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Accelerating Entrepreneurs and Ecosystems: The Seed Accelerator Model

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Executive Summary

Recent years have seen the emergence of a new institutional form in the entrepreneurial ecosystem: the seed accelerator. These fixed-term, cohort-based "boot camps" for start-ups offer educational and mentorship programs for start-up founders, exposing them to a wide variety of mentors, including former entrepreneurs, venture capitalists (VCs), angel investors, and corporate executives, and culminate in a public pitch event, or "demo day," during which the graduating cohort of start-up companies pitch their businesses to a large group of potential investors. In practice, accelerator programs are a combination of previously distinct services or functions that were each individually costly for an entrepreneur to find and obtain. The accelerator approach has been widely adopted by private groups, public and government efforts, and by corporations. While proliferation of accelerators is clearly evident, with worldwide estimates of 3000+ programs in existence, research on the role and efficacy of these programs has been limited. In this article, I provide an introduction to the accelerator model and summarize recent evidence on its effects on the regional entrepreneurial environment.

"There is a start-up revolution occurring. Every major metro area in the world will eventually be able to support an accelerator."

—Brad Feld, Founder, Techstars

I. Introduction

Recent years have seen the emergence of a new institutional form in the entrepreneurial ecosystem: the start-up or "seed" accelerator. These

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fixed-term, cohort-based, "boot camps" for start-ups offer educational and mentorship programs for start-up founders, exposing them to wide variety of mentors, including former entrepreneurs, VCs, angel investors, and corporate executives, and culminate in a public pitch event, or "demo day," during which the graduating cohort of start-up companies pitch their businesses to a large group of potential investors. The first accelerator, Y Combinator, was founded in 2005, quickly establishing itself in Silicon Valley as the first program of its kind. Techstars, one of the largest programs to emerge, followed in 2007, when two local start-up investors in Boulder, Colorado founded an accelerator, hoping to transform the Boulder start-up ecosystem. Today, estimates of the number of accelerators range from 300+ to over 3,000 (spanning six continents), and the number is growing rapidly (Cohen 2013; Cohen and Hochberg 2014).

Figure 1 documents the total number of US-based programs meeting the formal definition of "accelerator" (as per Cohen and Hochberg 2014) over time, excluding university and corporate-affiliated programs. In addition to these programs, many others are founded that call themselves "accelerators" but do not technically meet the formal definition. Notably—as can be seen in the map in figure 2, which maps the

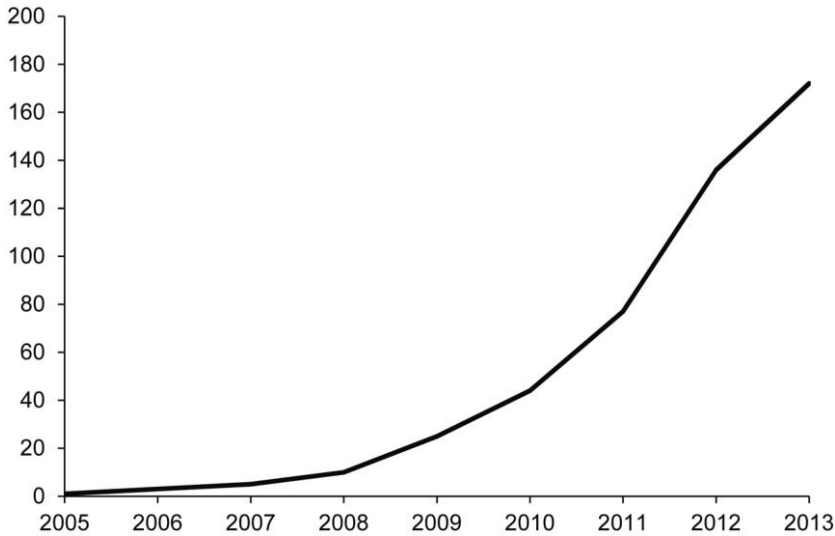

Fig. 1. Number of US-based accelerator programs meeting the formal definition of "accelerator" (per SARP data) over time

location of programs by year of founding—the vast majority of these programs are located outside of traditional technology hubs.

While proliferation of accelerators is clearly evident, evidence on the role and efficacy of these programs is scant at best. Yet many local governments have adopted the accelerator model, hoping to transform their local economies through the establishment of start-up technology clusters. As local governments devote tax dollars and resources to these programs, there is a clear need for additional research exploring the effects of such initiatives on regional ecosystem evolution and entrepreneurial activity.

Clearly, a careful understanding of the effects of entrepreneurial institutions and interventions on the dynamics of the growth of a region's capacity for entrepreneurship and innovation can have important policy implications. Despite significant allocations at the state and local level in the United States and globally, many entrepreneurship support programs have not produced significant returns (Lerner 2009). This may partly reflect a focus on characteristics of successful regions, which are consequences, rather than determinants of, entrepreneurial capacity (Feldman 2001). For example, while research has shown that an increase in VC allocation to a region can have a direct impact on economic growth (Samila and Sorenson 2011) and innovation (Kortum and Lerner 2000), less is known about the policies and interventions that shift VCs' supply preferences across regions.

Researchers have long noted the localization of economic activity, especially inventive and innovative economic activity. Recent work has provided a rigorous confirmation of the clustering phenomenon for entrepreneurship (Glaeser and Kerr 2009) while also describing in more detail the shape and content of these clusters (Delgado, Porter, and Stern 2012). A significant amount of scholarship has sought to account not only for the localization of innovation and entrepreneurship but also for the extreme differences in the level of activity across regions and the role of the regional economic environment in shaping these differences (Saxenian 1996; Feldman 2001: Glaeser and Kerr 2009).

Existing work has stressed the highly localized flow of technical and market information (Jaffe, Trajtenberg, and Henderson 1993; Arzaghi and Henderson 2008) and has also noted the localization of the distribution of VC, rooted in the investor's monitoring function (Sorenson and Stuart 2001). Others have connected the presence of dealmakers to the rates of firm formation (Feldman and Zoller 2012) or have that

Fig. 2. Geography of accelerators in 2008

Notes: The figure indicates the locations of accelerators in the United States in 2008. One marker is shown per municipality (multiple programs may be located in the same municipality).

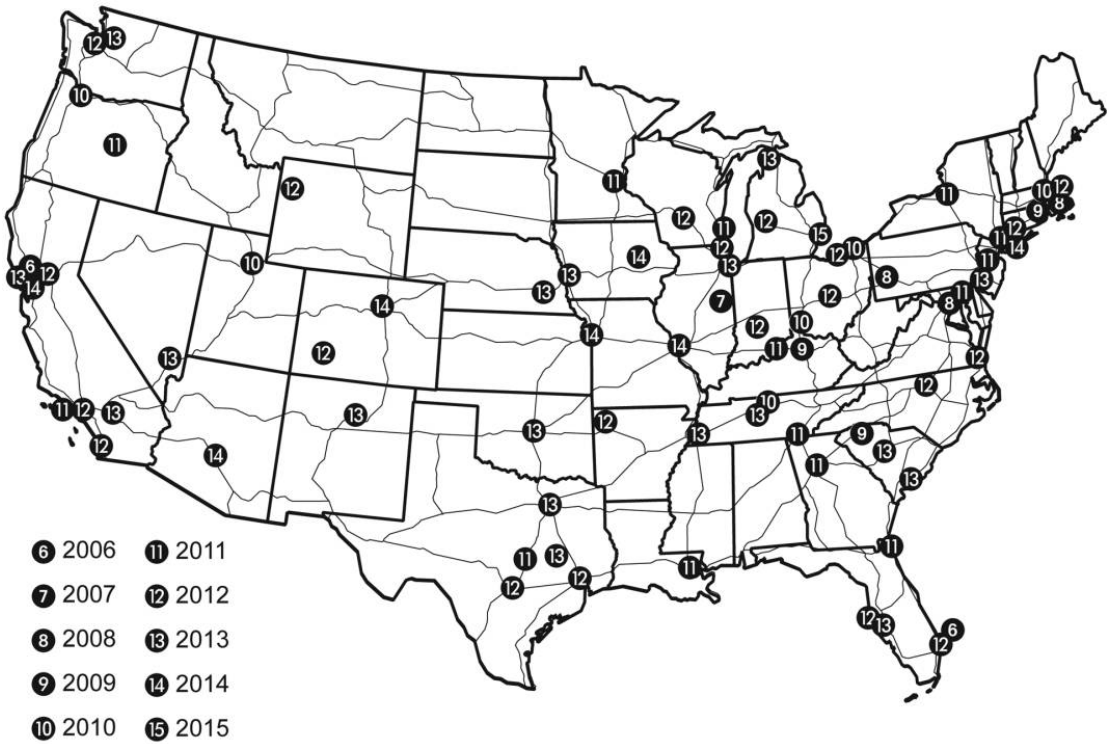

Fig. 3. Geography of accelerators in 2014

Notes: The figure indicates the locations of accelerators in the United States in 2014. The number labeling the marker indicates the year of establishment of the first accelerator in that region. One marker is shown per municipality.

current incumbents in the economic ecosystem of a region can have a large impact on a region's capacity for innovation and entrepreneurship for both the good (Agrawal and Cockburn 2003; Feldman 2003) and the detriment of a region (Chinitz 1961). Indeed, the composition of a region's economy in one period can have a long-term impact on the entrepreneurial capacity of a region moving forward (Glaeser, Kerr, and Ponzetto 2010).

With this motivation in mind, in this article, I provide an introduction to the accelerator phenomenon and summarize recent research on the impact of accelerator programs and its relevance for policymakers, with a focus on new results that speak to the value of these programs for the entrepreneurial ecosystems of the region in which accelerators are located.

Section II provides a detailed overview of the accelerator model. I review the formal definition of an "accelerator," which serves to distinguish these programs from other institutions such as incubators and "hubs" and discuss the emergence of the model and its perceived value as well as the shifts in investor behavior and deal composition that have resulted from the nature of these programs. In section III, I discuss the research challenges presented by the limited availability of data on these programs and review available data sources. Section IV is a brief overview of some initial research studies on accelerators, which primarily have focused on the effects such programs have on the start-ups that attend them, with mixed conclusions.

While this focus on outcomes for accelerated portfolio companies is motivated by the desire to identify the effect of accelerator "treatment" on the "treated," such analysis is challenged by the difficulties in measuring start-up company outcomes (given the early stage nature of the start-up companies who attend these programs and the newness of the phenomenon) and the endogeneity challenges presented by the potential for fundamental differences in the nature and quality of companies accepted into an accelerator program versus those who either do not apply or are not accepted. Of greater concern, if accelerators serve to shift the general equilibrium of the entrepreneurial ecosystem in some fashion, thereby affecting outcomes for both the treated *and* the nontreated in a region, studies examining the effects on accelerated start-ups or comparing accelerated to nonaccelerated start-ups will not capture the full effects of these programs for the ecosystem. This presents a crucial deficiency for policymakers, who may wish to support, encourage, or invest in accelerators if they have positive effects on the

ecosystem, even if they do not differentially affect the small number of companies that attend them.

In section V, therefore, I turn to the larger question of the entrepreneurial ecosystem, summarizing recent findings by myself and coauthors on the manner in which accelerators influence the general equilibrium of the regions in which they operate. Our statistical approach exploits the fact that accelerators emerge in different regions in different years, often for reasons exogenous to the nature of the ecosystem at the time of entry or precisely because of its lacking. This allows us to compare regions that receive an accelerator with very similar regions who do not yet have one, using a difference-in-differences methodology that compares the differences between treated and untreated regions after the arrival of an accelerator to the difference between them prior to its arrival. As the regions are carefully matched on levels and trends of the outcomes variables prior to the treatment date, this amounts to looking at how otherwise similar regions diverge from each other once one of them receives an accelerator, while the other remains without.

The resulting estimations demonstrate a striking shift in the nature of the seed and early stage funding environment for start-ups in accelerator-treated regions, a shift that results primarily from additional funding events for nonaccelerated companies and the emergence of new, local investor groups. Our conclusions substantiate the need for regional ecosystem-level analysis of the effects of accelerator programs, as they suggest a shift in the general equilibrium environment for start-up activities.

Finally, in section VI, I discuss recent trends in the accelerator space, which may further affect the entrepreneurial environment in years to come. While initial accelerator programs focused primarily on start-ups producing software and services, fueling a boom in seed-stage software and app start-ups, the last two years have seen an increasing number of programs designed specifically for start-ups in the hardware and device space as well as the emergence of programs equipped with wet labs to handle start-ups in the life sciences. Corporate-initiated programs are also on the rise, exhibiting a variety of forms and approaches. Universities, like many local governments, have also glommed onto the accelerator trend, opening summer programs to help facilitate their students' entrepreneurial aspirations. Networks and franchising have become common. But along with the birth of new programs has come the passing of others, including well-established programs. And the proliferation of programs and resulting commoditization of the descriptor has

also led to the choice by a number of marquee programs to transition away from the accelerator label and evolve into other models. These, and other trends, suggest that effects of the accelerator model for entrepreneurship are not yet finished evolving. With this in mind, section VII concludes the paper with a discussion of potential follow-on research that would be of value to policymakers and entrepreneurs alike.

II. An Overview of Seed Accelerators

The formal definition of a start-up or seed accelerator, first offered by Cohen (2013) and Cohen and Hochberg (2014), is a fixed-term, cohort-based program, including mentorship and educational components, that culminates in a public pitch event, often referred to as a "demo-day." Many accelerator programs, though not all, provide a stipend or small seed investment ($26,000, on average, with a range from $0 to $150,000) to their start-ups and receive an equity stake in the portfolio company in return, typically 5 to 7%. Most offer coworking space and other services in addition to mentorship and educational and networking opportunities. Some also offer a larger, guaranteed investment in the start-up, in the form of a convertible note, upon graduation. While many accelerators are generalist across industries, others are vertically focused (health care, energy, digital media). Despite the vertical or industry focus, careful examination of the products or services provided by the portfolio companies of accelerators reveals that historically, nearly all accelerator portfolio start-ups offer some form of software or Internet services, though such software may be targeted toward use in a specific industry vertical.[1]

The emergence of accelerators has been facilitated by a significant fall in the costs of experimentation over the last decade (Kerr, Nanda, and Rhodes-Kropf 2014). The capital requirements to seed a start-up software company have fallen dramatically along with the cost of experimentation; where building a software company may have cost $5 million, on average, 10 years ago, today it can often be accomplished with $500,000, and start-ups can often accomplish with a $50,000 seed investment what used to take $500,000 to $1 million. This has allowed accelerators to provide meaningful funding and assistance to their start-up portfolio companies with a seed investment or stipend as low as $15,000.

In practice, accelerator programs are a combination of previously distinct services or functions that were each individually costly for an

entrepreneur to find and obtain: seed investment, value added mentorship and advisement, coworking or colocation with other start-up companies, capital introductions and exposure, network building, and the opportunity to pitch to multiple investors, a likely result of which is a reduction in search costs for the entrepreneur, and an increase in leverage vis-à-vis potential VC investors. Indeed, accelerators often attempt to be an organized version of the "dealmakers" described in Feldman and Zoller (2012), drawing the community together and creating social capital surrounding entrepreneurial efforts. Top programs particularly emphasize the value of the network of mentors and investors that they bring to bear and that becomes available to participating start-ups not only during the course of the program, but also going forward as alumni. This emphasis is consistent with extant findings from the VC literature, which indicate that networks are highly important for the success of early stage start-up companies by facilitating the sharing of information and resources critical to the entrepreneurial production function (Hochberg, Ljungqvist and Lu 2007; Hochberg, Lindsey, and Westerfield 2015).

On the flip side of the market, from the perspective of the VC investors, accelerators serve a dual function as deal sorters and deal aggregators. The accelerator application process screens among a larger population of start-ups to identify high-potential candidates, and the program aggregates these candidates in a single location, attracting investors who might otherwise find the costs of searching for opportunities in smaller regions too high to justify. Investors often serve as mentors, thus getting an early look at the start-ups, business plans, team dynamics, and progress over the term of the program. The public demo day, or pitch event, allows them to observe multiple companies pitch in a single instance, and, because they are already traveling to the region, nonlocal investors may often choose to look at other opportunities in the area as well. The aggregation and sorting function performed by accelerators is thus believed to result in a reduction in search and sorting costs for the VCs when investing in smaller regions.

The perceived value of accelerators as deal aggregators and sorters is the primary enabler of the most common financial support model used for private accelerator programs. In this model, accelerators raise a fund for either a single cohort or a small number of cohorts. The fund is structured, similarly to VC funds, as a limited partnership; however, the investors in these accelerator funds are typically VC funds and superangel investors, rather than the typical institutional investors (pension

funds, endowments, etc.) that are seen in VC funds. The amounts contributed are usually small (on the order of a few hundred thousand dollars), and the expectation is that the investors will not see a return on these funds directly from the accelerator fund for many years, if at all: the typical time to exit for a seed stage VC start-up is seven to nine years, and accelerator companies are usually even earlier in stage of development. Moreover, the accelerators typically take either small common stock positions (5–7%) or small convertible notes ($22,000, on average). Given the lack of ability of the accelerators to participate in large follow-on rounds of VC financing raised by the companies, these positions will be severely diluted by the time a portfolio company reaches exit. As a result, some accelerators do not take equity stakes in the companies at all (e.g., MassChallenge).

Given these attributes, the investments in the accelerator program are made by the VCs not for the expected direct return on the contribution to the accelerator, but for the early access to the admitted portfolio companies, which allows the VCs to place larger bets out of their primary funds both with more information in hand and an established relationship with the companies that may make them preferential to unknown investors from the start-up's perspective. The accelerators themselves fund their activities and salaries directly from the fund capital as well as sponsorship from other service organizations that also desire early access to the selected companies.

As accelerator programs provide an initial sorting of high quality ideas and aggregate these deals into a single location with easy, batched access for investors, accelerator programs have, for many angels and VC firms, become a first line of attack both for the sourcing of deals and the due diligence process. Given the specific composition of companies that attend accelerators (primarily software and services), shifts in the composition of early stage VC financings have emerged in regions with accelerators, where the proportion of software deals (dollars) as a fraction of total funding events (dollars) increases post-accelerator arrival (Fehder and Hochberg 2015). Moreover, with their focus on earlier-stage companies, the emergence of accelerators has also led to shift in the stage composition of deals, with a higher proportion of investments in the software and information technology (IT) spaces being made in seed and early stage companies in a region post-accelerator arrival, relative to before the appearance of an accelerator (Fehder and Hochberg 2015).

III. Data Challenges and Opportunities

Limited research exists on the accelerator phenomenon, primarily due to the newness of the phenomenon and limited data availability. The definition of an "accelerator" among practitioners itself remains discordant. Some groups that would be defined as "incubators" based on the Cohen and Hochberg (2014) standardized definition refer to themselves as accelerators due to the current hype around the phenomenon, while others that meet the formal definition of "accelerator" still refer to themselves as "incubators." As a result, researchers must manually identify and categorize programs. Complicating matters further is the significant heterogeneity that exists even among groups that meet the formal definition.

The data challenges are also significant and affect both the ability of researchers to conduct rigorous program evaluation and the ability of entrepreneurs, investors, and policymakers to assess the relative quality of programs. There is a general absence of large-scale representative data sets covering accelerator programs. Researchers, entrepreneurs, and policymakers have little visibility into program features, the identity of the companies that enter and exit the programs, or the population of start-ups that apply to such programs but are not admitted. Most accelerators are small, lean organizations, with limited staff and little organized data tracking. The participants themselves are small private companies, often unincorporated at the start, for whom little data is available even if their identity were known. While some programs encourage their graduates to report to publicly available databases such as CrunchBase, and other start-ups voluntarily report or are identified through CrunchBase's own data collection efforts, other programs discourage public reporting for competitive reasons. Overall, the data on accelerator graduates present in public databases is as yet incomplete or inaccurate.[2]

Many of the publicly available resources are aggregated by Seed-DB (www.seed-db.com), which promotes itself as a database of seed accelerators and their companies. Seed-DB itself, however, offers a number of disclaimers, including the fact that the data is incomplete, with missing programs and companies. Seed-DB also notes that it pulls data from CrunchBase and, thus, relies on companies to update their information in that data source, which does not always occur. For many accelerator programs, no data is available on the nature of the program

or the companies that have graduated. Seed-DB also report exit values for accelerator companies but notes that most of its reported values for company exit valuations are guesses, except where provided by the company itself or public reporting (Seed-DB indicates its confidence in its estimates using a color-code system). Despite these limitations, Seed-DB likely represents the largest public repository of accelerator and graduate data.

Recent efforts by the research community to collect extensive data on the start-ups attending accelerator programs and on the features of the programs they attend offer a unique opportunity to address questions of interest to researchers and policymakers. These data collection efforts have been conducted in order to provide information and a measure of transparency for entrepreneurs seeking to attend an accelerator program. The Seed Accelerator Rankings Project (SARP; Hochberg and Kamath 2012; Hochberg et al. 2014; Hochberg, Cohen, and Fehder 2015) collects detailed data in order to produce an annual published ranking of accelerator programs throughout the United States on a variety of outcomes of interest to entrepreneurs. The desire to be included in these rankings incentivizes the accelerators to provide the researchers (under strict nondisclosure arrangements) with full transparency and access to data otherwise unavailable to the public; the resulting ranking project provides a measure of transparency, guidance, and valuable insight to entrepreneurs attempting to choose the best program for their start-up.

The data collected by SARP appears to be the most comprehensive data set on accelerators to date, and the reported benchmarking and ranking provides a comprehensive and objective set of measures available to entrepreneurs considering such programs. Moreover, by encouraging accelerators to track information about their portfolio companies and graduates, the rankings project has enabled the establishment of a data repository that can, over the longer run, be used to determine best-practices and design choices for these programs.

IV. Do Accelerators "Accelerate" Their Participant Start-Ups?

Much of the limited research on accelerators to date falls into one of two categories: (1) conceptual description of the accelerator model (e.g., Cohen and Hochberg 2014) or qualitative assessment of how accelerators may serve to accelerate start-ups; or (2) empirical attempts to assess whether accelerators indeed have a positive effect on the outcomes of the companies that participate in the programs.

In the first category, Cohen (2013) utilizes an embedded multiple case study of nine US-based programs to assess how accelerators accelerate the new venture process. Cohen proposes a framework suggesting that a combination of extreme mentorship and coopetition between peers may help new ventures quickly set and implement their strategy. Radojevich-Kelley and Hoffman (2012) offer a multiple case study that describes how accelerator programs connect start-ups with potential investors, and Kim and Wagman (2012) present a game theory model of the accelerator as certification of start-up quality.

In the second category, two studies attempt to compare the start-up companies that complete accelerator programs to other populations of start-ups that did not attend accelerator programs. Hallen, Bingham, and Cohen (2014) use two distinct samples to compare accelerated start-ups that eventually raise VC to nonaccelerated ventures that eventually raise VC. Performance is measured by whether the start-up remains operating at the time of data gathering, the number of employees it has, whether it has raised over $1M in financing, and web traffic measures a year after graduation from the accelerator. The authors find that ventures that were accepted into an accelerator cohort were generally more likely than their "almost" accepted counterparts to be alive or acquired, had more employees at time of data collection, and were more likely to have raised over $1M in VC funding, with small differences across the four cohorts. For a larger sample of accelerator graduate companies and matched nonaccelerator graduates, the analysis reveals no statistically significant average accelerator effect in the speed at which companies reach the three key milestones examined, though statistically significant differences on certain measures exist for some of the top-ranked programs. The authors conclude that, while start-up progression can be accelerated, it cannot be done generically, and argue that success of these programs relies on a complex combination of human capital, networks, and experience, which must be built over time.

Winston Smith and Hannigan (2015) compare ventures that have participated in two of the leading accelerators, Techstars and Y Combinator, to similar ventures that do not go through these programs but instead raise angel funding. They find that start-ups that graduate from these top two programs achieve exit (acquisition or failure) faster than their matched, angel-funded counterparts, due to both higher acquisition rates and higher failure rates than for angel-funded start-ups. Winston Smith and Hannigan also demonstrate that attendees of these

top two accelerator programs are more likely to come from educational backgrounds that include attendance at one of the institutions in the top-thirty producers of computer science doctoral graduates, which suggests that there is a particular "type" of background that characterizes start-ups that choose to attend (or are accepted to) premier accelerator programs.

V. Ecosystem Effects

The distinguishing characteristic of the studies discussed in the preceding is their focus on the outcomes for accelerator portfolio companies. In other words, their authors are interested in the effect of treatment on the treated (do accelerators add value to the companies that attend them?). Outcomes, however, are difficult to measure in this setting, given the early stage nature of the start-up companies who attend these programs, and endogeneity issues are rife when conducting research of this nature. Furthermore, if accelerators serve to shift the general equilibrium of the entrepreneurial ecosystem by improving outcomes or resources for both the treated *and* the nontreated in a region, studies of this nature will not be able to properly capture the full effects of accelerators. From a policy perspective, this distinction is critical: if accelerators have positive effects on the ecosystem (regardless of their effects on the small number of companies that attend them), investment in accelerator programs will have an impact on the region.

In recent work, therefore, my coauthors and I take a different approach, examining the regional effects of programs on the general equilibrium in the entrepreneurial ecosystem rather than the treatment effects of the accelerator on the treated start-ups (Fehder and Hochberg 2015). We focus on a particular aspect of the ecosystem: the availability and provision of seed and early stage VC financing for start-ups. Our empirical design seeks to measure the impact of start-up accelerator formation on the VC financing activity in a metropolitan statistical area (MSA) region.

Accelerators, by design, likely lower the search costs for both entrepreneurs and investors seeking early stage investments. As such, start-up accelerators are predicted to stimulate an increase in the level of seed stage investment activity in a region. At the same time, accelerators may be more likely to be founded in regions that have higher levels of start-up investment activity or have experienced swift growth in that activity. Thus, we are interested in separating the causal impact

of start-up accelerator formation from the endogenous selection of start-up accelerators into "hot" regions for start-up activities.

Assessing whether accelerators affect the level and availability of VC funding in their region is nontrivial, as there is no source of guaranteed exogenous variation in the location of accelerators, and no natural experiments exist to help researchers in this task. While the locational choices of many accelerators are rooted in the birthplace of founders who found success in Silicon Valley and returned home hoping to transform their hometowns,[3] others are established for reasons we cannot directly establish. In other contexts, researchers have found that short-term changes in outcomes, like a wage dip, can drive a treatment decision, like attending a job-training program (Ashenfelter 1978; Abadie 2005). Given this challenge, our approach mimics that of other studies faced with similar program evaluation settings (e.g., Autor 2003). First, we carefully match MSAs that are treated with an accelerator program to other MSAs that are very similar in terms of pretreatment trends in the entrepreneurial ecosystem. We then employ a fixed effects difference-in-differences model, augmented by linear time trends to capture any pretrends in funding patterns that might not be fully captured in the matching process.

To create our matched sample, we estimate a dynamic hazard rate model that flexibly estimates how both the level and the short-term rate of change in VC funding events predicts the arrival of an accelerator in a given MSA. We thus obtain an instantaneous probability, based on current levels of funding, that an accelerator will choose to locate in a specific MSA. With our estimated dynamic hazard rate model, we then choose a match for each treated region by finding the untreated region with the most similar probability of founding an accelerator in that year when the treated region is on the common support.[4]

Using a panel data set of US Census MSA regions across 10 years, we then exploit the fact that different accelerators were founded in different years in different MSA regions to assess the impact of accelerator foundation through a difference-in-differences model that controls for time-invariant heterogeneity in the entrepreneurial capacity of different MSA regions with an MSA fixed effect and for national-level dynamics in the VC market with year-fixed effects. Our primary variable of interest is a dichotomous variable that is set to 1 for MSAs that received accelerators for all years greater than or equal to the year of the accelerator's first cohort. We further include time x MSA-specific controls. This specification allows us to measure the impact of the founding of

an accelerator by comparing treated regions to untreated while controlling for fixed differences in regional levels of venture activity and time-period specific shocks that are shared across all regions as well as the MSA-specific slope across all years of the sample. The parameter of interest then measures the average deviation from MSA-specific slope term observed after the arrival of an accelerator in an MSA. The MSA-specific slope parameter absorbs unobserved variation in the growth rate in venture financing in each MSA. Adding the MSA-specific time trend to our regressions tests how sensitive our estimates of the impact of accelerator founding are to the assumption that treatment and control groups are fundamentally similar.

In Fehder and Hochberg (2015), we demonstrate that our set of matched, never-treated, MSAs are highly similar to their treated counterparts in financing trends and other characteristics in the years prior to treatment, which occurs in a staggered manner across multiple MSAs over the years 2005 to 2012. Posttreatment, however, our preliminary findings suggest that MSAs that receive an accelerator program exhibit significant differences in seed and early stage financing patterns. In our difference-in-differences model with a strictly matched sample, fixed effects, and linear time trends, the arrival of an accelerator is associated with an annual increase of 104% in the number of seed and early stage VC deals in the MSA, an increase of 289% in the log total dollar amount of seed and early stage funding provided in the region, and a 97% increase in the number of distinct investors investing in the region. This increase in the number of distinct investors comes primarily from an increase in local investment groups (i.e., groups located within 200 miles of the center of the MSA) rather than from entry of additional investors from outside the region.

Moreover, the analysis in Fehder and Hochberg (2015) demonstrates that the increase in funding events post-accelerator arrival are not merely of accelerator graduates—much of the increase in funding events involves investments made in nonaccelerated companies in the MSA. Taken together, these findings suggest that the presence of an accelerator leads to a shift in the general equilibrium of funding activity in the region rather than merely to an effect of treatment on the treated, consistent with the notion that an accelerator program may serve as a catalyst to draw attention to the region more generally or may serve to galvanize local activity. This finding emphasizes the need to consider regional effects more generally rather than limiting analysis to comparing treated start-ups to untreated start-ups.

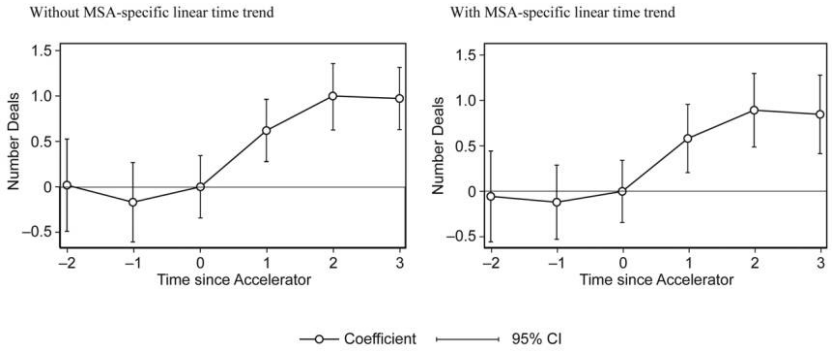

Fig. 4. Treatment effect for treated region over time—number of deals

Source: Fehder and Hochberg (2015, fig. 1).

Notes: The figure presents the difference in number of seed and early stage VC financing deals between a region that receives and accelerator and a carefully matched region that does not receive one, for the six years surrounding the opening of the program. As can be seen from the graph, prior to the accelerator arrival at time $t = 0$, both the treated and untreated regions have similar levels of seed and early stage funding events. After the arrival of the accelerator in the treated regions, however, funding levels diverge in a striking manner, with the treated (accelerator) region experiencing a large increase in seed and early stage financing deals relative to its untreated counterpart.

The goal of Fehder and Hochberg (2015), as well as our follow-on research currently in progress, is to provide baseline measures of the impact accelerators have at the *regional* level on entrepreneurial activity and downstream growth. It is important to highlight that our analysis in Fehder and Hochberg (2015) does not distinguish de novo growth in investment dollars from a shift of investment dollars from other regions into the accelerator's region, possibly to the detriment of the other regions. Thus, a strong positive finding at the regional level may have a more neutral interpretation in terms of the general welfare change at the national level from the arrival of accelerators. Similarly, one could argue that the companies being funded locally may simply be companies that would otherwise have gone to one of the coasts and been financed there and now are instead financed in their original home regions. While we believe that these two critiques are valid, it is important to note that reallocation of investment dollars and firms to a region may, in fact, be extremely acceptable outcomes for the local officials and business people that help found accelerators.

That said, our work does not represent a policy prescription for local development officials. While the findings of Fehder and Hochberg (2015) suggest that accelerators may shift the local entrepreneurial

ecosystem in a manner consistent with an increase in entrepreneurial funding activity, the analysis to date does not allow us to identify what ecosystem elements must already be in place in order for accelerators to be effective in this manner or what the nature of programs must be to have the desirable effects. Future research may shed more light on the types of regions for which accelerators can be particularly effective and the types of program elements that are most effective. Moreover, existing research on accelerators and other types of program interventions does not allow us to speak to whether local funds would be more effective if spent on opening an accelerator versus allocating those funds to a different type of entrepreneurial program.

While work to date has treated accelerators as a homogenous phenomenon, there is some variation in the design of accelerators, especially in terms of their admissions criteria. In ongoing work, we focus on design choices for accelerators that interact with the existing regional economy from which the accelerator draws key resources (mentors, industry expertise, and investors). Previous research suggests that regional growth in entrepreneurial activity surges forward after a key event unlocks the underlying entrepreneurial capacity of the region (Feldman 2001, 2003; Acs, Desai, and Hessels 2008). Our preliminary qualitative research has suggested that there are a few key design choices for accelerators, which potentially impact the extent to which they effectively build upon the existing economic resources in their region. Often, the choice of admission criteria is predicated on the preferences of the accelerator's founders rather than the underlying industry specialization of the region. Some accelerators, however, select early stage firms that are a broadly representative of the industry mix in their region. Others consider themselves generalists and select teams that they perceive to have the most potential, agnostic to industry. An example of specialization would be the Surge Accelerator in Houston, Texas, which admits companies focused on developing software and services for the energy industry. In contrast, accelerators like Techstars in Boulder, Colorado, are generally industry agnostic.

Building on this observation, there is a good amount of variation in the level of accelerator specialization across regions with a high degree of industry cluster specialization (Delgado, Porter, and Stern 2013). While accelerator founders often discuss building connections between industries in their region, not all industry clusters may be equally amenable to building relationships with entrepreneurial firms. Recent research has noted a strong and persistent relationship between the

average firm size in a region and the level of entrepreneurship and innovation in that region and subsequent job growth (Glaeser, Kerr, and Ponzetto 2010; Agrawal et al. 2012; Glaeser, Kerr, and Kerr 2012). These papers suggest that regions with smaller firms lower the cost of entry for entrepreneurial firms by providing greater levels of resources specialized for smaller firms (e.g., lawyers, accountants, etc.). By lowering the costs of entry for start-ups in their program (and more broadly) by increasing access to greater levels of VC, accelerators should be complementary to the other resources in the region specialized for small and new firms. Thus, we expect to see heterogeneity in the treatment effect of accelerator founding on a region based on the underlying industry structure of the region overall. Our preliminary analysis focuses on measuring such differences in treatment effect. Even without a strong causal interpretation, differences in the treatment effect measured will provide important data about the potential match between regional features and accelerator design that are associated with maximum impact.

VI. Emerging Trends

A. Vertical Specialization and Diversification of Start-Up Type

Perhaps the most notable trend over the last two years has been the movement towards vertically specialized accelerators. Initial entrants into the accelerator space were primarily characterized as "generalists," agnostic to the industry being served by their start-up applicants. Recent years have seen a transition toward industry-specialization, primarily in industry verticals characterized by specialized knowledge or regulation, such as health care and energy. In practice, however, an examination of the accelerator portfolio companies suggests that both generalist and specialist programs shared a common tendency toward software and services start-ups, regardless of whether they generalized across the industries those start-ups were to serve or specialized in a specific industry, such as health care IT.

The last two years, however, have seen the emergence of a number of groups focused not on software, but on hardware or other physical product. A number of prominent programs (e.g., StartX) now offer wet-lab space and admit life sciences-related start-ups to their programs. Another common configuration is the hardware-oriented accelerator (e.g., Bolt, AlphaLab Gear, Highway1). Given the higher capital requirements and longer timeline for these types of start-up, however, it re-

mains to be seen whether these new accelerator programs will succeed in fueling a boom in their spaces similar to the one observed in software and apps over the last decade. However, as much as accelerators have served as sorting and aggregation tools for investors and as aggregators of much-needed services and networks for software start-ups, the emergence of hardware and life sciences-oriented programs may herald a sea change in bargaining power and resource acquisition for these verticals as well over the coming years.

B. Corporate Accelerators

The 1990s and the advent of open innovation policies and the Internet economy saw a proliferation of corporate VC arms. Corporations augmented business development departments with VC arms that had either strategic or financial goals. Many of these efforts were shut down early in the twenty-first century following the collapse of the Internet bubble and reemerged over the course of the last decade. While corporate VC is a relatively well understood phenomenon, the recent era has seen the emergence of a new form of corporate innovation activity in the form of the corporate accelerator. The emergence of the corporate accelerator appears to have arisen from a desire by many companies to bring themselves closer to innovation and gain access to windows on emerging technology, thus staving off the gale of creative destruction.

Corporate accelerators are often similar to private accelerators in structure (fixed-term, cohort-based) but also follow other, more fluid definitions. There are many ways for corporations to participate in accelerator activities. At the most basic level, corporations and their executives or emissaries can join existing private accelerators as mentors or investors. A second model, "Powered by," has corporations contracting with others to run an accelerator for them. The most prominent organization engaged in "powering" corporate accelerators is Techstars, and notable such programs are the Disney Accelerator, powered by Techstars; Barclays Accelerator, powered by Techstars; Sprint Accelerator, powered by Techstars; and the Kaplan EdTech Accelerator, powered by Techstars. In this model, the outside powering organization provides services such as program creation and management, staffing, marketing, and back office services as well as physical space where requested. A third model has corporations creating their own internally run and led accelerators, as is the case for Microsoft, Telefonica, and others. Finally, in the consortium model, some corporations choose to partner

with other companies to create a jointly run dual or multiple partnership accelerator. A fifth model remains completely internal, with companies attempting to accelerate their own internal product teams.

C. Accelerator Networks

While most accelerator programs have a single location and run one to two cohorts each year, using the same managing directors and mentors, an emerging phenomenon is the franchising of accelerator programs to multiple locations with different managing directors and mentors for each location. Prominent among these groups is Techstars, with programs in Austin, Berlin, Boston, Boulder, Chicago, London, New York City, Seattle, and San Antonio (Techstars Cloud); Healthbox, with programs in Chicago, Miami, and Salt Lake City; 500 Start-ups, with programs in San Francisco, Mountain View, and Mexico City; and Dreamit, with programs in Philadelphia, New York City, Austin, and Baltimore (Dreamit Health).

D. Vertical Integration into Seed Funds

With the proliferation of the accelerator model, we have begun to see older, established programs expand their activities beyond the standard accelerator format. Some established programs have begun to vertically integrate and add seed funds in addition to their accelerator batches. Two prominent examples of this type of expansion are 500 Start-ups and Techstars, both of whom continue to run accelerator programs and refer to them as accelerators but have also added seed-stage-focused VC funds to their portfolio. 500 Start-ups runs a number of funds with different geographical focuses that invest both in their accelerator graduates and in other seed-stage companies; Techstars Ventures runs a seed and series A stage fund that invests not only in Techstars graduates, but also in companies started by Techstars alumni and mentors. More recently, accelerator directors have also begun to establish their own, separate funds in order to take advantage of information gathered on start-ups during the accelerator program.

Other programs have chosen to move away from both the accelerator model and the accelerator label. RockHealth and Y Combinator are the most prominent examples of this trend. As noted on Y Combinator's website (https://www.ycombinator.com/about/), Y Combinator now presents itself as a provider of "seed funding for start-ups. Seed fund-

ing is the earliest stage of venture funding. It pays your expenses while you're getting started." While Y Combinator has chosen to retain the cohort-based approach of its prior accelerator phase, they now state that "Y Combinator has a novel approach to seed funding: we fund start-ups in batches." They furthermore state expressly that they are not following the "boot camp for start-ups" accelerator model: "Y Combinator is occasionally described as a boot camp, but this is not really accurate. We probably get called that because we fund a lot of start-ups at once, and most have to move to participate. But the similarities end there; the atmosphere is the opposite of regimented." RockHealth, one of the earliest and most prominent digital health-focused accelerators, has similarly moved away from the label and model of accelerator and now describe themselves as a seed fund doing "Full Service Start-up Funding."

E. Transition into Incubators

A second approach taken by some accelerator groups has been to morph their programs from the accelerator model into a model of business incubation. For example, Capital Factory in Austin, Texas, a highly ranked accelerator program, changed its business model a number of years ago to one of incubation, rather than the fixed-term, cohort-based boot camp approach of an accelerator. Similarly, Amplify LA, a Los Angeles-based program, has chosen to abolish strict entry cohorts or an established timeline for acceleration for some of its companies, instead admitting companies at will for undefined lengths of time and often refers to itself as an incubation program.

F. University Accelerators

Another emerging accelerator subset are university-affiliated accelerators, such as StartX (Stanford), Global Founders Skills Accelerator (MIT), the New Venture Challenge (University of Chicago), OwlSpark (Rice University), SkyDeck (University of California, Berkeley), and RedLabs (University of Houston). These programs typically require applicants to have some affiliation with the educational institution and often focus more on the educational opportunities than on future profitability potential for the businesses admitted. Programs typically run during the summer months.

G. Development of International Presence

A final emerging trend is the expansion of established, US-based accelerator networks into the international arena, with the opening of programs in the United Kingdom, Europe, and Latin America. For example, Techstars has opened a program in London, while 500 Start-ups has opened a program in Mexico City.

VII. Parting Thoughts: A Roadmap for Future Research

Over the last decade, accelerators have emerged and evolved to become substantial players in the early stage entrepreneurial ecosystem. Understanding the role and efficacy of such programs is particularly useful for policymakers considering the benefits of accelerators for the local entrepreneurial economy and ecosystem, given the importance of entrepreneurial activity for economic growth (Davis, Haltiwanger, and Schuh 1998; Haltiwanger, Jarmin, and Miranda 2013) and the desire to spur such activity.

Experimentation at the state and local level has been one of the hallmarks of entrepreneurial policy in the United States for some time (Lerner 2009), and it is important for researchers to bring the tools of rigorous program evaluation to bear on this experimentation when possible in order to understand the impact of these programs on regions, the unit of analysis considered by these policymakers (Chatterji, Glaeser, and Kerr 2013). By understanding what fosters both growth in or reallocation of entrepreneurial firms and investment dollars across different regions, we will begin to build a stronger understanding of what policies make a difference to start-up founders and investors and, as a result, to regional economic activity more generally.

Accelerator programs specifically address outcomes with clear societal interest: start-up activity, including VC funding and support for new ventures; science, technology, engineering, and math (STEM) employment; and regional economic development. These outcomes are all considered critical to the increased economic competitiveness of the United States over the long term. The emerging research surveyed in this article can, therefore, provide important insights for regional policymakers, who are increasingly looking to accelerators and other new entrepreneurial institutions such as incubators to stimulate start-up activity in their regions. The emerging research results inform

not only on the overall value of accelerators to the local entrepreneurial ecosystem, but also on the value of linking these institutions to local industry clusters versus diversifying away from local industry foci.

That said, research on the accelerator phenomenon is in its infancy, and much remains to be done before final conclusions can be drawn regarding the value of these programs to entrepreneurs and local ecosystems. A number of items appear to be of primary importance in this regard. First, policymakers often face the question of which type of intervention to allocate (often scarce) dollars to. While accelerators appear to have an impact on the entrepreneurial funding environment, other types of interventions may also positively impact funding availability. Further research is needed to determine, on a dollar-for-dollar basis, which types of interventions are most beneficial. Second, while the work in Fehder and Hochberg (2015) suggests that accelerators impact early stage financing in the region, it would be useful to explore other elements of the entrepreneurial ecosystem that may be affected by the establishment of an accelerator. To this end, better measures are needed for assessing the presence of early stage entrepreneurial activity. Third, additional research should asses which types of programs or program elements are most important for the success of an accelerator, both from the perspective of the entrepreneurs that attend it and from the perspective of local policymakers or business people looking to establish a program. Here, too, multiple measures of success must be considered as "success" itself may differ based on the goals of the program founders. Furthermore, it is possible that the nature of the local region, its existing institutions, and its ecosystem more generally may cause certain types of programs to be more or less effective in a given region. Future work should explore regional characteristics such as industry composition, wealth, education, culture, and so forth. Finally, more work should be done to illuminate the mechanisms by which accelerators shift the equilibrium of a region (e.g., cultural effects, presence of role models, creation of supporting institutions, etc.).

Endnotes

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of the author's material financial relationships, if any, please see http://www.nber.org/chapters/c13584.ack.

1. Notably, accelerators differ considerably from previously extant institutional structures in the entrepreneurial ecosystem, such as incubators. Incubators are primarily real estate ventures, offering start-up coworking space at reduced rent. Incubators, unlike accelerators, lack a fixed term and experience continuous entry and exit of start-up groups, which stay resident for much longer periods of time (one to four years, on average, versus three to four months for an accelerator). Most offer fee-based professional services. They do not offer investment or stipends, and their educational and mentorship offerings, if provided, are ad hoc at best. Incubators are primarily thought to shelter vulnerable nascent businesses from the harsh realities of the real world, while accelerators force start-ups to quickly confront those realities and determine whether the business is viable (Cohen 2013; Cohen and Hochberg 2014).

2. As reported by the SARP (Hochberg and Kamath 2012; Hochberg et al. 2014; Hochberg, Cohen, and Fehder 2015) and Cohen and Hochberg (2014).

3. For example, Techstars, one of the first accelerators, was founded in Boulder, Colorado, in 2007 by local entrepreneurs and investors for the purpose of starting a start-up cluster in Boulder where none previously existed. Similarly, DreamIt was launched by Steve Welch in Philadelphia in 2008 simply because Welch at the time resided in Philadelphia and "altruistically" (in his words as said to the author) wished to offer a service to local entrepreneurs; the Austin, Texas, branch of DreamIt was subsequently launched after Welch and Kerry Rupp, another DreamIt director, both relocated to Austin for other reasons.

4. This matching procedure excludes certain regions, such as Silicon Valley and the Boston/Cambridge region, which do not have a natural counterpart in the population of potential control MSAs. We believe that the exclusion of regions with disproportionately rich entrepreneurial ecosystems yields the proper counterfactual for the research question at hand. Consistent with this belief, each of the top-five regions for total yearly venture capital allocations received start-up accelerators relatively early in the diffusion of this organizational form (Cambridge, Massachusetts, and Silicon Valley were the first two locations). Thus, we focus on understanding the causal impact of accelerators in regions with less developed start-up infrastructure.

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