paid an average wage of $52,000, in

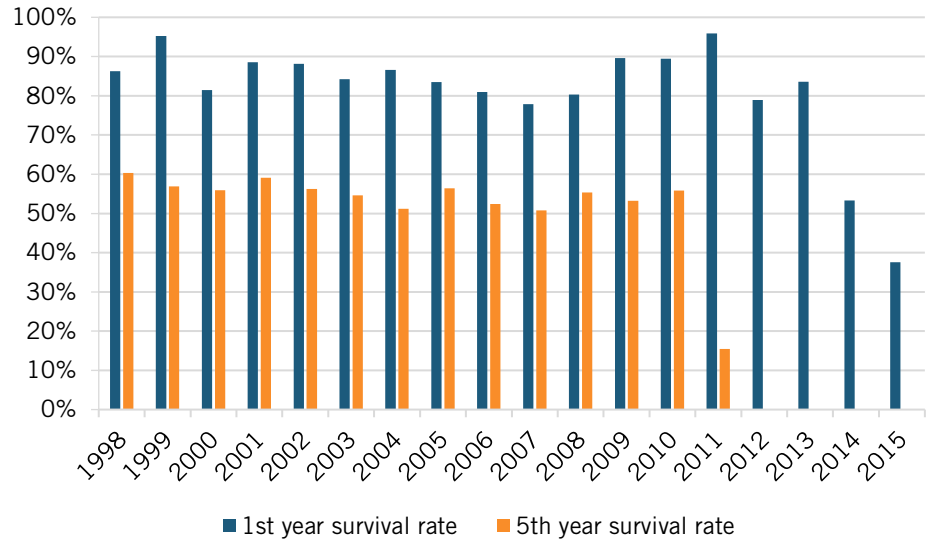
contrast to the $59,000 industry average—a difference of 15 percent. Real wages have grown faster among start-ups than across the industry. From 2007 to 2016, real wages grew by 33 percent among start-ups, as compared to 18 percent across the industry. In 2016, start-ups paid an average wage of $69,000, in contrast to the $70,000 industry average. While real wages among start-ups stagnated from 2007 to 2014, they increased by 30 percent from 2014 to 2016, bringing these wages into parity with the industry average.

Figure 77: Average Annual Wage (Real 2009 $) in the Medical Equipment Manufacturing Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 19 percent of new firms did not survive their first year in business; year, only 53 percent survived through the fifth year (figure 78). First-year survival rates have remained generally stable, but have been decreasing since 2011. Fifth-year survival rates have remained stable at just above 50 percent. In other words, firms appear to have had the same chances of surviving in the industry in 2010 as in 1998. Sixty percent of firms established in 1998 were still in business by 2013, while only 55 percent of firms that were established in 2010 were still in business by 2015.

Figure 78: Survival Rate of Start-Ups in the Medical Equipment Industry, 1998 to 2015



Software Publishers

Businesses in this sector design, develop, and/or publish computer software. The sector employs 80,000 workers, is comprised of 900 firms, and accounts for 0.6 percent of gross U.S. output.[99] In terms of R&D investments, the sector invests $35 billion in domestic R&D, which translates to an R&D intensity of 9 percent; it represents 11 percent of U.S. business R&D investments.[100] The average firm employs 90 workers who are paid an average annual wage of $133,000. Additionally, approximately a quarter of the sector's workforce is in R&D-related occupations.[101]

Start-ups employ 10,000 workers across 600 firms. Overall, the state of technology-based entrepreneurship in the software publishing industry is mixed. After a huge increase in start-ups post-recession, the number of start-ups started to decrease from 2010 onwards, and employment among these firms stagnated. The share of early-stage start-ups has been constant in recent years, while high-growth start-ups appeared with greater frequency in the earlier half of this ten-year period. Wages among start-ups have caught up to the industry average in recent years and fifth-year survival rates have been higher than average for firms opened in 2010 and 2011.

From 2007 to 2016 in the software publishing industry:

- Start-ups increased from 500 firms to 600 firms, a 56 percent increase.
  - As a share of all firms, an increase from 59 percent to 66 percent.
- Employment among start-ups remained stable at approximately 10,000 workers.
  - As a share of total employment, a decrease from 13 percent to 12 percent.
- Early-stage start-ups account for 18 percent of firms in the industry and employ 2.1 percent of workers.
- Nine percent of start-ups experience high growth annually, i.e., the firm increased employment by over 25 percent compared to the previous year

- Start-ups provide an annual wage 19 percent lower than the industry average.
  - From 2007 to 2016, real annual wages grew by 42 percent among start-ups, as compared to 12 percent across the industry.

From 2007 to 2010, software start-ups have increased sharply, then over the next six years decreased in both gross figures and as a share of all firms. From 2007 to 2010, the number of start-ups increased 53 percent, from 500 to 1,000 firms; then from 2010 to 2016, decreased 33 percent to 600 firms (figure 79). Start-ups as a share of all firms increased from 60 percent to 77 percent from 2007 to 2010, then decreased to 66 percent from 2010 to 2016—an overall increase of 6 points (figure 80). Across the rest of the industry, the number of older firms has remained stable across this period at approximately 300.

Figure 79: Number of Firms in the Software Publishing Industry, 2007 to 2016

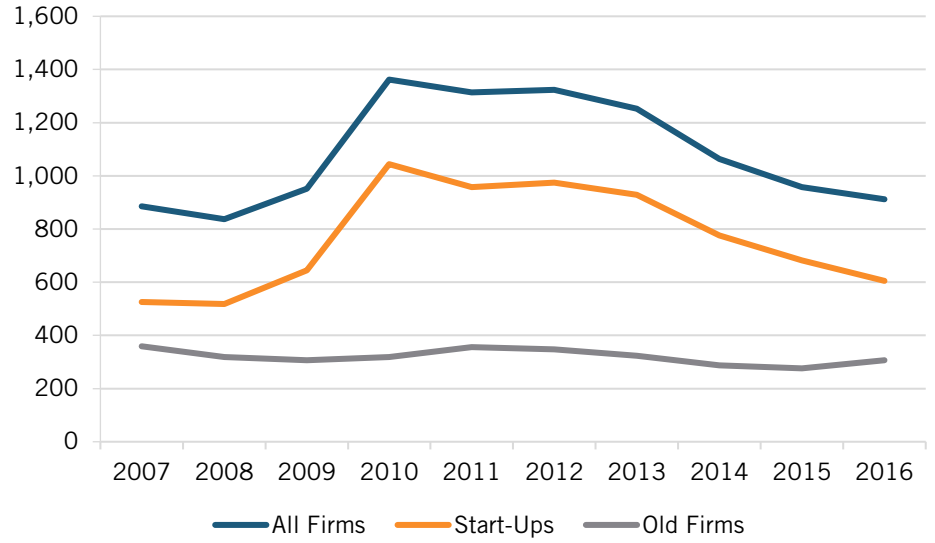
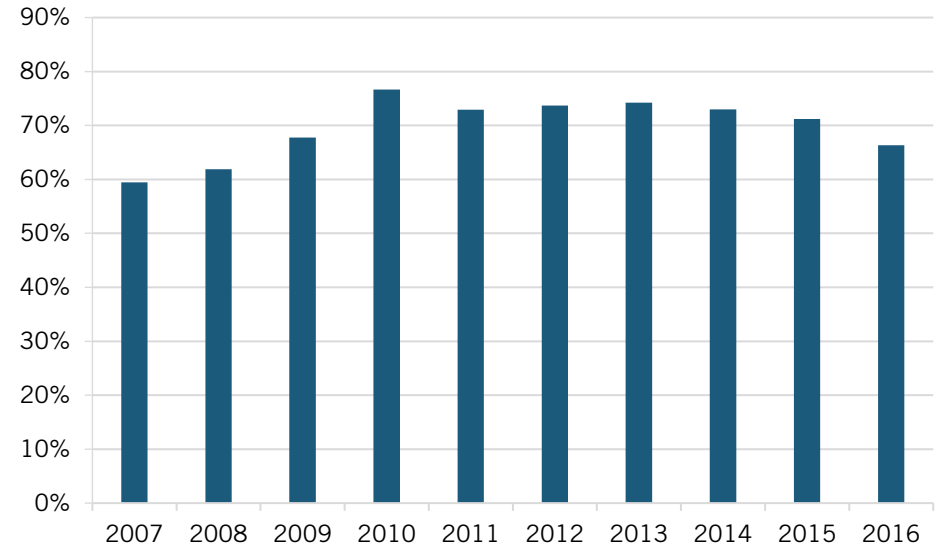


Figure 80: Start-Ups as a Share of Total Firms in the Software Publishing Industry, 2007 to 2016



While start-ups have displayed strong growth and contractions in numbers, employment among those firms has remained quite stable; they employed an average 11,000 workers annually from 2007 to 2016 (figure 81). Start-ups employed 14 percent of all industry workers in 2007, with this share increasing to 18 percent in 2013, then decreasing to 12 percent by 2016—an overall decrease of 2 points (figure 82).

Figure 81: Employment in the Software Publishing Industry, 2007 to 2016

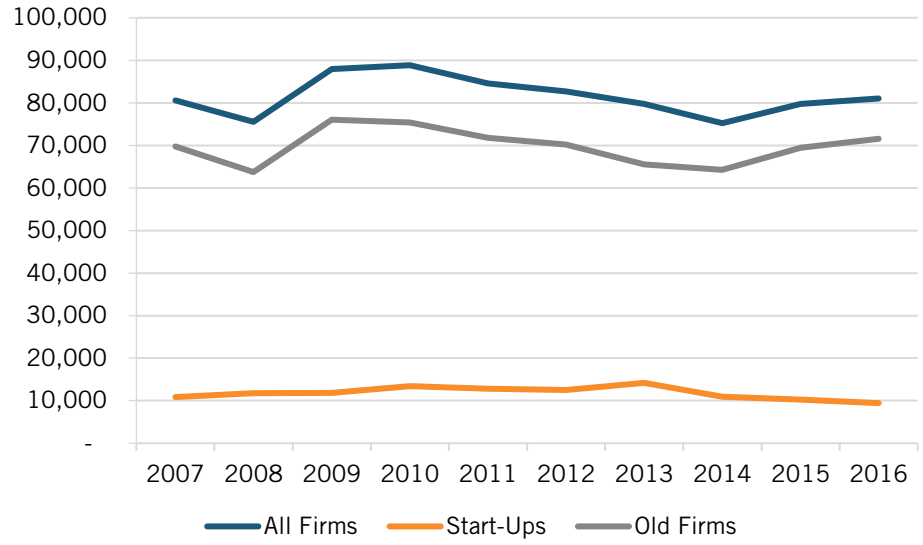
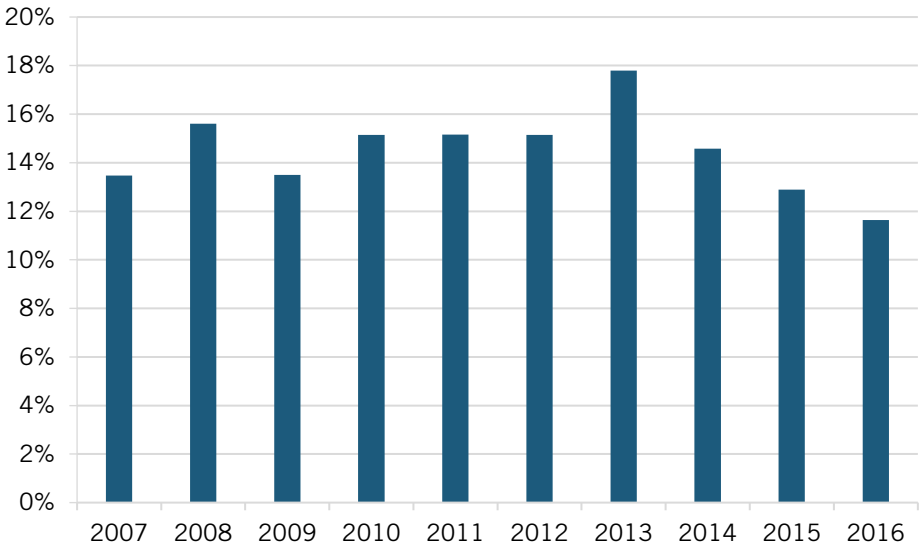


Figure 82: Employment in Start-Ups as a Share of Total Employment in the Software Publishing Industry, 2007 to 2016



Early-stage start-ups, those that generate less than $750,000, account for 18 percent of all firms, and 26 percent of all start-ups; and these values have increased gradually from 2007 to 2016 (figure 83). In 2016, early-stage start-ups accounted for 19 percent of all firms, up from 14 percent in 2007. Most early-stage start-ups are small, with an average of eight workers. From 2007 to 2016, they accounted for 2.1 percent of industry employment and 14.7 percent of start-up employment (figure 84). In 2016, early-stage start-ups employed 1.5 percent of all workers, down from 2.5 percent in 2007.

Figure 83: Early-Stage Start-Ups as a Share of All Firms in the Software Publishing Industry, 2007 to 2016

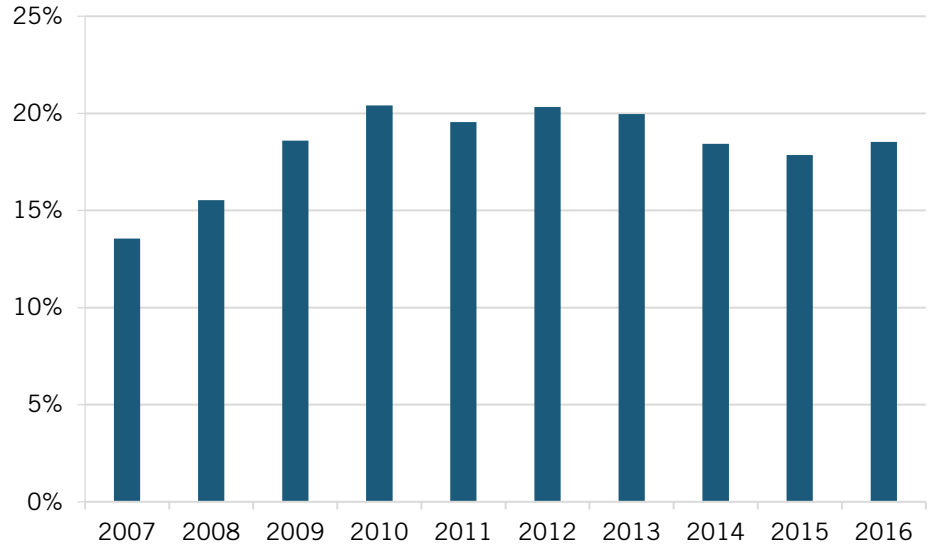
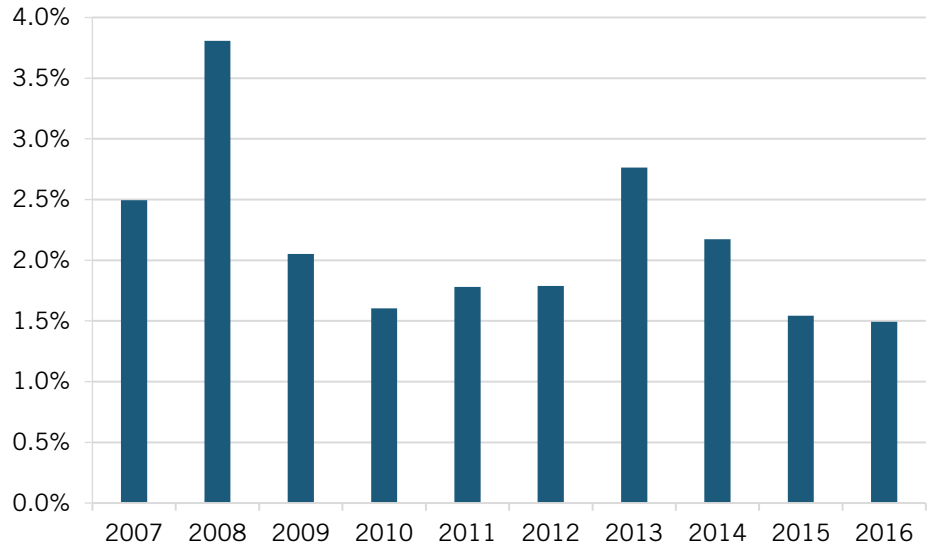
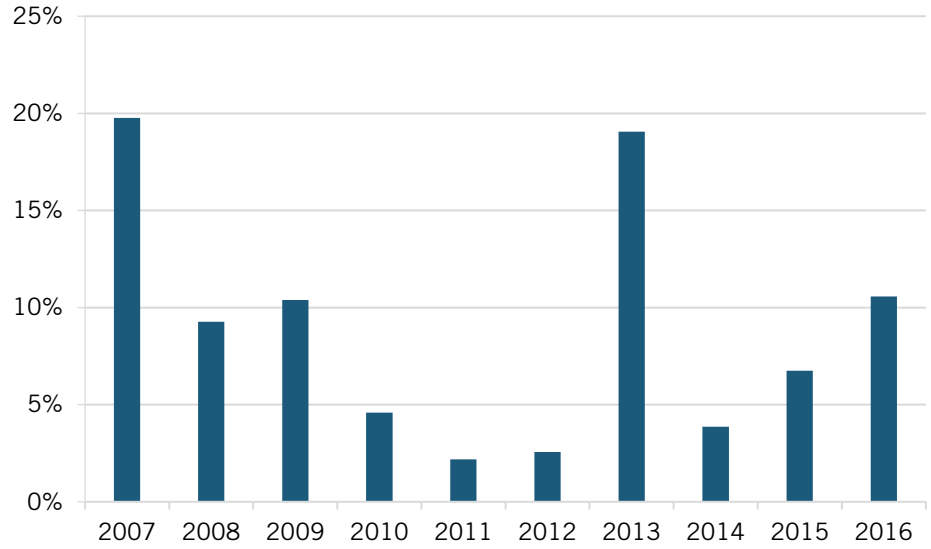


Figure 84: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Software Publishing Industry, 2007 to 2016



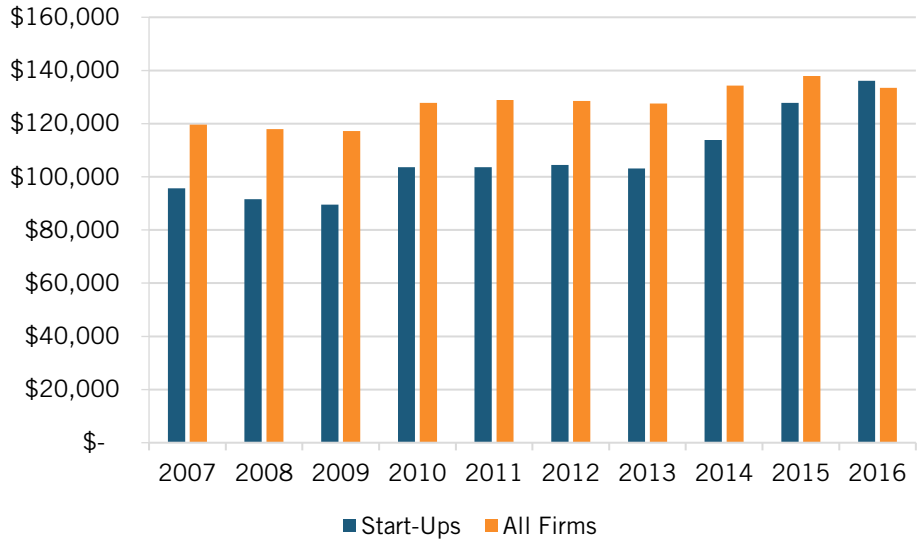
High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past decade. On average, 9 percent of start-ups demonstrate high growth annually, with the share of start-ups experiencing growth in excess of 10 percent in 4 of the 10 past years (figure 85). This group of firms has made outsized contributions to employment. For example, in 2016, high-growth start-ups made up 11 percent of start-ups but employed 14 percent of all those employed by start-ups.

Figure 85: Share of Start-Ups With High Employment Growth in the Software Publishing Industry, 2007 to 2016



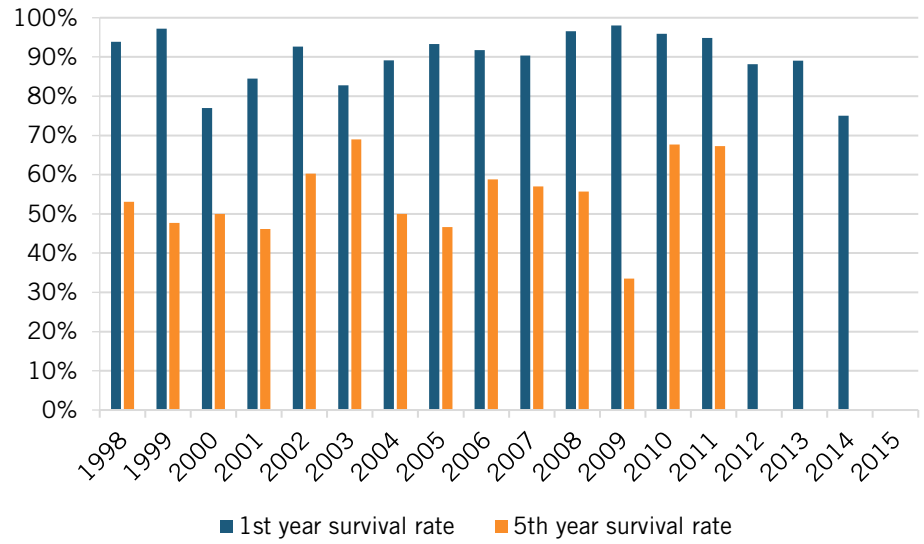
Examining real wages, start-ups paid their workers 19 percent less than the industry average over the past ten years. In 2016, start-ups offered a higher wage then the industry average (figure 86). In 2007, start-ups paid an average wage of $95,000, in contrast to the $119,000 industry average. Due to real wages growing faster among start-ups than across the industry over the following 10 years, in 2016, start-ups paid an average wage of $136,000, in contrast to the $133,000 industry average. Over this period, real wages grew by 42 percent among start-ups, compared to 12 percent growth across the industry.

Figure 86: Average Annual Wage (Real 2009 $) in the Software Publishing Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 10 percent of new firms did not survive their first year in business; only 54 percent survived through the fifth year (figure 87). First-year survival rates remained at around 90 percent from 1998 to 2013, with the survival rate decreasing to below 80 percent in 2014. Fifth-year survival rates remained at around 50 percent from 1998 until a sharp decrease to 30 percent for firms that started during the recession year of 2009. Approximately 70 percent of firms that started business in 2010 and 2011 were still in business in 2015 and 2016 respectively.

Figure 87: Survival Rate of Start-Ups in the Data Processing Industry, 1998 to 2015



Data Processing, Hosting, and Related services

Businesses in this sector develop and provide infrastructure for hosting or data processing services (i.e., hosting physical servers, cloud computing services).

The sector employs 500,000 workers, is comprised of 38,000 firms, and accounts for just under half-a-percent of gross U.S. output.[102] In terms of R&D investments, the sector invests $6 billion in domestic R&D, which translates to an R&D intensity of 8 percent; it represents 2.5 percent of U.S. business R&D investments.[103] The average firm employs 14 workers who are paid an average annual wage of $98,000. Additionally, approximately 15 percent of the sector's workforce is in R&D-related occupations.[104]

Start-ups employ 200,000 workers across 30,000 firms. Overall, the state of technology-based entrepreneurship in the data processing services industry is mixed. The number of start-ups entering the industry has decreased in recent years, while employment among these firms has remained stable. However, start-ups have consistently paid wages in excess of the industry average since 2010. In recent years, early-stage start-ups have decreased, but high-growth start-ups have appeared more frequently. From 2011 onwards, start-ups have also had greater difficulty surviving through their first year of business than in previous years.

From 2007 to 2016 in the data processing service industry:

- Start-ups increased from 24,000 firms to 30,000 firms, a 27 percent increase.
  - As a share of all firms, an increase from 87 percent to 80 percent.
- Employment among start-ups remained stable at 200,000 workers.
  - As a share of total employment, a decrease from 57 percent to 40 percent.
- Early-stage start-ups account for 10 percent of firms in the industry and employ 1.8 percent of workers.
- Seven percent of start-ups experience high growth annually, i.e., these firms increased employment by over 25 percent compared to the previous year.
- Start-ups provide an annual wage 8 percent higher than the industry average.
  - From 2007 to 2016, real annual wages grew by 53 percent among start-ups, as compared to 29 percent across the industry.

Over the past ten years, data processing start-ups have increased steadily in gross figures, but have decreased as a share of all firms. Since 2007, the number of start-ups has increased 27 percent, from 24,000 firms in 2007 to 30,00 firms in 2016 (figure 88), while start-ups as a share of all firms have decreased 7 percentage points from 87 percent to 80 percent (figure 89). The number of start-ups remained stable during the recession years before increasing rapidly since 2011 (The number of start-ups decreased slightly in 2016). Older firms increased gradually over the recession years and the number of these firms has remained stable since 2012. Start-ups as a share of all firms have decreased since 2007; this was driven mainly by the number of older firms growing faster than start-ups.

Figure 88: Number of Firms in the Data Processing Industry, 2007 to 2016

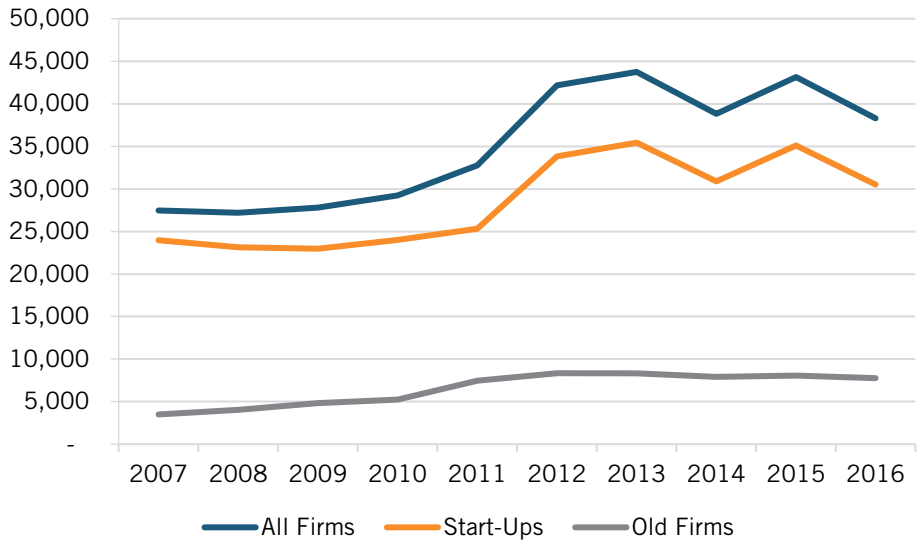
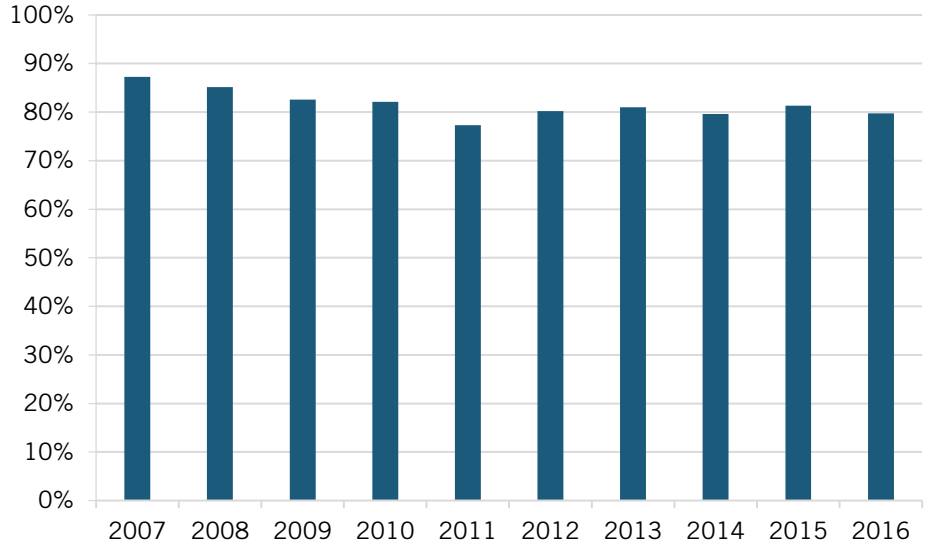


Figure 89: Start-Ups as a Share of Total Firms in the Data Processing Industry, 2007 to 2016



While the number of start-ups has increased over the past decade, employment among start-ups remained stable. They employed an average 200,000 workers annually (figure 90). Among old firms, employment more than doubled from 150,000 to 320,000 over the same period. Due to the increase in employment among old firms, start-ups have gradually accounted for less and less of the industry's share of workers. In 2007, start-ups employed more than half of the workers in this industry (57 percent); this figure decreased by 17 percentage points by 2016 (figure 91). As this industry continues to mature, it is likely that start-ups will account for an ever-decreasing share of total employment.

Figure 90: Employment in the Data Processing Industry, 2007 to 2016

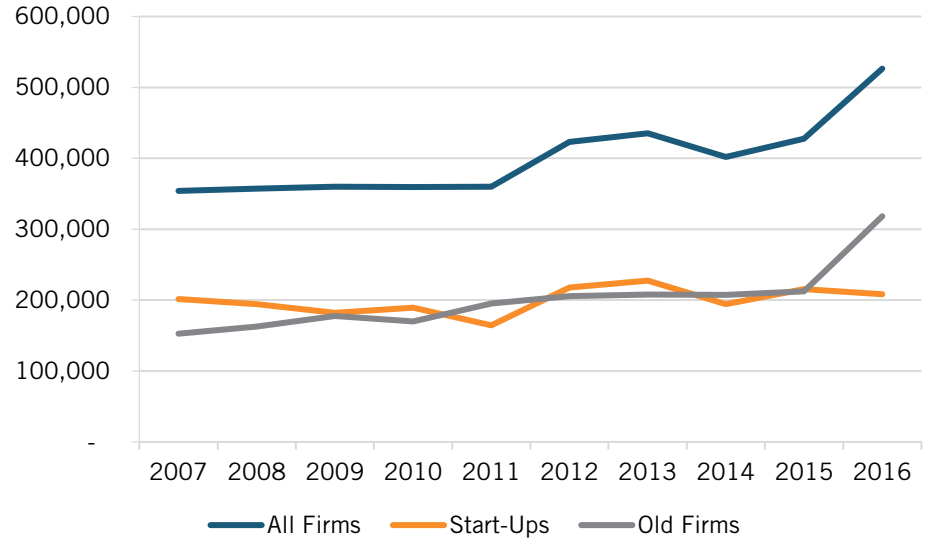
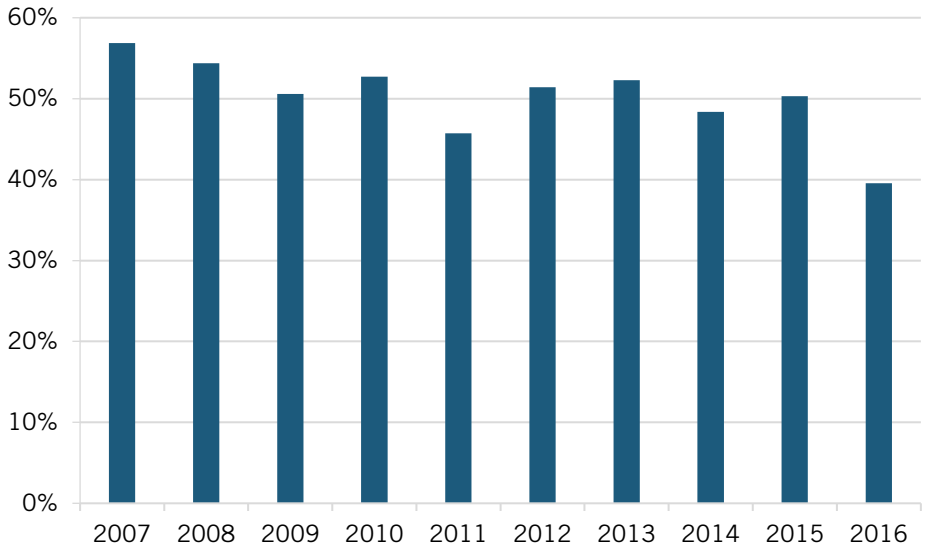


Figure 91: Employment in Start-Ups as a Share of Total Employment in the Data Processing Industry, 2007 to 2016



Early-stage start-ups account for 10 percent of all firms, and 12 percent of all start-ups, and these figures have sharply decreased from 2007 to 2016 (figure 92). In 2016, early-stage start-ups accounted for 5 percent of all firms, down from 16 percent in 2007. Most early-stage start-ups are very small, with an average of two workers. From 2007 to 2016, they accounted for 1.8 percent of industry employment and 3.4 percent of start-up employment (figure 93). In 2016, early-stage start-ups employed 0.7 percent of all workers, down from 3.3 percent in 2007.

Figure 92: Early-Stage Start-Ups as a Share of All Firms in the Data Processing Industry, 2007 to 2016

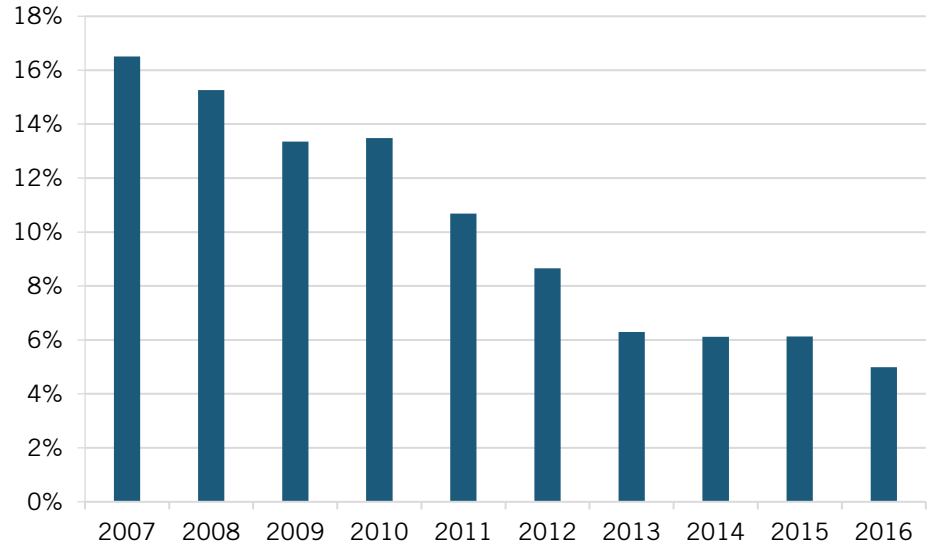
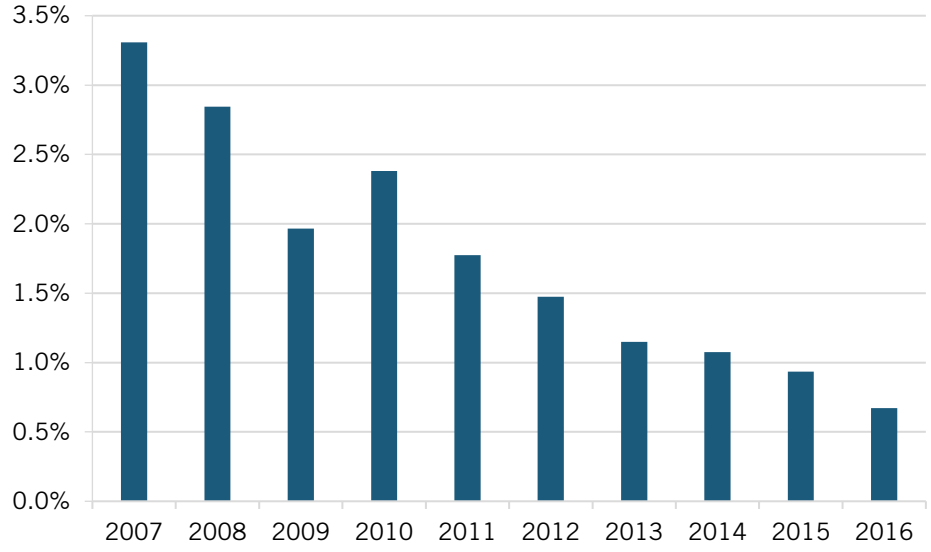
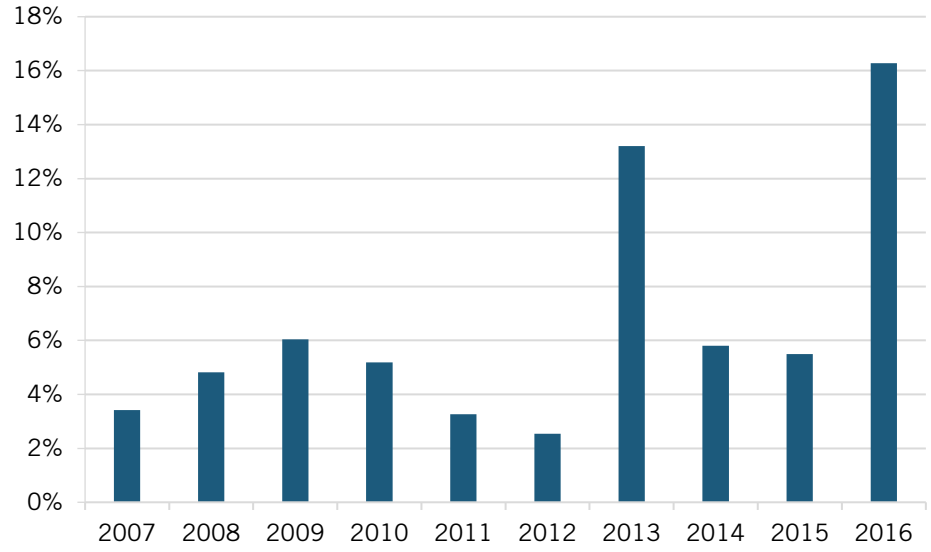


Figure 93: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Data Processing Industry, 2007 to 2016



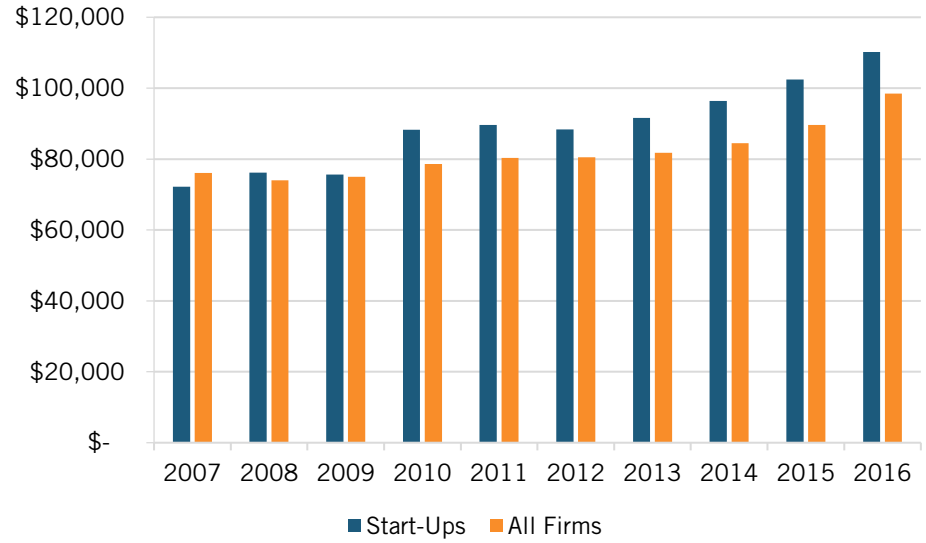
High-growth start-ups generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past decade. On average, 7 percent of start-ups demonstrate high growth annually, with start-ups in the more recent five years performing better than those in the earlier five years (figure 94). In 2007, 4 percent of start-ups grew fast, with this share of firms decreasing to a low of 3 percent in 2012 before increasing to 16 percent in 2016. This group of firms has made outsized contributions to employment. For example, in 2016, high-growth start-ups made up 16 percent of start-ups but employed 17 percent of all those employed by start-ups.

Figure 94: Share of Start-Ups With High Employment Growth in the Data Processing Industry, 2007 to 2016



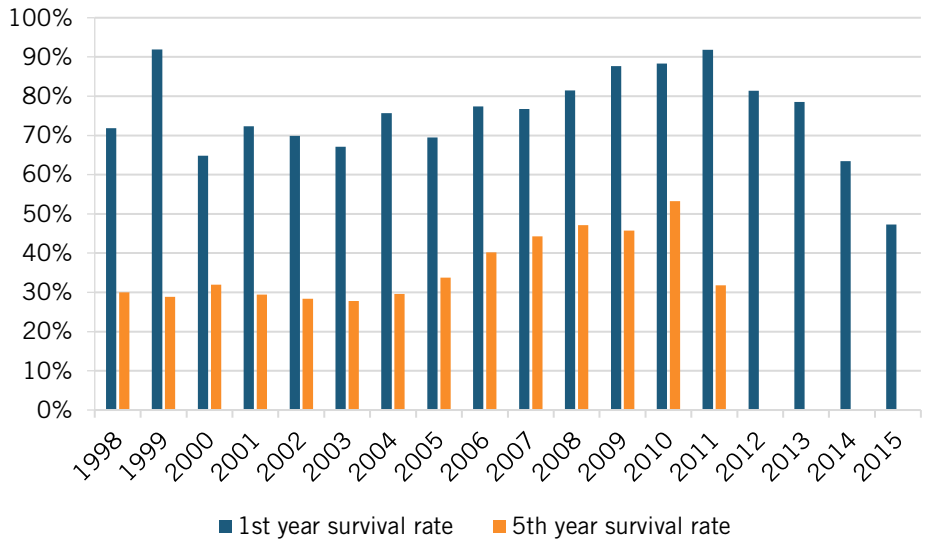
Examining real wages, start-ups paid their workers 8 percent more than the industry average over the past ten years. In nine of these ten years, average annual wages paid by start-ups were higher than the industry average (figure 95). In 2007, start-ups paid an average wage of $72,000, in contrast to the $76,000 industry average. Real wages have also grown faster among start-ups than across the industry. In 2007, the average wage among start-ups was 8 percent lower than the industry average, but by 2016, start-ups paid an average wage 12 percent higher than the industry average. From 2007 to 2016, real wages grew by 53 percent among start-ups, as compared to 29 percent across the industry. In 2016, start-ups paid an average wage of $110,000, in contrast to the $98,000 industry average.

Figure 95: Average Annual Wage (Real 2009 $) in the Data Processing Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 25 percent of new firms did not survive their first year in business; only 36 percent survived through the fifth year (figure 96). First-year survival rates remained around 70 percent from 1998 to 2007, with survival rate increasing over the recession years to a high of 92 percent in 2011, before decreasing to a low of 47 percent in 2015. Fifth-year survival rates remained stable in the early 2000s before increasing to a high of 50 percent in 2010, then decreasing to 30 percent in 2011. In fact, a firm started in 1998 had the same chances of surviving through its fifth year as a firm started in 2011.

Figure 96: Survival Rate of Start-ups in the Data Processing Industry, 1998 to 2015



Computer Systems Design and Related Services

Businesses in the computer system design services sector provide services for customer-specific software development, integrating computer systems and networks, and management of business IT infrastructure.

The sector employs 800,000 workers, is comprised of 96,000 firms, and accounts for 1.1 percent of gross U.S. output.[105] In terms of R&D investments, the sector invests $9 billion in domestic R&D, which translates to an R&D intensity of 8.4 percent. It represents 3 percent of U.S. business R&D investments.[106] The average firm employs eight workers who are paid an average annual wage of $100,000. Additionally, approximately 15 percent of the sector's workforce is in R&D-related occupations.[107]

Start-ups employ 440,000 workers across 75,000 firms. Overall, the state of technology-based entrepreneurship in the computer systems and design services industry is positive, especially in recent years. Start-ups have entered the industry in greater numbers than before, with employment growth keeping pace. High-growth start-ups have appeared in greater numbers over the past five years than in the preceding five. Wage growth has also increased much faster in start-ups than across the industry.

From 2007 to 2016 in the computer systems and design services industry:

- Start-ups increased from 48,000 firms to 75,000 firms, a 56 percent increase.
  - As a share of all firms, a decrease from 82 percent to 78 percent.
- Employment among start-ups increased from 340,000 to 440,000, a 28 percent increase.
  - As a share of total employment, a decrease from 56 percent to 54 percent
- Early-stage start-ups account for 12 percent of firms in the industry and employ 2.3 percent of workers.
- Six percent of start-ups experience high-growth annually, i.e., these firms increase employment by over 25 percent compared to the previous year.
- Start-ups provide an annual wage 2 percent less than the industry average.
  - From 2007 to 2016, real annual wages grew by 13 percent among start-ups, as compared to 9 percent across the industry.

Over the past ten years, computer design services start-ups have increased in gross numbers but decreased as a share of all firms. Since 2007, the number of start-ups has increased 56 percent, from 48,000 firms in 2007 to 75,000 firms in 2016 (figure 97), while start-ups as a share of all firms have decreased 4 percentage points from 82 percent to 78 percent (figure 98). Start-up growth remained stable during the recession years, experienced a sizable increase in 2012, and then decreased until 2014, before experiencing an increase over the past two years.

Figure 97: Number of Firms in the Computer Systems Design Services Industry, 2007 to 2016

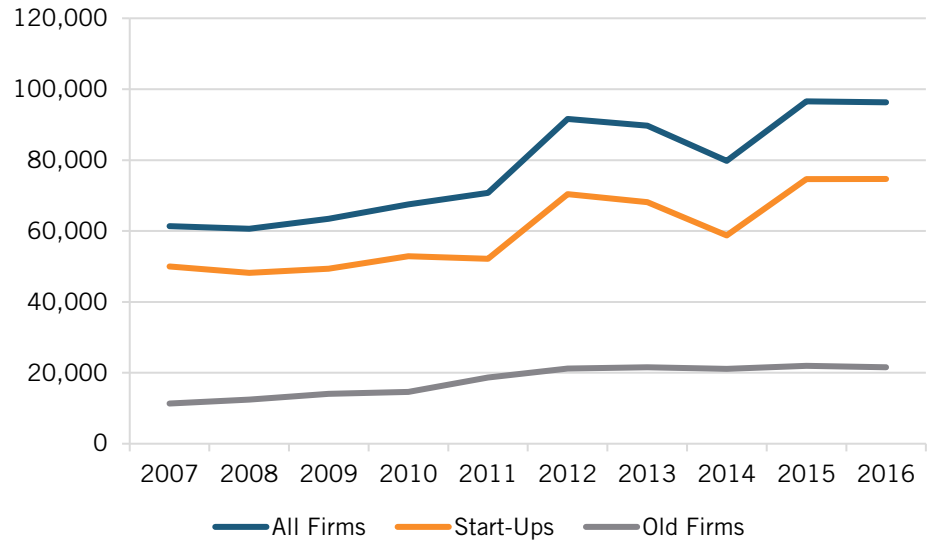
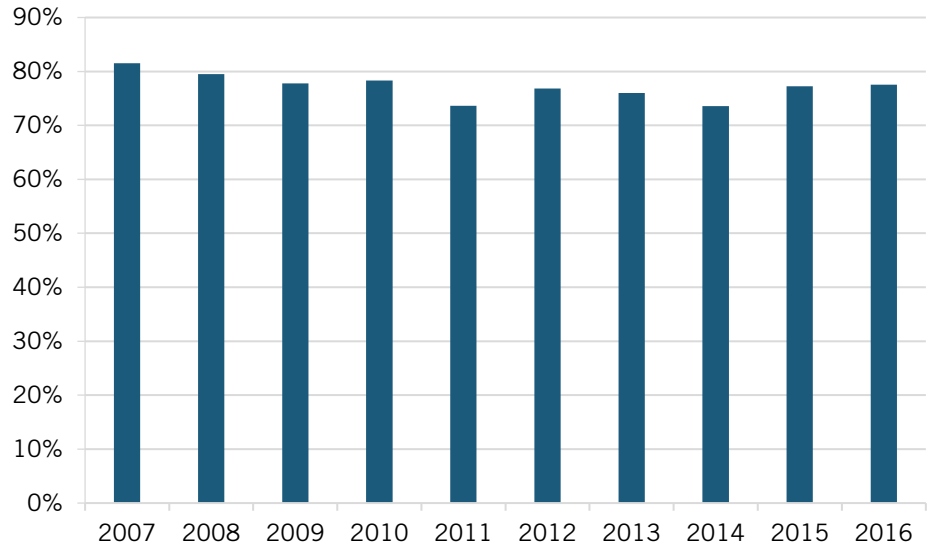


Figure 98: Start-Ups as a Share of Total Firms in the Computer Systems Design Services Industry, 2007 to 2016



Employment across the industry, for both start-ups and older firms, grew by approximately 100,000 workers each from 2007 to 2016. In 2007, start-ups employed 340,000 workers, with this figure increasing by 28 percent to 440,000 in 2016 (figure 99). Meanwhile, across

the rest of the industry, employment increased by 42 percent. Start-ups were also responsible for a smaller share of total industry employment in 2016 than in 2007, 56 percent as compared to 54 percent (figure 100). Although start-up's share of employment decreased slightly, this share has remained stable over this period.

Figure 99: Employment in the Computer Systems Design Services Industry, 2007 to 2016

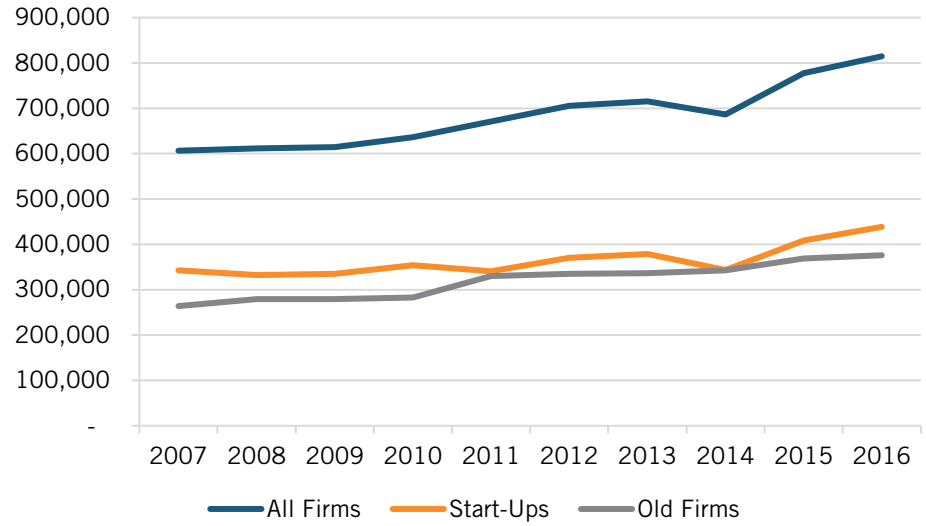
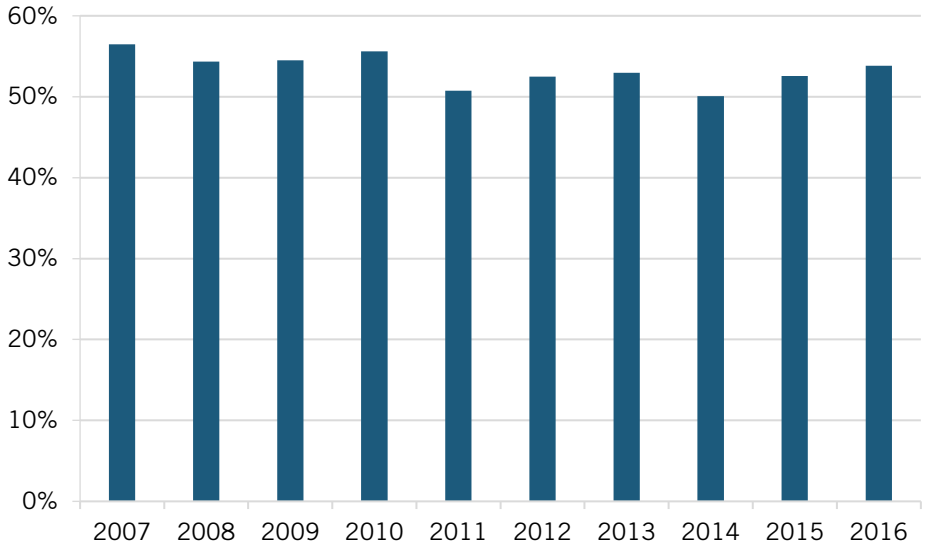


Figure 100: Employment in Start-Ups as a Share of Total Employment in the Computer Systems Design Services Industry, 2007 to 2016



Early-stage start-ups account for 12 percent of all firms, and 15 percent of all start-ups, and these figures have decreased from 2007 to 2016 (figure 101). In 2016, early-stage start-ups accounted for 8 percent of all firms, down from 13 percent in 2007. Most early-stage start-ups are very small, with an average of two workers. From 2007 to 2016, they accounted for 2.3 percent of industry employment and 4.3 percent of start-up employment (figure 102).

In 2016, early-stage start-ups employed 1.5 percent of all workers, down from 2.9 percent in 2007.

Figure 101: Early-Stage Start-Ups as a Share of All Firms in the Computer Systems Design Services Industry, 2007 to 2016

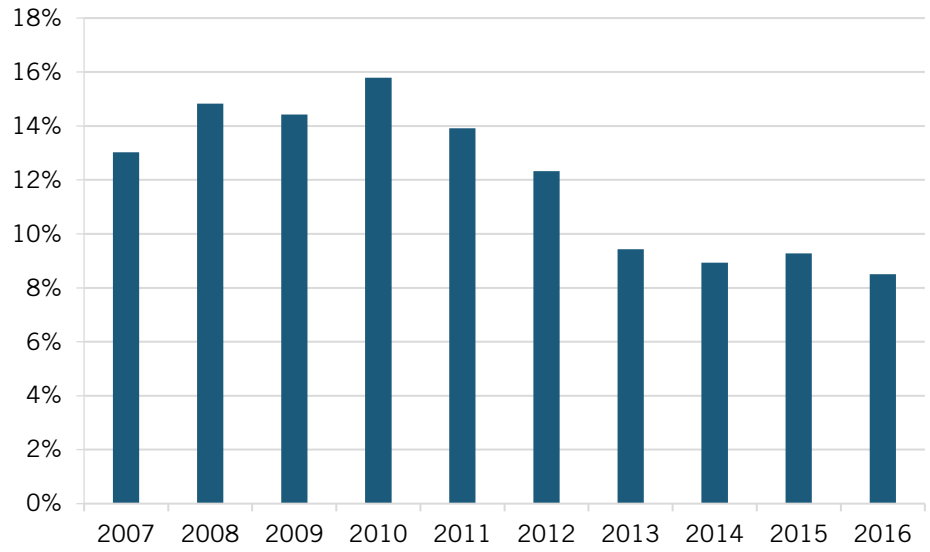
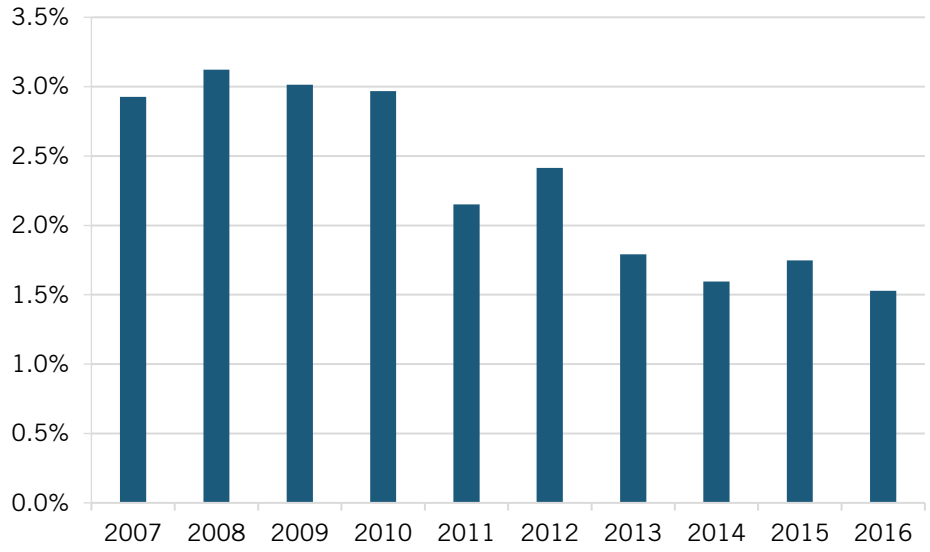


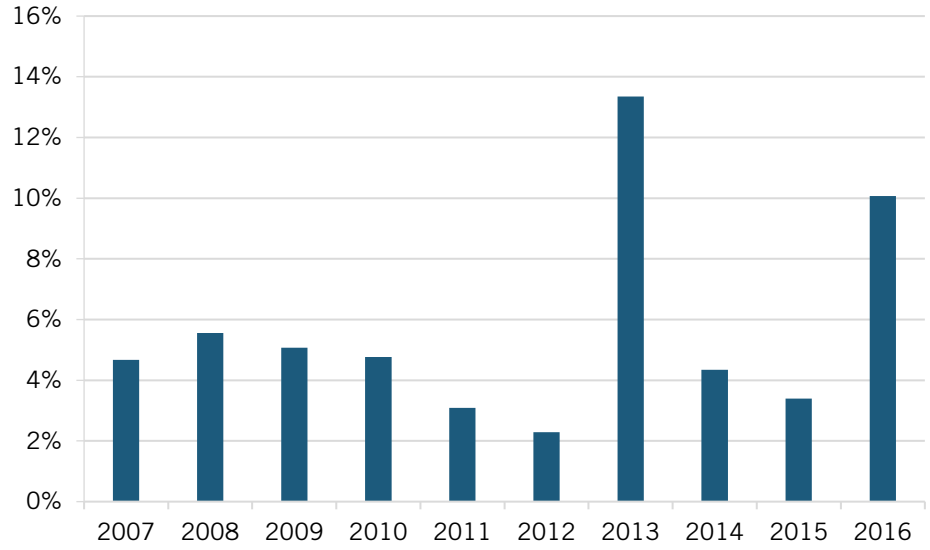
Figure 102: Employment in Early-Stage Start-Ups as a Share of Total Employment in the Computer Systems Design Services Industry, 2007 to 2016



Start-ups that grow fast generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past ten years. On average, 6 percent of start-ups demonstrate high growth annually (figure 103). The share of high-growth start-ups has remained under 6 percent of all start-ups in 8 of the past 10 years. The share of high-growth start-ups exceeded 10 percent in 2013 and 2016. This group of firms has made

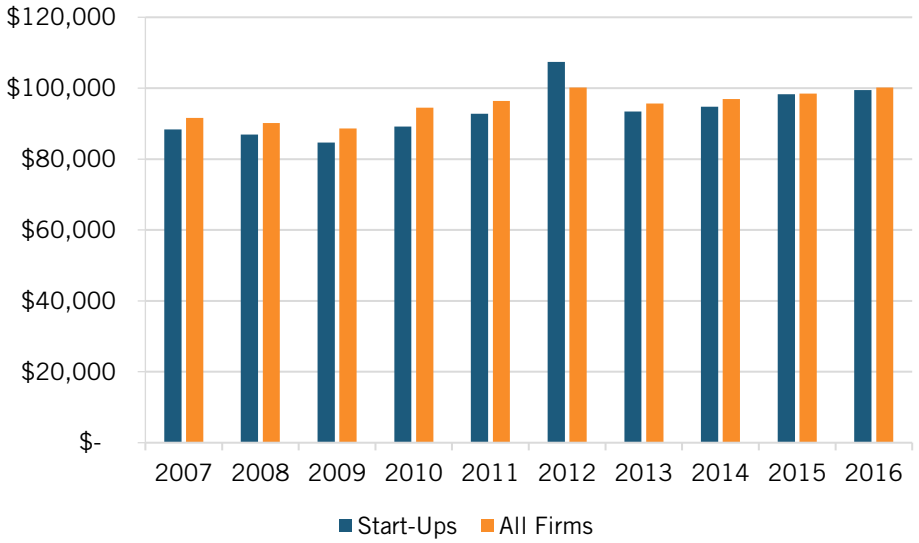
outsized contributions to employment. For example, in 2016, high-growth start-ups made up 10 percent of start-ups but employed 11 percent of all those employed by start-ups.

Figure 103: Share of Start-Ups with High Employment Growth in the Computer Systems Design Services Industry, 2007 to 2016



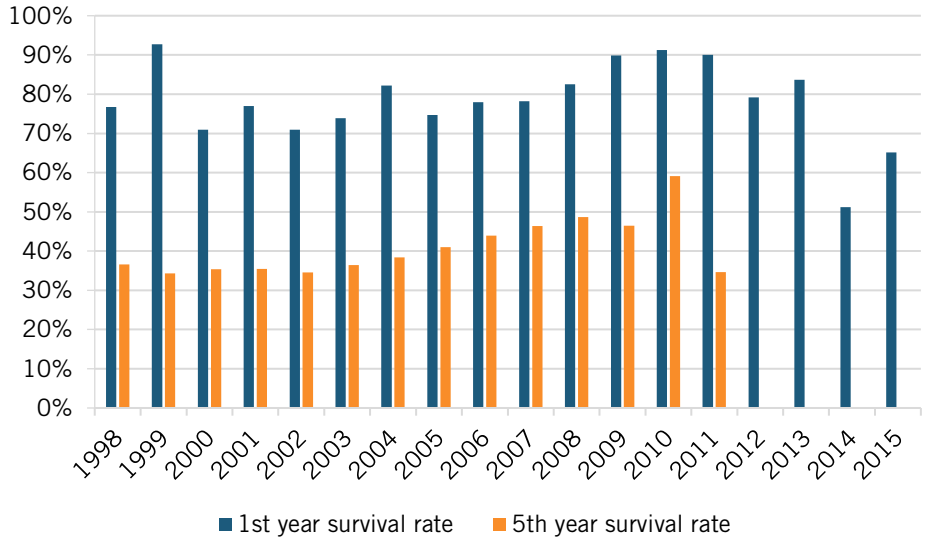
Examining real wages, start-ups paid their workers 2 percent less than the industry average over the past ten years. In nine of these ten years, average annual wages paid by start-ups were less than the industry average (figure 104). In 2007, start-ups paid an average wage of $88,000, in contrast to the $91,000 industry average. Fortunately, real wages have grown faster among start-ups than across the industry. From 2007 to 2016, real wages grew by 13 percent among start-ups, as compared to 9 percent across the industry. In 2016, start-ups paid an average wage of $99,000, in contrast to the $100,000 industry average. Due to faster growing wages among start-ups, in 2007, start-ups paid 96 percent of the industry average, with this difference shrinking to 99 percent in 2016.

Figure 104: Average Annual Wage (Real 2009 $) in Computer Systems Design Services Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 22 percent of new firms did not survive their first year in business; only 41 percent survived through the fifth year (figure 105). First-year survival rates have increased since 1998, but have decreased in the post-recession years. In 2015, only 65 percent of new businesses stayed in operation past their first year, a much lower first-year survival rate than the high of 90 percent for firms started in 1999. Fifth-year survival rates have mirrored this trend, with 40 percent of firms established in either 1998 or 2011 surviving past their fifth year of operations.

Figure 105: Survival Rate of Start-Ups in the Computer Systems Design Services Industry, 1998 to 2015



Science and Technology R&D Services

Businesses in the science and technology R&D services sector generally conduct contracted R&D across a range of applied science fields, from biotechnology to agriculture to weapons.

The sector employs 575,000 workers, is comprised of 50,000 firms, and accounts for less than 1 percent of gross U.S. output.[108] In terms of R&D investments, the sector invests $14 billion in domestic R&D, which translates to an R&D intensity of 20 percent. It represents 16 percent of U.S. business R&D investments.[109] The average firm employs 11 workers who are paid an average annual wage of $120,000. Additionally, approximately a third of the sector's workforce is in R&D-related occupations.[110]

Overall, the state of technology-based entrepreneurship in the R&D services sector is mixed, especially in recent years. Start-ups have entered the industry in greater numbers than before, accounting for 79 percent of all firms in 2016, a ten-year high. In addition, strong employment growth among start-ups allowed these firms to exceed 50 percent of all industry employment in 2015. However, start-up wages have remained lower than the industry average, and their growth has been sluggish over the past ten years. The wage gap between start-ups and the industry average increased from 1 percent in 2007 to 5 percent in 2016.

From 2007 to 2016 in the R&D services industry:

- Start-ups increased from 21,000 firms to 52,600 firms, a 95 percent increase.
  - As a share of all firms, an increase from 76 percent to 79 percent.
- Employment among start-ups increased from 200,000 to 300,000, a 50 percent increase.
  - As a share of total employment, an increase from 46 percent to 52 percent.
- Five percent of start-ups experience high growth annually, i.e., these firms increase employment by over 30 percent compared to the previous year
  - In 2016, these firms accounted for 8.5 percent of all start-ups.
- Start-ups provide an annual wage 4 percent lower than the industry average.
  - From 2007 to 2016, real annual wages grew by 17 percent among start-ups, as compared to 30 percent across the industry.

Over the past ten years, R&D services start-ups have increased steadily, in both gross numbers and as a share of all firms. Since 2007, the number of start-ups has increased 95 percent, from 21,000 firms in 2007 to 41,000 firms (figure 106), while start-ups as a share of all firms have increased from 76 percent to 79 percent (figure 107). Start-up growth increased rapidly post-recession, decreased from 2012 to 2014, then increased again. While the number of start-ups increased rapidly over the past ten years, other firms in the industry have experienced a more gradual increase of 57 percent, from 7,000 firms in 2007 to 11,000 firms in 2016.

Figure 106: Number of Firms in the R&D Services Industry, 2007 to 2016

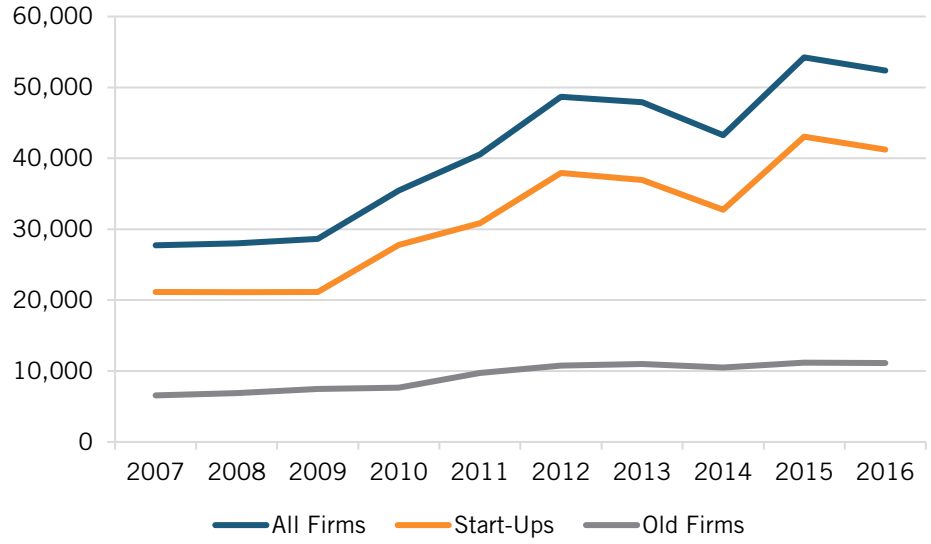
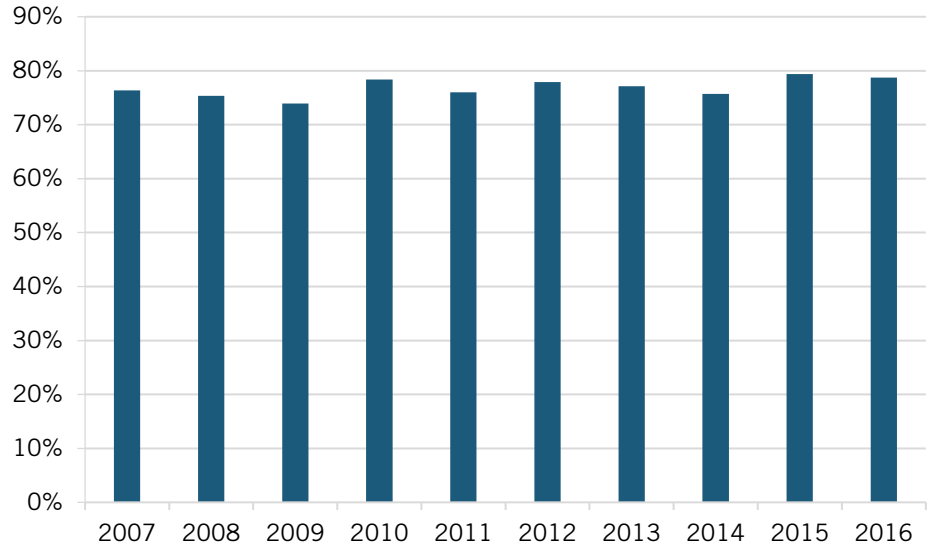


Figure 107: Start-Ups as a Share of Total Firms in the R&D Services Industry, 2007 to 2016



Alongside the increase in the number of start-ups, employment among these firms has grown faster than among older firms. In 2007, start-ups employed 200,000 workers, with this figure increasing by 50 percent to 300,000 in 2016 (figure 108). Meanwhile, across the

industry, employment increased by a more modest 17 percent. By 2015, total employment among start-ups exceeded that of total employment among older firms. Employment across the industry remained stable through the recession and in the immediate years post-recession. This contrasts the sharp rise in start-ups in 2010 through 2011, suggesting that there was some time lag between start-up formation and an expansion in employment. Due to the employment among start-ups increasing faster than among older firms, start-ups are responsible for a larger share of total industry employment in 2016 than in 2007, 52 percent as compared to 46 percent, a 6 percentage point difference (figure 109). Start-up's share of employment remained stable from 2007 through 2014 before increasing to over 50 percent in the past two years.

Figure 108: Employment in the R&D Services Industry, 2007 to 2016

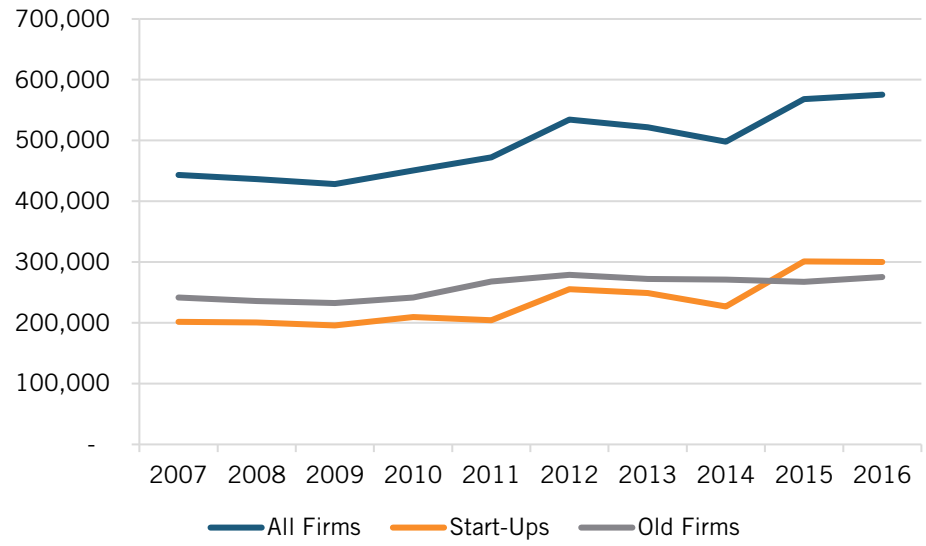
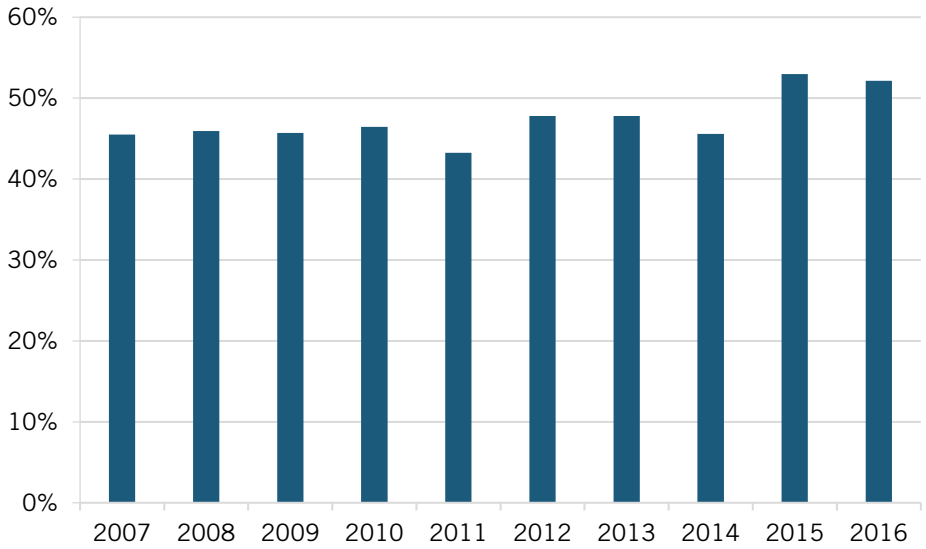
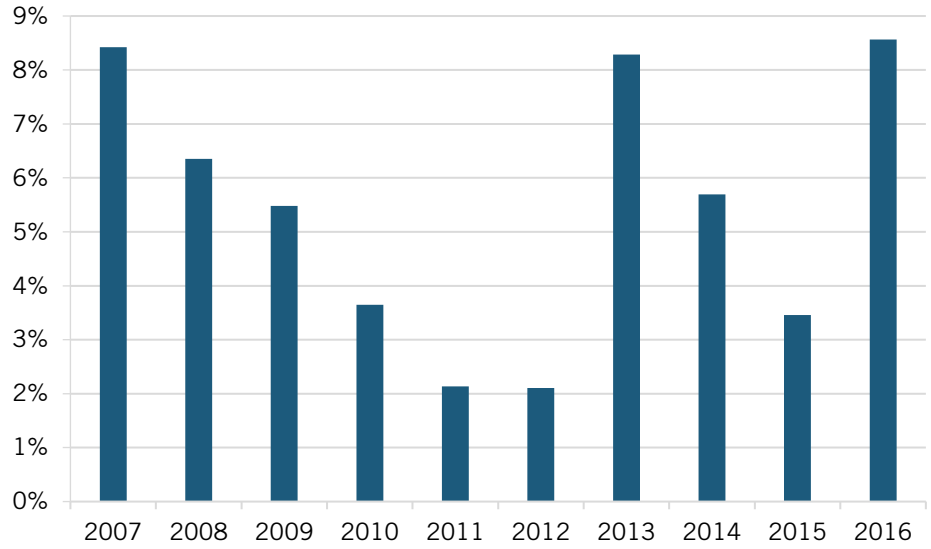


Figure 109: Employment in Start-Ups as a Share of Total Employment in the R&D Services Industry, 2007 to 2016



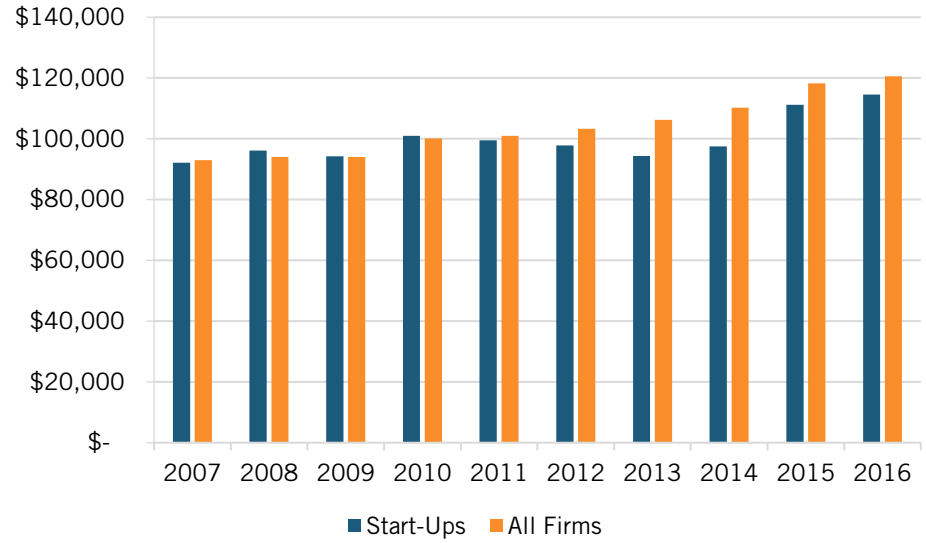
Start-ups that grow fast generate long-term employment and have the potential to make large economic contributions to the industry. The economic performance of this group of firms has varied greatly over the past ten years. On average, 5 percent of start-ups demonstrate high growth annually (figure 110). In 2007, 8.5 percent of start-ups grew fast, with this share of firms decreasing to a low of 2 percent in 2011 before increasing to 8.5 percent in 2016.

Figure 110: Share of Start-Ups With High Employment Growth in the R&D Services Industry, 2007 to 2016



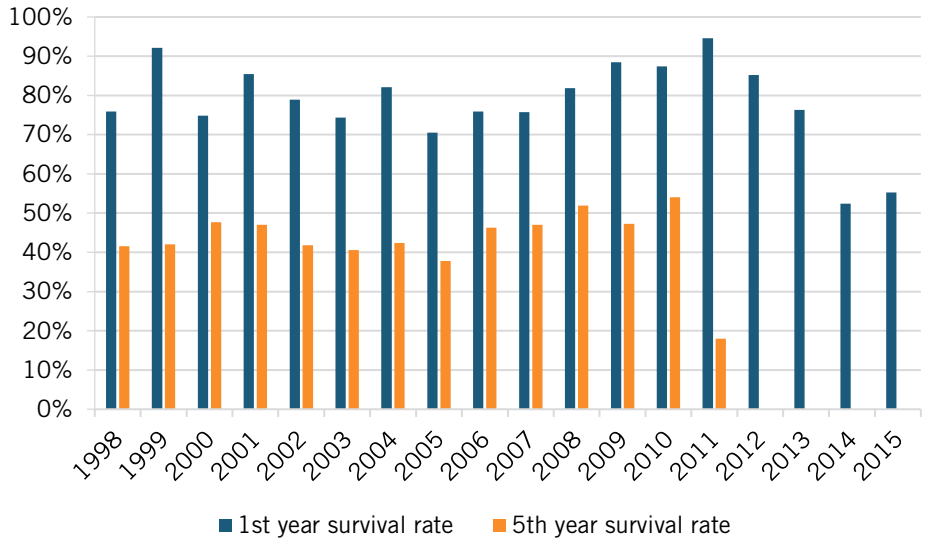
Examining real wages, start-ups paid their workers 4 percent more than the industry average over the past ten years. In 2008 and 2010, start-ups offered a higher wage than older firms (figure 111). In 2007, start-ups paid an average wage of $92,000, in contrast to the $93,000 industry average. Real wages have also grown more slowly among start-ups than across the industry. From 2007 to 2016, real wages grew by 24 percent among start-ups, as compared to 30 percent across the industry. In 2016, start-ups paid an average wage of $114,000, in contrast to the $120,000 industry average. Real wages among start-ups grew moderately through the recession, decreased in the post-recession years, and increased particularly rapidly from 2014 to 2016—by 17 percent. While the start-ups offered a wage 1 percent less than the industry average in 2007, this gap widened to 5 percent by 2016.

Figure 111: Average Annual Wage (Real 2009 $) in the R&D Services Industry, 2007 to 2016



Compared to older firms, start-ups are more likely to go out of business. From 1998 to 2016, 22 percent of new firms did not survive their first year in business; only 43 percent survived through the fifth year (figure 112). First-year survival rates have oscillated between a 70 percent and 90 percent, but were much lower than average in the past two years (possibly due to increased competition). However, fifth-year survival rates have hovered around 40 percent from 1998 to 2005, increasing to 50 percent by 2010, and decreasing to less than 20 percent for firms established in 2011. In other words, 40 percent of firms started in 1998 were still operational in 2003 whereas only 20 percent of firms started in 2011 were still operational by 2016.

Figure 112: Survival Rate of Start-Ups in the R&D Services Industry, 1998 to 2015



APPENDIX D: VENTURE CAPITAL BACKED START-UPS

VC-backed start-ups offer high potential for significant growth—one major reason why private investors invest in such businesses in the first place. VC-backed firms make up 0.44 percent of all start-ups and approximately 11 percent of technology-based start-ups.[111] In addition, VC investments tend to be concentrated in certain states, therefore presenting a skewed, but useful look of start-up activity. For example, in 2016, start-ups in California and Massachusetts received 64 percent of total venture capital investment even though they account for only 21 percent of all technology-based start-ups.[112]

This section highlights two main findings:

- In 2016, VC-backed start-ups constituted 11 percent of all technology-based start-ups, with this share ranging from 9 percent for the aerospace industry to 30 percent for the medical devices industry.
- In 2016, of all VC-backed firms, 87 percent were start-ups, with this share ranging from 80 percent for the medical devices sector to 89 percent for the information technology sector.

As a side note, this sub-section uses industry classifications slightly different to the ones used in the previous sub-sections. The totals seen in this section may not always reflect the same totals seen in previous sections.

Table 5 lists the number of VC-backed start-ups by industry. This group of start-ups represents 11 percent of all technology-based start-ups. Because VC investors gravitate to start-ups with high-growth potential, this 11 percent figure could be compared to the 6 percent share of high-growth technology-based start-ups in 2016 (figure 14).

Table 6 lists VC-backed start-ups as a share of all VC-backed firms (i.e., VC-backed firms 10 years or younger in age as a share of all VC-backed firms). In 2016, VC-backed start-ups represented 87 percent of all VC-backed firms. This is a much higher share than the 71 percent share of start-ups in technology-based industries (figure 5). This suggests that VC-backed firms have high rates of either failure or success (i.e., VC-backed firms are less likely to survive the older they get, or VC-backed firms more likely to get acquired the older they get).

Table 5: VC-Backed Start-Ups as a Share of Technology-Based Start-Ups, by Industry, 2016

	Total	Aerospace	Biotech & Pharma	Medical Devices	Information Technology
VC-Backed Start-Ups	19,573	154	1,303	1,935	16,181
Tech-Based Start-Ups	175,247	1,732	12,078	6,254	127,126
VC Share of Start-Ups	11%	9%	11%	31%	13%

Table 6: VC-Backed Start-Ups as a Share of All VC-Backed Firms, by Industry, 2016

	Total	Aerospace	Biotech & Pharma	Medical Devices	Information Technology
VC-Backed Start-Ups	19,573	154	1,303	1,935	16,181
VC-Backed Firms	22,468	176	1,622	2,431	18,239
VC-Backed Start-Ups Share of All VC-firms	87.1%	87.5%	80.3%	79.6%	88.7%

APPENDIX E: SUPPLEMENTAL STATE TABLES

Some states have attracted businesses in certain technology sectors over the years such that they have become almost analogous to these technology fields. For example: Massachusetts and biopharmaceuticals; Washington and aerospace technologies; and California and information technologies. These supplemental tables disaggregate a state's number of technology-based start-ups and employment into the ten technology-based industries.

Table 7: Number of Technology-Based Start-Ups by Industry and by State, 2016

State	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
AL	1,761	49	182	39		14	63	257	3	788	405
AK	526	6	30	2		7	8	72		221	182
AZ	3,746	36	416	132	1	18	157	781	14	1,550	773
AR	842	5	53	7		3	30	205	1	306	239
CA	30,261	274	3,197	1,019	4	349	1,192	5,025	106	12,572	7,542
CO	4,647	25	556	64		29	117	813	24	1,968	1,115
CT	2,204	119	277	47	1	14	67	300	12	957	457
DE	510	9	37	4		2	11	86	4	235	126
FL	13,091	81	1,073	145		95	536	2,613	34	5,378	3,281
GA	5,242	25	485	70	2	55	151	850	23	2,628	1,023
HI	506	5	17	6		6	14	99	2	184	179
ID	806	3	51	19		4	34	206	3	312	193
IL	6,561	46	545	119		55	261	1,125	32	3,131	1,366
IN	2,458	16	173	42		16	94	454	5	1,069	631
IA	907	6	83	12		8	30	177	7	401	195
KS	1,222	31	152	16		11	31	244	4	491	258
KY	1,333	2	87	14		21	50	267	3	525	378
LA	1,616	8	93	5		11	59	229	5	579	632
ME	655	2	34	5	1	11	36	126	1	271	173
MD	4,081	26	329	32		66	126	539	19	1,982	994
MA	6,069	9	621	152	4	133	187	876	36	2,631	1,572
MI	4,231	7	316	59		34	147	839	9	1,956	923
MN	3,016	3	310	62	4	16	129	590	15	1,403	546
MS	690	2	46	9		3	19	206	1	236	177
MO	2,561	107	168	23	2	13	70	696	8	1,052	445
MT	574	5	24	7		5	31	117	1	200	191
NE	772	5	45	6		5	27	170	1	365	154
NV	1,574	14	111	27		11	78	408	6	599	347
NH	1,412	5	122	50		9	27	262	7	643	337
NJ	5,940	28	457	64	3	142	262	819	26	2,810	1,393
NM	980	7	74	21		4	25	194	5	392	279
NY	10,093	32	856	159	3	84	342	1,922	48	4,390	2,416
NC	5,067	15	534	72		48	169	1,039	23	2,021	1,218
ND	291	2	20	5			5	55		133	76
OH	4,605	16	388	69	3	37	167	915	13	1,991	1,075
OK	1,446	22	149	7		6	62	223	4	538	442
OR	2,898	23	199	59	1	15	123	576	13	1,367	581
PA	5,517	53	478	111	2	58	185	918	15	2,219	1,589
RI	450	1	30	8		3	12	75	2	194	133
SC	1,665	23	116	16		8	50	301	5	703	459
SD	302	3	28	5		1	12	55		140	63
TN	2,380	5	156	15		16	92	444	5	1,076	586
TX	13,452	89	1,459	337	2	86	396	2,171	61	5,710	3,478
UT	1,783	14	131	22	1	12	102	404	9	784	326
VT	403	1	68	8			20	58	2	162	92
VA	6,007	63	482	50	1	29	132	794	25	3,490	991
WA	5,095	380	361	54		28	200	913	24	2,108	1,081
WV	491	6	22			1	12	120	2	177	151
WI	2,258	16	173	34		20	91	440	5	1,026	487
WY	250	2	11	2			13	45	3	101	75
Average	3,505	35	317	68	2	35	125	622	14	1,523	837
Median	1,772	14	154	27	2	14	69	353	7	786	451

Table 8: Employment in Technology-Based Start-Ups by Industry and by State, 2016

State	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
AL	24,336	234	11,857	1,164		82	481	1,773	23	7,079	2,807
AK	3,153	27	804	52		79	18	346		1,069	810
AZ	26,402	502	6,377	1,958	6	274	1,107	4,392	182	7,767	5,795
AR	7,048	43	1,047	102		17	153	1,952	20	1,890	1,926
CA	300,676	11,149	112,570	19,771	204	7,895	11,353	32,966	2,085	70,040	52,414
CO	42,937	379	17,483	796		341	1,846	5,781	172	8,955	7,980
CT	18,247	686	6,019	971	7	121	1,471	1,780	52	4,224	3,887
DE	3,648	33	1,111	31		6	44	322	24	1,381	727
FL	82,700	694	16,322	2,312		902	3,274	14,877	600	27,773	18,258
GA	39,955	308	9,034	741	10	854	1,224	6,677	329	15,487	6,032
HI	3,458	39	269	72		21	64	511	8	1,014	1,532
ID	5,213	21	983	554		30	112	1,496	34	1,488	1,049
IL	50,183	192	11,123	3,577		819	3,104	7,146	679	18,627	8,493
IN	23,274	4,389	3,414	646		890	976	3,804	96	5,101	4,604
IA	9,127	100	3,616	206		133	581	1,012	156	1,855	1,674
KS	12,149	455	4,014	384		201	484	1,656	8	2,396	2,935
KY	9,250	12	1,966	382		306	580	1,444	23	2,691	2,228
LA	13,137	54	1,072	49		139	364	2,021	44	3,148	6,295
ME	4,163	7	794	96	1	134	180	653	8	971	1,415
MD	36,719	163	7,284	625		1,302	805	6,058	264	13,941	6,902
MA	75,544	433	19,202	4,222	123	2,221	3,513	7,482	627	21,412	20,531
MI	30,333	75	7,232	2,652		535	1,436	4,787	224	11,084	4,960
MN	25,489	24	6,535	1,358	273	677	2,359	3,523	108	8,361	3,629
MS	4,621	30	1,187	265		30	99	1,201	10	1,130	934
MO	22,372	536	2,767	361	38	169	759	8,093	165	6,051	3,794
MT	2,816	23	314	108		34	162	469	7	593	1,214
NE	8,044	53	1,230	143		804	131	1,301	2	2,487	2,036
NV	9,686	68	2,035	407		137	265	1,888	24	2,806	2,463
NH	10,116	69	3,048	696		32	342	1,438	16	3,731	1,440
NJ	49,235	389	7,948	1,251	37	3,742	3,306	5,328	776	18,538	9,171
NM	6,413	61	1,828	437		27	115	648	519	1,049	2,166
NY	82,434	576	14,721	3,289	41	1,135	4,140	13,379	680	29,760	18,002
NC	48,440	186	18,017	1,885		2,443	2,856	5,043	247	11,340	8,308
ND	2,534	33	361	150			18	754		522	846
OH	36,727	234	7,700	1,366	22	676	2,456	5,745	140	12,982	6,772
OK	11,147	461	2,928	155		32	194	1,312	34	2,689	3,497
OR	17,988	171	3,785	1,781	7	178	812	2,854	300	6,010	3,871
PA	49,901	438	10,996	2,805	11	2,613	1,892	7,542	241	13,205	12,963
RI	3,280	5	600	131		44	693	312	45	953	628
SC	11,627	138	2,189	287		104	1,212	1,899	68	3,126	2,891
SD	1,800	51	519	122		8	56	273		535	358
TN	26,263	19	6,908	320		534	900	3,153	155	5,741	8,853
TX	103,749	896	23,426	4,836	16	647	3,358	15,666	1,173	34,469	24,098
UT	15,461	96	2,059	486	6	163	618	3,980	81	5,749	2,709
VT	2,718	4	1,350	156			69	214	13	647	421
VA	48,850	362	8,390	980	16	594	888	5,023	236	27,341	6,000
WA	34,347	7,040	4,777	477		287	1,437	5,789	285	8,857	5,875
WV	4,014	22	501			3	40	894	61	1,008	1,485
WI	18,681	104	3,686	866		246	2,085	3,570	43	5,215	3,732
WY	1,339	17	299	39			88	202	8	314	411
Average	29,635	642	7,674	1,358	51	695	1,290	4,209	236	8,892	6,036
Median	16,725	102	3,515	486	16	201	726	1,987	96	4,663	3,563

APPENDIX F: TECHNOLOGY-BASED START-UP ACTIVITY BY CONGRESSIONAL DISTRICTS

Congressional districts are segmented by population. Therefore, some districts will have a greater density of businesses per population than others, and in turn, are more likely to give rise to technology-based start-ups that take advantage of the benefits of locating near these other businesses. On the other hand, some districts (through no fault of their own) may be skewered more toward locally-traded businesses, such as retail stores. To illustrate, a district encompassing the outer rims of a metropolitan area tends to be suburban, and therefore the businesses in that district may skew more toward the "local" Walmart and other locally-focused services. But just one district over, within the center of the metropolitan area, there might be a high concentration of businesses that focus on supplying traded goods and services to the national and global markets, an area ripe for technology-based start-up activity. Take for example, TX-24 and TX-33 (centered around Dallas). These two districts border each other, but one district had over 1,000 technology-based start-ups in 2016 while the other had barely 50 such start-ups; those figures translate to one Texan district being among the top fifteen districts while the other being among the bottom five districts (when ordering the 435 congressional districts by gross number of technology-based start-ups). This does not mean that policymakers representing districts that have minimal technology-based start-up activity should ignore innovation policies. In fact, they should support policies that enable greater technology-based start-up activity, because if a neighboring district fosters more start-ups, it attracts greater economic activity through spillover effects such as indirect jobs, greater demand for housing (from new employees), and more money circulating into the regional economy.

Whereas all districts will benefit from greater technology-based start-up activity, certain districts have become synonymous with such firms; these include Silicon Valley, the San Diego metro area, districts surround the nation's capital, and biotech clusters in-and-around Boston. Our analysis identifies just how concentrated such activity is in these districts (i.e., technology-based start-ups as a share of all firms). The top ten districts based on technology-based start-up concentration include: CA-17 at 16.1 percent (Silicon Valley); VA-10 at 11.6 percent (just outside DC); TX-02 at 8.9 percent (in-and-around Houston); WA-01 at 8.3 percent (just outside Seattle); VA-08 at 8.3 percent (Alexandria); CA-14 at 8.2 percent (just outside San Francisco); CA-49 at 8.1 percent (Hillsborough/just outside San Francisco); CA-45 at 8.1 percent (Orange County); MA-05 at 7.7 percent (just outside Boston); and TX-03 at 7.5 percent (Plano/just outside Dallas). For comparison, technology-based start-ups comprise 2.3 percent of all firms in the median congressional district.

Table 9 provides several key statistics on technology-based start-ups by congressional district. It lists the number of start-ups, the number of workers employed in these firms, and the share of start-ups in that district's total firms and employment

Table 9: Technology-Based Start-Ups Statistical Snapshot by Congressional District, 2016

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
AK00	526	3,153	16,967	267,999	3.1%	1.2%
AL01	257	4,778	11,512	232,247	2.2%	2.1%
AL02	228	4,590	10,724	216,671	2.1%	2.1%
AL03	159	2,646	8,398	168,831	1.9%	1.6%
AL04	135	1,911	9,283	182,407	1.5%	1.0%
AL05	458	4,944	11,180	252,035	4.1%	2.0%
AL06	414	3,231	11,972	249,998	3.5%	1.3%
AL07	110	2,236	10,358	287,438	1.1%	0.8%
AR01	129	890	10,741	189,011	1.2%	0.5%
AR02	372	3,075	14,582	292,635	2.6%	1.1%
AR03	249	2,405	14,228	312,589	1.8%	0.8%
AR04	92	678	10,730	188,158	0.9%	0.4%
AZ01	389	2,863	8,895	159,347	4.4%	1.8%
AZ02	388	3,185	11,951	211,918	3.2%	1.5%
AZ03	162	1,039	7,467	164,198	2.2%	0.6%
AZ04	292	1,365	9,612	139,021	3.0%	1.0%
AZ05	432	3,114	10,594	178,001	4.1%	1.7%
AZ06	1,092	7,486	18,787	376,190	5.8%	2.0%
AZ07	644	4,623	10,648	378,440	6.0%	1.2%
AZ08	109	513	8,636	144,864	1.3%	0.4%
AZ09	239	2,222	17,732	457,181	1.3%	0.5%
CA01	414	2,441	12,526	169,517	3.3%	1.4%
CA02	735	5,876	17,664	223,076	4.2%	2.6%
CA03	497	4,087	9,495	162,731	5.2%	2.5%
CA04	575	4,932	14,877	218,205	3.9%	2.3%
CA05	252	1,446	13,796	232,744	1.8%	0.6%
CA06	398	3,782	12,430	258,004	3.2%	1.5%
CA07	236	3,567	10,903	202,729	2.2%	1.8%
CA08	364	1,888	7,474	113,138	4.9%	1.7%
CA09	272	2,078	8,674	158,636	3.1%	1.3%
CA10	198	1,532	9,746	184,057	2.0%	0.8%
CA11	870	7,162	13,635	221,811	6.4%	3.2%
CA12	1,885	18,789	26,391	596,285	7.1%	3.2%
CA13	689	5,339	15,447	295,428	4.5%	1.8%
CA14	1,284	18,096	15,728	356,813	8.2%	5.1%
CA15	808	8,996	13,607	278,582	5.9%	3.2%
CA16	193	1,109	7,338	146,588	2.6%	0.8%
CA17	2,769	35,105	17,169	546,765	16.1%	6.4%
CA18	1,265	13,480	17,985	387,806	7.0%	3.5%
CA19	471	5,926	11,207	205,961	4.2%	2.9%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
CA20	266	1,853	13,223	195,929	2.0%	0.9%
CA21	144	840	5,542	104,215	2.6%	0.8%
CA22	150	747	11,510	206,140	1.3%	0.4%
CA23	170	1,202	9,857	186,985	1.7%	0.6%
CA24	642	5,049	16,377	243,093	3.9%	2.1%
CA25	525	7,103	9,840	159,576	5.3%	4.5%
CA26	403	3,930	15,214	243,089	2.6%	1.6%
CA27	728	6,721	17,570	254,257	4.1%	2.6%
CA28	946	7,760	20,070	499,895	4.7%	1.6%
CA29	281	2,258	9,767	167,001	2.9%	1.4%
CA30	571	4,933	24,350	395,057	2.3%	1.2%
CA31	183	1,373	10,435	239,343	1.8%	0.6%
CA32	280	2,663	12,239	244,466	2.3%	1.1%
CA33	1,545	15,133	32,770	495,669	4.7%	3.1%
CA34	335	2,323	19,097	334,849	1.8%	0.7%
CA35	290	2,508	10,856	261,350	2.7%	1.0%
CA36	191	1,055	9,944	165,276	1.9%	0.6%
CA37	226	1,798	17,052	313,618	1.3%	0.6%
CA38	423	4,841	11,924	236,983	3.5%	2.0%
CA39	597	6,020	15,606	248,499	3.8%	2.4%
CA40	63	448	9,184	215,690	0.7%	0.2%
CA41	263	1,694	8,048	178,910	3.3%	0.9%
CA42	334	1,842	9,328	151,040	3.6%	1.2%
CA43	192	2,393	12,252	285,436	1.6%	0.8%
CA44	166	1,402	7,077	162,591	2.3%	0.9%
CA45	1,678	19,468	20,639	400,922	8.1%	4.9%
CA46	390	3,537	14,450	391,479	2.7%	0.9%
CA47	380	4,669	12,810	243,630	3.0%	1.9%
CA48	599	7,515	20,217	321,044	3.0%	2.3%
CA49	1,413	17,184	17,347	270,582	8.1%	6.4%
CA50	299	2,580	12,929	195,372	2.3%	1.3%
CA51	399	3,289	8,313	141,244	4.8%	2.3%
CA52	869	8,117	23,751	529,811	3.7%	1.5%
CA53	149	1,072	13,006	231,355	1.1%	0.5%
CO01	1,451	12,458	23,908	485,005	6.1%	2.6%
CO02	1,300	14,851	24,245	354,047	5.4%	4.2%
CO03	408	1,693	20,981	247,105	1.9%	0.7%
CO04	533	5,036	15,911	235,841	3.3%	2.1%
CO05	492	3,734	15,875	246,254	3.1%	1.5%
CO06	272	3,549	16,418	309,840	1.7%	1.1%
CO07	190	1,608	15,848	264,104	1.2%	0.6%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
CT01	536	5,368	14,888	361,306	3.6%	1.5%
CT02	281	1,598	11,539	214,841	2.4%	0.7%
CT03	481	4,840	13,310	306,934	3.6%	1.6%
CT04	681	5,076	17,725	330,175	3.8%	1.5%
CT05	225	1,365	14,258	263,075	1.6%	0.5%
DE00	510	3,648	20,017	397,385	2.5%	0.9%
FL01	368	2,080	13,619	204,902	2.7%	1.0%
FL02	382	2,505	11,957	171,671	3.2%	1.5%
FL03	348	2,561	13,269	211,256	2.6%	1.2%
FL04	641	3,788	19,011	341,132	3.4%	1.1%
FL05	639	5,002	11,747	225,407	5.4%	2.2%
FL06	314	1,447	13,564	176,971	2.3%	0.8%
FL07	531	4,480	19,314	336,635	2.7%	1.3%
FL08	553	4,514	14,696	212,400	3.8%	2.1%
FL09	296	2,290	10,505	186,465	2.8%	1.2%
FL10	247	1,559	17,848	454,769	1.4%	0.3%
FL11	270	1,141	9,777	134,581	2.8%	0.8%
FL12	560	4,036	13,291	169,210	4.2%	2.4%
FL13	600	6,331	16,882	297,458	3.6%	2.1%
FL14	688	5,709	19,561	413,625	3.5%	1.4%
FL15	279	1,956	12,844	255,136	2.2%	0.8%
FL16	558	2,758	16,715	220,407	3.3%	1.3%
FL17	202	852	10,955	135,133	1.8%	0.6%
FL18	558	2,906	17,143	213,491	3.3%	1.4%
FL19	509	2,802	20,257	287,169	2.5%	1.0%
FL20	878	4,697	13,944	253,701	6.3%	1.9%
FL21	456	2,297	17,510	196,716	2.6%	1.2%
FL22	612	3,156	26,621	336,756	2.3%	0.9%
FL23	820	4,439	21,137	290,553	3.9%	1.5%
FL24	453	3,004	13,105	203,396	3.5%	1.5%
FL25	573	2,758	20,883	327,220	2.7%	0.8%
FL26	443	1,995	12,041	127,774	3.7%	1.6%
FL27	313	1,637	26,066	349,670	1.2%	0.5%
GA01	202	1,316	12,073	227,013	1.7%	0.6%
GA02	195	1,799	10,068	200,550	1.9%	0.9%
GA03	256	1,624	11,293	216,296	2.3%	0.8%
GA04	425	2,735	8,522	146,650	5.0%	1.9%
GA05	912	7,599	16,890	516,714	5.4%	1.5%
GA06	1,477	13,590	21,858	459,039	6.8%	3.0%
GA07	474	3,386	18,855	355,091	2.5%	1.0%
GA08	143	909	10,328	182,607	1.4%	0.5%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
GA09	311	1,781	11,188	192,288	2.8%	0.9%
GA10	127	584	9,989	153,088	1.3%	0.4%
GA11	400	2,896	16,119	350,076	2.5%	0.8%
GA12	138	687	10,173	210,009	1.4%	0.3%
GA13	86	496	8,580	169,472	1.0%	0.3%
GA14	96	553	8,170	171,734	1.2%	0.3%
HI01	311	2,575	14,141	316,823	2.2%	0.8%
HI02	195	883	10,799	181,204	1.8%	0.5%
IA01	248	3,224	15,168	349,195	1.6%	0.9%
IA02	191	1,165	14,571	313,490	1.3%	0.4%
IA03	283	2,396	15,629	367,959	1.8%	0.7%
IA04	185	2,342	17,077	286,050	1.1%	0.8%
ID01	417	3,056	17,696	231,794	2.4%	1.3%
ID02	389	2,157	19,645	303,201	2.0%	0.7%
IL01	322	1,991	9,550	187,223	3.4%	1.1%
IL02	96	667	8,220	166,246	1.2%	0.4%
IL03	280	1,894	12,388	223,309	2.3%	0.8%
IL04	331	2,280	8,714	139,687	3.8%	1.6%
IL05	691	5,569	18,622	379,412	3.7%	1.5%
IL06	1,272	10,692	20,163	378,661	6.3%	2.8%
IL07	802	6,708	23,949	798,226	3.3%	0.8%
IL08	403	3,268	19,026	436,313	2.1%	0.7%
IL09	367	2,770	16,374	284,880	2.2%	1.0%
IL10	435	3,295	17,165	364,038	2.5%	0.9%
IL11	348	3,094	13,025	283,140	2.7%	1.1%
IL12	223	1,602	11,862	218,417	1.9%	0.7%
IL13	305	1,946	12,543	243,623	2.4%	0.8%
IL14	183	908	13,973	188,940	1.3%	0.5%
IL15	95	516	12,395	201,170	0.8%	0.3%
IL16	178	1,277	12,233	220,945	1.5%	0.6%
IL17	134	955	12,040	272,058	1.1%	0.4%
IL18	96	751	12,943	258,150	0.7%	0.3%
IN01	262	1,546	11,093	242,092	2.4%	0.6%
IN02	257	2,178	11,769	311,487	2.2%	0.7%
IN03	230	1,978	13,069	316,415	1.8%	0.6%
IN04	267	2,350	11,241	247,952	2.4%	0.9%
IN05	620	4,738	16,077	376,043	3.9%	1.3%
IN06	175	1,107	10,711	233,506	1.6%	0.5%
IN07	292	7,202	11,297	343,470	2.6%	2.1%
IN08	198	1,350	12,185	276,241	1.6%	0.5%
IN09	157	825	11,394	232,889	1.4%	0.4%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
KS01	173	1,002	15,832	244,531	1.1%	0.4%
KS02	208	1,142	12,511	233,966	1.7%	0.5%
KS03	547	5,811	16,553	399,557	3.3%	1.5%
KS04	294	4,194	13,344	287,707	2.2%	1.5%
KY01	143	770	10,823	217,235	1.3%	0.4%
KY02	221	1,550	11,011	229,605	2.0%	0.7%
KY03	353	2,459	14,571	412,801	2.4%	0.6%
KY04	215	1,831	10,717	240,159	2.0%	0.8%
KY05	134	682	8,920	161,299	1.5%	0.4%
KY06	267	1,958	12,762	280,770	2.1%	0.7%
LA01	450	2,792	16,266	320,713	2.8%	0.9%
LA02	346	3,423	12,148	294,953	2.8%	1.2%
LA03	277	2,375	15,373	301,403	1.8%	0.8%
LA04	196	1,827	11,647	218,177	1.7%	0.8%
LA05	118	642	11,792	209,785	1.0%	0.3%
LA06	229	2,078	14,134	325,892	1.6%	0.6%
MA01	311	2,067	13,019	249,573	2.4%	0.8%
MA02	599	6,816	13,403	284,809	4.5%	2.4%
MA03	830	11,606	13,071	272,355	6.4%	4.3%
MA04	949	9,971	16,704	328,712	5.7%	3.0%
MA05	1,300	21,126	16,823	386,671	7.7%	5.5%
MA06	536	7,819	16,986	346,988	3.2%	2.3%
MA07	798	10,629	13,518	486,329	5.9%	2.2%
MA08	411	3,603	19,498	521,925	2.1%	0.7%
MA09	334	1,900	18,054	243,241	1.8%	0.8%
MD01	470	3,681	14,119	194,743	3.3%	1.9%
MD02	674	5,935	12,839	329,457	5.2%	1.8%
MD03	845	8,589	16,610	375,435	5.1%	2.3%
MD04	422	2,960	9,975	191,803	4.2%	1.5%
MD05	280	2,703	11,141	207,028	2.5%	1.3%
MD06	951	9,488	14,830	287,158	6.4%	3.3%
MD07	128	1,121	12,323	293,327	1.0%	0.4%
MD08	311	2,242	16,735	321,593	1.9%	0.7%
ME01	437	2,707	19,092	292,515	2.3%	0.9%
ME02	218	1,456	14,335	205,095	1.5%	0.7%
MI01	278	1,637	15,514	207,722	1.8%	0.8%
MI02	421	2,642	12,900	308,107	3.3%	0.9%
MI03	176	976	12,309	306,448	1.4%	0.3%
MI04	250	1,358	10,871	186,742	2.3%	0.7%
MI05	172	1,061	10,823	211,943	1.6%	0.5%
MI06	201	1,625	11,405	229,008	1.8%	0.7%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
MI07	536	4,135	9,925	198,618	5.4%	2.1%
MI08	402	2,825	12,493	218,396	3.2%	1.3%
MI09	727	5,594	13,850	268,424	5.2%	2.1%
MI10	120	695	11,621	203,021	1.0%	0.3%
MI11	399	3,816	18,842	453,544	2.1%	0.8%
MI12	216	1,399	12,074	290,233	1.8%	0.5%
MI13	192	1,378	7,870	201,538	2.4%	0.7%
MI14	141	1,192	12,738	326,210	1.1%	0.4%
MN01	233	1,541	13,476	293,201	1.7%	0.5%
MN02	382	3,356	13,387	268,095	2.9%	1.3%
MN03	866	8,843	18,602	452,974	4.7%	2.0%
MN04	528	4,730	13,969	361,601	3.8%	1.3%
MN05	479	4,423	16,622	521,476	2.9%	0.8%
MN06	168	900	13,116	221,170	1.3%	0.4%
MN07	192	1,035	15,371	240,103	1.2%	0.4%
MN08	168	661	13,744	213,230	1.2%	0.3%
MO01	658	5,213	18,698	422,194	3.5%	1.2%
MO02	444	3,313	19,427	439,517	2.3%	0.8%
MO03	312	2,820	13,728	226,946	2.3%	1.2%
MO04	216	1,913	12,797	201,481	1.7%	0.9%
MO05	393	3,322	16,441	394,814	2.4%	0.8%
MO06	156	1,858	12,820	211,039	1.2%	0.9%
MO07	248	2,212	15,106	297,236	1.6%	0.7%
MO08	134	1,721	14,345	207,917	0.9%	0.8%
MS01	169	980	10,821	224,475	1.6%	0.4%
MS02	224	1,318	9,608	191,121	2.3%	0.7%
MS03	144	826	13,078	262,764	1.1%	0.3%
MS04	153	1,497	10,803	226,418	1.4%	0.7%
MT00	574	2,816	32,224	375,041	1.8%	0.8%
NC01	693	6,783	10,726	251,674	6.5%	2.7%
NC02	725	7,964	11,429	182,588	6.3%	4.4%
NC03	232	1,737	12,081	182,392	1.9%	1.0%
NC04	830	8,726	18,840	461,441	4.4%	1.9%
NC05	459	4,908	12,186	268,045	3.8%	1.8%
NC06	284	2,267	10,273	195,248	2.8%	1.2%
NC07	163	1,631	12,608	206,090	1.3%	0.8%
NC08	275	2,248	10,555	198,756	2.6%	1.1%
NC09	804	7,475	12,720	238,436	6.3%	3.1%
NC10	277	1,940	13,709	272,684	2.0%	0.7%
NC11	167	1,362	12,067	195,331	1.4%	0.7%
NC12	59	450	17,855	493,300	0.3%	0.1%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
NC13	99	949	15,424	365,336	0.6%	0.3%
ND00	291	2,534	20,428	365,893	1.4%	0.7%
NE01	272	2,754	13,401	237,617	2.0%	1.2%
NE02	380	4,541	14,256	346,475	2.7%	1.3%
NE03	120	749	15,185	208,714	0.8%	0.4%
NH01	864	5,993	15,885	283,759	5.4%	2.1%
NH02	548	4,123	14,431	263,728	3.8%	1.6%
NJ01	351	2,512	13,377	244,400	2.6%	1.0%
NJ02	183	1,170	14,503	225,441	1.3%	0.5%
NJ03	416	2,994	14,050	244,547	3.0%	1.2%
NJ04	609	4,410	17,847	280,789	3.4%	1.6%
NJ05	741	5,755	19,601	306,009	3.8%	1.9%
NJ06	738	6,834	15,759	301,873	4.7%	2.3%
NJ07	901	8,308	19,882	367,198	4.5%	2.3%
NJ08	477	4,494	12,751	238,159	3.7%	1.9%
NJ09	371	2,892	17,566	291,578	2.1%	1.0%
NJ10	113	671	11,233	194,347	1.0%	0.3%
NJ11	642	6,044	21,411	416,784	3.0%	1.5%
NJ12	396	3,133	15,782	327,382	2.5%	1.0%
NM01	583	2,898	12,900	264,361	4.5%	1.1%
NM02	156	2,044	10,203	171,641	1.5%	1.2%
NM03	241	1,471	11,391	177,108	2.1%	0.8%
NV01	747	4,518	14,662	419,292	5.1%	1.1%
NV02	488	3,074	14,686	261,384	3.3%	1.2%
NV03	234	1,429	13,592	279,574	1.7%	0.5%
NV04	105	656	7,342	140,516	1.4%	0.5%
NY01	567	3,874	19,522	234,234	2.9%	1.7%
NY02	463	3,920	17,570	245,350	2.6%	1.6%
NY03	549	4,341	25,348	380,744	2.2%	1.1%
NY04	271	1,443	20,935	265,713	1.3%	0.5%
NY05	90	887	9,468	152,690	1.0%	0.6%
NY06	231	1,640	15,697	171,117	1.5%	1.0%
NY07	736	5,528	18,701	210,008	3.9%	2.6%
NY08	193	829	9,635	133,517	2.0%	0.6%
NY09	70	284	10,775	118,291	0.6%	0.2%
NY10	1,549	15,002	34,564	783,690	4.5%	1.9%
NY11	140	620	13,684	152,306	1.0%	0.4%
NY12	1,104	10,614	60,541	1,506,062	1.8%	0.7%
NY13	109	736	8,458	142,612	1.3%	0.5%
NY14	135	1,118	10,475	146,140	1.3%	0.8%
NY15	30	127	7,771	123,074	0.4%	0.1%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
NY16	222	2,102	13,860	174,457	1.6%	1.2%
NY17	606	5,858	22,248	335,386	2.7%	1.7%
NY18	416	3,403	16,337	224,294	2.5%	1.5%
NY19	295	2,136	14,292	163,003	2.1%	1.3%
NY20	376	2,308	16,188	329,158	2.3%	0.7%
NY21	197	1,023	13,256	179,106	1.5%	0.6%
NY22	237	2,569	12,223	223,525	1.9%	1.1%
NY23	221	1,409	12,505	224,368	1.8%	0.6%
NY24	320	2,917	14,144	275,488	2.3%	1.1%
NY25	440	3,298	14,534	345,751	3.0%	1.0%
NY26	395	3,310	15,060	351,068	2.6%	0.9%
NY27	128	968	13,729	206,842	0.9%	0.5%
OH01	686	5,685	12,358	389,726	5.6%	1.5%
OH02	185	1,011	11,670	264,932	1.6%	0.4%
OH03	645	4,480	11,091	363,369	5.8%	1.2%
OH04	346	2,669	10,735	268,884	3.2%	1.0%
OH05	207	1,419	12,037	304,696	1.7%	0.5%
OH06	173	1,145	9,616	178,658	1.8%	0.6%
OH07	345	2,621	10,601	220,170	3.3%	1.2%
OH08	159	1,430	10,159	239,700	1.6%	0.6%
OH09	188	1,598	9,930	245,781	1.9%	0.7%
OH10	275	2,126	11,125	290,568	2.5%	0.7%
OH11	554	4,957	13,769	419,129	4.0%	1.2%
OH12	223	2,282	12,633	317,126	1.8%	0.7%
OH13	275	2,129	11,064	253,239	2.5%	0.8%
OH14	214	2,401	15,151	331,053	1.4%	0.7%
OH15	76	395	10,289	223,984	0.7%	0.2%
OH16	54	379	13,562	290,238	0.4%	0.1%
OK01	444	3,150	16,918	375,824	2.6%	0.8%
OK02	115	585	10,321	162,732	1.1%	0.4%
OK03	258	1,632	13,742	200,544	1.9%	0.8%
OK04	248	1,431	13,186	212,117	1.9%	0.7%
OK05	381	4,349	19,024	380,144	2.0%	1.1%
OR01	1,132	8,512	18,596	359,902	6.1%	2.4%
OR02	466	2,005	18,840	244,444	2.5%	0.8%
OR03	701	4,738	20,839	381,970	3.4%	1.2%
OR04	382	1,678	15,799	236,459	2.4%	0.7%
OR05	216	1,042	17,365	261,782	1.2%	0.4%
PA01	429	4,542	10,742	272,706	4.0%	1.7%
PA02	446	5,703	10,866	354,970	4.1%	1.6%
PA03	238	1,452	12,667	267,518	1.9%	0.5%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
PA04	309	3,321	12,165	298,000	2.5%	1.1%
PA05	194	1,518	12,059	219,805	1.6%	0.7%
PA06	780	8,263	15,502	363,929	5.0%	2.3%
PA07	399	5,331	13,773	298,637	2.9%	1.8%
PA08	443	3,445	16,210	286,996	2.7%	1.2%
PA09	186	1,631	11,086	212,468	1.7%	0.8%
PA10	229	1,230	12,216	217,401	1.9%	0.6%
PA11	176	1,956	11,285	261,381	1.6%	0.7%
PA12	408	3,043	12,970	247,564	3.1%	1.2%
PA13	113	1,493	13,651	314,454	0.8%	0.5%
PA14	521	2,390	14,876	449,041	3.5%	0.5%
PA15	257	1,877	12,069	304,373	2.1%	0.6%
PA16	127	806	12,013	292,513	1.1%	0.3%
PA17	107	502	11,494	256,892	0.9%	0.2%
PA18	158	1,583	14,285	319,821	1.1%	0.5%
RI01	270	2,183	11,355	201,213	2.4%	1.1%
RI02	180	1,097	12,612	219,642	1.4%	0.5%
SC01	430	2,575	14,201	222,636	3.0%	1.2%
SC02	307	2,080	9,979	198,015	3.1%	1.1%
SC03	250	1,471	8,571	172,155	2.9%	0.9%
SC04	267	1,960	13,630	330,850	2.0%	0.6%
SC05	129	730	9,003	180,774	1.4%	0.4%
SC06	133	1,898	11,517	280,354	1.2%	0.7%
SC07	149	913	12,450	222,874	1.2%	0.4%
SD00	302	1,800	22,166	353,540	1.4%	0.5%
TN01	195	1,426	9,947	234,256	2.0%	0.6%
TN02	400	11,482	11,469	285,755	3.5%	4.0%
TN03	215	1,617	10,385	272,440	2.1%	0.6%
TN04	238	1,060	9,387	230,656	2.5%	0.5%
TN05	613	4,506	14,956	444,871	4.1%	1.0%
TN06	108	584	9,701	192,795	1.1%	0.3%
TN07	121	810	10,823	223,009	1.1%	0.4%
TN08	336	3,161	10,801	245,310	3.1%	1.3%
TN09	155	1,584	9,717	319,883	1.6%	0.5%
TX01	194	1,379	12,656	262,046	1.5%	0.5%
TX02	1,316	9,796	14,821	362,119	8.9%	2.7%
TX03	1,141	11,606	15,265	361,991	7.5%	3.2%
TX04	217	1,874	10,212	195,050	2.1%	1.0%
TX05	336	2,267	9,374	177,873	3.6%	1.3%
TX06	464	3,259	10,276	222,756	4.5%	1.5%
TX07	636	3,940	19,011	464,626	3.3%	0.8%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
TX08	363	2,099	10,750	195,375	3.4%	1.1%
TX09	313	2,247	9,720	323,758	3.2%	0.7%
TX10	1,027	9,308	14,228	284,812	7.2%	3.3%
TX11	294	1,498	14,433	275,805	2.0%	0.5%
TX12	477	3,764	12,912	308,480	3.7%	1.2%
TX13	193	1,083	12,464	223,170	1.5%	0.5%
TX14	294	2,367	10,226	231,199	2.9%	1.0%
TX15	235	1,087	9,076	185,065	2.6%	0.6%
TX16	179	1,588	10,056	217,989	1.8%	0.7%
TX17	364	2,744	10,795	254,460	3.4%	1.1%
TX18	265	1,668	12,521	422,211	2.1%	0.4%
TX19	165	1,087	12,484	238,280	1.3%	0.5%
TX20	460	3,287	8,466	255,698	5.4%	1.3%
TX21	875	7,426	19,571	413,255	4.5%	1.8%
TX22	293	2,233	11,373	199,423	2.6%	1.1%
TX23	61	349	8,375	173,177	0.7%	0.2%
TX24	1,311	10,667	20,537	677,799	6.4%	1.6%
TX25	213	1,590	12,911	212,230	1.6%	0.7%
TX26	170	1,208	10,930	230,020	1.6%	0.5%
TX27	195	1,152	11,797	248,371	1.7%	0.5%
TX28	118	1,034	8,366	168,357	1.4%	0.6%
TX29	93	596	8,013	220,469	1.2%	0.3%
TX30	410	3,512	10,037	324,373	4.1%	1.1%
TX31	215	1,747	11,035	228,876	1.9%	0.8%
TX32	285	2,386	16,046	325,576	1.8%	0.7%
TX33	26	169	9,411	270,007	0.3%	0.1%
TX34	74	398	7,988	165,791	0.9%	0.2%
TX35	48	314	11,510	288,619	0.4%	0.1%
TX36	132	1,019	9,548	246,786	1.4%	0.4%
UT01	311	1,872	14,736	228,627	2.1%	0.8%
UT02	542	4,409	17,183	359,280	3.2%	1.2%
UT03	736	7,585	15,452	251,798	4.8%	3.0%
UT04	194	1,396	15,248	297,665	1.3%	0.5%
VA01	538	4,057	12,839	212,069	4.2%	1.9%
VA02	413	2,669	12,447	221,726	3.3%	1.2%
VA03	286	2,127	12,628	335,445	2.3%	0.6%
VA04	246	1,423	11,852	268,497	2.1%	0.5%
VA05	420	2,611	12,730	205,526	3.3%	1.3%
VA06	232	1,398	13,675	303,170	1.7%	0.5%
VA07	282	1,549	14,344	285,973	2.0%	0.5%
VA08	1,277	11,962	15,474	351,230	8.3%	3.4%

Congressional District	Tech-Based Start-Ups (Firm)	Tech-Based Start-Ups (Employ)	District Total (Firm)	District Total (Employ)	Tech-Based Start-Ups (Firm Share)	Tech-Based Start-Ups (Employ Share)
VA09	148	1,026	10,926	211,661	1.4%	0.5%
VA10	1,937	18,340	16,633	317,416	11.6%	5.8%
VA11	227	1,678	16,753	436,487	1.4%	0.4%
VT00	403	2,718	18,166	266,363	2.2%	1.0%
WA01	1,279	9,276	15,484	264,413	8.3%	3.5%
WA02	354	2,583	15,977	271,300	2.2%	1.0%
WA03	239	1,278	12,873	186,087	1.9%	0.7%
WA04	174	964	11,479	183,213	1.5%	0.5%
WA05	219	1,088	13,836	225,334	1.6%	0.5%
WA06	465	1,820	13,868	190,382	3.4%	1.0%
WA07	1,247	8,126	23,273	450,490	5.4%	1.8%
WA08	586	5,298	12,423	168,279	4.7%	3.1%
WA09	388	3,239	18,316	430,541	2.1%	0.8%
WA10	144	675	11,925	199,408	1.2%	0.3%
WI01	334	2,415	11,739	243,306	2.8%	1.0%
WI02	513	5,262	14,777	351,650	3.5%	1.5%
WI03	226	2,179	13,208	273,183	1.7%	0.8%
WI04	375	3,075	10,382	322,886	3.6%	1.0%
WI05	242	2,125	16,506	399,173	1.5%	0.5%
WI06	164	1,240	13,034	306,734	1.3%	0.4%
WI07	211	1,174	14,822	248,332	1.4%	0.5%
WI08	193	1,211	14,215	324,374	1.4%	0.4%
WV01	202	1,815	9,772	212,349	2.1%	0.9%
WV02	168	1,315	9,243	185,184	1.8%	0.7%
WV03	121	884	8,397	159,911	1.4%	0.6%
WY00	250	1,339	18,052	219,881	1.4%	0.6%

The following tables provide additional district-level details on technology-based start-ups by industry; Table 10 tracks the number of firms and Table 11 tracks employment.

Table 10: Number of Technology-Based Start-Ups by Industry and by Congressional District, 2016

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
AK00	526	6	30	2		7	8	72		221	182
AL01	257	1	21	4		3	12	45		104	71
AL02	228	7	23	1		1	11	42		98	46
AL03	159	1	10	3		1	5	23		71	48
AL04	135	2	22	7		1	12	22		54	22
AL05	458	36	74	22		1	9	48		199	91
AL06	414	2	21	2		6	12	56	3	220	94
AL07	110		11			1	2	21		42	33
AR01	129	1	6				8	32		44	38
AR02	372	2	18	2		2	10	97	1	134	108
AR03	249	2	18	5		1	11	50		97	70
AR04	92		11				1	26		31	23
AZ01	389	1	46	17		3	12	88	2	134	103
AZ02	388	2	34	9			14	68	1	158	111
AZ03	162		22	6		1	6	43		51	39
AZ04	292	6	31	4			18	75	1	112	49
AZ05	432	12	60	23	1	3	22	80	2	181	71
AZ06	1,092	5	106	26		6	45	223	3	502	202
AZ07	644	7	71	25		5	26	129	2	276	128
AZ08	109	1	10	2			10	33		38	17
AZ09	239	2	36	20		1	4	42	3	98	53
CA01	414	2	32	10		4	18	79		180	99
CA02	735	1	43	14	1	18	20	127	2	318	205
CA03	497	4	31			8	14	99	1	173	167
CA04	575	1	50	11		4	19	99	2	268	132
CA05	252		21	1		3	10	41		110	67
CA06	398	2	23	1		5	14	75		150	129
CA07	236		13			1	18	39	2	104	59
CA08	364	3	25	3		3	13	68	1	160	91
CA09	272	1	19	7		2	21	56		117	56
CA10	198		20	6		3	10	36		82	47
CA11	870	3	72	21		10	34	129	2	402	218
CA12	1,885		66	14		14	18	329	12	860	586
CA13	689		47	5		7	14	89	4	248	280
CA14	1,284	1	127	23		32	34	179	9	608	294
CA15	808	2	123	64	1	15	24	75	1	383	184
CA16	193	1	8	3		1	11	43	1	75	53
CA17	2,769	2	646	358		14	64	294	13	1309	427
CA18	1,265	2	166	53		13	24	170	4	592	294
CA19	471	1	116	47	1	1	10	53	3	219	67
CA20	266	3	16	3		4	11	53		118	61
CA21	144	1	9	1		1	4	25		49	55

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
CA22	150		8	1		1	8	30		67	36
CA23	170	5	16	1		1	14	37		50	47
CA24	642	5	55	4		3	13	118	4	273	171
CA25	525	12	97	16		3	21	84	1	193	114
CA26	403	8	59	23		8	11	63	1	149	104
CA27	728	8	64	16		5	34	127	1	273	216
CA28	946	5	73	7		11	73	212	4	340	228
CA29	281	1	24	3			26	52		122	56
CA30	571	10	37	4		6	27	141	2	242	106
CA31	183		20	3		3	16	35		63	46
CA32	280	7	22	8		3	19	44	1	96	88
CA33	1,545	32	134	17		12	43	357	8	599	360
CA34	335	1	16	2			20	93		115	90
CA35	290	2	38	11		8	12	43	1	104	82
CA36	191		17	3		2	12	38		69	53
CA37	226	4	8			2	9	48		88	67
CA38	423	22	43	6		4	38	70	3	116	127
CA39	597	14	84	28		6	74	93	1	199	126
CA40	63	1	3			2	6	13		19	19
CA41	263	3	21	4		2	9	50	2	99	77
CA42	334	5	19	2		4	13	59	1	143	90
CA43	192	5	35	9		3	13	30		55	51
CA44	166	4	12	2		3	6	29		62	50
CA45	1,678	31	219	88		19	84	261	3	706	355
CA46	390	5	44	14		1	24	68	2	136	110
CA47	380	23	43	7		3	17	61	1	130	102
CA48	599	15	56	17		4	12	122	2	237	151
CA49	1,413	7	129	47		50	60	186	9	532	440
CA50	299	2	34	7		3	9	52		139	60
CA51	399	2	26	3		5	27	89		153	97
CA52	869	4	61	21	1	9	31	135	2	418	208
CA53	149	1	8	1		1	6	28	1	58	46
CO01	1,451	7	122	10		8	37	247	5	666	359
CO02	1,300	4	186	26		10	28	196	12	511	353
CO03	408	3	20	2		1	8	94	1	145	136
CO04	533	5	71	7		3	10	99	3	237	105
CO05	492	4	84	12		3	15	94		213	79
CO06	272	1	60	3		3	8	46		116	38
CO07	190	1	13	4			11	37	3	80	45
CT01	536	23	67	3		3	17	78	1	232	115
CT02	281	7	26	6		3	9	35	1	134	66
CT03	481	69	50	10		4	15	49	1	163	130
CT04	681	16	98	19	1	4	16	106	7	326	107

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
CT05	225	4	36	9			10	32	2	102	39
DE00	510	9	37	4		2	11	86	4	235	126
FL01	368	8	31	4		2	13	55	2	161	96
FL02	382	2	16	5		4	13	66		165	116
FL03	348	2	18	1		3	23	72		123	107
FL04	641	2	46	1			22	130	1	316	124
FL05	639	1	42	8		6	14	132		284	160
FL06	314	2	21	5		2	11	78		122	78
FL07	531	4	62	14		3	22	91	4	231	114
FL08	553	4	84	12		5	17	91		229	123
FL09	296	5	33	5		3	12	51		119	73
FL10	247	2	13	1		2	11	61		89	69
FL11	270	1	20	2		2	8	90	1	86	62
FL12	560		49	8		4	33	108		239	127
FL13	600	6	48	14		3	25	129	3	240	146
FL14	688	2	47	7		3	22	124	2	303	185
FL15	279		23	4			8	38		122	88
FL16	558	4	35	3		4	25	119	4	248	119
FL17	202	5	5			1	10	64	1	57	59
FL18	558	4	39	5		6	31	95	1	201	181
FL19	509	3	25	3		8	25	100	1	210	137
FL20	878	4	63	7		6	36	194	2	352	221
FL21	456	3	31	6		1	27	95	2	191	106
FL22	612	4	46	6		3	26	147	1	259	126
FL23	820	2	69	6		6	31	186	4	318	204
FL24	453	1	39	3		9	6	88	1	186	123
FL25	573	4	103	9		6	29	77	1	224	129
FL26	443	3	44	5		2	18	72	1	183	120
FL27	313	3	21	1		1	18	60	2	120	88
GA01	202	1	20	3		2	7	42		79	51
GA02	195	4	20	2			5	53	2	65	46
GA03	256	4	25	6		2	12	40		116	57
GA04	425	4	36	6		2	15	73	2	204	89
GA05	912	3	62	5		7	11	171	2	482	174
GA06	1,477	2	139	25		14	33	208	8	864	209
GA07	474	1	62	9		3	19	63	5	238	83
GA08	143	5	10	1		1	2	26	1	56	42
GA09	311		18	5	1	20	21	44		127	80
GA10	127		6	2		1	8	20		54	38
GA11	400	1	61	4	1	1	8	54	2	202	70
GA12	138		7			2	6	30		52	41
GA13	86		12				2	11		41	20
GA14	96		7	2			2	15	1	48	23

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
HI01	311	2	12	5		1	11	57	2	116	110
HI02	195	3	5	1		5	3	42		68	69
IA01	248	5	25	4			16	44	1	119	38
IA02	191	1	11	3			7	40	2	84	46
IA03	283		25	3		4	6	50	2	134	62
IA04	185		22	2		4	1	43	2	64	49
ID01	417	1	30	11		3	19	103	3	174	84
ID02	389	2	21	8		1	15	103		138	109
IL01	322		22	3		5	19	58	1	122	95
IL02	96	1	10	1		1	1	18		40	25
IL03	280	2	25	4		2	9	40	2	120	80
IL04	331	2	29	5		5	15	63		160	57
IL05	691	3	59	19		4	23	140	2	340	120
IL06	1,272	2	134	39		4	41	204	10	678	199
IL07	802	7	55	3		3	18	147	1	426	145
IL08	403	1	29	7		4	28	46	4	210	81
IL09	367		29	6		3	26	70	2	159	78
IL10	435	1	39	10		18	20	48	4	163	142
IL11	348	2	26	3		1	19	54	2	176	68
IL12	223	15	15	2		1	11	32		111	38
IL13	305	6	17	4		3	7	49	2	140	81
IL14	183		10	5			4	36		86	47
IL15	95	2	6			1	5	34	1	30	16
IL16	178	1	19	4			11	31	1	71	44
IL17	134	1	9	1			1	37		57	29
IL18	96		12	3			3	18		42	21
IN01	262	1	14	3		1	8	56		110	72
IN02	257		24	6		5	10	60	1	116	41
IN03	230		19	4		1	9	61		93	47
IN04	267	3	20	8		4	9	43		119	69
IN05	620	4	41	14		2	32	87	2	320	132
IN06	175		9	2		1	8	32		72	53
IN07	292	5	22	2		1	6	48		112	98
IN08	198	2	14	3		1	9	37	2	63	70
IN09	157	1	10				3	30		64	49
KS01	173	1	12	2		3	4	47	1	68	37
KS02	208	3	14	1			5	53		81	52
KS03	547	1	57	7		8	15	91	2	259	114
KS04	294	26	69	6			7	53	1	83	55
KY01	143		3			2	2	38		58	40
KY02	221	1	18	5		4	8	52		81	57
KY03	353	1	19	3		2	18	51	3	166	93
KY04	215		15	1		3	8	44		85	60

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
KY05	134		7			1	4	35		37	50
KY06	267		25	5		9	10	47		98	78
LA01	450	1	29	1		3	23	56		178	160
LA02	346	2	18			2	9	51	2	127	135
LA03	277	3	9	3		3	7	43	1	92	119
LA04	196	2	21				11	32		58	72
LA05	118		3				6	22		37	50
LA06	229		13	1		3	3	25	2	87	96
MA01	311		19	4		1	15	68	1	118	89
MA02	599		84	8	1	19	17	83	3	245	147
MA03	830	3	127	43	1	10	22	81	3	391	192
MA04	949		79	17		21	33	145	3	458	210
MA05	1,300	1	119	22	1	44	45	149	13	566	362
MA06	536	2	93	41	1	8	18	76	4	198	136
MA07	798	1	42	7		26	10	143	7	346	223
MA08	411	1	37	6		4	16	77	1	176	99
MA09	334	1	21	4			11	53	1	133	114
MD01	470	3	41	4		6	13	72	1	215	119
MD02	674	6	53	7		10	18	85	4	336	162
MD03	845	2	51	8		9	29	114	1	427	212
MD04	422	2	36	2		4	15	67		225	73
MD05	280	8	29	2		1	5	23	3	136	75
MD06	951	5	87	9		33	32	121	6	432	235
MD07	128		18			1	7	6	1	58	37
MD08	311		14			2	7	51	3	153	81
ME01	437	2	26	4	1	9	16	86	1	188	108
ME02	218		8	1		2	20	40		83	65
MI01	278	1	16	1		1	13	63		113	71
MI02	421		27	7		3	22	98		194	77
MI03	176		8	1		1	9	35		89	34
MI04	250	1	10			1	11	60		115	52
MI05	172	2	13	2		1	7	52		59	38
MI06	201		10	1		4	11	35		100	41
MI07	536		39	4		3	16	90	3	234	151
MI08	402		44	9		2	15	77	3	193	68
MI09	727	2	58	10		7	17	146	2	373	122
MI10	120		8	3		1	2	33		58	18
MI11	399	1	45	17		6	8	46	1	215	77
MI12	216		12	1		2	5	46		85	66
MI13	192		16	2			7	30		63	76
MI14	141		10	1		2	4	28		65	32
MN01	233		34	3			10	52	1	85	51
MN02	382	1	54	7	1	2	18	63	2	194	47

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
MN03	866	1	104	30		5	36	140	5	430	145
MN04	528		50	9	1	6	41	94	2	226	108
MN05	479	1	29	5	1		4	104	1	245	94
MN06	168		13	1		2	5	28	2	82	36
MN07	192		14	4	1	1	7	63		72	34
MN08	168		12	3			8	46	2	69	31
MO01	658	49	54	5		7	14	97	3	308	126
MO02	444	47	43	6		1	20	63	1	210	59
MO03	312	5	18	3	1		5	147	2	81	53
MO04	216	3	7	1		1	6	102		68	29
MO05	393	1	24	4		2	14	90	2	172	88
MO06	156	1	12	4			1	64		48	30
MO07	248		10		1	2	7	67		129	32
MO08	134	1	0				3	66		36	28
MS01	169	2	6	2			5	52	1	62	41
MS02	224		14	4		2	7	70		77	54
MS03	144		9	1		1	6	47		50	31
MS04	153		17	2			1	37		47	51
MT00	574	5	24	7		5	31	117	1	200	191
NC01	693	1	72	14		8	29	159	2	220	202
NC02	725		114	11		12	16	133	5	307	138
NC03	232	2	6			1	10	60		81	72
NC04	830	2	122	12		10	20	117	4	355	200
NC05	459	4	32	6		3	21	131	1	166	101
NC06	284		24	3		3	10	66	2	109	70
NC07	163		13	4		1	10	39	1	44	55
NC08	275	1	23	3		1	6	67	3	111	63
NC09	804	1	81	14		6	21	135	4	395	161
NC10	277	2	17	1		2	14	56		106	80
NC11	167		9	1			11	46	1	61	39
NC12	59	2	7	2		1	1	6		25	17
NC13	99		14	1				24		41	20
ND00	291	2	20	5			5	55		133	76
NE01	272	2	23	5		2	8	55		131	51
NE02	380	3	19	1		2	13	75	1	187	80
NE03	120		3			1	6	40		47	23
NH01	864	2	72	29		7	18	157	6	360	242
NH02	548	3	50	21		2	9	105	1	283	95
NJ01	351	4	39	2		3	14	45	2	147	97
NJ02	183	3	9			2	7	30	1	84	47
NJ03	416	3	34	4		7	13	62		177	120
NJ04	609	2	57	13		8	19	88	4	302	129
NJ05	741	9	48	6	1	8	95	94	1	330	155

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
NJ06	738	1	46	7	1	13	15	95	2	407	158
NJ07	901	1	85	8		41	27	115	3	415	214
NJ08	477		18	3		3	19	89	3	235	110
NJ09	371	1	24	5		5	20	64	4	156	97
NJ10	113	1	5				4	20		49	34
NJ11	642	1	69	16	1	42	23	72	1	305	128
NJ12	396	2	23			10	6	45	4	203	103
NM01	583	6	43	17		4	12	112	1	255	150
NM02	156	1	19	2			8	26	2	53	47
NM03	241		12	2			5	56	2	84	82
NV01	747	7	44	12		5	47	216	3	266	159
NV02	488	2	41	11		4	19	114	2	186	120
NV03	234	3	18	2		2	10	52	1	100	48
NV04	105	2	8	2			2	26		48	19
NY01	567	3	54	24		5	25	109		202	169
NY02	463	2	43	14		7	16	88	3	208	96
NY03	549	1	38	9	1	4	20	109	1	255	120
NY04	271	1	16	2		1	14	51	1	127	60
NY05	90	1	6	1			5	16		38	24
NY06	231		10	2		2	25	61	3	72	58
NY07	736	2	31	3		2	11	172	2	312	204
NY08	193		12	1			20	43	3	64	51
NY09	70		2			1	9	19		22	17
NY10	1,549	6	62	10		7	28	366	12	792	276
NY11	140	1	7	1			17	20		67	28
NY12	1,104	1	77	12		15	22	214	8	539	228
NY13	109	1	6			5	5	20		36	36
NY14	135	1	4			3	6	29		43	49
NY15	30		1			1		6		8	14
NY16	222	1	19	3		2	5	41		106	48
NY17	606		106	7		9	22	66	4	276	123
NY18	416	2	109	12		4	13	46	4	152	86
NY19	295		30	8		1	6	57	1	107	93
NY20	376	1	32	8	1	1	3	58	1	161	118
NY21	197	2	4			2	7	44		67	71
NY22	237	1	54	8			10	24		82	66
NY23	221		13	4		5	4	41	2	93	63
NY24	320	3	40	11		2	9	51	1	143	71
NY25	440	2	36	11	1	2	18	81	1	197	102
NY26	395		28	4		3	16	72	1	161	114
NY27	128		16	4			5	17		60	30
OH01	686	2	69	6	1	5	20	103	3	316	167
OH02	185		9			4	4	30		82	56

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
OH03	645	2	51	9		6	22	138	1	271	154
OH04	346	1	20	3		2	14	96	1	143	69
OH05	207	2	13	4			4	54		93	41
OH06	173	1	9	2		1	4	47		63	48
OH07	345	3	21	5		1	17	78	3	155	67
OH08	159		23	3		2	6	31	1	66	30
OH09	188		23	6		4	11	36		64	50
OH10	275	3	22	3		2	8	52	1	114	73
OH11	554	1	51	14	1	6	28	87	2	252	126
OH12	223		16	2			6	40	1	107	53
OH13	275		26	2	1	1	14	60		106	67
OH14	214		28	10			7	36		95	48
OH15	76	1	2			3	1	23		32	14
OH16	54		5				1	4		32	12
OK01	444	11	54	2		2	19	65	1	183	109
OK02	115		9			1	5	32		37	31
OK03	258	5	36	2		2	13	42	2	83	75
OK04	248	2	24	1			10	26		96	90
OK05	381	4	26	2		1	15	58	1	139	137
OR01	1,132	4	105	42	1	3	32	171	8	633	175
OR02	466	5	18	4		5	32	127	2	180	97
OR03	701	8	38	10		3	16	126	1	344	165
OR04	382	1	26	1		2	24	88	2	145	94
OR05	216	5	12	2		1	19	64		65	50
PA01	429	13	20	2		3	15	92	1	166	119
PA02	446	3	32	3		9	11	71	1	195	124
PA03	238	1	19	6			11	54		88	65
PA04	309	2	31	15			7	61		141	67
PA05	194	2	13	5			2	42	1	71	63
PA06	780	12	89	23	1	19	19	107	3	355	175
PA07	399	12	55	9		10	17	42	3	173	87
PA08	443	1	56	11		4	27	75	1	169	110
PA09	186	1	16	2	1		9	27	1	70	61
PA10	229		15	1			6	52		81	75
PA11	176	2	16	6		1	9	40		56	52
PA12	408	2	36	10		7	15	65	1	166	116
PA13	113		3				8	19		50	33
PA14	521	1	20	3		1	7	66	2	165	259
PA15	257	1	24	8		2	11	38	1	119	61
PA16	127		10	2		2	3	28		57	27
PA17	107		5	1			1	22		42	37
PA18	158		18	4			8	18		55	59
RI01	270		22	5		3	6	40	1	123	75

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
RI02	180	1	8	3			6	35	1	71	58
SC01	430	17	21	1		2	12	84	1	179	114
SC02	307		20	2		1	9	40	3	131	103
SC03	250	3	21	5		1	9	40	1	108	67
SC04	267		20	1		1	4	46		127	69
SC05	129	1	11	2			4	20		52	41
SC06	133	1	9	1		3	3	27		49	41
SC07	149	1	14	4			9	44		57	24
SD00	302	3	28	5		1	12	55		140	63
TN01	195		7			4	7	47	1	70	59
TN02	400	1	37	3		2	18	58		180	104
TN03	215		14	2			10	37		99	55
TN04	238	2	13	3			10	62		99	52
TN05	613		35	3		5	13	112	2	320	126
TN06	108	2	10				1	13		53	29
TN07	121		6	3			8	26		60	21
TN08	336		22			4	17	58	2	145	88
TN09	155		12	1		1	8	32		50	52
TX01	194	1	14	6		1	5	46		72	55
TX02	1,316	4	116	19		9	27	186	5	572	397
TX03	1,141	9	135	33	1	5	26	158	6	642	159
TX04	217	2	25	5		2	8	55	1	74	50
TX05	336	2	30	5		3	23	63		143	72
TX06	464	6	75	9			18	87	4	159	115
TX07	636		41	9		4	24	92	1	325	149
TX08	363	2	24	2			8	60	1	145	123
TX09	313	1	20	4		3	16	48	1	117	107
TX10	1,027	1	154	68		4	26	132	10	494	206
TX11	294	1	28	2		1	10	52		97	105
TX12	477	6	99	6		3	11	77	1	155	125
TX13	193	2	17	3		1	7	52		62	52
TX14	294	3	18			4	12	50		95	112
TX15	235		16	6		3	9	52		79	76
TX16	179	2	24	9		3	8	33		65	44
TX17	364	1	40	16		6	11	65	3	138	100
TX18	265	1	19	2		1	6	51	1	95	91
TX19	165		5	1		1	5	29		69	56
TX20	460	7	34	6		3	20	58	1	185	152
TX21	875	8	95	43		6	20	131	8	343	264
TX22	293	5	36	4			10	34	2	121	85
TX23	61		7					16		18	20
TX24	1,311	11	163	29		10	29	183	8	654	253
TX25	213	1	23	8			2	36	2	92	57

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
TX26	170	1	26	3		2	3	22		78	38
TX27	195	1	13	4		2	8	41		58	72
TX28	118	2	12	2		1	3	22	1	35	42
TX29	93		6	3		2	1	12	1	20	51
TX30	410	2	38	3		2	16	81		185	86
TX31	215	1	39	10		1	9	47	1	81	36
TX32	285	2	40	14	1	1	9	45	3	141	43
TX33	26		5			2	1	4		10	4
TX34	74	1	6	1			1	12		35	19
TX35	48		0					14		18	16
TX36	132	3	15	1			4	26		38	46
UT01	311	7	33	4		2	18	58	1	116	76
UT02	542	5	41	4	1	6	20	142	1	208	118
UT03	736	2	42	12		4	44	162	7	370	105
UT04	194		15	2			20	41		91	27
VA01	538	5	42	6	1	2	9	66	2	308	103
VA02	413	10	37	4		4	16	72	1	190	83
VA03	286		19	2		3	6	59		130	69
VA04	246	1	16	2		2	11	36		120	60
VA05	420	4	27	4		4	15	79	1	166	124
VA06	232	1	9	2		1	7	43		103	68
VA07	282		15	6		3	11	55	2	140	56
VA08	1,277	19	123	7		2	24	121	6	804	178
VA09	148	1	11	5		2	5	44	2	41	42
VA10	1,937	20	159	12		6	23	187	7	1356	179
VA11	227	2	24				5	31	4	132	29
VT00	403	1	68	8			20	58	2	162	92
WA01	1,279	83	105	21		4	50	214	12	597	214
WA02	354	48	43	5		5	24	50	1	125	58
WA03	239	3	22	9		1	11	43	3	100	56
WA04	174	2	18				6	34		46	68
WA05	219	1	19	1		1	10	52	1	84	51
WA06	465	8	16			2	25	122	1	187	104
WA07	1,247	69	58	8		9	24	218	5	533	331
WA08	586	94	49	5		4	24	93		213	109
WA09	388	69	20	4			18	63	1	157	60
WA10	144	3	11	1		2	8	24		66	30
WI01	334	3	31	4		1	16	68	1	146	68
WI02	513	1	31	2		14	15	68	2	249	133
WI03	226	1	20	6			10	60		102	33
WI04	375	3	27	8		1	13	71	1	160	99
WI05	242		20	6			8	43	1	124	46
WI06	164	1	17	4			6	38		71	31

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
WI07	211	3	10	1		4	10	55		89	40
WI08	193	4	17	3			13	37		85	37
WV01	202	4	9			1	5	45		68	70
WV02	168	1	9				5	45	1	67	40
WV03	121	1	4				2	30	1	42	41
WY00	250	2	11	2			13	45	3	101	75

Table 11: Employment in Technology-Based Start-Ups by Industry and by Congressional District, 2016

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
AK00	3,153	27	804	52		79	18	346		1,069	810
AL01	4,778	2	769	33		33	77	281		3,129	487
AL02	4,590	32	3,435	1		11	95	241		458	318
AL03	2,646	1	1,670	19		2	19	271		330	353
AL04	1,911	4	1,323	279		1	65	208		189	121
AL05	4,944	191	2,065	814		7	111	453		1,573	544
AL06	3,231	4	912	18		25	104	214	23	1,204	745
AL07	2,236		1,683			3	10	105		196	239
AR01	890	25	84				26	311		248	196
AR02	3,075	13	378	17		13	60	1,142	20	836	613
AR03	2,405	5	346	85		4	65	350		706	929
AR04	678		239				2	149		100	188
AZ01	2,863	93	886	276		21	36	500	3	637	687
AZ02	3,185	10	675	144			42	327	60	714	1,357
AZ03	1,039		275	88		3	17	217		286	241
AZ04	1,365	41	292	40			71	295	1	413	252
AZ05	3,114	108	978	280	6	66	74	336	8	998	540
AZ06	7,486	41	1,547	462		96	310	1,411	76	2,737	1,268
AZ07	4,623	109	1,038	364		86	491	943	3	1,337	616
AZ08	513	9	116	15			35	114		134	105
AZ09	2,222	91	570	289		10	31	249	31	511	729
CA01	2,441	20	1,053	153		22	69	297		595	385
CA02	5,876	2	1,594	549	85	153	370	559	12	1,674	1,427
CA03	4,087	29	1,106			137	111	372	1	592	1,739
CA04	4,932	7	2,409	137		51	110	378	3	1,112	862
CA05	1,446		566	46		6	37	203		317	317
CA06	3,782	14	2,115	25		45	41	170		628	769
CA07	3,567		2,169			35	75	382	202	454	250
CA08	1,888	21	465	147		18	65	212	10	729	368
CA09	2,078	10	738	59		16	77	361		485	391
CA10	1,532		683	51		6	33	173		405	232
CA11	7,162	153	2,866	354		174	244	854	26	1,537	1,308

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
CA12	18,789		2,540	157		241	67	3,577	319	8,464	3,581
CA13	5,339		1,294	46		105	165	614	56	1,284	1,821
CA14	18,096	7	7,822	632		897	459	1,974	315	3,024	3,598
CA15	8,996	14	3,670	1,097	19	523	398	657	11	2,425	1,279
CA16	1,109	10	322	35		2	29	210	2	220	314
CA17	35,105	14	20,125	5,990		253	526	2,371	195	8,683	2,938
CA18	13,480	14	6,892	700		51	537	853	66	3,214	1,853
CA19	5,926	2	3,007	657	90	35	56	279	144	1,886	427
CA20	1,853	19	825	32		20	30	229		508	222
CA21	840	7	238	8		2	40	82		155	316
CA22	747		62	9		2	12	146		240	285
CA23	1,202	167	377	19		3	68	132		244	211
CA24	5,049	30	1,815	105		7	66	914	8	1,138	1,071
CA25	7,103	575	3,307	259		50	779	444	4	1,109	835
CA26	3,930	175	1,609	380		191	199	233	10	768	745
CA27	6,721	384	2,259	353		66	168	810	11	1,290	1,733
CA28	7,760	241	1,917	179		101	222	1,303	18	2,219	1,739
CA29	2,258	70	716	56			81	303		649	439
CA30	4,933	419	1,236	69		102	99	1,023	8	1,262	784
CA31	1,373		323	97		112	108	204		333	293
CA32	2,663	371	752	112		48	123	236	3	491	639
CA33	15,133	1,947	4,001	447		288	619	2,244	67	3,124	2,843
CA34	2,323	73	233	42			79	540		650	748
CA35	2,508	10	1,201	141		132	78	232	5	444	406
CA36	1,055		454	133		4	44	123		201	229
CA37	1,798	221	142			37	99	300		402	597
CA38	4,841	1,383	942	58		44	395	394	205	589	889
CA39	6,020	698	2,314	591		172	616	354	15	1,090	761
CA40	448	73	54			22	12	77		78	132
CA41	1,694	21	825	357		4	18	163	8	305	350
CA42	1,842	33	679	17		41	52	183	6	448	400
CA43	2,393	238	911	180		19	388	183		255	399
CA44	1,402	200	316	55		25	93	161		309	298
CA45	19,468	1,199	8,329	1,923		1,579	644	1,532	37	3,988	2,160
CA46	3,537	210	1,016	318		2	154	463	177	767	748
CA47	4,669	1,174	1,645	112		218	137	276	2	578	639
CA48	7,515	603	2,171	382		147	151	2,571	20	1,106	746
CA49	17,184	43	6,141	1,698		1,394	1,112	1,150	90	2,711	4,543
CA50	2,580	14	1,159	139		8	126	250		732	291
CA51	3,289	10	679	36		102	837	433		686	542
CA52	8,117	217	2,181	600	10	194	209	855	33	3,147	1,271
CA53	1,072	7	341	65		2	26	127	1	294	274
CO01	12,458	94	3,223	99		84	252	2,043	55	3,841	2,866

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
CO02	14,851	36	7,575	365		144	312	1,498	94	2,203	2,989
CO03	1,693	67	200	11		12	34	365	2	393	620
CO04	5,036	105	2,332	70		33	180	701	11	998	676
CO05	3,734	47	1,942	148		26	362	324		722	311
CO06	3,549	15	2,042	52		34	40	717		509	192
CO07	1,608	15	169	51			666	133	10	289	326
CT01	5,368	250	2,037	52		33	334	675	7	1,174	858
CT02	1,598	72	329	92		33	127	161	5	565	306
CT03	4,840	280	1,525	280		26	834	363	1	790	1,021
CT04	5,076	72	1,539	397	7	29	142	386	33	1,321	1,547
CT05	1,365	12	589	150			34	195	6	374	155
DE00	3,648	33	1,111	31		6	44	322	24	1,381	727
FL01	2,080	69	519	36		12	56	349	24	596	455
FL02	2,505	9	332	81		20	29	692		925	498
FL03	2,561	12	221	13		21	523	683		338	763
FL04	3,788	7	619	9			122	705	5	1,616	714
FL05	5,002	9	958	100		59	52	713		1,777	1,434
FL06	1,447	12	409	110		16	74	255		325	356
FL07	4,480	24	976	198		18	161	589	228	1,733	751
FL08	4,514	45	1,618	160		37	67	385		1,632	730
FL09	2,290	25	450	35		23	36	197		1,066	493
FL10	1,559	12	192	13		22	50	259		419	605
FL11	1,141	10	205	25		16	35	345	10	304	216
FL12	4,036		1,138	165		31	189	653		1,255	770
FL13	6,331	35	2,274	333		28	291	718	43	1,583	1,359
FL14	5,709	10	671	141		32	238	1,301	75	2,279	1,103
FL15	1,956		422	102			118	271		648	497
FL16	2,758	27	623	33		30	98	556	44	863	517
FL17	852	24	47			1	60	224	2	200	294
FL18	2,906	40	549	135		83	113	537	20	770	794
FL19	2,802	15	326	22		49	79	459	4	1,122	748
FL20	4,697	19	753	98		50	254	897	40	1,367	1,317
FL21	2,297	12	363	81		8	136	570	22	744	442
FL22	3,156	17	558	115		19	112	998	15	851	586
FL23	4,439	12	732	72		130	174	817	30	1,427	1,117
FL24	3,004	10	221	40		134	12	584	2	1,527	514
FL25	2,758	118	626	132		44	95	378	20	1,044	433
FL26	1,995	23	361	54		8	40	345	5	809	404
FL27	1,637	98	159	9		11	60	397	11	553	348
GA01	1,316	11	492	22		17	54	271		271	200
GA02	1,799	67	583	18			23	357	4	264	501
GA03	1,624	44	354	23		27	100	242		592	265
GA04	2,735	41	630	60		48	176	398	75	702	665

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
GA05	7,599	26	1,164	34		53	85	1,699	15	3,411	1,146
GA06	13,590	15	2,350	193		341	421	2,612	168	6,296	1,387
GA07	3,386	24	1,007	133		33	117	339	41	1,234	591
GA08	909	45	156	9		11	5	133	2	418	139
GA09	1,781		304	34	5	297	141	179		540	315
GA10	584		111	18		11	19	80		209	154
GA11	2,896	35	1,370	86	5	11	35	157	4	1,026	253
GA12	687		86			5	24	141		171	260
GA13	496		216				19	32		174	55
GA14	553		211	111			5	37	20	179	101
HI01	2,575	19	142	42		11	49	377	8	828	1,141
HI02	883	20	127	30		10	15	134		186	391
IA01	3,224	99	1,579	51			536	140	70	530	270
IA02	1,165	1	161	60			20	287	12	356	328
IA03	2,396		813	72		51	23	346	12	764	387
IA04	2,342		1,063	23		82	2	239	62	205	689
ID01	3,056	7	820	487		26	74	676	34	942	477
ID02	2,157	14	163	67		4	38	820		546	572
IL01	1,991		453	121		55	106	255	8	565	549
IL02	667	4	203	20		6	1	85		189	179
IL03	1,894	6	513	224		22	22	224	2	619	486
IL04	2,280	16	486	89		58	101	435		886	298
IL05	5,569	12	1,282	420		33	652	963	34	1,918	675
IL06	10,692	16	2,862	1,164		74	628	1,322	451	4,143	1,196
IL07	6,708	28	1,100	128		29	203	1,365	20	3,027	936
IL08	3,268	4	721	211		33	253	318	38	1,461	440
IL09	2,770		596	264		26	213	467	16	734	718
IL10	3,295	4	716	207		442	484	136	57	788	668
IL11	3,094	8	852	81		10	257	280	14	1,257	416
IL12	1,602	60	143	13		4	67	189		691	448
IL13	1,946	21	287	142		25	28	258	24	887	416
IL14	908		200	131			15	139		309	245
IL15	516	8	75			2	17	240	3	127	44
IL16	1,277	1	222	136			34	162	12	349	497
IL17	955	4	132	50			4	191		441	183
IL18	751		280	176			19	117		236	99
IN01	1,546	6	109	22		2	58	286		638	447
IN02	2,178		489	67		55	108	772	5	521	228
IN03	1,978		481	59		30	104	571		541	251
IN04	2,350	13	534	168		595	100	264		394	450
IN05	4,738	40	705	177		179	371	692	9	1,588	1,154
IN06	1,107		225	70		15	49	262		213	343
IN07	7,202	4,315	464	23		11	45	521		673	1,173

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
IN08	1,350	10	243	60		3	124	301	82	230	357
IN09	825	5	164				17	135		303	201
KS01	1,002	20	228	30		20	48	298	1	211	176
KS02	1,142	40	394	10			38	250		208	212
KS03	5,811	9	856	63		181	370	844	3	1,468	2,080
KS04	4,194	386	2,536	281			28	264	4	509	467
KY01	770		70			50	4	205		236	205
KY02	1,550	9	547	230		39	93	238		369	255
KY03	2,459	3	326	52		15	139	328	23	1,054	571
KY04	1,831		331	3		75	316	261		501	347
KY05	682		224			2	8	189		134	125
KY06	1,958		468	97		125	20	223		397	725
LA01	2,792	1	255	1		107	225	323		958	923
LA02	3,423	11	251			4	37	846	22	832	1,420
LA03	2,375	21	95	40		8	28	342	5	509	1,367
LA04	1,827	21	217				40	209		238	1,102
LA05	642		56				27	119		162	278
LA06	2,078		198	8		20	7	182	17	449	1,205
MA01	2,067		257	37		11	151	276	2	524	846
MA02	6,816		2,587	257	40	126	1,243	429	68	1,337	986
MA03	11,606	207	3,531	882	3	181	254	571	25	4,323	2,511
MA04	9,971		2,595	734		302	290	1,462	10	3,065	2,247
MA05	21,126	3	4,473	457	30	749	831	1,645	381	6,179	6,835
MA06	7,819	120	3,018	920	50	129	193	616	32	2,028	1,633
MA07	10,629	100	1,252	465		696	155	1,550	84	2,686	4,106
MA08	3,603	1	908	278		27	244	737	15	821	850
MA09	1,900	2	581	192			152	189	10	449	517
MD01	3,681	9	767	64		344	86	602	2	1,280	591
MD02	5,935	22	1,082	108		155	216	799	98	2,711	852
MD03	8,589	24	1,138	241		182	218	2,748	4	3,125	1,150
MD04	2,960	6	765	24		26	47	305		1,299	512
MD05	2,703	56	630	8		2	10	89	8	1,001	907
MD06	9,488	46	2,338	180		574	148	1,130	84	2,986	2,182
MD07	1,121		321			14	51	37	60	409	229
MD08	2,242		243			5	29	348	8	1,130	479
ME01	2,707	7	623	95	1	118	123	452	8	693	682
ME02	1,456		171	1		16	57	201		278	733
MI01	1,637	2	209	14		1	138	263		791	233
MI02	2,642		619	329		30	218	481		934	360
MI03	976		163	14		46	73	142		396	156
MI04	1,358	10	189			11	33	307		537	271
MI05	1,061	16	237	35		2	31	235		292	248
MI06	1,625		171	6		120	146	144		517	527

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
MI07	4,135		1,089	128		63	177	870	31	1,175	730
MI08	2,825		780	356		22	214	373	33	1,037	366
MI09	5,594	25	1,498	495		118	164	957	145	2,062	625
MI10	695		207	125		26	7	142		197	116
MI11	3,816	22	1,297	917		59	24	231	15	1,772	396
MI12	1,399		172	23		15	96	316		426	374
MI13	1,378		359	110			56	114		571	278
MI14	1,192		242	100		22	59	212		377	280
MN01	1,541		643	68			54	269	1	353	221
MN02	3,356	5	1,176	63	15	61	542	736	11	615	195
MN03	8,843	1	2,267	682		276	754	956	23	3,450	1,116
MN04	4,730		1,292	379	50	306	826	397	16	1,197	646
MN05	4,423	18	490	55	8		107	642	49	2,034	1,075
MN06	900		307	10		14	38	101	5	320	115
MN07	1,035		245	79	200	20	22	267		163	118
MN08	661		115	22			16	155	3	229	143
MO01	5,213	236	744	62		99	281	557	137	2,064	1,095
MO02	3,313	147	741	81		11	200	352	6	1,451	405
MO03	2,820	15	457	54	19		36	1,655	10	329	299
MO04	1,913	131	90	15		5	78	1,281		221	107
MO05	3,322	3	410	72		50	109	700	12	792	1,246
MO06	1,858	1	168	77			12	1,367		199	111
MO07	2,212		157		19	4	25	818		781	408
MO08	1,721	3	-				18	1,363		214	123
MS01	980	30	120	61			21	338	10	286	175
MS02	1,318		237	97		22	33	385		326	315
MS03	826		177	15		8	42	270		189	140
MS04	1,497		653	92			3	208		329	304
MT00	2,816	23	314	108		34	162	469	7	593	1,214
NC01	6,783	5	1,991	336		403	472	641	24	1,571	1,676
NC02	7,964		2,972	224		1,012	437	624	41	1,961	917
NC03	1,737	32	89			11	24	291		285	1,005
NC04	8,726	10	3,736	189		553	212	714	61	1,953	1,487
NC05	4,908	109	2,729	175		39	176	518	2	748	587
NC06	2,267		529	82		23	98	341	13	977	286
NC07	1,631		993	333		2	116	143	1	148	228
NC08	2,248	12	738	101		200	36	412	11	477	362
NC09	7,475	3	2,081	367		124	1,040	822	89	2,379	937
NC10	1,940	9	670	26		51	175	276		363	396
NC11	1,362		811	30			68	144	5	156	178
NC12	450	6	96	16		25	2	39		160	122
NC13	949		582	6				78		162	127
ND00	2,534	33	361	150			18	754		522	846

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
NE01	2,754	44	783	128		761	42	273		616	235
NE02	4,541	9	374	15		13	49	732	2	1,681	1,681
NE03	749		73			30	40	296		190	120
NH01	5,993	11	1,850	501		26	153	995	15	1,928	1,015
NH02	4,123	58	1,198	195		6	189	443	1	1,803	425
NJ01	2,512	40	751	28		42	91	354	17	616	601
NJ02	1,170	21	113			41	47	105	300	290	253
NJ03	2,994	30	531	72		155	138	420		812	908
NJ04	4,410	20	958	362		79	123	497	104	1,745	884
NJ05	5,755	123	738	66	4	101	1,670	716	2	1,541	860
NJ06	6,834	10	710	65	10	412	134	607	78	3,624	1,249
NJ07	8,308	10	1,622	191		1,154	237	541	53	2,981	1,710
NJ08	4,494		333	49		70	151	700	193	2,440	607
NJ09	2,892	5	397	49		329	212	580	8	969	392
NJ10	671	6	50				14	84		296	221
NJ11	6,044	100	1,323	369	23	1,045	442	486	2	1,855	768
NJ12	3,133	24	422			314	47	238	14	1,369	705
NM01	2,898	36	910	297		27	84	348	2	704	787
NM02	2,044	25	604	105			23	95	501	116	680
NM03	1,471		314	35			8	205	16	229	699
NV01	4,518	53	709	82		49	176	1,077	15	1,202	1,237
NV02	3,074	5	941	299		67	39	500	4	885	633
NV03	1,429	3	244	18		21	39	209	5	494	414
NV04	656	7	141	8			11	102		226	169
NY01	3,874	20	931	394		138	149	564		952	1,120
NY02	3,920	116	1,040	504		175	482	353	9	1,165	580
NY03	4,341	3	580	112	10	121	520	689	3	1,781	634
NY04	1,443	1	186	24		4	78	252	2	652	268
NY05	887	2	298	1			15	39		193	340
NY06	1,640		357	8		13	111	137	9	418	595
NY07	5,528	30	549	131		10	53	1,395	22	2,475	994
NY08	829		90	2			45	125	19	318	232
NY09	284		12			5	42	57		93	75
NY10	15,002	138	831	88		26	368	3,828	81	7,766	1,964
NY11	620	6	65	4			43	98		267	141
NY12	10,614	6	1,491	241		124	245	1,944	451	4,856	1,497
NY13	736	6	100			18	19	146		242	205
NY14	1,118	140	208			12	17	113		179	449
NY15	127		25			4		30		26	42
NY16	2,102	6	324	24		50	16	265		779	662
NY17	5,858		1,691	124		215	404	407	18	1,853	1,270
NY18	3,403	28	1,761	206		69	125	137	26	523	734
NY19	2,136		553	204		11	48	209	6	373	936

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
NY20	2,308	6	463	91	26	5	20	382	1	754	651
NY21	1,023	7	70			21	102	354		183	286
NY22	2,569	10	831	246			181	183		264	1,100
NY23	1,409		288	176		56	8	131	7	490	429
NY24	2,917	27	682	193		7	490	344	1	615	751
NY25	3,298	24	549	225	5	22	231	450	15	1,385	617
NY26	3,310		453	135		29	97	652	10	951	1,118
NY27	968		293	156			181	60		207	227
OH01	5,685	140	1,497	88	8	116	192	884	31	1,865	952
OH02	1,011		141			69	10	224		273	294
OH03	4,480	5	865	59		147	102	773	10	1,657	921
OH04	2,669	6	366	54		12	248	380	20	1,017	620
OH05	1,419	7	247	73			37	325		513	290
OH06	1,145	4	180	56		50	11	195		240	465
OH07	2,621	6	323	57		11	59	631	26	1,071	494
OH08	1,430		646	149		20	58	158	2	320	226
OH09	1,598		418	152		13	103	305		409	350
OH10	2,126	35	376	64		54	58	240	1	988	374
OH11	4,957	30	959	253	7	115	237	880	35	1,886	808
OH12	2,282		297	37			38	166	15	1,544	222
OH13	2,129		574	46	7	36	382	316		428	386
OH14	2,401		703	278			914	125		433	226
OH15	395	1	56			33	3	109		116	77
OH16	379		52				4	34		222	67
OK01	3,150	345	742	75		8	56	368	4	1,010	617
OK02	585		191			4	8	179		115	88
OK03	1,632	39	573	11		13	44	168	24	301	470
OK04	1,431	30	349	35			31	98		485	438
OK05	4,349	47	1,073	34		7	55	499	6	778	1,884
OR01	8,512	48	2,464	1,444	7	57	238	875	291	3,153	1,379
OR02	2,005	77	153	24		73	332	416	5	486	463
OR03	4,738	23	553	187		20	63	953	1	1,785	1,340
OR04	1,678	2	410	20		12	118	331	3	377	425
OR05	1,042	21	205	106		3	61	279		209	264
PA01	4,542	104	408	62		122	76	785	5	1,109	1,933
PA02	5,703	24	687	39		113	81	1,034	6	1,444	2,314
PA03	1,452	8	543	204			59	193		267	382
PA04	3,321	11	836	430			121	577		717	1,059
PA05	1,518	16	658	519			4	202	18	286	334
PA06	8,263	89	2,163	457	9	939	229	1,215	89	2,253	1,277
PA07	5,331	108	1,077	123		688	140	793	5	1,394	1,126
PA08	3,445	8	1,181	117		34	247	374	7	888	706
PA09	1,631	8	288	12	2		30	118	95	734	356

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
PA10	1,230		344	25			16	186		312	372
PA11	1,956	18	351	118		420	142	293		496	236
PA12	3,043	30	740	152		246	273	424	3	746	581
PA13	1,493		35				98	610		379	371
PA14	2,390	8	277	17		15	96	338	11	748	897
PA15	1,877	6	660	306		20	147	167	2	536	339
PA16	806		304	175		16	63	91		214	118
PA17	502		53	15			2	98		176	173
PA18	1,583		391	34			118	94		506	474
RI01	2,183		424	50		44	553	174	2	567	419
RI02	1,097	5	176	81			140	138	43	386	209
SC01	2,575	101	431	17		16	59	324	2	794	848
SC02	2,080		374	90		4	52	203	64	836	547
SC03	1,471	12	393	68		2	117	285	2	333	327
SC04	1,960		413	15		45	11	562		555	374
SC05	730	4	199	38			14	67		140	306
SC06	1,898	3	123	3		37	937	167		280	351
SC07	913	18	256	56			22	291		188	138
SD00	1,800	51	519	122		8	56	273		535	358
TN01	1,426		63			283	34	158	2	483	403
TN02	11,482	5	5,096	75		22	151	419		838	4,951
TN03	1,617		235	91			44	201		515	622
TN04	1,060	6	195	45			57	235		321	246
TN05	4,506		637	36		110	129	639	2	1,712	1,277
TN06	584	8	164				1	42		212	157
TN07	810		116	64			52	146		393	103
TN08	3,161		243			117	205	805	151	886	754
TN09	1,584		159	9		2	227	475		381	340
TX01	1,379	3	172	68		2	144	282		321	455
TX02	9,796	12	2,210	338		75	98	1,153	152	3,704	2,392
TX03	11,606	65	2,625	354	8	93	306	1,963	239	5,421	886
TX04	1,874	10	577	21		17	125	317	5	537	286
TX05	2,267	6	426	119		24	241	403		661	506
TX06	3,259	235	866	132			206	409	15	818	710
TX07	3,940		611	73		23	219	442	15	1,758	872
TX08	2,099	6	412	62			24	311	2	519	825
TX09	2,247	3	404	116		25	270	191	10	631	713
TX10	9,308	5	2,515	1,025		34	161	1,038	528	3,340	1,687
TX11	1,498	20	439	24		2	43	171		316	507
TX12	3,764	51	1,289	29		22	96	504	3	878	921
TX13	1,083	54	154	10		10	68	250		270	277
TX14	2,367	9	231			25	170	288		656	988
TX15	1,087		245	70		16	29	142		302	353

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
TX16	1,588	6	578	138		7	46	263		474	214
TX17	2,744	3	543	193		54	51	380	31	795	887
TX18	1,668	1	189	6		2	30	268	1	490	687
TX19	1,087		117	3		11	29	153		352	425
TX20	3,287	71	428	44		19	207	376	13	1,183	990
TX21	7,426	52	1,667	661		37	117	1,420	78	1,971	2,084
TX22	2,233	49	732	53			30	133	7	850	432
TX23	349		89					66		85	109
TX24	10,667	139	2,178	327		84	280	1,702	27	4,358	1,899
TX25	1,590	21	367	118			10	378	33	408	373
TX26	1,208	7	501	49		7	8	149		282	254
TX27	1,152	5	187	99		3	50	205		218	484
TX28	1,034	28	171	46		10	7	97	2	148	571
TX29	596		60	17		4	3	51	1	111	366
TX30	3,512	6	499	25		13	107	1,187		1,039	661
TX31	1,747	7	892	153		2	76	253	2	352	163
TX32	2,386	10	722	413	8	4	45	478	9	765	345
TX33	169		45			22	1	25		52	24
TX34	398	3	58	3			7	40		134	156
TX35	314		-					113		107	94
TX36	1,019	9	191	11			54	100		163	502
UT01	1,872	67	514	121		14	89	349	2	375	462
UT02	4,409	25	675	70	6	133	232	1,346	10	1,202	780
UT03	7,585	4	688	277		16	206	1,731	69	3,588	1,283
UT04	1,396		182	18			91	354		585	184
VA01	4,057	42	553	131	16	20	59	419	11	2,379	558
VA02	2,669	40	770	107		35	67	244	7	1,031	475
VA03	2,127		505	28		50	24	322		673	553
VA04	1,423	5	274	162		46	39	149		540	370
VA05	2,611	38	448	111		49	92	557	1	700	726
VA06	1,398	3	112	22		35	128	305		439	376
VA07	1,549		241	95		19	77	283	3	633	293
VA08	11,962	82	2,470	76		211	151	834	43	6,982	1,189
VA09	1,026	3	191	142		20	24	366	4	239	179
VA10	18,340	122	2,363	106		109	211	1,379	92	12,893	1,171
VA11	1,678	27	463				16	155	75	832	110
VT00	2,718	4	1,350	156			69	214	13	647	421
WA01	9,276	1,188	1,241	173		50	349	1,884	156	3,031	1,377
WA02	2,583	499	733	34		48	130	424	21	395	333
WA03	1,278	34	253	138		16	121	194	25	255	380
WA04	964	28	316				20	172		166	262
WA05	1,088	6	305	10		25	60	264	1	263	164
WA06	1,820	46	145			3	114	410	2	807	293

District	Tech-Based Start-Ups	Aero	Computers	Semi-conductors	Semi. Mach.	Pharma	Med. Dev.	Data Process.	Software	Comp. Design	R&D Serv.
WA07	8,126	1,231	846	57		93	285	1,330	75	2,127	2,139
WA08	5,298	2,697	488	36		40	210	461		862	540
WA09	3,239	1,293	226	23			114	549	5	715	337
WA10	675	18	224	6		12	34	101		236	50
WI01	2,415	13	640	120		8	216	411	1	743	383
WI02	5,262	8	749	17		217	562	603	9	1,466	1,648
WI03	2,179	1	523	258			354	541		573	187
WI04	3,075	40	664	235		3	345	606	31	781	605
WI05	2,125		308	66			236	414	2	789	376
WI06	1,240	5	360	56			157	312		200	206
WI07	1,174	21	160	43		18	85	445		271	174
WI08	1,211	16	282	71			130	238		392	153
WV01	1,815	14	187			3	9	381		382	839
WV02	1,315	3	160				13	293	60	428	358
WV03	884	5	154				18	220	1	198	288
WY00	1,339	17	299	39			88	202	8	314	411

ENDNOTES

1. Ian Hathaway and Robert E. Litan, "Declining Business Dynamism in the United States: A Look at States and Metros," (Brookings Institute, May 5, 2014).
2. Benjamin Wild Pugsley and Erik Hurst, "What Do Small Businesses Do?," paper presented at the Brookings Conference on Economic Activity, Washington, DC, Fall 2011, https://www.brookings.edu/bpea-articles/what-do-small-businesses-do; Robert D. Atkinson and Michael Lind, *Big Is Beautiful: Debunking the Myth of Small Business* (MIT Press, forthcoming, March 2018).
3. Zoltan Acs and David Hart, "Immigration and High-Impact, High-Tech Entrepreneurship," (Brookings Institution, February 7, 2011), https://www.brookings.edu/research/immigration-and-high-impact-high-tech-entrepreneurship/; Peter L. Singer and William B. Bonvillian, "Innovation Orchards: Helping Tech Start-Ups Scale," (Information Technology and Innovation Foundation, March 27, 2017), https://itif.org/publications/2017/03/27/innovation-orchards-helping-tech-start-ups-scale; U.S. Bureau of Labor Statistics, "Entrepreneurship and the U.S. Economy," accessed June 1, 2017, https://www.bls.gov/bdm/entrepreneurship/entrepreneurship.htm.
4. John Haltiwanger, Ian Hathaway, and Javier Miranda, "Declining Business Dynamism in the U.S. High-Technology Sector," (Kauffman Foundation, February 2014), http://www.kauffman.org/-/media/kauffman_org/research-reports-and-covers/2014/02/declining_business_dynamism_in_us_high_tech_sector.pdf.
5. Bill Aulet and Fiona Murray, "Tale of Two Entrepreneurs: Understanding Differences in the Types of Entrepreneurship in the Economy," (Martin Trust Center for MIT Entrepreneurship, May 2013), http://www.kauffman.org/~/media/kauffman_org/research%20reports%20and%20covers/2013/05/a_tale_of_two_entrepreneurs_report.pdf.
6. David L. Deeds, "The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups," *Journal of Engineering and Technology Management 18*, 2001, pp 29-47.
7. Bill Aulet and Fiona Murray, "Tale of Two Entrepreneurs: Understanding Differences in the Types of Entrepreneurship in the Economy," (Martin Trust Center for MIT Entrepreneurship, May 2013), http://www.kauffman.org/~/media/kauffman_org/research%20reports%20and%20covers/2013/05/a_tale_of_two_entrepreneurs_report.pdf.
8. Emily Fetsch, "The Economic Impact of High-Growth Start-ups," (Kauffman Foundation, October 10, 2016), http://www.kauffman.org/what-we-do/resources/entrepreneurship-policy-digest/the-economic-impact-of-high-growth-start-ups.
9. John Halitwanger, Ron S. Jarmin, Robert B. Kulick, and Javier Miranda, "High Growth Young Firms: Contribution to Job, Output and Productivity Growth," November 15, 2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866566.
10. Mariacristina Piva and Marco Vivarelli, "Is R&D Good for Employment? Microeconometric Evidence from the EU," Institute of Labor Economics Discussion Paper No. 10581, February 2017, http://ftp.iza.org/dp10581.pdf.
11. Dirk Czarnitzki and Julie Delanote, "Young innovative companies: the new high-growth firms?" (ZEW Discussion Papers, No. 12-030), April 2012.
12. Alex Coad, Agusti Segarra and Mercedes Teruel, "Innovation and firm growth: does firm age play a role?" *Research Policy 45*(2), March 2016, pp. 387-400.
13. Alex Coad, Agusti Segarra and Mercedes Teruel, "Innovation and firm growth: does firm age play a role?" *Research Policy 45*(2), March 2016, pp. 387-400.
14. Ian Hathaway, "Tech Starts: High-Technology Business Formation and Job Creation in the United States," (Kauffman Foundation, August 2013), http://www.kauffman.org/what-we-do/research/firm-

formation-and-growth-series/tech-starts-hightechnology-business-formation-and-job-creation-in-the-united-states.

15. Ian Hathaway, "Tech Starts: High-Technology Business Formation and Job Creation in the United States," (Kauffman Foundation, August 2013), http://www.kauffman.org/what-we-do/research/firm-formation-and-growth-series/tech-starts-hightechnology-business-formation-and-job-creation-in-the-united-states.
16. Author's calculations from U.S. Bureau of Economic Analysis Value Add data. Share of computer and electronic manufacturing, chemical manufacturing, information industries, computer systems design industry, and scientific and technical services. https://www.bea.gov/industry/gdpbyind_data.htm.
17. Rui Baptista and Miguel Torres Preto, "New Firm Formation and Employment Growth: Regional and Business Dynamics," *Small Business Economics 36*(4), May 2011, pp. 419-442.
18. Dirk Czarnitzki and Julie Delanote, "Young innovative companies: the new high-growth firms?" (ZEW Discussion Papers, No. 12-030), April 2012.
19. Rui Baptista and Miguel Torres Preto, "New Firm Formation and Employment Growth: Regional and Business Dynamics," *Small Business Economics 36* (4), May 2011, pp. 419-442.
20. J. Daniel Kim, "Is there a start-up wage premium? Evidence from MIT graduates," June 4, 2017, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2977460&download=yes.
21. Diane Burton, Michael Dahl and Olav Sorenson, "Do start-ups create good jobs?" Draft Manuscript, March 15, 2016, http://inequality.hks.harvard.edu/files/inequality/files/sorenson16.pdf.
22. Enrico Moretti and Per Thulin, "Local multipliers and human capital in the United States and Sweden," *Industrial and Corporate Change 22* (1), 2013, pp. 339-362.
23. Enrico Moretti, *The New Geography of Jobs* (New York: Houghton Mifflin Harcourt, 2012).
24. Massachusetts Biotechnology Council, "President Obama, the 111th Congress, and Biotechnology: Working Together Today to Ensure a Healthy Tomorrow," 2009, http://www.bioin.or.kr/fileDown.do?seq=8804&bid=industry.
25. Josh Bivens, "Updated Employment Multipliers for the U.S. Economy," (NBER Working Paper 268, August 2003), https://www.nrc.gov/docs/ML1224/ML12243A398.pdf.
26. Alex Coad, Agusti Segarra and Mercedes Teruel, "Innovation and Firm Growth: Does Firm Age Play a Role?" *Research Policy 45* (2), March 2016, pp. 387-400.
27. U.S. Census Bureau, American Fact Finder (Series: SE1400CSCB29, All firms with reported R&D activity, accessed May 31, 2017), https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.
28. Jorge Guzman and Scott Stern, "The State of American Entrepreneurship," (NBER Working Paper 22095, March 2016), http://www.nber.org/papers/w22095.pdf.
29. Erik Stam and Karl Wennberg, "The roles of R&D in new firm growth," *Small Business Economics 33*, 2009, pp 77-89.
30. Daron Acemoglu, Ufuk Akcigit, Nicholas Bloom, and William R. Kerr, "Innovation, Reallocation, and Growth," (NBER Working Paper 18993, April 2013), http://www.nber.org/papers/w18993.
31. David L. Deeds, "The Role of R&D Intensity, Technical Development and Absorptive Capacity in Creating Entrepreneurial Wealth in High Technology Start-Ups," *Journal of Engineering and Technology Management 18*, 2001, pp 29-47.
32. David L. Deeds, "The Role of R&D Intensity, Technical Development and Absorptive Capacity in Creating Entrepreneurial Wealth in High Technology Start-Ups," *Journal of Engineering and Technology Management 18*, 2001, pp 29-47.
33. Joern H Block, Christian O Fisch, and Mirjam van Praag, "The Schumpeterian Entrepreneur: A Review of the Empirical Evidence on the Antecedents, Behavior, and Consequences of Innovative Entrepreneurship," *Industry and Innovation 24* (1), August 9, 2016.

34. Dirk Czarnitzki and Julie Delanote, "Young innovative companies: the new high-growth firms?" (ZEW Discussion Papers, No. 12-030), April 2012.

35. Alex Rialp, Josep Rialp, and Gary A. Knight, "The Phenomenon of Early Internationalizing Firms: What do We Know After a Decade (1993-2003) of Scientific Inquiry?" *International Business Review 14*, 2005 pp. 147-166.

36. Alex Coad, Agusti Segarra and Mercedes Teruel, "Innovation and firm growth: does firm age play a role?" *Research Policy 45*(2), March 2016, pp. 387-400.

37. Lucia Foster, Cheryl Grim, and Nikolas Zolas, "A Portrait of firms that invest in R&D," (US Census Bureau Center for Economic Studies Paper No. CES-WP-16-41, October 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2845982.

38. Valdemar Smith, Eril Strojer Madsen, and Mogen Dilling-Hansen, "Do R&D Investments Affect Export Performance," December 2002, https://pdfs.semanticscholar.org/bb8d/ec734a68f2a9d5484208895f5492cfd4d73d.pdf.

39. Stephen B. Preece, Grant Miles, and Mark C. Baetz, "Explaining the international intensity and global diversity of early-stage technology-based firms, *Journal of Business Venturing 14*(3), May 1999, pp. 259-281.

40. Panagiotis Ganotakis and James H. Love, "R&D, Product Innovation, and Exporting: Evidence from UK New Technology Based Firms," *Oxford Economic Papers 63* (2), April 2011, pp. 279-306.

41. Bo Carlsson, Zoltan Acs, David Audretsch, and Pontus Braunerhjelm, "Knowledge Creation, Entrepreneurship, and Economic Growth: a Historical Review," *Industrial and Corporate Change 18* (6), October 13, 2009, pp. 1193-1229.

42. Masayuki Hirukawa and Masako Ueda, "Venture Capital and Innovation: Which is First?" *Pacific Economic Review 16*(4), 2011, pp. 421-465.

43. Christian Helmers and Mark Rogers, "Does Patenting Help High-Tech Start-Ups?" *Research Policy 40* (7), September 2011, pp. 1016-1027.

44. Joan Farre-Mensa, Deepak Hegde, and Alexander Ljungqvist, "What is a Patent Worth? Evidence from the U.S. Patent 'Lottery'," (NBER Working Paper 23268, March 2017), http://www.nber.org/papers/w23268.

45. Federico Munari and Laura Toschi, "Do Patents Affect VC Financing? Empirical Evidence from the Nanotechnology Sector," *International Entrepreneurship and Management Journal 11*, 2015, pp. 623-644.

46. Monika Schnitzer and Martin Watzinger, "Measuring the Spillovers of Venture Capital," (CESifo Working Paper Series No. 6623), 2017, http://www.cesifo-group.de/DocDL/cesifo1_wp6623.pdf.

47. Fabio Bertoni, Massimo G. Colombo, and Luca Grilli, "Venture Capital Financing and the Growth of High-Tech Start-Ups: Disentangling Treatment from Selection Effects," *Research Policy 40*, May 25, 2011, pp: 1028-1043.

48. Sampsa Samila and Olav Sorenson, "Venture Capital, Entrepreneurship, and Economic Growth," *The Review of Economics and Statistics 93*(1), February 2011, pp. 338-349.

49. Sabrina Howell, "Financing Innovation: Evidence from R&D Grants," *American Economic Review 107* (4), April 2017, https://www.aeaweb.org/articles?id=10.1257/aer.20150808.

50. R&D intensity figures only apply to firms that invest in R&D, which is approximately 5 percent of all firms in the economy.

51. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.

52. An example of this narrative: Jeffery Sparshott, "Sputtering Startups Weigh on U.S. Economic Growth," (The New York Times, October 23, 2016), https://www.wsj.com/articles/sputtering-startups-weigh-on-u-s-economic-growth-1477235874.

53. John Halitwanger, Ron S. Jarmin, Robert B. Kulick, and Javier Miranda, "High Growth Young Firms: Contribution to Job, Output and Productivity Growth," November 15, 2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866566.

54. Wage data from NAICS 3332 used in lieu of NAICS 333242.

55. U.S. Small Business Association, "Survival Rates and Firm Age," accessed October 31, 2017, https://www.sba.gov/sites/default/files/SurvivalRatesAndFirmAge_ADA_0.pdf.

56. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.

57. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.

58. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.

59. One firm always consists of at least one establishment, while multiple establishments may make up one firm (for example, a business may have its headquarters in California but then opens another branch in Massachusetts, therefore, this business counts as one firm and one establishment for California and one establishment for Massachusetts).

60. "Tech Policy To-Do List," Information Technology and Innovation Foundation, updated April 2017, https://itif.org/tech-policy-to-do-list

61. Information Technology and Innovation Foundation, "Winning the Race Memo: Corporate Taxes" (2012), http://www2.itif.org/2012-wtr-taxes.pdf?_ga=1.202252433.1806060799.1471894729.

62. Joe Kennedy, "Tax Proposals Attempt to Bridge the "Valley of Death" for Small Research Firms," (Information Technology and Innovation Foundation, March 24, 2015), https://itif.org/publications/2015/03/24/tax-proposals-attempt-bridge-%E2%80%9Cvalley-death%E2%80%9D-small-research-firms.

63. Stephen Ezell and Scott M. Andes, "Localizing the Economic Impact of Research and Development: Policy Proposals for the Trump Administration and Congress" (Information Technology and Innovation Foundation and Brookings Institution, December 2016), https://itif.org/publications/2016/12/07/localizing-economic-impact-research-and-development-policy-proposals-trump.

64. Ibid.

65. Joe Kennedy, "Reforming Regulation to Drive International Competitiveness," (Information Technology and Innovation Foundation, March 2015), https://itif.org/publications/2015/03/16/reforming-regulation-drive-international-competitiveness.

66. Joe Kennedy, "How Regulatory Reform Can Advance Automation in the Transportation Sector," (Information Technology and Innovation Foundation, June 2017), https://itif.org/publications/2017/06/12/how-regulatory-reform-can-advance-automation-freight-transportation-sector.

67, Stuart Minor Benjamin and Arti K. Rai, "Structuring U.S. Innovation Policy: Creating a White House Office of Innovation Policy, (Information Technology and Innovation Formation, June 2009), https://itif.org/publications/2009/06/24/structuring-us-innovation-policy-creating-white-house-office-innovation.

68. "Tech Policy To-Do List," Information Technology and Innovation Foundation, updated April 2017, https://itif.org/tech-policy-to-do-list.

69. Stephen Ezell and Robert D. Atkinson, "25 Recommendations for the 2013 America COMPETES Act Reauthorization" (Information Technology and Innovation Foundation, April 2013), https://itif.org/publications/2013/04/22/25-recommendations-2013-america-competes-act-reauthorization; Adams Nager and Robert D. Atkinson, "The Case for Improving U.S. Computer

Science Education" (Information Technology and Innovation Foundation, May 2016), https://itif.org/publications/2016/05/31/case-improving-us-computer-science-education.

70. Robert D. Atkinson and Merrilea Mayo, "Refueling the U.S. Innovation Economy: Fresh Approaches to STEM Education" (Information Technology and Innovation Foundation, December 2010), https://itif.org/publications/2010/12/07/refueling-us-innovation-economy-fresh-approaches-stem-education.
71. Adams Nager, David M. Hart, Stephen Ezell, and Robert D. Atkinson, "The Demographics of Innovation in the United States," (Information Technology and Innovation Foundation, February 24, 2016), https://itif.org/publications/2016/02/24/demographics-innovation-united-states.
72. Ibid.
73. Stephen Ezell and Robert D. Atkinson, "25 Recommendations for the 2013 America COMPETES Act Reauthorization" (Information Technology and Innovation Foundation, April 2013), https://itif.org/publications/2013/04/22/25-recommendations-2013-america-competes-act-reauthorization.
74. Stephen Ezell and Scott M. Andes, "Localizing the Economic Impact of Research and Development: Policy Proposals for the Trump Administration and Congress" (Information Technology and Innovation Foundation and Brookings Institution, December 2016), https://itif.org/publications/2016/12/07/localizing-economic-impact-research-and-development-policy-proposals-trump.
75. Ezell and Atkinson, "Fifty Ways to Leave Your Competitiveness Woes Behind: A National Traded Sector Competitiveness Strategy" (Information Technology and Innovation Foundation, September 2012), https://itif.org/publications/2012/09/20/fifty-ways-leave-your-competitiveness-woes-behind-national-traded-sector.
76. U.S. National Science Foundation, Business R&D Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2; U.S. Bureau of Labor Statistics, "The High Tech Industry, what is it and why it matters to our economic future," May 2016, https://www.bls.gov/opub/btn/volume-5/the-high-tech-industry-what-is-it-and-why-it-matters-to-our-economic-future.htm; Eurostat, "Annex 3-High-Tech aggregation by NACE Rev. 2," http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf; Organisation for Economic Co-operation and Development, "ISIC Rev. 3 Technology Intensity Definition," July 7, 2011, https://www.oecd.org/sti/ind/48350231.pdf.
77. Matthew Boch, Businesses Face NAICS Classification Risks and Opportunities in State Taxand Incentive Systems, Journal of Multistate Taxation and Incentives (Thomson Reuters/Tax & Accounting) Volume 25, Number 10, February 2016.
78. Ibid.
79. John Halitwanger, Ron S. Jarmin, Robert B. Kulick, and Javier Miranda, "High Growth Young Firms: Contribution to Job, Output and Productivity Growth," November 15, 2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866566.
80. David B. Audretsch, "Determinants of High-Growth Entrepreneurship," report presented at OECD/DBA International Workshop on "High-growth firms," March 28, 2012, https://www.oecd.org/cfe/leed/Audretsch_determinants%20of%20high-growth%20firms.pdf.
81. Richard Clayton, Akbar Sadeghi, David Talan, and James Spletzer, "High-employment-growth firms: defining and counting them," (U.S. Bureau of Labor Statistics Monthly Labor Review, June 2013), https://www.bls.gov/opub/mlr/2013/article/clayton.htm.
82. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.

83. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
84. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
85. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
86. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
87. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
88. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
89. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
90. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
91. Do note that wage data is only available at the 4-digit level, wage rates for this industry is likely an underestimate. It uses wage data from NAICS 3332 in lieu of NAICS 333242.
92. Ibid.
93. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
94. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
95. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
96. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
97. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
98. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
99. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
100. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
101. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
102. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
103. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
104. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.
105. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.

106. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.

107. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.

108. Author's estimate; U.S. Bureau of Economic Analysis, Industry Data (Gross Output, accessed October 15, 2017), https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.

109. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 19, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.

110. U.S. National Science Foundation, Business R&D and Innovation Survey 2013 (Table 53, accessed October 1, 2017), https://www.nsf.gov/statistics/2016/nsf16313/#chp2.

111. Author's estimate; U.S. Census Bureau, Annual Survey of Entrepreneurs 2015 (Company Summary 2015 Tables; accessed October 1, 2017), https://www.census.gov/programs-surveys/ase/data/tables.html.

112. Robert D. Atkinson and J. John Wu, "State New Economy Index 2017" (Information Technology and Innovation Foundation, November 6, 2017), https://itif.org/publications/2017/11/06/2017-state-new-economy-index.

ACKNOWLEDGMENTS

The authors wish to thank the following individuals for providing input to this report: Alex Key for his editorial assistance, Joe Kennedy for his policy suggestions, and Stephen Ezell for his comments. Any errors or omissions are the authors' alone.

ABOUT THE AUTHORS

J. John Wu is an economic analyst at the Information Technology and Innovation Foundation. His research interests include green technologies, labor economics, and time use. He graduated from The College of Wooster with a bachelor of arts in economics and sociology, with a minor in environmental studies.

Robert D. Atkinson is the founder and president of the Information Technology and Innovation Foundation. He is also the co-author of the book *Innovation Economics: The Race for Global Advantage* (Yale, 2012). Atkinson received his Ph.D. in city and regional planning from the University of North Carolina at Chapel Hill in 1989.

ABOUT ITIF

The Information Technology and Innovation Foundation (ITIF) is a nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy. Recognized as one of the world's leading science and technology think tanks, ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

FOR MORE INFORMATION, VISIT US AT WWW.ITIF.ORG.