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Entrepreneurship and Job Creation in the U.S. Life Sciences Sector

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Abstract

This brief analyzes entrepreneurship and job creation in the U.S. life sciences sector—defined as the group of industries engaged in the application of biological science and related knowledge for commercial purposes, primarily for human health care. This definition contains three major subgroups: drugs and pharmaceuticals; medical devices and equipment; and research, testing, and medical laboratories.

Building on previous research that highlights the importance of entrepreneurship and business dynamism to innovation, productivity, and net job creation, this brief analyzes how those trends apply to the life sciences sector. Overall, the life sciences sector plays an outsized role in new job creation and makes important contributions to entrepreneurship—not to mention the perhaps immeasurable benefits these firms play in enhancing and extending human life.

However, these trends have waned over time—matching previously documented declines in job creation, business dynamism, and entrepreneurship across a wide range of sectors and geographies. A variety of factors may have contributed to this—some specific to life sciences, others not. The precise causes of this decline remain unclear, but what is certain is that the innovation, productivity, and net job creation unleashed by these startups requires a regular flow of new firm formations far in excess of what we've seen in recent years.

Finally, there is considerable variation within life sciences. The drugs and pharmaceuticals segment is particularly dynamic, as exhibited by steadily increasing firm formation and very high rates of net job growth for young startups. The research, testing, and medical labs segment has outperformed the private sector as a whole on a number of measures, but was hit hard during the recent economic downturn. Entrepreneurship and net job creation in medical devices and equipment have been on a secular decline over the last two decades—firm formations are down more than fifty percent, and those that are born create fewer new jobs.

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Introduction

The study of business dynamics involves measuring the flows of firms and workers that underlie a modern economy. Businesses are continually being born, failing, growing, or shrinking, while jobs are created, destroyed, or turned-over. Though potentially costly and disruptive in the short-term, research has firmly established that this dynamic process is critical to productivity gains, new job creation, and sustained economic growth.[1]

Particularly important to this process is the role of the entrepreneur—who forms a new venture in order to create a new market or compete against incumbents in an existing one. Entrepreneurial ventures—measured here by firm age of five years or less —are critical to the productivity-enhancing process of "creative destruction," whereby new and superior ideas replace established ones, and savvy startups displace older, less-productive firms.

Entrepreneurs are also an important source of new job creation. While older firms account for the substantial majority of employment, it is new and young businesses that drive net *new* job creation.[2] But not all startups will grow much; in fact the substantial majority of them were never intended to.[3] Indeed, it is a small group of high-growth firms that account for the lion's share of new job growth.[4]

One recent report analyzed business dynamics in the high-technology sector to get a better sense of the job creation contribution of startups in an innovation-driven, generally growth-oriented sector.[5] It found that of job-creating young firms, high-tech startups play a particularly outsized role in that process.[6]

That research is extended here to measure how these trends apply to another innovation-driven sector: the life sciences. Though a notoriously difficult sector to start and grow a successful business, entrepreneur-led companies have developed some of the most important life-saving innovations used today. Indeed, a healthy amount of entrepreneurship in the life sciences sector is good for the economy and for society.

Defining Life Sciences

In 2004, the Battelle Memorial Institute published the first in a series of bi-annual reports on the state of the biosciences industry throughout the United States.[7] The reports, which focus primarily on national and regional biosciences employment and public policy trends, also advance a detailed definition of the industrial composition of the biosciences sector that is useful for the analysis of economic data (see Appendix A).

Broadly speaking, Battelle defines the biosciences sector as "a diverse group of industries [that span a wide range of manufacturing and services] and [research] activities with a common link—they apply knowledge of the way in which plants, animals, and humans function" to address a host of "global problems from human health to food generation and security to environmental sustainability and clean energy."[8]

Battelle's definition has primarily consisted of four broad subgroups: agricultural feedstock and chemicals; drugs and pharmaceuticals; medical devices and equipment; and research, testing, and medical laboratories. A fifth subgroup—bioscience-related distribution—was added in 2012, the latest iteration of the series.

Three of these subgroups will be analyzed here as the "Life Sciences" sector. Generally speaking, these are the three Battelle biosciences subgroups with a primary focus on human health-care:

Table 1: Life Sciences Sector Components

Drugs and Pharmaceuticals	Pharmaceutical preparation and manufacturing, diagnostic substances, biopharmaceuticals, and vaccines
Medical devices and equipment	Biomedical instruments, electromedical equipment and devices, healthcare products and supplies, and lab instrumentation
Research, testing, and medical laboratories	Biotechnology and other life sciences research and development, testing laboratories, and medical laboratories

Source: Battelle Technology Partnership Practice

Job Creation and Firm Age

To analyze business and employment flows, data from the Census Bureau's Center for Economic Studies are utilized. The Business Dynamics Statistics (BDS) are a public-use administrative database that aggregates establishment-level (i.e. a physical location) business and employment dynamics for the universe of private-sector employer-businesses in the United States.[9]

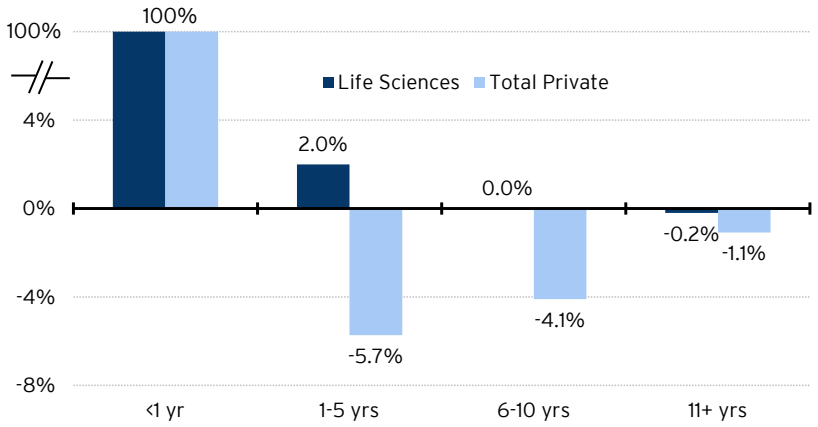
Importantly, while the BDS captures economic activity at the local level, it ties each establishment to its parent firm (in the case of multi-establishment enterprises). This allows for the analysis of business and employment dynamics by size and age characteristics of the parent firm, which is crucial to our analysis here. For example, we can identify true startups instead of confusing those with an existing firm that expands into a new location.

Since its release in 2008, research utilizing the BDS has overturned previous conventional wisdom on job creation and small businesses. Most notably, these studies have established that it isn't small business generally that are the primary source of net job creation, but new and young businesses specifically. In fact, after controlling for firm age, there is no discernible relationship between firm size and net job creation.[10]

The public-use BDS and a special tabulation for the life sciences sector are used here to compare the firm age/job creation relationship in the total private sector against the life sciences.[11] **Figure 1** shows the average annual net job creation rates for the total private sector, life sciences sector, and its three subgroups between 2000 and 2011. These rates show annual net job creation (job creation minus job destruction) as a share of employment for each age-industry group.[12]

Fig. 1a

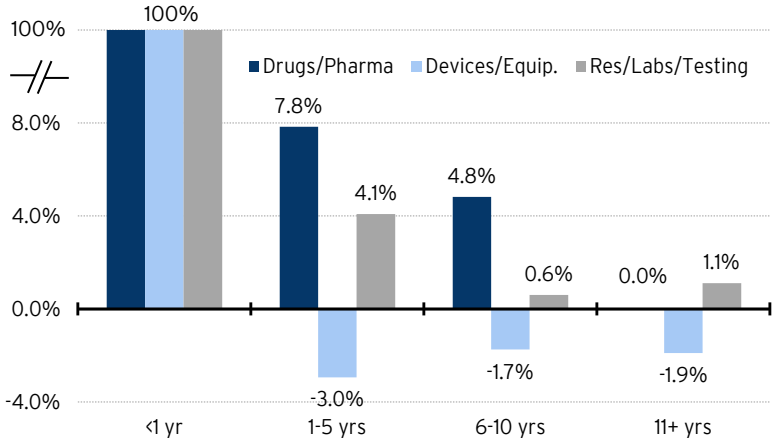
Avg. Annual Net Job Creation Rates by Firm Age and Sector (2000-2011)



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

Fig. 1b

Avg. Annual Net Job Creation Rates by Firm Age and Life Sciences Subgroup (2000-2011)



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

A few trends stand out. First, we see that the net job creation rate for new firms (those aged less than one year) is fixed at approximately 100 percent for each of the sectors. Because the BDS are collected as annual snapshots in time, a new firm can only add positively to net job creation—it can't destroy jobs. Therefore, the net rate is fixed at approximately 100 percent.[13]

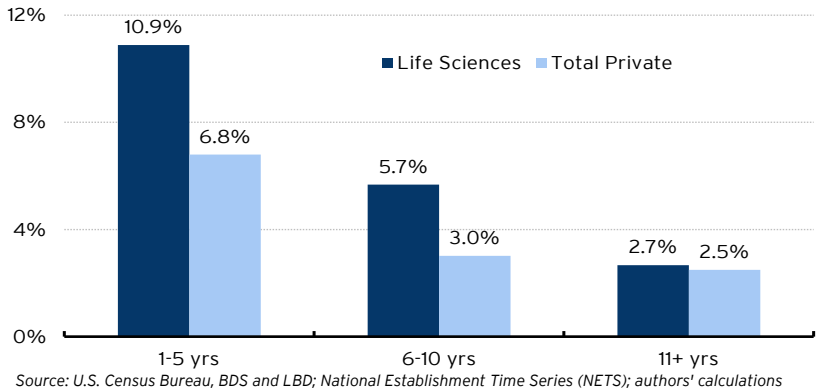
Secondly, we see that new and young firms (aged five years or less) drive new job creation in the life sciences sector, whereas job creation and destruction for medium-aged (six to ten years) and mature firms (eleven years or more) mostly cancel each other out. The same is not true for the private sector as a whole, where substantial net job destruction can be seen at each age interval outside of freshly launched firms. In short, outside of new firms, the forces of job destruction are greater than the forces of job creation for the private sector overall.

Finally, there is a great deal of variation among life sciences firms. Though representing a small portion of young life sciences firms overall (5 percent), drugs and pharmaceuticals businesses increase net employment at a very high pace in the early- and middle-years while holding steady for mature firms. The diverse research, labs, and medical testing segment increases employment at each of the age groups in a typical year. The medical devices and equipment segment mimics the total private sector—it was an overall net job destroyer at each of the three age categories-outside of freshly launched firms-on average during this eleven-year period.

Much of the negative net job creation seen in **Figure 1** is driven by the significant amount of job destruction from business failures—particularly in the early stages. In fact, about half of all firms fail in their first five years—a trend that has remained remarkably consistent over time.[14] To get a better sense of the employment dynamics of surviving firms, **Figure 2** shows the same annual net job creation rates seen before in **Figure 1**, but instead removes the job destruction from business establishment failures.

Fig. 2a

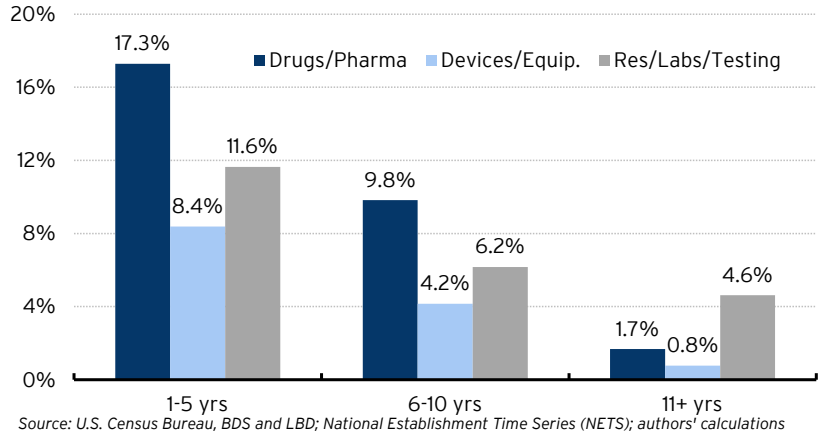
Avg. Annual Net Job Creation Rates by Firm Age and Sector (2000-2011) *Excluding Job Destruction from Establishment Failures*



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

Fig. 2b

Avg. Annual Net Job Creation Rates by Firm Age and Life Sciences Subgroup (2000-2011) *Excluding Job Destruction from Establishment Failures*



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

By removing the job destruction from business closures, **Figure 2** shows the net job creation rates of surviving firms. Because new firms can only add jobs, those were not included here. As we can see, the negative net job creation that was pervasive in the total private sector and in the medical devices and equipment segment of life sciences is reversed once the job destruction from failures is removed.

Net job creation rates for the remaining three groups—life sciences, drugs and pharmaceuticals, and research, labs, and medical testing—become more positive at each of the intervals. In short, surviving young- and to a lesser extent medium- and mature-aged firms add positively to net job creation on average.

Overall, the life sciences sector and each of its components has a higher net job creation rate relative to the total private sector for young- and medium-aged firms: those most closely linked to entrepreneurship in the sector. What's remarkable is the magnitude of growth occurring in a typical life sciences firm during these years. For example, net job creation expanded by an average of 17 percent annually among surviving young drugs and pharmaceuticals firms during this period, compared with almost 7 percent for the private sector as a whole.

Entrepreneurship

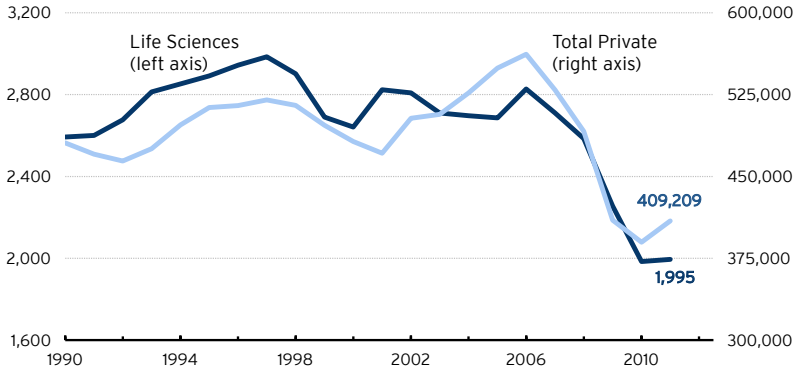
Firm Formation

Now that we have established the importance of new and young firms—what we'll call startups, or entrepreneurial ventures—to net job creation in the U.S. private sector, and in particular in the life sciences sector, next we look at two trends to gauge performance over time. First, in order for these startups to continue growing and creating jobs, we need a regular flow of firm births each year to sustain it. Later we'll see how the net job creation of startups has performed over time.

Figure 3 shows the level of new firm formations for the entire private sector, life sciences sector, and three subgroups of life sciences. It shows that, like the private sector as a whole, new firm formations in life sciences actually declined between 1990 and 2011. There were nearly 2,000 new life sciences firms born in 2011, compared with almost 2,600 in 1990—a decline of 23 percent. By comparison, total private sector new firm formations fell by 15 percent during the same period.

Fig. 3a

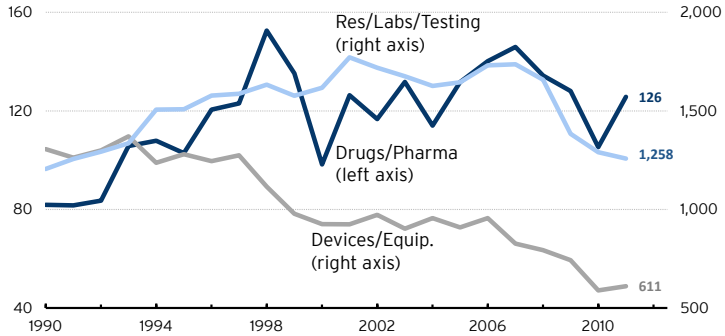
New Firm (aged <1 yr.) Formations by Sector (1990-2011)



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

Fig. 3b

New Firm Formations by Life Sciences Subgroup(1990-2011)



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

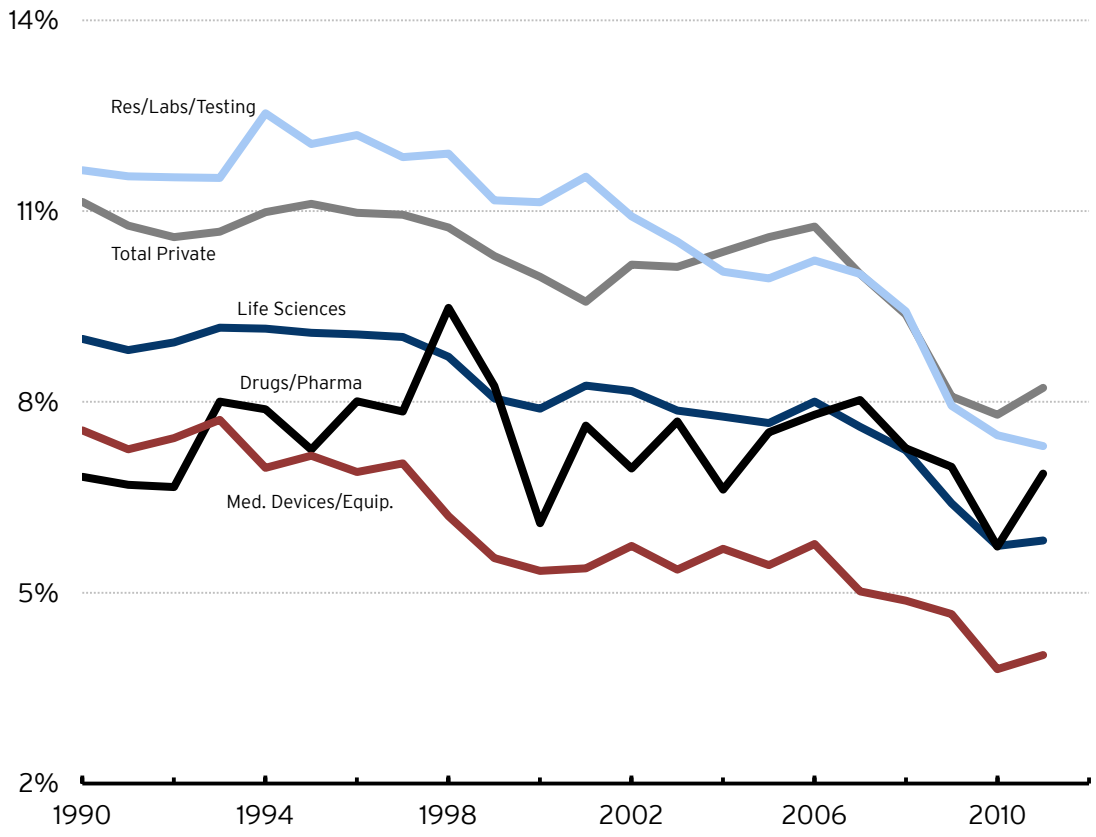
Like the private sector as a whole, the level of new firm births in life sciences held fairly steady throughout this period, fluctuating mildly from one year to the next until the effects of the Great Recession became evident in 2008. In fact, the four years between 2007 and 2011 account for the entire drop in startup rates that cover the two-decade period. To what extent this decline is temporary and will eventually see a rebound will be known with future data releases.

But looking just at life sciences as a whole obscures the wide divergence in performance among its components. The drugs and pharmaceutical sector increased the most in percentage terms—birthing 44 more firms in 2011 versus 1990, for an increase of 53 percent. This subgroup increased its share of all new life sciences firms to 6 percent in 2011 from 3 percent in 1990, having a limited impact on the overall life sciences trend. The level of new research, labs, and medical testing firms grew 38 percent between 1990 and 2007, but the effects of the Great Recession hit it hard. By 2011, the increase in new firm formations was just 4 percent greater than in 1990. This segment increased its share of new life sciences firms to 63 percent in 2011 from 47 percent in 1990.

The medical devices and equipment sector, on the other hand, saw new firm formations decline steadily and persistently between 1990 and 2011—falling by 695 firms or 53 percent during that period. Its share of new life sciences firms fell to 31 percent in 2011 from 50 percent in 1990. Unlike its life sciences sector counterparts, the decline in new firm formations in this segment appears to stretch beyond the cyclical effects of the Great Recession.

Though the level of new firm formations is critical, so too is the rate of new firm formation—or the new firm share of total firms in a sector. Previous research has shown that the rate of new firm entry is critical to measures of productivity and employment growth.[15] Additional research has also found that declining entrepreneurship rates are the single biggest contributor to declining business dynamism across a broad range of sectors in the American economy.[16]

Fig. 4
New Firm Formation Rates (% of Total Firms) by Sector (1990-2011)



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

Figure 4 shows the new firm share of total firms—which we'll use to measure entry rates here—for each of our five groups. All but one of these—drugs and pharmaceuticals—saw its new firm share decline, though even it increased by just one-tenth of a percentage point. Still, given the broad declines in entrepreneurship rates across the economy—including in the innovative high-technology sector—any increase at all may indicate a highly entrepreneurial sector.[17]

The remaining four groups saw new firm formation rates fall during the two-decade period. Each of the three remaining life sciences-related groups—life sciences overall, medical devices and equipment, and research, testing, and medical laboratories—declined more than the private sector as a whole.

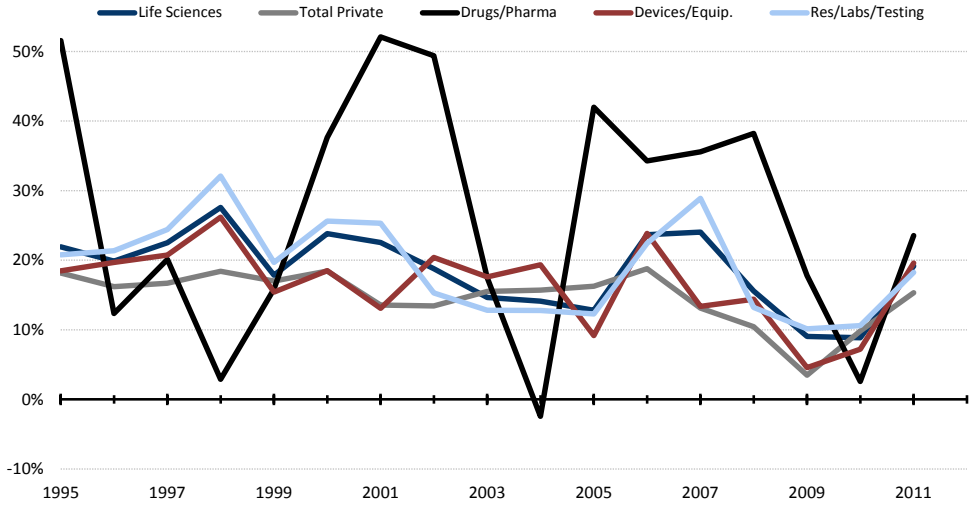
Net Job Creation

Now that we've seen signs of declining entrepreneurship as evidenced by firm formation levels and rates, next we look to see how net job creation rates for young firms have changed over time.

Figure 5 shows the annual net job creation rates for startups (aged less than five years) in each of our five sector/subgroups between 1995 and 2011. The top panel shows the actual rates, but since they are somewhat noisy from year-to-year, the bottom panel shows statistical trends for each of those rates. Compare this with **Figure 1**, which showed the average of these annual rates.

Fig. 5a

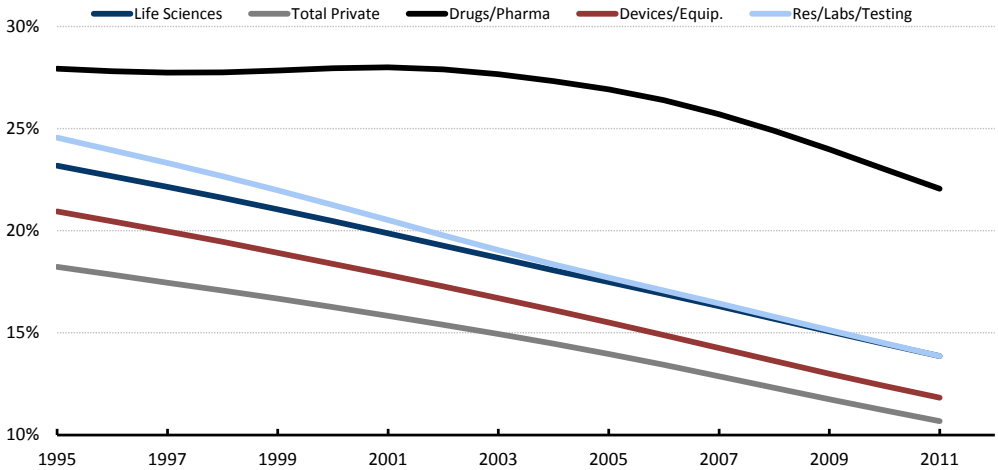
Net Job Creation Rates of Startups (5 years or less) by Sector (1995-2011)



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

Fig. 5b

Net Job Creation Rates of Startups by Sector (1995-2011) – *Trend Rates*



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations.
Note: Trends calculated using a Hodrick-Prescott filter using a multiplier of 400.

Figure 6 also shows net job creation rates over time, but like in **Figure 2**, it excludes the job destruction from business establishment closures to get a better understanding of net job creation rates of surviving startup firms.

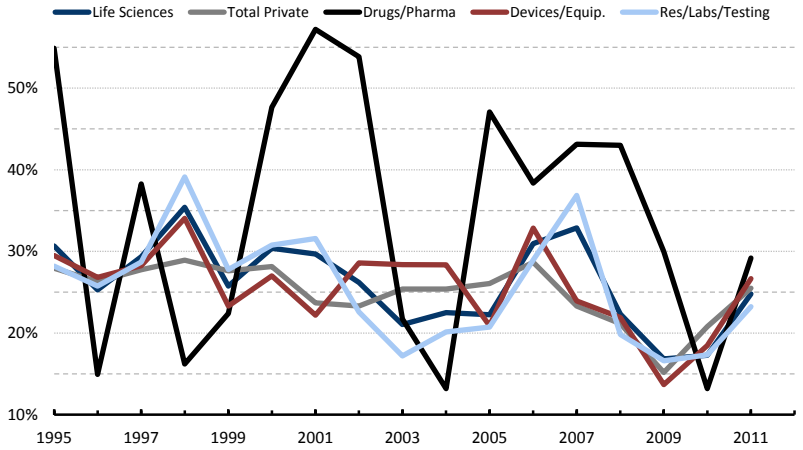
Figure 5 and **Figure 6** show that the pace of net job creation at startups has been on a steady decline during the last couple of decades—whether we include or exclude the job destruction from business failures.[18]

Though it's difficult to make precise estimates on the declining rates in each sector from 1995 to 2011—both because the data are noisy and because the trend rates are for illustrative purposes only—it is clear that there has been a persistent decline in net job creation for startups across the private sector economy.

The decline in the net job creation rate of life sciences startups overall appears to be about the same as for the private sector as a whole. Drugs and pharmaceuticals, and research, testing, and medical laboratories appear to have declined the least, while medical devices and equipment segment appears to have declined the most over time. Though widespread rebounds in 2011 look promising, the noisiness of these data makes it too soon to tell if a sustained recovery has taken hold. Future data releases will provide more information.

Fig. 6a

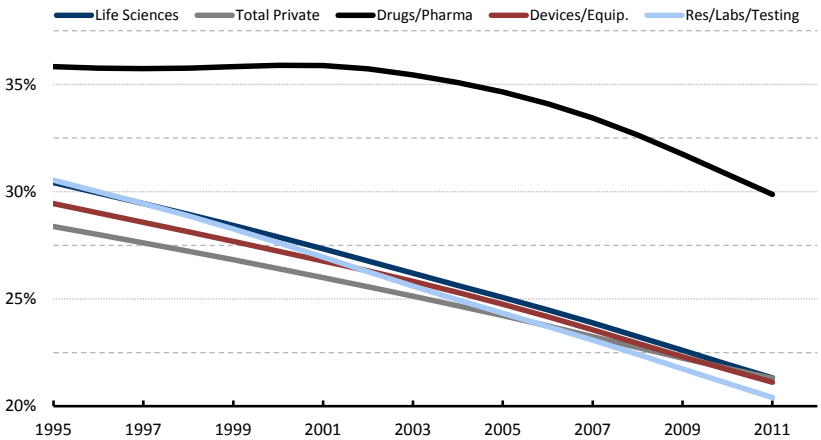
Net Job Creation Rates of Startups by Sector (1995-2011)
Excluding Job Destruction from Establishment Failures



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations

Fig. 6b

Net Job Creation Rates of Startups by Sector (1995-2011)
Trend Rates, Excluding Job Destruction from Establishment Failures



Source: U.S. Census Bureau, BDS and LBD; National Establishment Time Series (NETS); authors' calculations
Note: Trends calculated using a Hodrick-Prescott filter using a multiplier of 400

Conclusions

New and surviving young firms play an outsized role in net job creation in the U.S. economy. This is especially true for the life sciences sector, where the forces of job creation are great enough to offset the substantial job destruction of early-stage failures. This is not true for the private sector as a whole, where the job destruction from firm failures offsets net job gains from the remaining firms. In fact, outside of new firm job gains, net job creation was negative for the private sector as a whole during this period. Even after removing job destruction from early-stage failures, net job creation in the life sciences sector and each of its components exceeds the rates across the private sector as a whole.

New firm formation has been down in the U.S. economy in the wake of the Great Recession, and the life sciences sector has been no exception—broadly matching the decline across the private sector as a whole. This is true for both entrepreneurship levels and rates, and is problematic because the net job creation and innovation unleashed by these young, generally growth-oriented firms requires a regular flow of new firm births each year.

Compounding this, like we saw with entrepreneurship rates, the net job creation rates of startups have also been on a steady decline over time. In other words, the strong net job creation seen on average over the decade has lessened in recent years. Though the noisy data make it difficult to calculate these declines with much precision, it appears that the drop in net job creation at life sciences startups has been similar to the drop for the private sector overall. To what extent this is simply the result of the Great Recession or part of a broader secular decline is unclear from the information contained here alone.

Within the life sciences there is a great deal of variation too. Entrepreneurship in the drugs and pharmaceuticals segment has been on a secular rise during the last two decades. This growth was interrupted during the Great Recession but has rebounded strongly. Early and middle age firms in this segment exhibit particularly high growth rates overall, but did see lower growth as a result of the broader economic downturn. Research, labs, and medical testing startups also exhibited robust growth throughout much of the two decades, but contracted sharply in recent years. Net job creation in this segment has been robust at each age group. The medical devices segment, on the other hand, saw sustained declines in entrepreneurship and related net job creation that point to a clear secular decline over the last two decades.

In short, fewer firms are being launched over time—both in terms of levels and rates—and those startups that are creating new jobs, are doing so at a lower pace than they used to overall. This has been true for the private sector as a whole as well as in the life sciences sector. Within life sciences, the drugs and pharmaceutical segment has had a strong performance across a broad range of measures; research, labs, and medical testing firms have been just above average, mostly as a result of the recession; and medical devices and equipment has been on a persistent secular decline.

A variety of factors may have contributed to these developments—some specific to life sciences. For example, the innovation-by-outsourcing model of research and development activities by large pharmaceutical companies may be a contributing factor to increased entrepreneurship in that segment. Factors affecting the medical devices sector—insurance reimbursement schemes, regulatory restrictions and delays, technological and economic challenges, venture funding scarcity, and competition for talent from other technology sectors—may be partly to blame.

But they also can't explain the entire decline in business dynamism and entrepreneurship, which has occurred in a wide variety of sectors throughout the U.S. economy—even in other high-tech segments. While the specific cause of this decline in dynamism and entrepreneurship is still unknown, it is clear that the life sciences sector has not been immune.

Appendix A: Data Methodology

The primary data source used in this brief is the U.S. Census Bureau's Business Dynamics Statistics (BDS). The publicly available files were used for the total private sector, and a special tabulation of the BDS for the biosciences industries was provided by the Center for Economic Studies at the Census Bureau. The data was provided for the original four subgroups of the biosciences sector as defined by Battelle (agricultural feedstock and chemicals; drugs and pharmaceuticals; medical devices and equipment; and research, testing, and medical laboratories).

Because of Census Bureau restrictions that data not reveal the identity of any particular firm, for sectors with relatively few entries and exists—as is the case for both agricultural feedstock and chemicals (Ag/Chem) and drugs and pharmaceuticals (Drugs/Pharma)—the data needs to be suppressed in certain cases. To avoid potentially widespread data suppression for these two sectors—and therefore with biosciences overall—these two groups were combined into one by the Census Bureau. While probably of little help to analyze as a group, this approach did prevent significant data suppression overall.

To create individual Ag/Chem and Drugs/Pharma subgroups, the BDS were adjusted here with data from the National Establishment Time Series (NETS)—a privately-produced for-purchase dataset published by Walls & Associates that structures annual snapshots of Dun & Bradstreet data of business establishments in the United States. Like the BDS, NETS contains data on establishment industries (by NAICS) and characteristics of the parent firm (such as age).[19]

Weights were constructed with the NETS data to determine the share either subgroup (Ag/Chem or Drugs/Pharma) comprised of the combined group in the BDS data for a variety of measures (firms, employment, job flows, etc.) and characteristics (age, industry, year, etc.) required for this analysis. Therefore, the weights for each year-age-sector-measure combination sum to equal one.

Each NETS weight for Drugs/Pharma was then applied to the combined group in the BDS data to generate estimates for this subgroup. For example, if the NETS data showed that 66 percent of new firm formations in the combined group in 1997 were accounted for by the Drugs/Pharma segment (and therefore, Ag/Chem accounted for 34 percent), it would be assumed that this same distribution would apply to the BDS data. This same technique was then carried out for each year-age-sector-measure combination.

As was mentioned before, Battelle's definitions of the "biosciences" industries are utilized here. To define the life sciences however, only three of the groups are kept (drugs and pharmaceuticals; medical devices and equipment; and research, testing, and medical laboratories) and two are excluded (agricultural feedstock and chemicals; and bioscience-related distribution)—since our primary interest here is those sectors focused most on human health.[20] A detailed list of industries using the North American Industry Classification System (NAICS) is provided in Table A1.

Table A1: Life Sciences Sector Composition: NAICS Codes and Industries

Drugs and Pharmaceuticals		*Medical Devices & Equipment*		*Research, Testing, & Medical Laboratories*	
325411	Medicinal & Botanical Manufacturing	334510	Electromedical & Electrotherapeutic Apparatus Manufacturing	541380	Testing Laboratories
325412	Pharmaceutical Preparation Manufacturing	334516	Analytical Laboratory Instrument Manufacturing	54171	Research and Development in the Physical, Engineering, and Life Sciences
325413	In-Vitro Diagnostic Substance Manufacturing	334517	Irradition Apparatus Manufacturing	621511	Medical Laboratories
325414	Biological Product (except Diagnostic) Manufacturing	339112	Surgical and Medical Instrument Manufacturing		
		339113	Surgical Appliance and Supplies Manufacturing		
		339114	Dental Equipment and Supplies Manufacturing		

Source: Battelle Technology Partnership Practice

Endnotes

1. Decker, Haltiwanger, Jarmin, and Miranda (2014), "The Role of Entrepreneurship in US Job Creation and Economic Dynamism,"; Haltiwanger, Jarmin, and Miranda (2013), "Who Creates Jobs? Small vs. Large vs. Young," *Review of Economics and Statistics*; Syverson (2011), "What Determines Productivity?" *Journal of Economic Literature*, 49(2): 326-65; Haltiwanger (2011), "Job Creation and Firm Dynamics in the U.S.," Innovation Policy and the Economy, Volume 12, *NBER*

2. Haltiwanger, Jarmin, and Miranda (2013), "Who Creates Jobs? Small vs. Large vs. Young," *Review of Economics and Statistics*; Horrell and Litan (2010), "After Inception: How Enduring is Job Creation by Startups?", *Kauffman Foundation*; Kane (2010), "The Importance of Startups in Job Creation and Job Destruction," *Kauffman Foundation*; and Haltiwanger, Jarmin, and Miranda (2009), "Jobs Created from Business Startups in the United States," *Kauffman Foundation*

3. Hurst and Pugsley (2011), "What Do Small Businesses Do?" *NBER Working Paper No. 17041*.

4. Stangler (2010), "High-Growth Firms and the Future of the American Economy," Kauffman Foundation; Motoyama, et al. (2012), "The Ascent of America's High-Growth Companies," *Kauffman Foundation*.

5. For a broader discussion on innovation-driven entrepreneurship (IDE), see Aulet and Murray (2013), "A Tale of Two Entrepreneurs: Understanding the Differences in the Types of Entrepreneurship in the Economy," *Kauffman Foundation*

6. Hathaway (2013), "Tech Starts: High-Technology Business Formation and Job Creation in the United States," *Kauffman Foundation*. Even among young, job creating firms, young high-tech businesses add jobs at a rate twice that of all firms and the rate of job creation is so robust that it offsets losses from early-stage failures—something that is not true for young firms as a whole.

7. See Battelle (2004, 2006, 2008, 2010, 2012), "Battelle/Bio State Bioscience Initiatives," *Battelle Technology Partnership Practice*

8. Mimeo

9. For more on the BDS, see U.S. Census Bureau Center for Economic Studies: http://www.census.gov/ces/dataproducts/bds/

10. Haltiwanger, Jarmin, and Miranda (2013), "Who Creates Jobs? Small vs. Large vs. Young," *Review of Economics and Statistics*

11. In order to make certain adjustments to the BDS, the National Establishment Time Series (NETS) database is also utilized in this report. For more, see Appendix A.

12. It's not precisly net job creation as a share of employment, but rather, as a share of the average of the current year's and previous year's employment to adjust for regression to the mean. For more see, Davis, Haltiwanger, and Schuh (1996), *Job Creation and Destruction*, Cambridge: MIT Press.

13. It's not exactly 100 percent because the rate is partially based on the prior year's level, which varies from year to year. The denominator in this case is the average of the current year's and the previous year's employment.

14. Stangler (2009), "The Economic Future Just Happened" *Kauffman Foundation*

15. Syverson (2011), "What Determines Productivity?" *Journal of Economic Literature*, 49(2): 326-65; Haltiwanger (2011), "Job Creation and Firm Dynamics in the U.S.," Innovation Policy and the Economy, Volume 12, *NBER*

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18. To ensure that this isn't driven by a survivorship bias, whereby the best young life sciences firms are merged into older and larger firms and their net job creation would register into older firms, an analysis (not shown here) was conducted that shows net job creation at all age groups has generally been on the decline during this time period as well, with the exception of drugs and pharmaceutical firms, which became more positive for medium- and mature-aged firms.

19. For more on NETS, see http://youreconomy.org/YE2010/downloads/NETSDatabaseDescription2013.pdf

20. See Battelle (2008, 2010, 2012), "Battelle/Bio State Bioscience Initiatives," *Battelle Technology Partnership Practice*