Measuring High-Growth High-Technology Entrepreneurship Ecosystems

Edward J. Egan*

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Abstract

This paper advances measures of high-growth high-tech entrepreneurship activity, which are part of a venture pipeline framework. It defines these measures, as well as 15 related terms-of-the-art, and provides 35 real-world examples of how municipalities can use them to assess ecosystem support organizations, municipal venture capital fund-of-funds, and other startup policy initiatives. The measures are based on quantities and qualities of local venture capital investment, its recipients, and the institutions that enable it. They support a range of policy analyses. For example, a coincident change in a municipality's rank among U.S. startup cities can provide a cursory assessment of a policy's efficacy, while a pipeline analysis can explore various dimensions of startup policy quality. A pipeline analysis uses raise rates that measure the propensities of local institutions to transform pre-venture firms into venture-backed firms. Raise rates can be predicted using observable proxy measures when an institution's client information is unobservable or unreliable. Finally, this paper considers the implications of its framework on the incentives and capabilities of policy cartels that typically control municipal startup policy.

Keywords: Entrepreneurship, Ecosystem, Measurement, High-Growth High-Technology, Venture Capital, Ecosystem Support Organization, Accelerator, Incubator, Hub, Policy Cartel

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1 Introduction

Venture capital (VC) investment is no longer just a Silicon Valley or Route 128 phenomenon. There are now promising high-growth high-technology ('high tech') entrepreneurship ecosystems across America's Rust Belt, Heartland, and in the Deep South, as well as maturing, if not established, ecosystems in most major U.S. cities. Two hundred and five U.S. cities have had more than $10 million of venture capital in a single year since 1985, and America will likely see around $1 trillion of venture investment in the next decade.[1] If startups in this new wave prosper, they will bring economic diversification, social change, and community development to their home towns, and have a profound collective effect on the nation's economy.

The extraordinary positive externalities of nascent high-growth high-tech (HGHT) firms provide a normative economic justification for their public subsidization. Nevertheless, startup policy may create non-profit institutions that crowd-out private organizations. Cumming and MacIntosh (2006), Brander et al. (2010), and others provide evidence of crowding-out in government interventions in venture capital markets. Large or frequent policy interventions in entrepreneurship markets could also result in an inefficient over-supply of new ventures or venture financing. And the admonition that spontaneous order can create "a more efficient allocation of societal resources than any design could achieve" (Hayek 1978) may apply: A city's HGHT entrepreneurship activity is highly interconnected and subject to feedback loops, making policy interventions inherently unpredictable and prone to perverse outcomes.

Most direct startup policy focuses on pre-venture firms (i.e., those that have yet to receive venture capital) and occurs at the municipal level. So America's future technological economy is in the hands of its current city governments. However, the academic literature has struggled to provide grounded and actionable policy advice to municipalities concerning high-growth high-tech entrepreneurship ecosystems. Feldman (2001) points out that entrepreneurs build entrepreneurship ecosystems, while "many of the conditions that the literature indicates should be in place to promote entrepreneurship appear to lag rather than lead development". Accordingly, most municipal interventions in startup markets have been ad hoc, and it is an open empirical question as to whether they have improved or destroyed welfare.

In this paper, I advance measures of high-growth high-tech entrepreneurship activity, which are part of a 'venture pipeline' framework, to address this issue. Specifically, I artic-

[1] This 10-year cumulative venture capital estimate uses linear extrapolation from the previous decade's trend. It was made before the COVID-19 pandemic.

ulate 15 definitions of terms-of-the-art and seven new measures, and I illustrate their use by applying them to 35 real-world examples. The examples are drawn from initiatives in Houston, St. Louis, Cincinnati, and other U.S. cities over the last 20 years. The framework is intentionally simple so that non-expert policymakers and practitioners can apply it to develop data-driven, evidence-based high-growth high-tech entrepreneurship policy. For instance, if a municipality secures a branch office of an accelerator with a 25% 'raise rate' to support a cohort of 12 nascent firms, the venture pipeline framework suggests that the city will see an additional three venture capital deals around two years after that cohort graduates.

I begin by providing definitions of venture capital and related concepts, including high-growth high-tech entrepreneurship expertise. These definitions highlight three key concepts.

First, high-growth high-tech entrepreneurship expertise is a scarce resource. Municipalities usually delegate entrepreneurship policy to non-profit and non-government organizations, which in turn commission reports from consulting firms.[2] Practical expertise in HGHT entrepreneurship is obtained by founding and leading successful startup firms, and making or receiving venture capital investments, so it is very seldom found in these organizations. Likewise, the few economists that specialize in designing policy on this topic face excess demand in academia and command large salaries in industry.[3] (Universities often participate in HGHT entrepreneurship policy, but administrators and staff, not expert faculty, usually lead their efforts.)

Second, not all investments from venture capitalists, or all investment labeled as venture capital, involves startup firms. Only 'growth' VC investments pertain to new enterprises and provide relevant and comparable measures of activity in HGHT entrepreneurship ecosystems. Growth VC investments are made as a part of a milestone-based growth process. They occur as a part of a series of investments at the seed, early, and later stages. Transactional VC, on the other hand, supports a specific transaction, like a restructuring or an acquisition, and is invested in mature firms from a wide variety of industries.[4] Rankings of U.S. startup cities

[2]The standard policymaking process may be inappropriate for developing startup policy. The policy cycle (i.e., the sequence of steps for developing policy, see Anderson 2014) resembles the waterfall development model (see Royce 1987), which assumes that needs are well understood. Entrepreneurship instead requires methodologies where the needs, and solution alignment, must be learned (see Ries 2011, Blank and Dorf 2012, and others) through direct experience.

[3]There are almost 90,000 local governments, including 20,000 municipalities, in the U.S. The Bureau of Labor Statistics reports that these local governments employ just over 1,000 economists. Perhaps 1% of economists specialize in entrepreneurship economics. (In May of 2020, the IDEAS database listed works for 58,437 economists, 814 of which have an article categorized as entrepreneurship). Only a small subset of entrepreneurship economists specialize in HGHT entrepreneurship.

[4]Venture capitalists also make Private Investments In Public Entities (PIPEs) as a third distinct type of investment, though these are easy to exclude in most venture capital data sources.

based on three growth VC measures provide a prima facie review of startup policy efficacy.

Third, not all venture capital is equal. Kaplan and Schoar (2005) documents a strong persistence to returns in venture capital, which measure VC quality. I advance proxy measures of VC quality because returns are private information. One measure is the MOOMI (Money-Out-Over-Money-In) ratio. It provides reliable performance information for funds with sufficient investment histories and can be calculated using publicly available data.

Another measure of VC quality concerns the distinction between 'market vs. non-market money'. Funds that get their capital from markets of professional limited partners (LPs) are disciplined by competition, while non-market funds that get their capital from non-expert LPs are not. For various reasons, non-expert LPs do not price venture investment correctly. Accordingly, market-based funds are usually of much higher quality than their non-market counterparts. Policymakers are usually unaware of this distinction or the prevalence of non-market venture capital. Examples of non-market funds (and so non-expert LPs) include Government-Sponsored Venture Capital (GSVC) funds, Corporate Venture Capital (CVC) funds, and evergreen funds based on endowments, though most micro-VCs and many traditional VCs also rely on non-market money.

I then describe the venture pipeline framework. Although a startup 'pipeline' and related terms-of-the-art appear in industry vernacular, their formalization and integration into a consistent framework are essential contributions to the literature. In the venture pipeline framework, activities and institutions transform pre-venture firms into venture-backed firms at 'raise rates'. Raise rates can be from local VCs, top-tier VCs, or market-based VCs, and for women-led, veteran-led, or minority-led ventures, and so forth. As such, these measures can explore many different dimensions of startup policy performance. A raise rate can also be compared to a policy's cost to perform a basic benefit-cost-analysis.

Ecosystem support organizations (ESOs), like accelerators, incubators, and hubs, provide specialized services to startup firms, and so they are crucial components of a city's pipeline of new ventures. Unfortunately, some ecosystem support organizations withhold or obfuscate their client lists, which makes their raise rates hard to calculate. In such cases, computations of policy effects can sometimes use the number of startups within an institution's surrounding area. However, I also provide various proxy measures for the quality of an ESO's pipeline and show that they can quickly provide near-sufficient information. Example proxy ESO quality measures include an entity's relationship with market or non-market money, its use of best-practice financial instruments and methods, the expertise of its leadership and mentors, its type of development strategy, and the size and quality (i.e., the fraction of expert members) of its governing board.

Beyond ecosystem support organizations, research institutions and other entities often

conduct activities that may generate startups. For these activities, I use conversion rates to describe the efficacy of sequences of activities, such as the progression from grants to patents to ventures. These conversion rates can also provide a tool to examine the alignment between an institution and its surrounding entrepreneurship ecosystem.

Finally, I turn to how, why, and by whom the venture pipeline framework might be used. In practice, groups of non-profit and non-government organizations control municipal policymaking. I describe these groups as 'policy cartels', and argue that they are motivated by 'policy rents', which include favorable media coverage, access to donors, economic rents, and control over state resources. Through the lens of this positive theory, municipal policymakers have incentives to report non-standard measures and engage in non-market actions to foreclose rivals. However, there are both larger policy rents and superior economic outcomes available from improved policy, and so the venture pipeline framework inherently encourages policymakers to focus on the determinants of demonstrable success. It also provides practitioners, academics, and members of the press with a systematic measurement method to assess a city's pipeline components objectively.

2 Venture Capital

Definition 1 (Venture Capitalists)**.** Venture capitalists (VCs) use equity-based instruments to make investments in (predominantly) high-growth, high-tech, privately-held firms using capital raised from outside investors.

Venture capital investment provides a rich set of relevant, objectively observable metrics for high-growth high-tech entrepreneurship activity. VC investment is also a near-perfect complement with a startup growth process that results in an inital public offering (IPO) or an acquisition.[5] In recent years, venture capitalists have participated in around 90% of all IPOs and more than 95% of all disclosed value acquisitions of private companies. I, therefore, use venture-capital-based metrics to measure HGHT entrepreneurship.

Guzman and Stern (2019) identifies high-growth high-tech firms that do not secure venture capital. Non-venture-backed startups are challenging to quantify en masse, making Guzman and Stern (2019)'s approach potentially very important. At present, policymakers can use this approach to create counts and densities of non-venture-backed firms in their cities. Further research will need to identify measurable determinants or improvement processes for these firms before they can be used to make policy decisions.

Venture capitalists specialize in mitigating information asymmetry problems inherent in

[5]A third type of 'exit event', a secondary sale, can, by definition, only happen if there was a primary venture investor.

startup firms (see Amit et al. 1998), and only a small number of firms have the extraordinary growth potential to attract VC. Puri and Zarutskie (2011) find that just 0.11% of companies created from 1981-2005 secured venture investment, though they emphasize that these firms went on to account for around 6% of U.S. employment. Likewise, Gompers et al. (2019) estimates that only about 1.5% of new enterprises that approach a VC eventually secure their financing.

Stuart and Sorenson (2003) find that IPOs and acquisitions lead to the creation of new ventures in metropolitan statistical areas. Likewise, Feldman et al. (2005), Gompers et al. (2005), Stangler (2013), and Klepper (2010) find that entrepreneurial firms are spawned from incumbents, particularly formerly venture-backed firms. Startups thus beget startups, and measures of current venture activity predict future levels.

2.1 Standardized Measures

Measures should be comparable, verifiable, and, when assembled from different sources, demonstrate congruence. Hence, I advocate using standardized measures, which are replicable using widely available data sources, and that exist within a common framework. The common framework should be empirically and theoretically grounded, while also sufficiently simple that it can provide clear, actionable insights to policymakers and practitioners.

To these ends, I advance measures based on startup counts and venture capital investment, as well as a venture pipeline view of an ecosystem as an overarching framework. Lamentably, at present, most organizations operating in the HGHT support sector report numbers that are subject to the $2 billion fallacy.

Definition 2 ($2 billion fallacy)**.** The $2 billion fallacy is when an organization reports numbers for jobs, investment, economic impact, or other measures, which cannot be verified or recreated using publicly-accessible client company information, or which otherwise have no foundation in a standardized assessment methodology.[6]

Most typically, high-growth high-tech support organizations report numbers like jobs created or development dollars invested. Such numbers are indirect consequences of HGHT entrepreneurship and not normative economic objectives in themselves. They also usually rely on private models with unknown assumptions. Another common set of reported numbers allow mixing of direct and indirect outcomes, as well as double counting and other obscurifications. Examples include 'money raised' and 'organizations helped'. Lastly, organizations sometimes report absurd numbers using valid metrics.

[6]The amount does not need to be $2 billion, and some examples are not dollar amounts, but $2 billion is mentioned with sufficient regularity to make it immediately suspect.

Example 1 ($2 billion fallacy)**.** Examples include: "Cortex will likely generate $2 billion of development and create 13,000 jobs," Wagner (2016). "The [HTC] reports having helped companies create more than 6,000 jobs and raise more than $3.5 billion in capital," Leinfelder (2018). And "Houston Exponential's goals are to ... create 10,000 technology jobs ... and lure $2 billion in venture capital investment to Houston-based startups in 2022 alone," Leinfelder (2018).[7]

Legitimate startup support measures are those that report client counts on a per-program basis, as well as venture capital raised by their clients post-treatment. Venture capital can be expressed in terms of rounds, deals, or dollars, in total or by appropriate characteristics. Likewise, institutions should embed their metrics in a venture pipeline view of an ecosystem.

Example 2 (Legitimate measures)**.** Counter-examples to the $2 billion fallacy (i.e., legitimate measure uses) include: "The Techstars portfolio of 1,900 companies currently attracts an annual $2 billion in downstream investment from the venture capital industry," Techstars (2019). And "[At Cintrifuse] more than 700 startups have gone through our pipeline, with one-third of these having attracted seed and later-stage investment," Molski (2019)

Data on venture capital are available from a wide array of sources, including VentureXpert, Pitchbook, Crunchbase, Preqin, and CBInsights.[8] Aggregate data is also available from the National Venture Capital Association (NVCA) and PWC's Moneytree website. Although there are minor differences in coverage (for example, Crunchbase provides better data on informal venture investments), all sources give approximately the same results provided that their data is suitably processed. Comparisons between cities or over time using the same data source are also valid with minimal processing.[9]

2.2 Growth vs. Transactional VC

Not all venture capital goes to nascent high-growth high-tech firms, and so not all venture capital makes for an appropriate measure of startup activity. When measuring an HGHT entrepreneurship ecosystem, one should consider only growth venture capital.

[7]It is infeasible for Houston, which raised around $150m of growth venture capital in 2018, to grow its ecosystem by over 1200% in 4 years. One Houston ecosystem participant described this claim as "aspirational". Though, absurd claims imply incompetence to experts and can cause reputational damage.

[8]This paper uses data from VentureXpert, which is studied in Kaplan et al. (2002), unless otherwise stated.

[9]Some organizations complain that their performance would be higher if analysts used another data source. Actual discrepancies usually occur because of very low-value deals, deals using non-standard instruments, or deals involving non-market VCs (see definition 6) or investors that are not VCs. As such, complaints usually originate from low-quality organizations.

Definition 3 (Growth Venture Capital)**.** Growth venture capital entails investment at the seed, early or later stage in nascent, privately-held, high-growth, high-tech firms (i.e., 'startups') to support a milestone-based growth process, which should lead to an exit event for early-stage investors.

Beginning in the 1980s, venture capitalists leveraged their experience with startups to provide investments to mature firms from a wide variety of sectors. Such investment is called transactional VC. Most databases include transactional VC along with growth VC, and some end-user expertise is required to separate the two.

Definition 4 (Transactional Venture Capital)**.** Transactional venture capital investments support specific transactions, such as bridge loans to get to an IPO, acquisition finance, and funding for expansion or restructuring. Many recipients of transactional VC never receive growth VC and are mature (even publicly-traded) firms from non-high-tech sectors. Private equity firms, investment banks, and some hedge funds, as well as venture capitalists, make these kinds of investments.

If the proportion of transactional VC were the same everywhere every year, the distinction between growth and transaction VC would not matter. Unfortunately, the proportion of transactional VC to growth VC is much higher in cities that have large non-high-tech sectors, and has been trending down since the dot-com crash. Transactional venture capital usually goes to large firms, so it often involves large amounts.

Example 3 (Transactional VC)**.** Houston had \$72m of growth VC and \$1.25b of transactional VC in 2016. In the same year, Cincinnati saw \$54m of growth VC and \$95m of transactional VC. Almost all of Houston's transactional VC goes to mature oil and gas firms to support their M&A activities, while in Cincinnati, which is home to Proctor & Gamble, transactional VC mostly goes to established life sciences and consumer good firms.

2.3 Rankings

I use a composite of three standard growth venture capital measures to create a ranking that describes the level of startup activity in a city.

Measure 1 (Startup Ranking)**.** *The ranking of an entity, such as a city, is the rank of the sum of ranks of three measures:*

1. *Growth venture investment in dollars (i.e., the flow of dollars)*
2. *New deals (i.e., the flow of startups): only a startup's first growth VC investment counts as a new deal*

3. *Actively-funded startups (i.e., the stock of startups): a startup is actively-funded if it has received a round of growth venture capital within the last five years and has not exited.*[10]

The dynamics of venture funding make comparisons based on just one measure, or even two measures, potentially misleading. Because investment amounts generally increase with each round, older startups tend to receive more investment than younger ones. Using a rank-of-ranks over these three measures also generates a less volatile measure.

Example 4 (Dallas' ranking)**.** The flow of new startups in Dallas, Texas, almost ceased in 2011 and 2013, when the city saw just two and three new deals respectively. Yet, Dallas' ranking did not plummet: Follow-on investment into Dallas's existing stock of startups mostly covered the gap in the amount invested, and its startups were not achievings exits, so Dallas's startup stock remained mostly unchanged.

Some practitioners advocate measuring performance using mergers and acquisitions (M&As) and initial public offerings (IPOs). These exit events are the natural outcomes of a startup growth process. However, these measures are much more volatile than investment metrics, and have substantial lags. Only about 17% of venture-backed firms achieve an M&A (38% of which have disclosed values), and about 5% achieve an IPO. Furthermore, the average successful startup exits five years and eight months after its first venture investment.

Profits go hand-in-hand with social welfare in entrepreneurship and innovation: Private firms that make more money tend to create more social value. This principle applies to startups, venture capitalists, and ecosystem support organizations. Non-profit or government-sponsored organizations, though, need a way to measure their impact. As a consequence, policymakers and practitioners often turn to ecosystem rankings, which reflect a city's relative performance.

Example 5 (Policymakers use rankings)**.** Station Houston, an startup hub known locally as just 'Station', became a non-profit in 2018. Its new CEO said that she would be judging Station's progress using the Kauffman Index of Entrepreneurial Activity.[11]

There are just three reoccurring high-growth high-tech rankings of U.S. cities or metropolitan statistical areas (MSAs) available.[12,13] These are the Startup Genome reports, the City

[10]We can not observe the population of bankruptcies or the 'living dead'. This academic convention overstates the stock of VC backed startups, but does so systematically.

[11]The Kauffman Index was not available in 2018 and does not measure high-growth high-tech entrepreneurship activity.

[12]The Kauffman Index (see Fairlie 2013) is an equally-weighted index of four normalized measures of business ownership drawn from the U.S. Census.

[13]Crunchbase, Pitchbook, and other data providers put out reports on venture activity. These reports sometimes include cities or MSAs.

Lab/Martin Prosperity Institute reports (see Florida and King 2016), and my ranking (see below). Startup Genome rely on their own surveys and measures, while both the City Lab reports and my ranking use readily-available, near-population data on venture-capital-backed firms.[14]

This ranking of U.S. startup cities provides considerable insight into venture capital as an urban phenomenon. At the top, there are perhaps 10 cities that have investment amounts above a billion dollars a year, receive at least thirty new deals a year, and have a stock of 200 or more startups in their ecosystems.[15] Top 25 cities generally have at least a quarter of a billion in investment, double-digit deal flow, and stocks of 100 or more actively-funded startups. At rank number 50, investment has dropped below $100 million a year, with cities receiving perhaps five deals a year with a stock of about 35 actively-funded startups.

Variation, on almost every dimension, is material and increases as one progresses down the rankings. For example, over half of the top 25 cities are in California, but cities from 10 additional states appear in the rankings between 26^{th} and 50^{th} position. Rankings of cities near the top of the league table are comparatively stable, while there is a greater movement among the second 50 cities, and cities ranked beyond 100^{th} can often rise and fall more than 50 positions in a single year.

Rankings are a simplistic policy analysis tool. Nevertheless, high-growth high-tech entrepreneurship policies that result from municipal initiatives can have a sustained effect on a city's rankings.

Example 6 (Single policy ranking impact in Cincinnati)**.** The City of Cincinnati launched its 'Cintrifuse' initiative in 2011. Cintrifuse runs a fund-of-funds with investment from local corporates, a coworking space in the Over-the-Rhine neighborhood, and a wealth of programs, including through partnerships with local ecosystem support organizations. Cincinnati was ranked 239^{th} among startup cities in 2011, but rose to 66^{th} in 2014. New deal flow and a wave of new growth-oriented investment, rather than follow-on investment into previously backed ventures, drove its rise. Cincinnati broke into the top 50 startup cities, ranked 49^{th}, in 2019 (using estimated data).

Of course, not every policy initiative is large enough to change a city's rankings, and some policies are associated with ranking declines. And, a ranking change, or lack thereof, does not identify a causal effect.

Example 7 (Single policy impact in Houston, Texas)**.** In 1998, the City of Houston's

[14]Startup Genome's surveys are based on non-random samples and use self-reported data from non-experts.

[15]An earlier version of this ranking, which used self-reported cities, is available in Egan et al. (2017). The methodology used to create this ranking is identical, except that it uses geocoded addresses and place boundaries provided by the U.S. Census's TIGER platform. Details on the methodology, as well as rankings for other years, are available from www.edegan.com.

Table 1: Top 50 Startup Cities in 2018

Rank	Place	Growth VC Inv. $m	Growth VC Inv. Rank	No. Deals #	No. Deals Rank	No. Startups #	No. Startups Rank	Pop. (k)	Area (km^2)	1yr Up(+) /Down(-)
1	San Francisco, CA	22,529	1	207	1	1468	1	864	601	0
2	New York, NY	5,777	2	159	2	1218	2	8,560	1,213	0
3	Boston, MA	2,284	5	39	6	357	3	669	232	0
4	Cambridge, MA	4,141	3	41	5	232	8	111	18	+1
4	Los Angeles, CA	1,599	7	43	4	275	5	3,950	1,302	+1
6	Palo Alto, CA	897	14	45	3	287	4	67	67	-3
7	San Diego, CA	2,297	4	23	10	207	10	1,391	964	+2
8	Seattle, WA	943	13	32	7	239	7	688	369	-1
9	Chicago, IL	659	18	30	9	227	9	2,723	606	-1
10	Mountain View, CA	1,490	8	13	19	179	11	80	32	0
11	Austin, TX	454	26	31	8	259	6	917	828	+1
12	San Jose, CA	1,175	12	14	17	143	14	1,023	468	+1
13	Menlo Park, CA	2,074	6	11	22	117	18	34	45	-2
14	Santa Clara, CA	646	20	19	11	119	17	125	48	+3
15	Santa Monica, CA	777	17	14	17	117	18	92	22	+6
16	Redwood City, CA	1,206	11	10	26	135	16	84	90	-2
17	San Mateo, CA	653	19	11	22	137	15	104	41	-2
18	South San Francisco, CA	1,440	9	7	30	73	24	67	78	0
19	Denver, CO	509	24	13	19	90	22	678	401	+6
20	Philadelphia, PA	266	43	19	11	150	13	1,570	370	+6
21	Oakland, CA	316	34	16	14	68	28	417	202	+10
22	Sunnyvale, CA	287	40	11	22	106	20	152	59	-4
23	Portland, OR	422	27	6	33	72	25	630	376	+5
24	Boulder, CO	269	42	11	22	84	23	106	67	-2
25	Atlanta, GA	159	55	16	14	105	21	465	348	-9
26	Waltham, MA	347	31	7	30	59	31	63	36	+1
27	Houston, TX	153	56	15	16	71	26	2,267	1,725	+2
28	Fremont, CA	800	16	4	43	34	43	231	227	+8
29	Durham, NC	298	39	7	30	53	34	257	287	+14
30	Columbus, OH	236	44	8	29	56	33	852	581	+29
31	Berkeley, CA	173	51	12	21	46	39	120	46	+8
31	Irvine, CA	184	50	5	35	71	26	257	171	-8
33	Baltimore, MD	207	49	5	35	58	32	620	238	+28
34	Campbell, CA	389	28	4	43	32	46	41	15	+12
35	Burlingame, CA	313	36	4	43	39	41	30	16	+5
36	Washington, DC	145	59	6	33	66	30	672	177	-12
37	Bellevue, WA	135	62	9	27	52	35	139	87	-6
38	Minneapolis, MN	361	30	3	53	31	48	411	149	-4
39	Pittsburgh, PA	57	111	17	13	179	11	305	151	-19
40	Culver City, CA	339	32	4	43	26	62	39	13	+17
41	Salt Lake City, UT	173	52	4	43	33	44	194	289	-4
42	Hayward, CA	221	47	4	43	29	53	157	165	-2
43	Los Altos, CA	141	60	4	43	37	42	31	17	-5
44	Reston, VA	105	75	5	35	47	38	60	41	0
45	Ann Arbor, MI	100	78	5	35	48	36	119	75	-16
46	Nashville-Davidson, TN	86	87	5	35	67	29	654	1,289	+20
47	Dallas, TX	73	98	9	27	48	36	1,300	997	+23
48	Newton, MA	165	53	3	53	25	63	88	47	+83
49	Indianapolis city, IN	92	85	4	43	32	46	853	953	+31
50	Tysons Corner, VA	82	91	5	35	29	53	20	11	+21

Table 2: Startup Cities Ranked 51-100 in 2018

Rank	Place	Growth VC Inv. $m	Growth VC Inv. Rank	No. Deals #	No. Deals Rank	No. Startups #	No. Startups Rank	Pop. (k)	Area (km^2)	1yr Up(+) /Down(-)
51	Raleigh, NC	130	64	2	67	24	65	449	379	+118
52	Charlotte, NC	74	97	3	53	30	49	826	796	-17
53	Somerville, MA	83	89	4	43	22	71	80	11	+7
54	Albuquerque, NM	82	90	3	53	24	65	557	492	-3
55	Lexington, MA	372	29	1	126	27	58	33	43	+3
56	Milpitas, CA	810	15	1	126	18	82	75	35	-8
57	Sandy Springs, GA	223	46	2	67	12	111	104	100	+154
58	San Carlos, CA	275	41	1	126	27	58	30	14	-4
59	Newport Beach, CA	80	92	4	43	14	96	87	137	+42
59	St. Louis, MO	42	138	3	53	40	40	315	171	-10
61	Gaithersburg, MD	299	38	2	67	10	133	67	27	+295
62	West Hollywood, CA	315	35	3	53	8	153	36	5	+156
63	Miami, FL	36	151	5	35	27	58	443	145	+28
64	Carlsbad, CA	113	70	1	126	30	49	113	101	-9
65	Lehi, UT	86	86	2	67	14	96	58	72	+51
66	Princeton Junction, NJ	97	81	2	67	13	102	2	5	+40
67	Wilmington, DE	55	112	2	67	21	72	71	44	+6
68	Madison, WI	43	136	2	67	30	49	249	244	+119
69	Pasadena, CA	53	118	2	67	23	68	141	60	-16
70	Santa Barbara, CA	59	110	2	67	20	77	91	109	-14
71	Cupertino, CA	54	116	2	67	21	72	61	29	+6
72	Boca Raton, FL	119	69	2	67	11	120	94	81	+100
73	San Ramon, CA	98	80	2	67	12	111	75	48	+30
74	El Segundo, CA	61	108	2	67	17	85	17	14	-10
75	Arlington, VA	35	152	2	67	29	53	230	68	+7
76	Scottsdale, AZ	33	157	2	67	30	49	239	478	-7
77	Cary, NC	1,290	10	2	67	6	197	160	149	+155
77	Pleasanton, CA	93	83	1	126	24	65	79	63	-37
79	Phoenix, AZ	35	153	3	53	21	72	1,574	1,344	-5
80	Santa Cruz, CA	113	71	2	67	9	142	64	41	+309
81	Walnut, CA	38	146	5	35	13	102	30	23	+13
82	Fulton, MD	162	54	2	67	7	171	4	10	+91
82	King of Prussia, PA	28	172	2	67	29	53	20	22	+86
84	Malvern, PA	152	57	1	126	12	111	3	3	+86
85	Bloomington, MN	84	88	2	67	9	142	85	100	+144
85	Detroit, MI	72	99	1	126	21	72	680	370	+10
87	San Bruno, CA	109	72	1	126	13	102	43	14	+2
88	Farmington, CT	41	140	2	67	14	96	25	75	+29
89	Los Gatos, CA	31	160	2	67	19	78	31	29	-17
89	Provo, UT	30	162	3	53	16	90	116	114	-21
91	Carmel, IN	52	119	2	67	11	120	89	126	+6
92	Solana Beach, CA	109	73	2	67	7	171	13	9	+132
93	Milwaukee, WI	44	133	2	67	11	120	599	251	+6
94	Kansas City, MO	43	135	2	67	11	120	477	826	+25
95	Rockville, MD	29	169	2	67	16	90	66	35	+220
96	Cincinnati, OH	37	148	1	126	28	57	299	205	-5
96	San Leandro, CA	51	122	2	67	9	142	90	40	+13
98	Franklin, TN	39	145	2	67	11	120	73	108	+73
99	Brisbane, CA	105	74	1	126	10	133	5	52	+74
100	Alameda, CA	77	94	1	126	11	120	78	60	-24

Planning & Development Department, in partnership with individuals from the IC2 Institute at the University of Texas, created a non-profit incubator called the Houston Technology Center (HTC).[16] The HTC's inaugural promotional material stated that "entrepreneurial ventures often fail or relocate outside of Houston," and it sought to reverse those trends. Houston had been ranked 5$^{\text{th}}$ among startup cities in 1990 and had dropped to 16$^{\text{th}}$ by 2000. However, in the following 16 years, during most of which HTC had a near-monopoly on high-growth high-tech entrepreneurship support in the city, Houston's rank declined precipitously. Houston was ranked 48$^{\text{th}}$ in 2016 when a competitor to the HTC entered its market.

Policies are often multifaceted, and sometimes multiple different policy initiatives occur at the same time. In these cases, ranking changes provide a quick overall evaluation, and a venture pipeline analysis of the individual component initiatives can attribute the aggregate effect.

Example 8 (Multi-policy ranking impact in St. Louis)**.** In 2011, St. Louis opened its T-Rex entrepreneurship hub in a disused downtown building. Then, in the following year, St. Louis broke ground on its Cortex Innovation Community (CIC) innovation district, launched its $50,000 Arch Grants program, and endorsed the creation of the Prosper Women Entrepreneurs (PWE) accelerator. St. Louis rose from being ranked 224$^{\text{th}}$ for startups in the U.S. in 2010 to 51$^{\text{st}}$ in 2013. Its ranking has now stabilized into the second half of the top 100 U.S. startup cities.

2.4 VC Quality

The best measure of a VC's quality is its returns. Kaplan and Schoar (2005) document the strong persistence of returns in venture capital. They also show that top-quartile VCs massively outperform second-quartile VCs, and that bottom-quartile VCs probably lose money. Regrettably, venture capitalists' returns are generally not publicly available information. Researchers and practitioners often use proxy measures instead. This paper provides a first formal definition of three continuous proxy measures for returns: aggregate apportioned investment and exit values, and MOOMI ratios.

Measure 2 (Apportioned investment and exit value)**.** *Venture capitalists participate in syndicates to provide a round of investment to a startup firm. Most datasets on venture investments only disclose the aggregate round amount and the syndicate membership. To*

[16] Locally, the Greater Houston Partnership (GHP), Rice University, and the University of Houston led this effort. These three organizations, as well as a group of local industry leaders and philanthropists, retained control governance over the HTC.

address this issue, researchers apportion investments equally among syndicate members and use apportioned investment fractions to apportion exit values. Exit values are the total proceeds of an initial public offering or the transaction value, less any outstanding debt, of an acquisition.

Funds that have higher aggregate apportioned investment and exit value amounts are generally of higher quality.

Measure 3 (MOOMI ratio)**.** *The Money-Out-Over-Money-In (MOOMI) ratio of a startup is its value at exit divided by the total venture capital investment received. Aggregated apportioned MOOMI ratios provide quality metrics for funds, ecosystem support organizations, and cities.*

Analyses of league tables for funds show that a fund's return, or more commonly its return rank, is highly correlated with its MOOMI, providing that one limits the sample to funds that have made more than 20 investments.[17].

Kaplan and Schoar (2005) find that fund size has an inverted-U relationship with fund performance. Older firms also tend to have larger funds, with higher sequence numbers, due to competitive selection.[18]

There is little evidence that a fund's focus affects its returns. Venture funds can be specialists, which target specific industries, or generalists. They can also have preferences over a startup's stage of development, its geographic locations, new deals versus follow-on deals, and whether they will lead a syndicate. There is strong evidence, though, of local effects in venture capital. Cumming and Dai (2010), and others, examine the informal 20-minute rule, and Gompers et al. (2020) finds that a venture capitalist partner spends an average of 18 hours per week working with their portfolio companies. Egan (2020b) finds that median U.S. startup city is home to just two startup locales, each covering around 12 blocks, separated by around 30 blocks.

Anecdotally, a city needs at least one 'anchor fund' to build an ecosystem.

Definition 5 (Anchor Fund)**.** A local, generalist, mid-sized, first or second quartile, private venture capitalist that will lead on new early-stage deals is referred to as an "anchor fund".

[17]Some small funds report only their successful deals, and so have extraordinary and non-representative MOOMI ratios. Some limited partners produce publicly available return rank tables.

[18]Funds run by older venture capital firms tend to favor later-stage deals. This age effect might arise as a consequence of capacity constraints on partner time and/or because partners' risk preferences change with their tenure.

2.5 Market and Non-market Money

Goldfarb et al. (2009) point out that other forms of capital do not substitute for venture capital, particularly at large amounts. Part of the reason that venture capital is irreplaceable is that it is a partnership between the startup and its investors, with both sides bringing value. However, not all venture capital is equal. A large body of research documents the differing value-added roles and abilities of VCs. Examples include Sahlman (1990), Lerner (1995), Hellmann and Puri (2002), and Bottazzi et al. (2008). Hsu (2004) documents how entrepreneurs pay a premium to receive investment from higher quality venture capitalists. In short, the best VCs have the most valuable impact on their startups and make the most money each year.

Participating in a competitive market for capital disciplines venture capitalists, ensuring that they select high-quality ventures and then provide superior value-added services to improve them. During market-based fundraising, expert limited partners (LPs) evaluate a fund's investment strategy, team, and prior performance; and fund managers who do not live up to their potential may be unable to raise subsequent capital. None of this is true for non-market funds. A fund's source of capital is then a leading indicator of its future behavior and performance.

Definition 6 (Market and non-market money)**.** Venture capitalists manage other people's money.

1. Expert limited partners, who operate in competitive markets, provide market-based money. Market money is efficiently, or near-efficiently, priced in terms of a required rate of return.
2. Non-market money is raised in a non-competitive process from non-expert capital providers. These capital providers demand inefficiently low rates of return for their capital.

Previous work has explored specific categories of non-market funds. For example, Cumming and MacIntosh (2006), Brander et al. (2010), and others document the poor performance of government-sponsored venture capital (GSVC) funds and find that they may 'crowd-out' private venture capitalists. Likewise, Dushnitsky and Lenox (2005), and others, find corporate venture capitalists' (CVCs') primary objective is to build absorptive capacity for their parent company, as opposed to generating returns.[19]

Example 9 (Texas Emerging Technology Fund)**.** In 2005, Texas Governor Rick Perry announced the creation of a GSVC fund called the Texas Emerging Technology Fund

[19]CVCs have a semi-competitive market for talent, which disciplines them somewhat.

(TETF). The TETF was allocated $200m of state money, which was later expanded to $500m. It made investments in exchange for warrants and issued commercialization, pre-commercialization, and research grants through regional innovation centers, including the Gulf Coast Innovation Center (GCIC) at the HTC. A 2011 report to the State Legislature found the fund "lacked transparency and that the state had not properly tracked its performance." It is unclear how, and by whom, TETF investments were selected. Some TETF investment recipients were not nascent high-growth, high-tech firms. The TETF was also not benefit-cost positive (i.e., $\frac{benefit}{cost} > 1$) based on partial MOOMI calculations. Anecdotal evidence suggests that it crowded-out private venture capital investment.

Although most well-known, private venture capital (PVC) funds are market-based funds, most venture funds take advantage of non-market funds: Many traditional PVCs opt, presumably due to competitive pressure, to raise funds from non-expert LPs, particularly non-expert high net-worth individuals, family offices, and non-expert fund-of-funds. Aside from GSVC and CVCs, types of wholly non-market funds include micro-funds that are too small to attract investment from professional limited partners (LPs), evergreen funds financed by endowments, and venture funds financed by draw-downs from parent private equity and hedge funds. There are also venture funds supported by issues on stock exchanges.

2.6 Supply and Demand of Capital

Entrepreneurs frequently complain about a shortage of early-stage capital, which is not evidence that one exists.[20] U.S. venture capital investment levels, which are currently at all-time highs, reflect the intersection of supply and demand.[21] Investment levels do not provide information about an inefficient under- or over-supply, or a shortage or excess of demand. Policymakers should instead consider the characteristics of supply and demand to assess a potential shortage of early-stage capital.

Example 10 (Early-stage capital in Cincinnati)**.** Cincinnati may have had issues with early-stage capital provision before it created Cintrifuse. In 2010, Cincinnati had five small or mid-sized early-stage venture funds, three of which used non-market money, and four of which were in either the third or fourth performance quartiles using MOOMI ratios. The remaining fund specialized in life science deals, so Cincinnati did not have an anchor fund. Cincinnati had 26 actively-funded startups in 2010. Its ratio of local funds to startups was, therefore, below 1:5.

Example 11 (Early-stage capital in Houston)**.** VentureXpert records 21 Houston head-

[20] The extramarginal deal should not receive investment!

[21] At the time of writing, the aggregate impact of COVID-19 on venture investment is unknown.

quartered venture capital funds active in 2017.[22] Contemporaneous interviews and online data collection found an additional 25 Houston headquartered funds that were self-reporting as venture capitalists. At the same time, Houston had 54 actively-funded startups. A ratio of funds to startups of 2:5, and certainly 4:5, does not, prima facie, reflect a capital shortage.

In 2017, Houston had three mid-sized private funds that led on early-stage growth investments, two of which were generalists. However, in the last 20 years, these funds invested in only eight Houston area startups. From 1995 to 2017, 7.5% of the recorded venture capital invested in Houston startups came from Houston-based venture capitalists.[23] These numbers imply that there was a shortage of quality deal flow in Houston, an implication confirmed in interviews with local VCs.

Houston also did not have a resident first-quartile fund using MOOMI ratios.[24] Each of Houston's three mid-sized private funds raised market money, though one raised from European rather than American LPs, and Mercury Fund has taken some non-market investment (including from a municipal fund-of-funds). Houston also had headquarters or offices of eight of the largest energy-focused corporate venture funds in the world and a large number of non-market small funds and micro-funds. Because the vast majority of Houston's funds rely exclusively on non-market money, Houston might benefit from 'upskilling' its local fund managers.

Cities sometimes need to transition capital from non-market to market-based funds, or from micro to small to mid-size funds. This process is called upskilling.

Definition 7 (Upskilling)**.** Upskilling helps fund managers to develop the selection and value-added skills necessary to compete in the market for expert limited partner money.

A city can upskill its venture community by attracting non-local, private, market-based, top-quartile venture capitalists who could syndicate with local partners.[25] Organizing events for VCs, as well as creating a local venture capital association to share best practices, may provide mechanisms for upskilling. Although, events and associations can be captured by non-market institutions and become harmful to ecosystems too. Cities should examine the quality and characteristics of their venture communities before and after an initiative to assess the efficacy of their upskilling mechanisms.

[22] Woefully incomplete data on capital-under-management shows that these firms managed at least $4.2 billion.

[23] Some funds do not disclose their identity or home city; excluding them, this number is 4.6%.

[24] Mercury Fund is a second quartile fund on this measure.

[25] New York appears to have upskilled its local funds in the late 1990s and early 2000s. Internationally, Israel's Yozma initiative in 1993 is oft touted as a superlative example of importing VCs and upskilling a local venture community.

A municipal fund-of-funds can also contribute to upskilling if it brings in suitable syndicate partners. Beyond upskilling, there are two normative economic rationales for a municipal fund-of-funds: increasing the supply of early-stage capital, if it is underprovided, and stimulating engagement between local incumbents and local startups.

Definition 8 (Municipal Fund-of-Funds)**.** "A municipal fund-of-funds raises capital from local incumbents and invests it in venture capital funds that offer to consider deals in the region." (see Egan 2020b). A municipal fund-of-funds should not affect its venture capitalists' return profiles (i.e., it should not *require* local investment). It can incentivize local ecosystem participation by asking VCs to open branch offices, visit the region regularly, or otherwise establish and maintain local relationships. The inducement of new engagement between local incumbents, which commit capital to the fund, and local startups is likely the primary driver of a municipal fund-of-funds' effect.

Municipal funds-of-funds are problematic because they often have insufficient capital to gain access to top-quartile private market-based venture capitalists, particularly from the Bay Area and Boston/Cambridge where there is the greatest concentration of value-added expertise (see Chen et al. 2010). They also impose a second level of fees, which further dilute returns.[26] And, corporate investors need to receive, in expectation, their weighted-average cost of capital as a net return, which may not be possible given a fund-of-fund's characteristics.[27]

There are three ways to measure a municipal fund-of-funds: i) by its conformity to normative design principles; ii) through the characteristics of its investments; and iii) indirectly through its comparative effect on the local supply of venture capital (though this method suffers from attribution issues).

Example 12 (Cincinnati's fund-of-funds)**.** In 2012, Cincinnati's Centrifuse fund-of-funds raised $50m from local incumbents, around half of which were new to engagement with startups. The fund-of-funds promised incumbents "access to a streamlined technology sourcing and curation process", as well as financial returns. It invested in 14 out-of-state venture funds, including two top-tier venture firms, a Techstars fund, and one Cincinnati-based venture capital fund. Over the following seven years, Cincinnati doubled the size of its venture community, adding eight more small and mid-sized early-stage venture funds, including two that took residence in the same building as Centrifuse. The city also saw investment from five prominent, national, private, market-based venture funds,

[26] Typical funds-of-funds have the same '2 & 20' fee structure as venture funds: They charge 2% of capital as an annual management fee and take a 20% share of the carried interest.

[27] Corporate officers may owe shareholders a fiduciary duty not to undertake actions that reduce stockholder value, and can be exposed to shareholder lawsuits if they do.

in addition to Mercury Fund and Greycroft, which received funds from Cintrifuse.

Example 13 (Houston's fund-of-funds)**.** In 2018, Houston Exponential announced that it had raised $25m for its 'HX Fund' municipal fund-of-funds, modeled on Centrifuse and Renaissance Venture Capital, and lead by a Mercury fund advisor. The HX Fund's lead investor, Insperity, had a long history of providing services to the HTC. The next most prominent investors were Chevron and Shell, both of which have local corporate venture funds. (Each of these investors has a representative on the board of the GHP; see example 30). In 2019, the HX Fund made its first investment into a fund in Austin, Houston's nearest major tech center and the city most responsible for Houston's 20-year startup drain. VentureXpert records only four new funds for Houston in 2019, two of which were raised by existing local venture firms. As a comparison, in 2017, Houston-based VCs raised six new funds, four of which were from new fund managers.

2.7 Expertise

Each new enterprise is idiosyncratic, but academics and practitioners alike put a strong emphasis on the importance of experiential learning in high-growth high-tech entrepreneurship. Gompers et al. (2006), Hsu (2007), and others, use 'serial' entrepreneurship as an observable certification of this learning. Because venture capital is as much a growth process as it is a type of investment, mentors without experience 'sitting at the table', whether raising venture capital or investing it, lack key expertise needed to advise the next generation properly.[28]

Definition 9 (Expert)**.** An expert in high-growth, high-tech entrepreneurship has raised market-based venture capital for a startup they (co-)founded, or a has managed a venture capital fund that raised market-based money. Some practitioners and academics require entrepreneurs to have achieved a $50m acquisition or an initial public offering to qualify as an expert.

A recent wave of new economists who research high-growth high-tech entrepreneurship are former HGHT entrepreneurs and/or venture capitalists. Though many academics specializing in HGHT entrepreneurship do not meet the practical definition of an expert. Certifying academic expertise in this area is problematic. It is not sufficient to have taught courses nor to have published papers about HGHT entrepreneurship, let alone entrepreneurship more broadly. Specialized expertise is also required to process data on startups and their

[28]Bengtsson and Hsu (2015), Hegde and Tumlinson (2014), and Cherry et al. (2018) find support for homophily in venture investing, in terms of ethnicity, culture, and gender, respectively. Because homophily matters, there are likely advantages to having women mentoring women, entrepreneurs of color mentoring entrepreneurs of color, and so forth.

investments appropriately, and build models and interpret findings on this topic. [29]

Many policymakers and policy pundits assume that individuals involved with a non-market fund or a non-profit ecosystem support organization, or working for an organization developing or enacting high-growth high-tech policy, are experts. This is generally incorrect. Only a tiny minority of such individuals might later meet the definition of an expert.

In the high-growth high-tech world, information problems are rife. However, experts can mitigate these information problems, and readily assess expertise, which leads to sorting and reputational issues.

Example 14 (Information from non-experts)**.** In 2018, the then Director of Strategy at Houston Exponential, a non-expert who was formerly at the GHP and now leads MassChallenge Houston, stated that Houston only had a single venture fund in 2017 (see McDowell 2019). Startup Genome, a survey firm, subsequently published a quote to this effect. There were at least 46 venture funds active in Houston in 2017, and three of them held board seats at Houston Exponential. The GHP had commissioned a report from Accenture on Houston's startup ecosystem the previous year that listed 10 Houston-based venture funds by name.[30]

3 Ecosystem Support Organizations

Once a startup receives venture capital, it is easy to track. However, pre-VC startups are generally only visible through their association with an ecosystem activity or entity. Accordingly, researchers strive to identify which activities and entities to observe, and then understand how the number, quality, and characteristics of the next period's startups can be estimated from them. A quintessential class of these entities is ecosystem support organizations (ESOs).

Definition 10 (Ecosystem Support Organization)**.** Ecosystem support organizations specialize in providing services to nascent high-growth, high-tech firms. ESOs include accelerators, incubators, hubs, coworking spaces, cofounders, business plan competitions, HGHT program providers, and startup event organizers. They can be for-profit or non-profit, as well as affiliated with a corporate parent or a university.

The first three types of ecosystem support organizations are defined as follows:

Definition 11 (Accelerator)**.** Cohen and Hochberg (2014) defines an accelerator as "A

[29] Peer-based certification can work internally. An organization like the Kauffman Foundation might be able to certify academics to policymakers and the press.

[30] The Accenture report also erroneously claimed that Houston had a 'Tier 1 Venture Investment Firm', citing an unspecified Houston Business Journal article.

fixed-term, cohort-based program, including mentorship and educational components, that culminates in a public pitch event or demo day." I refine this definition by excluding virtual accelerators and those that focus exclusively on social entrepreneurship.

Techstars Boulder, which opened in 2007, is a prototypical accelerator.[31] It accepts around 10 startups into each of its cohorts, which run for three months.

Definition 12 (Hub)**.** A hub is a large, membership-based coworking flex-space with specialized services and resources, like events and programming, for nascent high-growth high-tech firms, which engages in the active management of a startup community. Membership in a hub is by application, subject to capacity constraints, though most encourage startups to leave when they reach a certain size (e.g., 16 employees). Hubs often have internal venture funds and accelerator programs.

Prototypical hubs first formed in the late 2000s and include the Capital Factory in Austin, Texas, 1776 in Washingon, DC, and 1871 in Chicago. The Capital Factory, for example, has around 800 members working at about 500 startups in 100,000 square feet of space. It has an in-house accelerator and venture fund, and it provides offices to other ESOs.

Definition 13 (Incubator)**.** A high-growth, high-tech incubator is an organization that provides workspace, mentorship, and other specialized resources to support the growth of startup firms for variable durations. Incubators do not have fixed cohorts, though many have a cap on their maximum duration. Incubators curate their clients.

The Houston Technology Center was an incubator, though through its monopoly position it also partially managed its local startup community as if it were a small hub. In practice, many ESOs blur the lines between definitions.

The literature on ecosystem support organizations is far less developed than that on venture capital. However, some theoretical arguments made in the VC literature also apply to ESOs. In particular, subject to some caveats, ESO performance should be associated with profit-motives, and non-profit ESOs can crowd out their for-profit counterparts.[32,33]

Expert management disproportionately occurs within for-profit ecosystem support organizations and is strongly associated with superior performance. (Expert management can better locate, secure, and deploy value-added services.) A non-profit ESO might receive

[31] TechStars now runs almost 50 different accelerator programs.

[32] Ecosystem support organizations generally provide services to pre-venture startups, and many take equity in their client companies in exchange for their services, either instead of, or as well as, charging fees. Markets for ESO services are then only long-run efficient, and the tie between performance and profit-motives is weaker than for VCs.

[33] Crowding-out is akin to Gresham's law, where bad money drives out good. For crowding-out to occur, bad suppliers (i.e., ESOs, VCs, etc.) must charge lower prices than good suppliers, and there must be an information asymmetry that prevents buyers (i.e., entrepreneurs) from correctly discerning quality.

funding from grants or philanthropists, who may give credence to non-standard performance metrics. As such, a non-profit ESO might be able to continue operation long past the point where a for-profit incubator would be removed from the market by competitive forces.

Egan (2020a) provides three results that support crowding-out by non-profit ecosystem support organizations. First, it finds that a city can have too many accelerators or incubators. Several U.S. cities are either approaching or have passed the point were an additional ESO provides a negative marginal contribution to its city's ecosystem growth. Second, Egan (2020a) finds that cities with more non-profit accelerators have, on average, materially lower growth rates than cities with fewer of them. And third, it provides findings consistent with substitution effects between different types of ecosystem support organizations. This last result implies that crowding-out may transcend ESO types.

It is almost surely not the case that every ecosystem support organization, or any high-growth high-tech entrepreneurship policy, is welfare improving, as many policymakers claim.[34] Instead, it is an open empirical question whether a typical HGHT policy does more good than harm or vice versa. Until further research establishes answers, it is prudent to assume that a typical non-profit ESO, like a typical non-market VC, does induce crowding-out.[35]

3.1 Pipelines of Startups

The venture pipeline view of startup ecosystems simplifies a more nuanced economic model, where startups have a stochastic arrival process, and the environment influences distributional parameters. It computes the product of a set of factors, and so is analogous to the Drake equation.[36] The expected volume (V) of a city's next wave of venture-backed firms is equal to the size of the city's pipeline (P) multiplied by the fraction of local startup within that pipeline (L), multiplied by the pipeline's corresponding raise rate (R).[37]

Correctly estimating values for the factors is crucial. I advocate separating a city's venture pipeline into additive components, which can inform policy for each institution (i). Ecosystem support organizations are by far the most common pipeline institutions. Nevertheless, universities, corporate engagement programs, government and private research labs, and other organizations can and do participate in some cities' venture pipelines.

[34]These claims also miss the more fundamental point that every policy should be judged against its opportunity cost.

[35]In the meantime, a non-profit ESOs should be demonstrably atypical before they can be assumed worthwhile, and the burden of proof should lie with those seeking to reject the hypothesis that an ESO is typical.

[36]The Drake equation (see Burchell 2006) estimates the number of local actively-communicating extraterrestrial civilizations.

[37]While being a temporary host to non-local firms may provide indirect benefits to an ecosystem, it is the local startups that directly impact an ecosystem's venture pipeline.

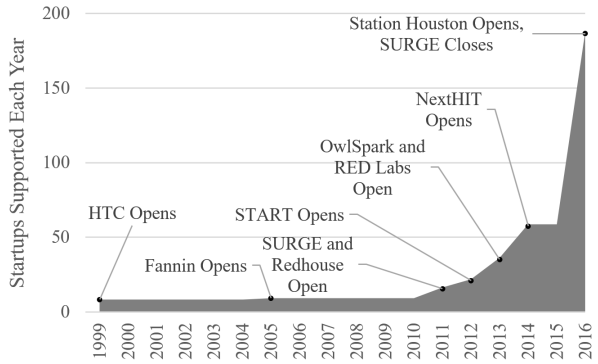
$$V_i = P_i \times L_i \times R_i \tag{1}$$

$$V = \sum_{i=1}^{N} V_i \tag{2}$$

Measure 4 (Pipeline)**.** *An entity's pipeline, P_i, is the number of nascent high-growth, high-tech firms that it processes each year. Typically, pipeline counts are restricted to startups that have not already raised venture capital and applied to entities that serve young firms that are at risk of raising venture capital.*

Example 15 describes the venture pipeline created by ecosystem support organizations in Houston, Texas.

Figure 1: Venture Pipeline in Houston, TX, 1998-2016



Example 15 (Houston pipeline)**.** From 1999 through to 2005, the Houston Technology Center (HTC) was Houston' only ecosystem support organization (see Figure 1). It supported around 8.3 startups per year, totaling 149 clients by the time it closed its doors in January 2018. In 2006, Fannin Innovation Studio added one startup per year to Houston's venture pipeline. 2011 saw the opening of the SURGE Accelerator (6.4 startups/year, specializing in energy), and Redhouse (a for-profit incubator/cofounder with just five clients to date). In 2012, Houston added START, which supported 5.4 startups per year, to its pipeline. START was either a small hub or a coworking space with specialized resources. It closed in 2018. In 2013, two university accelerators, OwlSpark at Rice and RED Labs at the University of Houston, opened. 2014 then saw the arrival of NextHIT (2.6 startups per year) and the Texas Medical Center (TMC) accelerator, TMCx, which provides programming to around 20 life science startups each year. Lastly, Station Houston, a hub, opened its doors in 2016. Within a single year, Station had 129 members working in its space.

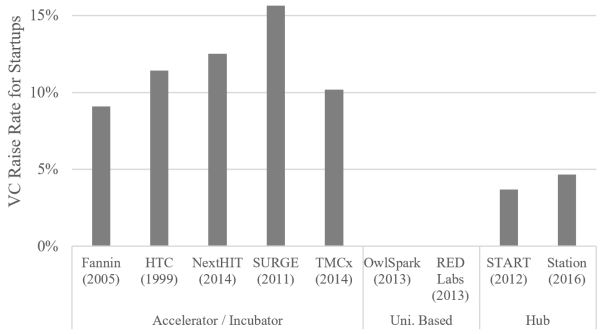
3.2 Raise Rates

The most straightforward and compelling measure of a venture pipeline's quality is its 'raise rate'.

Measure 5 (Raise Rate)**.** *A raise rate, R_i, is the fraction of startups that raise investment from venture capitalists after they begin participating in some program or activity. ESO raise rates generally exclude internal money (i.e., money invested from funds associated with the ESO).*[38] *Raise rates are typically calculated for only the first round of venture capital. However, they can be calculated using quartiles of VC performance, market vs. non-market money, for local or Bay Area/Boston VCs, for seed, Series A, or Series B rounds, et cetera.*

Techstars and Y Combinator have raise rates around 25% and provide well-known benchmarks for accelerators and incubators. Chicago's New Venture Challenge (NVC) provides a benchmark academic accelerator, with a raise rate just below 6%, as student startups are generally inferior to their commercial counterparts. Anecdotally, the raise rate for a hub is around 7% or 8%. Hubs support a much broader range of undertakings and are home to 'wannapreneurs' between projects. Gompers et al. (2019)'s estimate that around 1.5% of nascent firms that approach a VC eventually secure their financing. Assuming multiple approaches with non-independent draws, this would suggest that the background raise rate is around 5%.

Figure 2: Ecosystem Organization Raise Rates in Houston, TX, 2018



Example 16 (Houston raise rate)**.** Houston's raise rates are all well below industry benchmarks (see Figure 2). The best performing ESO in Houston was the SURGE accelerator, which focused on energy startups and closed its doors on April 8th, 2016 when the price of oil was $39.72 per barrel. SURGE was a for-profit firm. START,

[38] Some ESOs take equity in their client companies, and it can be challenging to distinguish participation fees from venture investment in data.

another for-profit, also closed its doors in 2017; and Station Houston, which started as a for-profit, became a non-profit in 2018. All of the other ESOs shown in figure 2 are non-profits.

3.3 Pipeline analysis

A pipeline analysis computes $V_i = P_i \times L_i \times R_i$ (i.e., equation 1) for a particular institution or policy, i. In some cases, such as relocation grants or long-term incubators, the fraction of startups that are local, L_i, is assumed to be one. The resulting volume of expected ventures, V_i, can be divided by the policy's cost to create an average cost per raise, which provides a simplistic benefit-cost metric.

Example 17 (Arch Grants pipeline analysis)**.** In 2017, St. Louis's Arch Grant program had over 100 recipients, but none of them had gone on to receive venture capital. There are now 156 Arch Grant recipients, implying that St. Louis may have given away $7.8 million without affecting its venture pipeline.

If a policy is intended to stimulate entrepreneurship within a particular focal group (i.e., veterans, women, minorities, et cetera), or within a specific geographical area or industry segment, this can be accounted for in the volume calculation.

Example 18 (PWE pipeline analysis)**.** The Prosper Women Entrepreneurs (PWE) accelerator was created in response to studies from the Kauffman Foundation and American Express OPEN, where St. Louis was ranked last for women's entrepreneurship. PWE won the SBA Growth Accelerator Competition in 2014, 2015, and 2016. Surprisingly then, a pipeline analysis of the PWE reveals that just 15% of PWE's 26 clients have gone on to secure venture capital. Of the two-thirds of PWE's clients with disclosed addresses, less than half are from Missouri and less than a third are from St. Louis. In fact, the PWE accelerator has contributed just two companies to St. Louis' community of venture-backed firms in the last seven years, one of which had an all-male management team (the other had both a male and female cofounder).

When client lists are unavailable, researchers may be able to use geographic proximity to estimate a policy's pipeline impact.

Example 19 (Local policy comparisons)**.** The St. Louis's Cortex Innovation Corridor (CIC) innovation district and the five-block radius around the T-Rex facility were home to six and seven startups, respectively, before their almost contemporaneous introductions. Subsequently, both areas have become home to an additional 23 startups. The CIC received $167 million of tax increment finance in 2012 and has received tens of millions more since. The T-Rex facility, on the other hand, has likely received less than $10

million of public support over its history. The T-Rex facility, therefore, appears an order of magnitude more efficient at generating venture-backed firms than the CIC.[39]

Pipelines have a delayed impact as it takes time for a startup to grow to the point where it could secure seed or early-stage venture investment: Startups are on average 17 months old when they receive their first seed round, and startups that skip the seed round are on average 31 months old when they receive their first early-stage round.[40] Likewise, the raise rate of an ESO is a function of its age. It takes times for an ESO to develop its services, and its raise rate will be volatile when its historic client count is low. (Note that an accelerator's raise rates will fluctuate as it takes in and graduates new cohorts.)

Example 20 (Pipeline impact)**.** It was events between 2014 and 2016, and not policy initiatives in 2017 or 2018, that led to the city's rise to 27$^{\text{th}}$ place in the rankings in 2018. Houston's venture pipeline increased by more than 150 startups per year, from 36 per year in 2013, to 188 in 2016. The three new ecosystem support organizations responsible for this increase had a weighted average raise rate of 5.5%, implying that they would create around eight new venture capital deals in subsequent years. There was a nine deal spike in Houston's deal flow, from six deals per year in 2016 to 15 deals per year in 2018. Two-thirds of this spike involved startups working with Station and the TMCx, two of the three new ESOs.

3.4 Additional ESO Measures

Repeat venture capital is a fundamental measure of an ESO's relationships with investors.

Measure 6 (Repeat VC)**.** *Repeat venture capital is the percentage of investments, by count or amount, from returning venture capitalists at a single institution. The repeat investment rate of top-quartile VCs is particularly instructive, as these VCs generate disproportionate value.*

Pipeline and raise rate calculations can be difficult and time-consuming. Fortunately, an ESO's expertise in its operations, leadership, and governance provide near-sufficient statistics of its quality.

Measure 7 (ESO Expertise)**.** *ESO expertise is measured as the fraction of experts (see definition 9) among its mentors, leadership, and board members. A quick rule-of-thumb is that any ESO with more than a dozen board members or a board composed of less than one-third experts is a non-profit with a low raise rate.*

[39] Brookings Institution scholar Bruce Katz frequently celebrates the CIC as a prototypical example of an 'anchor-plus' innovation district.

[40] By convention this round is called Series A.

Attracting mentors to an ESO is subject to adverse selection: expert mentors are in short supply and have many demands on their time, while non-expert mentors are in abundance and are eager to put themselves forward. However, expert leaders can assess mentor quality, which leads to sorting. Expert leaders also naturally pair with expert board members and tend to be governed by smaller boards, likely due to a combination of scarcity and better organizational focus.

Searching for opportunities is costly, so some experts will not do it when they observe widespread, inefficient behavior that might restrict or contaminate their deal flow. Hence, a public demonstration of incompetence can cause reputational damage that extends beyond an organization's boundaries and into the broader ecosystem.

Example 21 (Analysis of the HTC)**.** Data from the HTC's website shows it supported 149 clients in its 19 years of operation. Using this data, the HTC's performance was objectively poor: i) The HTC's external raise rate was around 11%. ii) During the HTC's operation, 21 Houston-based startups received investment from 10 different top-quartile venture capitalists, but none of these startups attended the HTC. iii) The HTC's external repeat venture capital rate was very low (around 4%), and came exclusively from non-market funds. And iv) Only one HTC client company went on to an initial public offering, and just four had disclosed-value acquisitions, two of which were for more than \$50m.[41] One client, which the HTC celebrated as a success, underwent a reverse takeover of an over-the-counter traded firm.

Observations of the HTC are consistent with inefficient behavior: i) The HTC rented half of one floor of its offices to a law firm that had nothing to do with startups. ii) None of the HTC's 18 energy mentors were experts. iii) The HTC's board of 57 people contained few, if any, experts. And iv) As documented in Egan (2020b), the HTC opened branch offices to "literally spread its city's startups to the points of the compass", undermining Houston's startup agglomeration economies.

The total operating cost of the HTC was likely around \$50m to \$75, and the HTC had a cost per raise of around \$4m.[42,43] The HTC: i) Started with a \$1.1m federal grant from the U.S. Economic Development Agency, as well as \$750,000 in tax increment finance. ii) Received more than \$1.7m from the Texas Emerging Technology Fund to run the Gulf Coast Innovation Center. iii) Raised around \$2m each year from philanthropy and related sources. And iv) Charged fees and later a mix of fees and warrants for its services.

[41]The HTC's sole IPO, Bellicum Pharmaceuticals, later attended JLabs@TMC (see example 24).

[42]Data from 990 filings and other sources.

[43]HTC client companies that did raise venture capital, raised a total of \$508m and an average of almost \$24m, though many of these firms may have secured comparable (or even better) investment without the HTC.

Other ready measures of ESO performance concern their operational use of best practices. ESOs that make unnecesary valuations, use inappropriate and/or suboptimal financial instruments, engage in financial engineering, describe their programs using non-standard terminology, or offer highly atypical programs, are disproportionately likely to be non-profits with benefit-cost ratios below one.

Example 22 (McNair Houston Ignition Fund)**.** In late 2014, the HTC created a side-car fund with the investment group of a local philanthropist. The fund set aside $1m each year and gave $25,000 to each client accepted to an HTC 'acceleration' program on an opt-in basis. Clients gave the HTC warrants on 2.5% of their companies in exchange for the money. Thus, the fund unnecessarily valued its startup firms at $1m post-money ($V_{post} = \frac{Inv}{F_{inv}} = \frac{25000}{0.025}$).[44] More importantly, the fund suffered from adverse selection as any firm worth less than $975,000 pre-money ($V_{pre} = V_{post} - Inv$) would opt-in, and any firm worth more would not, so every recipient was immediately over-valued deterring future investment. Finally, recipients were unsure whether they had received investment from a private company or a non-profit philanthropic organization, and some of the warrants where recorded in the HTC's name in Crunchbase, giving the impression of fraud.

3.5 Approaches

There are three purposeful development approaches that an ecosystem support organization can follow. These are: i) bottom-up, ii) by example, and iii) top-down. Which approach an organization follows, and the extent to which they match a normative process, provide readily observable measures of its quality.

The bottom-up approach involves learning through direct experimentation to develop three-way alignment between needs, solutions, and a business model. The lean startup methodology is a popular instantiation of a bottom-up approach. Because a bottom-up approach involves founding and operating a high-growth high-tech entrepreneurial firm, it is predominantly (and almost by definition) used by experts in for-profit businesses.

Example 23 (Embracing the lean startup)**.** In 2016, Station Houston, a then for-profit hub, changed Houston's startup landscape. Station's founding team and its chief advisors were serial entrepreneurs and venture capitalists with historical ties to Houston. They spoke with over 100 members of Houston's startup community in the three months before their launch announcement. The founders announced Station by calling a meeting of around 60 entrepreneurs, ESO leaders, venture investors, and academics. At this meeting, they asked for opinions on whether they should try to take over the HTC. The community

[44] They could have used convertible notes or SAFE instruments to avoid making a valuation.

unanimously rejected any engagement with the HTC, with some participants describing it as "cultural cancer". Station instead used the recently deceased for-profit SURGE accelerator's space as their first location. They continued their lean startup approach. During their transition to a 25,000 square foot space downtown, they identified parking as a critical issue, which led to a deal with the City of Houston to subsidize it for their members. Station was home to around 400 members and 180 nascent startups in mid-2018.

The second purposeful approach, of learning by example, requires a suitable precedent to follow. Every city is unique, and every ecosystem is different, so it is seldom productive to replicate external success. However, outside organizations open branch offices in a city either because it has a suitable pre-existing deal flow, or because it confers an innate advantage in some useful regard. Especially in the latter case, home-grown organizations may be able to learn from the example set by a newly arrived outsider.

Example 24 (Learning a competitive advantage)**.** The Texas Medical Center (TMC) is a non-profit firm that operates the largest medical complex in the world. The TMC's campus, which spans zip codes 77030 and 77054, covers 2.1 square miles and houses hundreds of medical offices for 49 member institutions. The TMC is primarily a medical treatment center, particularly for cancer, and performs around 1,200 clinical trials each year.[45]

In 2014, the TMC created its Innovation Institute, using revenues from its parking operations. This institute is now home to the TMCx (an accelerator program), TMCx+ (an incubator), JLabs@TMC (a branch of Johnson & Johnson's corporate accelerator program), and the AT&T Foundry (a corporate lab-share), as well as a host of other programs and initiatives. JLabs@TMC's raise rate is only 5% because its initial cohorts included six firms that had already received venture capital, as well as Bellicum Pharmaceuticals, which traded on the NASDAQ.[46] TMCx learned from JLabs and within three years had a raise rate of 10%. Interviews with recent participants suggest that the TMCx's quality has continued to improve.

The third approach, top-down, is data-driven and evidence-based. At present, this approach requires entrepreneurship economists who estimate models of policy interventions

[45]That the TMC is not primarily a research center is evident by comparison to the Longwood Medical Center in Boston. The TMC performs the most clinical trials of any medical center in the U.S. Longwood is in 2nd place with 25% fewer clinical trials. On the other hand, the TMC has received between 1,000 and 1,500 NIH grants (around five of which were SBIR/STTR grants) each year in recent years, averaging just 44% of Longwood's NIH grant count.

[46]Bellicum was previously at the HTC. JLabs@TMC has now removed Bellicum from their publicly accessible client list.

and/or design institutions as (on-going) experiments that have quantifiable effects.[47] One goal of this paper is to lower the barrier to well-founded, top-down planning of municipal high growth high-tech policy by articulating a simple, general framework for data and evidence in HGHT entrepreneurship.

3.6 Conversion rates

Startups do not operate in a vacuum; rather, they usually employ lean startup approaches that leverage partnerships with incumbents and institutions. In the spirit of Teece (1986), other organizations may have specialized or co-specialized resources that new enterprises need. Likewise, Gans and Stern (2003) points out that incumbents make the 'market for ideas' by offering to buy startup, as well as license technologies to or from them.

Some activities may create startups even though that is not their primary objective. For these activities, it is natural to think in terms of conversion rates, rather than raise rates. The main difficulty with conversion rates is identifying discrete categories of observable activities that matter. Commonly considered activities include joint-ventures, co-patenting, licensing, material transfer agreements, and certain contractual engagements. Though, creative startup policy might try to leverage newly-discovered types of partnerships with incumbents and institutions.

Example 25 (Corporate engagement)**.** Bechtel, a multinational Engineering, Procurement, and Construction (EPC) company, agreed to run a series of workshops at Station Houston in 2018. Each workshop brought together a team of Bechtel engineers and a group of resident startups to address a challenge. Bechtel gained new approaches to important problems in its industry. The startups got hands-on learning experiences, as well as the potential opportunity to try their solutions using Bechtel's infrastructure and on Bechtel's clients. Station changed its leadership and programming before this activity had a conversion rate.

There are often attribution issues with conversion rates, because patents, grants, contracts, and other outcomes can be associated with individuals rather than firms. Likewise, organizational boundaries can be fluid for young firms.

Example 26 (SBIR grant conversion ratio)**.** Fannin Innovation Studio, a biotech incubator and/or cofounder, opened in Houston in 2006. Three of Fannin's 11 clients have secured a total of 15 SBIR grants from the NIH, and one other client received venture investment. However, Fannin received five SBIR NIH grants in its own name, making its

[47]The Kauffman Foundation has provided grants to support the development of knowledge using this approach.

grant-to-VC conversion rate between zero and 25%.

Research institutions likely pay specialized roles in entrepreneurship ecosystems beyond just producing degree holders or housing researchers.[48] Within universities and other public or private research institutions, ventures are often the final outcome after many intermediate steps. Accordingly, it is constructive to chain together conversion rates, to measure the efficacy of steps in a process, such as moving from grants to patents to ventures. Conversion rates can then be applied to grants, especially Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants, as well as contracts, patenting, licensing, and other entrepreneurship-related activities.

Example 27 (Grants to patents to ventures)**.** In the 35 years from 1984 to 2018, the University of Vermont (UVM) received 7,791 National Institute of Health (NIH) grants. Over the same period, inventors at UVM made 117 patent applications and were cofounders of two venture-backed firms.[49] Around one-quarter of UVM's NIH grants (i.e., 2,054) were to Principal Investigators (PIs) listed as inventors on patent applications. These PI inventors account for about 60% (i.e., 71) of UVM's patent applications. Likewise, one startup cofounder was the PI on 22 NIH grants, while another was the PI on 17 NIH grants and the inventor on one patent application. Thus, UVM has conversion rates of 26.4% ($\frac{2,054}{7,791}$) from NIH grants to patent applications, 1.4% ($\frac{1}{71}$) from NIH-grant-PI-based patent applications to ventures, and 0.5% ($\frac{22+17}{7,791}$) from NIH grants to ventures, tracing PIs to startup executives.

Last but not least, the ebbs and flows of an institution's activities, in both absolute terms and conversion rates, can fill out a picture of its venture pipeline and its alignment with the market.

Example 28 (University alignment)**.** UVM accounts for around one-quarter of the population and perhaps half of the economy of Burlington, Vermont, but has been the fountainhead for just two of the city's 24 venture-backed firms.[50,51] One reason for this disparity is UVM's lack of alignment with its local ecosystem: UVM's two startups are Burlington's only life science ventures.

UVM's historical focus on NIH grants and life sciences is evident in its listing of technologies available for transfer. It offers 46 technologies from 100 innovators on its UVM

[48]The two epicenters of the American startup economy are land leased from Stanford University and the area abutting Harvard and MIT.

[49]Data from the NIH, Google Patents, and VentureXpert.

[50]UVM estimated its economic impact at $1.33b in 2014. GDP per capita for the Burlington metro area was $54,361 that year, with a population of 42,495.

[51]Burlington was ranked at 307$^{\text{th}}$ among U.S. startup cities for 2018. Its ranking has been in general decline since it peaked at 120$^{\text{th}}$ in 2014.

Innovations website. Forty-one of UVM Innovation's portfolio (i.e., 89%) are life sciences technologies, and 38 (83%) are associated with one or more NIH grants[52] Just three (i.e., 7%) of UVM Innovations' technologies state that they seek startup support, and during the tenure of its last president UVM's NIH grant rate declined to about 135 per year, 23% below its 35-year average.

On the other hand, UVM's recently created UVMVentures grant program uses competitive selection with development potential as a criterion. UVMVentures has provided financial support to between two and seven projects each year since 2016. Under half (46%) of the projects are in life sciences, and almost two-thirds (62%) of recipients use their funds to develop prototypes, perform benchmarking, or conduct other pre-commercialization activities. Moreover, UVMVentures winners are about half as likely to have received government grants as UVM Innovations innovators, and 40% of its government grant recipients received support from the National Science Foundation (NSF) rather than the NIH. At 45 grants in 2018 (with a grant to patent conversion rate of 17.59%), UVM's NSF grant rate is currently less than a third of its NIH grant rate. Still, it is on the rise, and NSF grants are better suited to producing firms that have synergies with other startups in Burlington's ecosystem.

4 Policy Cartels

> "The first of the classical problems that stall progress in a startup community is the patriarch problem. These patriarchs are the old white guys who run the show... you have to wait for a bunch of people to die [or] the leaders of the startup community should simply ignore the patriarchs."
>
> (Brad Feld in Startup Communities: Building an Entrepreneurial Ecosystem in Your City — 2012)

No study of high-growth, high-tech entrepreneurship measures would be complete without considering how, why, and by whom they might be used. Reform in the use of currently available measures is arguably more important than the development of new and more sophisticated measures.

Svaleryd and Vlachos (2009) points out that, even in first-world nations and absent corruption, there are legal rents available to politicians, and that these rents decrease when competition or information increases. I extend this observation to groups of organizations that extract rents from policymaking, which I name policy cartels.

[52] In total, the inventors of UVM Innovations technologies are listed as PIs on 866 NIH grants.

4.1 Policy Cartels & Rents

Definition 14 (Policy cartel)**.** A policy cartel is a group of non-profit and/or non-government organizations that band together to extract 'policy rents' from enacting or controlling policy on a topic.

Definition 15 (Policy rents)**.** Policy rents include favorable media, increased public profiles, and control over or access to financial and/or operational support, particularly from the government and philanthropy. When enacted policy influences markets, cartel members may also extract economic rents. Policy cartels often use state resources to maintain or enhance their positions.

Policy cartels and their non-profit organizations frequently make use of the $2 billion fallacy, as well as their relationships with local institutions and government, to generate rents.

Example 29 (Policy rents)**.** The Houston Technology Center (HTC) was created by a policy cartel that includes two local universities and the Greater Houston Partnership (GHP). During the time that the HTC had a near-monopoly on entrepreneurship support in Houston, it received nearly 400 complimentary media articles, directed the expenditure of more than $50m, and partnered with NASA.[53] A legion of officials and captains-of-industry, from mayors to presidential candidates, were associated with HTC events, or vice versa. Despite spear-heading the largest rank decline of any former top 20 U.S. city, the HTC was named by Forbes as one of "Ten Technology Incubators Changing the World". Its reign only came to an end after other ecosystem support organizations entered its market, and unaffiliated organizations provided objective data on its performance.

4.2 HGHT Entrepreneurship

High-growth high-tech entrepreneurship is a well-liked, value-creating, and zeitgeist topic with no natural incumbents in its policy space. It has transient constituents and is challenging to measure, with diffuse, long-term economic impacts that have unclear attribution. Expertise is also scarce and seldom found outside of for-profit ventures and their financiers. These features make HGHT entrepreneurship an attractive space for policy cartels to capture rents.

Municipal governments have incentives to endorse entrepreneurship policy cartels and delegate policymaking to them. They then share in the policy rents without having to

[53] HTC news items are available from historical versions of the HTC's website, stored on the Internet Archives.

undertake costly effort or incur accountability.[54] Moreover, cartel members typically have governing boards made up of small, highly-overlapping groups of local leaders and benefactors who have extraordinary influence with elected officials.

Example 30 (Cartel membership overlap)**.** The chairperson of the GHP's executive committee is the chairperson of Rice's board of trustees, and the president of Rice is on the GHP's executive committee. Many of the GHP's executive committee and Rice University's board of trustees also served on the HTC's board of directors – Both the CEO of the GHP and president of Rice had board seats. Following the dissolution of the City of Houston Task Force on Technology and Innovation, the GHP repurposed the HTC's 501(c)(3) into a policy organization named Houston Exponential (HX) in February 2018. The 20-member HX Governing Board is chaired by a director of the GHP, while the GHP chairperson, Rice's president, and the University of Houston's president all have seats.

There is little competition for rents between startup policy cartels within a city. Most cities have a single dominant policy cartel for high-growth high-tech entrepreneurship, and the remainder appear to have a fixed oligopolistic structure. Nascent ecosystems may provide opportunities to study cartel formation.

Example 31 (Cartel Market Structure)**.** In high-growth high-tech entrepreneurship, Houston and Cincinnati each have one dominant policy cartel with a fringe of smaller organizations. St. Louis has multiple policy cartels, though the cartel associated with the Cortex Innovation Community is the most influential. It is very similar in structure to the dominant Houston cartel (both feature leadership from large local universities, a local tax increment finance district, and a municipal NGO). Burlington, Vermont, does not yet have a policy cartel for HGHT entrepreneurship. However, the leader of a local non-profit has recently exhausted its government provided fund. This non-profit is now engaging with the administration at the University of Vermont to secure new support and an extended common mandate.

4.3 Non-market actions

Policy cartels have incentives to suppress competition to preserve their rents, and can use non-market actions to do so. An entrepreneurship community requires a critical mass of activity before it can self-organize. However, policy cartels are usually entrenched, in the name of ecosystem development, before this happens. Members of policy cartels often control

[54]There are also ego rents to both cartel leaders and local officials available from completing large transactions using public resources. A recent wave of tax increment finance districts, many of which have redirected hundreds of millions of dollar in tax revenue, provide examples.

Teecian (co-)specialized assets, including access to state resources, official certification, and even positive press. When new community leaders arise or arrive, policy cartels can often assimilate or remove them. The new leader's organization then either exits the market or is downskilled (i.e., converted to a non-profit or a non-market money organization, or otherwise reduced in scope and/or scale).

Example 32 (Cartel response to competition)**.** In 2018, Station Houston entered negotiations with Rice University to locate in a Rice owned property, subsequently named 'The Ion'.[55] Shortly after these negotiations began, rumors circulated that Station's CEO, a former serial entrepreneur, was viewed by Houston's establishment as disruptive.[56] Station's board then voted to replace its CEO with a former high-school principal and to become a non-profit. In 2019, Station's new CEO was appointed the executive director of the Ion, and, in the following year, she announced that Station's operations would be outsourced to the Capital Factory, a competitor from Austin.

Cartel managers are usually well-intentioned. However, policy cartels do not have incentives to design and enact efficient policy: expertise is scarce and costly, and their rents do not depend on their policy quality.

Example 33 (HX Expertise)**.** Just three of HX's 19 board members are high-growth, high-tech experts (a further two might qualify if one did not impose the market-money requirement). In its early days, HX was keen to be seen doing something, though it struggled to articulate actual courses of action.[57] Many of HX's initial 13 committees were disbanded after complaints from the community over their lack of relevance and inappropriate leadership.[58] HX has never employed a professional economist. It now produces reports based on proprietary surveys and data from Pitchbook that have an undisclosed processing methodology. HX's reports seem primarily intended to paint Houston's HGHT entrepreneurship ecosystem in a positive light, undermining their validity for policymak-

[55]Egan (2020b) finds that The Ion's innovation district will reduce Houston's agglomeration economies as it is "both in the wrong place and is much too big." It estimates the resulting economic damage to Houston at more than half a billion dollars.

[56]The choice of the word "disruptive" sheds light on the divide between the startup community where disruption is good, and the establishment (i.e., policy cartels) where disruption is bad.

[57]HX said that its "mission is to accelerate the development of Houston's innovation economy by fostering a robust ecosystem that supports high-growth, high-impact startups".

[58]Many of the committee chairs were representatives of major donors and partner organizations, and so appeared selected through patronage. Three notable exceptions were the former Station Houston CEO (who led the innovation district committee until his ouster), a local VC, and a local startup executive. The first HX website to provide working committees listed 12. However, "attracting talent" (along with "helping to build an innovation district" and "convening the ecosystem") was mentioned on the first HX homepage, so its omission as a committee was probably accidental. HX now has just three committees, two of which have vacant chairs. The chair of the investment committee has no experience with market-based venture capital.

ing.[59]

All of the municipal policies mentioned in this paper were initiated and controlled by policy cartels. To the best of my knowledge, none tried to estimate the effect of their intervention before they made it, and only the cartel behind Centrifuse made a pipeline impact assessment of its policy's effects after its implementation. Policy cartels, therefore, need to control information to avoid criticism.

Example 34 (Cartel information management)**.** As the City of Houston's Innovation and Technology Task Force prepared its final report (see City of Houston 2017), two sets of data on Houston's startup ecosystem were circulated: one commissioned from Accenture by the GHP, the other produced by academic experts. Egan and Carranza (2018) compares them and finds that the Accenture data conflated venture investment with private equity, and included transactional venture capital in with growth investment. The task force endorsed the Accenture data, which showed Houston in a much more positive light, before handing over responsibility for policy to Houston Exponential, which was overseen by the GHP. Houston Exponential then largely ignored the task force recommendations and decided Houston's startup policy behind closed doors.

5 Concluding Remarks

Effective startup policy is crucial for nations embracing an innovation economy as today's newly-founded high-growth high-tech firms are the drivers of tomorrow's economy.

Municipal policy cartels currently control the vast majority of American startup policy. These cartels are well-intentioned but lack high-growth high-tech expertise. They also have poorly-aligned incentives: they can choose how, when and what to report on their initiatives, and enjoy policy rents irrespective of their city's startup ecosystem's performance.

Accordingly, in this paper, I argue that there are two crucial antecedents to improvement in high-growth high-tech entrepreneurship policy: i) Standardized measures, to reduce the information asymmetry between policymakers and constituents, so that accountability and competition can drive productive change. And ii) a simple but grounded framework that can reduce the expertise required to develop and enact productive startup policy. With standardized measures and well-founded policymaking objectives, policy cartels should produce higher-quality policy and enjoy greater rents.

[59]HX reports 12-month trailing total venture capital investments of between around $200m and $400m for Houston between 2011 and 2019. These values are consistent with the inclusion of transactional VC investments made by venture capitalists. HX also claims that Houston is home to 32 ESOs (referred to as Startup Development Organizations – SDOs) but lists 35 'Accelerators, Incubators, & Mentors', 27 'Infrastructure Resource Providers', and 13 'Coworking Resources' for Houston on its website.

The venture pipeline framework described in this paper provides a foundation for better outcomes for startups, their cities, and the U.S. economy, and is extensible as new research yields new findings. Nevertheless, "a rising tiding lifts all boats", and on average venture investment increases fairly drastically within a city each year.[60] Because good news hides poor choices, suboptimal startup policy is likely to persist for many years to come, and the work needed to efficiently develop startup ecosystems in America's cities has barely begun.

Example 35 (Houston's future)**.** In 2019, five accelerators stated that they will open offices in downtown Houston.[61] These are: i) MassChallenge, a non-profit accelerator studied in Fehder (2016). ii) gBeta, an accelerator program run by gener8tor, an ESO from Wisconsin.[62] iii) a Smart Cities accelerator backed by Microsoft and Intel. And iv and v) branches of the Founder Institute and Plug-and-Play, two for-profit accelerators from Silicon Valley.

MassChallenge was brought to Texas by the Texas Foundation for Innovative Communities, an Austin based NGO, that is not associated with the dominant Houston policy cartel. However, a non-expert former director of Houston Exponential was appointed to run the Houston chapter. The terms of the MassChallenge deal likely include the provision of real estate and 50% of operating costs.[63] gBeta will receive space in the same building as MassChallenge and $250,000 per year for five years. Neither the extent of public support nor the leadership for the Smart Cities accelerator program has yet been disclosed, though it appears organized by a Rice University-led consortium. Likewise, no details of any tax incentives or other public support for the for-profit accelerators have been released.

In 2020, Station Houston and the Smart Cities accelerator will be moving to The Ion. Station likely peaked in terms of both pipeline and raise rate in 2018 under its former expert leadership. Its forthcoming change in location, and the outsourcing of its operational management, will likely further reduce Station Houston's efficacy, but it will be several years before these effects manifest. Even if the majority of attendees of Houston's new accelerators are non-local, Houston will still have a much greater pipeline of local startups, as well as a materially higher weighted-average raise rate, in say 2025, than it did in 2015. As a result, Houston's prognosis is overwhelmingly positive, despite its

[60] Considing only city-years with $10m or more of venture capital invested, the average annual increase in growth venture capital is around 35%.

[61] None of these accelerators focus on energy, while the Greater Houston Partnership reports that Houston, the "Energy Capital of the World", is home to 4,600 energy-related firms and at least 21 energy-focused R&D centers.

[62] Gener8tor co-founder Jon Eckhardt is an associate professor at the Wisconsin School of Business.

[63] Anecdotally, the operating cost provision is primarily to ensure policymaker buy-in.

abysmal policy history.

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