Accelerating Entrepreneurs and Ecosystems: The Seed Accelerator Model[*]

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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 startups offer educational and mentorship programs for startup founders, exposing them to wide variety of mentors, including former entrepreneurs, venture capitalists, angel investors, and corporate executives; and culminate in a public pitch event, or "demo day," during which the graduating cohort of startup 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 their effects on the regional entrepreneurial environment.

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"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 startup, or, "seed," accelerator. These fixed-term, cohort-based, "boot camps" for startups offer educational and mentorship programs for startup founders, exposing them to wide variety of mentors, including former entrepreneurs, venture capitalists, angel investors, and corporate executives; and culminate in a public pitch event, or "demo day," during which the graduating cohort of startup 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 3000, spanning six continents, and the number is growing rapidly (Cohen 2013; Cohen and Hochberg 2014).

Figure 1 below documents the total number of U.S.-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 location of programs by year of founding, the vast majority of these programs are located outside of traditional technology hubs.

Figure 1: Number of U.S.-Based Accelerator Programs Meeting the Formal Definition of Accelerator (per Seed Accelerator Rankings Project data) Over Time

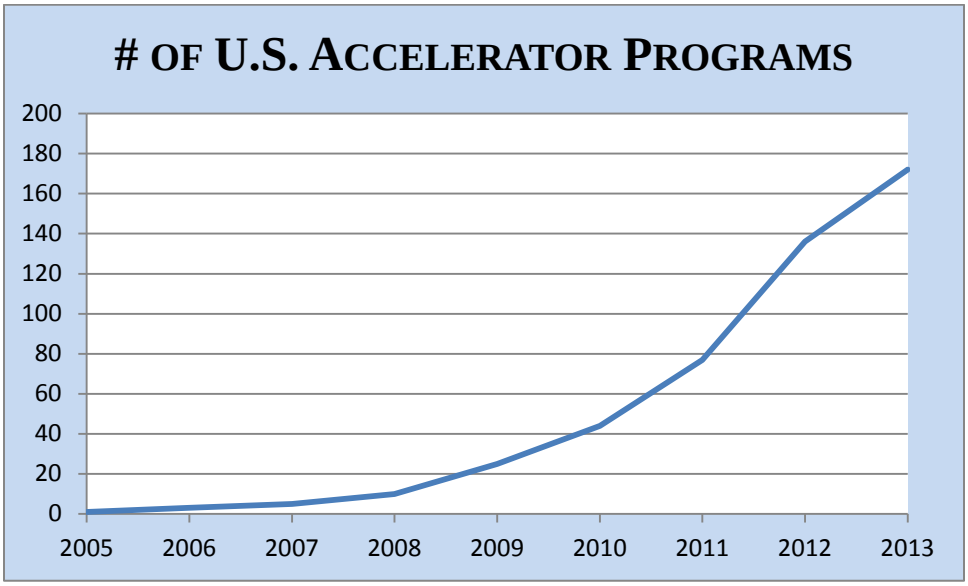
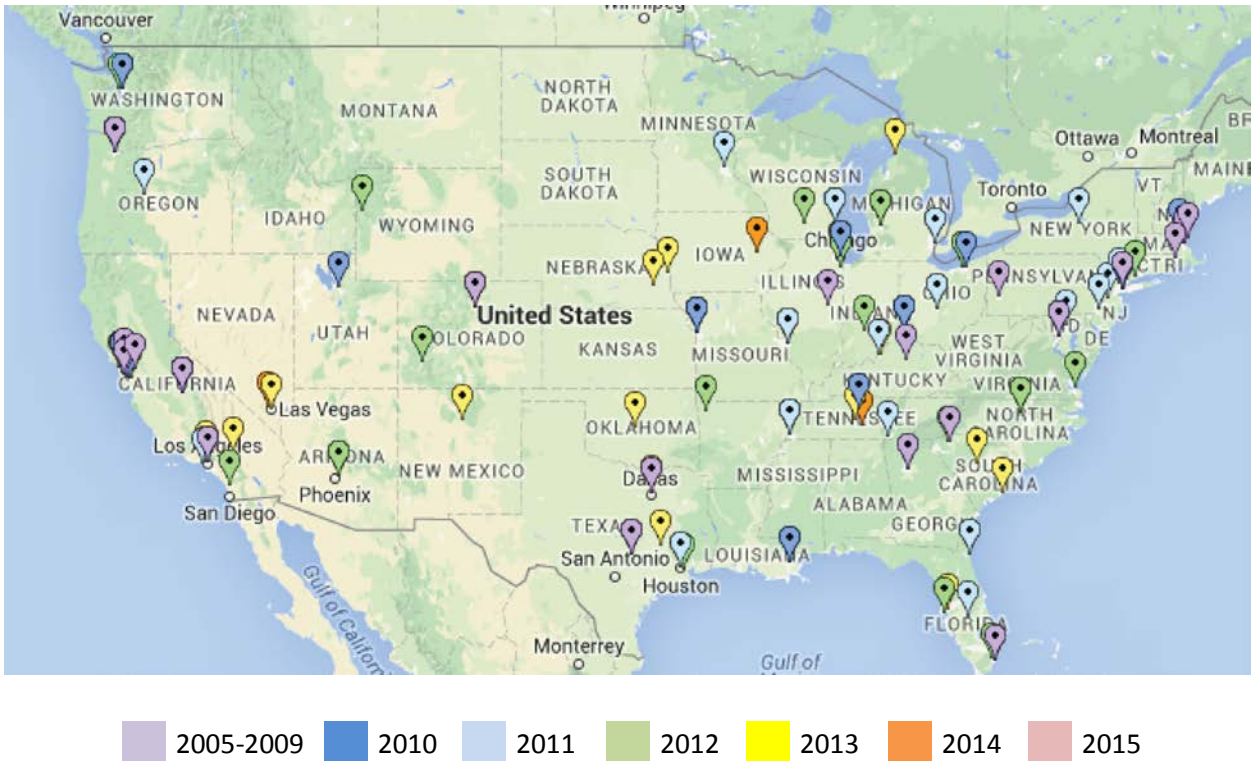


Figure 2: Locations of Accelerator Programs by Year Founded



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 startup 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 U.S. 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 venture capital 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 which shift venture capitalist's 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 venture capital, 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 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 policy makers, 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 a brief

overview of some initial research studies on accelerators, which primarily have focused on the effects such programs have on the startups 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 startup company outcomes (given the early stage nature of the startup 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 non-treated in a region, studies examining the effects on accelerated startups, or comparing accelerated to non-accelerated startups, will not capture the full effects of these programs for the ecosystem. This presents a crucial deficiency for policy-makers, 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, I therefore 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 present or precisely because of its lacking. This allows us to compare regions which 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 startups in accelerator-treated regions, a shift that results primarily from additional funding events for non-accelerated 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 startup 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 startups producing software and services, fueling a boom in seed-stage software and app startups, the last two years have seem an increasing number of programs designed specifically for startups in the hardware and device space, as well as the emergence of programs equipped with wet labs to handle startups 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 trends, 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.

II. An Overview of Seed Accelerators

The formal definition of a startup 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 thousand on average, with a range from $0 to $150 thousand) to their startups, and receive an equity stake in the portfolio company in return, typically 5-7%. Most offer co-working space and other services in addition to mentorship, educational and networking opportunities. Some also offer a larger, guaranteed investment in the startup, in the form of a convertible note, upon graduation. While many accelerators are generalist across industries, others are vertically-focused (healthcare, energy, digital media). Despite the vertical or industry focus, careful examination of the products/services provided by the portfolio companies of accelerators reveals that historically, nearly all accelerator portfolio startups offer some form of software or internet services, though such software may be targeted towards use in a specific industry vertical.[3]

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

[3] Notably, accelerators differ considerably from previously extant institutional structures in the entrepreneurial ecosystem, such as incubators. Incubators are primarily real estate ventures, offering startup co-working space at reduced rent. Incubators, unlike accelerators, lack a fixed term, and experience continuous entry and exit of startup groups, which stay resident for much longer periods of time (1-4 years on average versus 3-4 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 startups to quickly confront those realities and determine whether the business is viable (Cohen 2013; Cohen and Hochberg 2014).

requirements to seed a startup 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 thousand, and startups can often accomplish with a $50 thousand seed investment what used to take $500 thousand to $1 million. This has allowed accelerators to provide meaningful funding and assistance to their startup portfolio companies with a seed investment or stipend as low as $15 thousand.

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, co-working/co-location with other startup 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 a 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 which becomes available to participating startups 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 startup 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 startups 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 startups, 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 since they are already traveling to the region, non-local 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 super-angel 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 startup is 7-9 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 ($22K 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 startup'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 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 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 amongst 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 amongst 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 policy makers to assess the relative quality of programs. There is a general absence of large-scale representative datasets covering accelerator programs. Researchers, entrepreneurs and policy makers have little visibility into program features, the identity of the companies that enter and exit the programs, or the population of startups 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 who 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 startups 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.[4]

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 startups attending accelerator programs and on the features of the programs they attend offer a unique opportunity to address questions of interest to researchers and policy makers. 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, Cohen, Fehder and Yee 2014; Hochberg, Cohen and Fehder 2015) collects detailed data in order to produce an annual published ranking of accelerator programs throughout the U.S. on a variety of outcomes of interest to

[4] As reported by the Seed Accelerator Rankings project (Hochberg and Kamath 2012; Hochberg, Cohen, Fehder and Yee 2014; Hochberg, Cohen and Fehder 2015) and Cohen and Hochberg (2014).

entrepreneurs. The desire to be included in these rankings incentivizes the accelerators to provide the researchers (under strict non-disclosure 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 startup.

The data collected by SARP appears to be the most comprehensive dataset 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: (i) conceptual description of the accelerator model (e.g. Cohen and Hochberg (2014)) or qualitative assessment of how accelerators may serve to "accelerate" startups; or (ii) 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 U.S.-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 startup companies that complete accelerator programs to other populations of startups that did not attend accelerator programs. Hallen, Bingham and Cohen (2014) use two distinct samples to compare accelerated startups that eventually raise venture capital to non-accelerated ventures that eventually raise venture capital. Performance is measured by whether the startup 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 non-accelerator 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 startup 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 startups 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 startups. 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 30 producers of computer science doctoral graduates, which suggests that there is a particular "type" of background that characterizes startups that choose to attend (or are accepted to) premier accelerator programs.

V. Ecosystem Effects

The distinguishing characteristic of the studies discussed above 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 startup 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 non-treated 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 a larger 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 effect of the accelerator on the treated startups (Fehder and Hochberg (2015)). We focus on a particular aspect of the ecosystem: the availability and provision of seed and early

stage venture capital (VC) financing for startups. Our empirical design seeks to measure the impact of startup accelerator formation on the venture capital financing activity in a MSA region.

Accelerators, by design, likely lower the search costs for both entrepreneurs and investors seeking early stage investments. As such, startup 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 startup investment activity or have experienced swift growth in that activity. Thus, we are interested in separating the causal impact of startup accelerator formation from the endogenous selection of startup accelerators into "hot" regions for startup activities.

Assessing whether accelerators affect the level and availability of VC funding in their region is non-trivial, 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,[5] 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 Metropolitan Statistical Areas (MSAs) that are 'treated' with an accelerator program to other MSAs that are very similar in terms of pre-treatment trends in the

[5] For example, Techstars, one of the first accelerators, was founded in Boulder, CO in 2007 by local entrepreneurs and investors for the purpose of starting a startup 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, TX branch of DreamIt was subsequently launched after Welch and Kerry Rupp, another DreamIt director, both relocated to Austin for other reasons.

entrepreneurial ecosystem. We then employ a fixed effects difference-in-differences model, augmented by linear time trends to capture any pre-trends 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 region. 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.[6]

Using a panel data set of US Census MSA regions across ten 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 differences-in-differences model which 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 venture capital market with year fixed effects. Our primary variable of interested 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

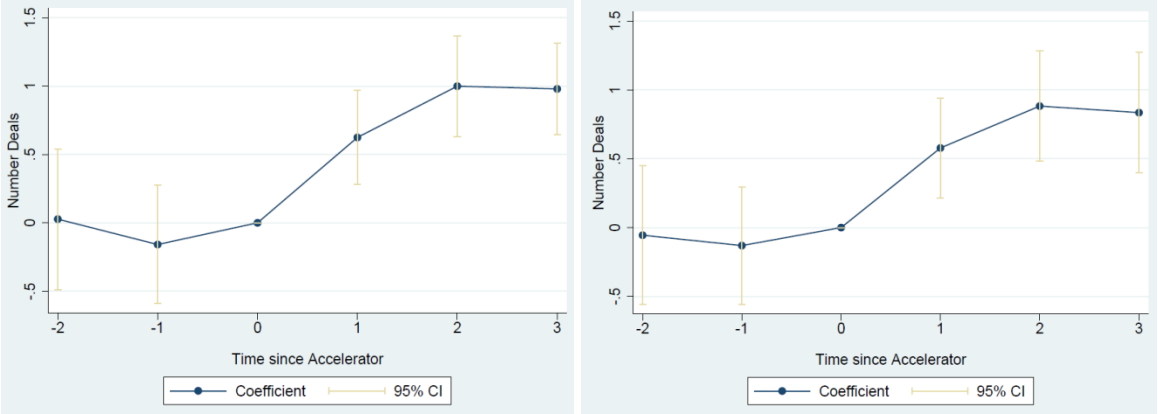
[6] This matching procedure excludes certain regions, like Silicon Valley and the Boston/Cambridge region, which do not have a natural counterpart in the population of potential control MSAs. We believe that the exclusion of regions with disproportionately rich entrepreneurial ecosystems yields the proper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

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. Post-treatment, 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 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.

Figure 3. Treatment Effect for Treated Region over Time—Number of Deals

(Hochberg and Fehder (2015), Figure 1.) 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.



Without MSA-specific linear time trend **With MSA-specific linear time trend**

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 non-accelerated 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 startups to untreated startups.

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 would both be extremely acceptable outcomes to *de novo* growth for the local officials and business people that help found accelerators.

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; Feldman 2003; Acs et al. 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 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 startups in their program (and more broadly) by increasing access to greater levels of venture capital, 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

VI.1. Vertical Specialization and Diversification of Startup 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 startup applicants. Recent years have seen a transition towards industry-specialization, primarily in industry verticals characterized by specialized knowledge or regulation, such as healthcare and energy. In practice, however, an examination of the accelerator portfolio companies suggests that both generalist and specialist programs shared a common tendency towards software and services startups, regardless of whether they generalized across the industries those startups were to serve or specialized in a specific industry, such as healthcare IT.

The last two years, however, has 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 startups 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 startup, however, it remains 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, much as accelerators have served as sorting and aggregation tools for investors and as aggregators of much-needed services and networks for software startups, 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.

VI.1. Corporate Accelerators

The 1990s and the advent of open innovation policies and the internet economy saw a proliferation of corporate venture capital arms. Corporations augmented business development departments with VC arms that had either strategic or financial goals. Many of these efforts were shut down in the early 2000s following the collapse of the internet bubble, and re-emerged over the course of the last decade. While corporate VC is a relatively well-understood phenomenon, 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.

VI.2. 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 startups, with programs in San Francisco, Mountain View and Mexico City; and Dreamit, with programs in Philadelphia, New York City, Austin and Baltimore (Dreamit Health).

VI.3. 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 startups 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 startups 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 startups during the accelerator program.

Other programs have chosen to move away from both the accelerator model and the accelerator label. RockHealth and YCombinator are the most prominent examples of this trend. As noted on YCombinator's website (https://www.ycombinator.com/about/), YCombinator now presents itself as a provider of "seed funding for startups. Seed funding is the earliest stage of venture funding. It pays your expenses while you're getting started." While YCombinator 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 startups in batches." They furthermore state expressly that they are not following the "boot camp for startups" 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 startups 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 Startup Funding."

VI.4. 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.

VI.5. 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.

VI.6. 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 UK, Europe, and Latin America. For example, Techstars has opened a program in London, while 500 Startups has opened a program in Mexico City.

VI. Summation

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 policy makers 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 to understand the impact of these programs on their regions, the unit of analysis considered by these policy makers (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 startup founders and investors, and as a result to regional economic activity more generally.

Accelerator programs specifically address outcomes with clear societal interest: startup activity, including venture capital funding and support for new ventures; STEM employment; and regional economic development. These outcomes are all considered critical to the increased economic competitiveness of the United States of over the long term. The emerging research surveyed in this article can therefore provide important insights for regional policy makers, who are increasingly looking to accelerators and other new entrepreneurial institutions such as incubators to stimulate startup 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.

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