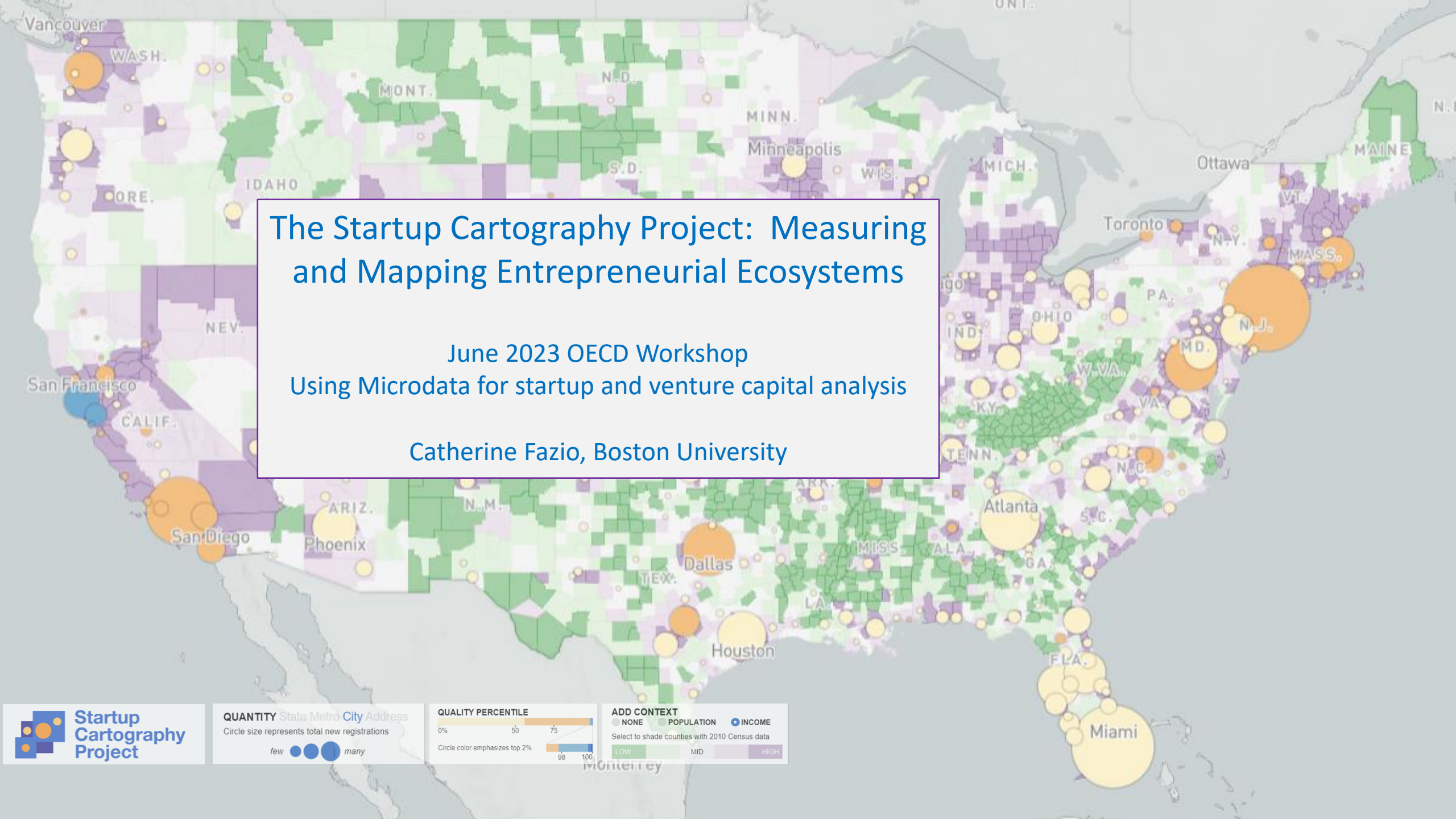
2023-06-29

The Startup Cartography Project: measuring and mapping entrepreneurial ecosystem



The Startup Cartography Project: Measuring and Mapping Entrepreneurial Ecosystems

June 2023 OECD Workshop
Using Microdata for startup and venture capital analysis

Catherine Fazio, Boston University

Catherine Fazio

- BU Questrom
  - Clinical Assistant Professor, Strategy & Innovation
  - Faculty Director, MBA Programs
- Startup Cartography Project Focus: Using core analytics to address policy-relevant questions
- Past Experience
  - Managing Director, MIT Lab for Innovation Science and Policy
  - Partner, Kirkland & Ellis LLP, Antitrust and Litigation
  - Trial Attorney, U.S. Department of Justice, Antitrust Division, Computers & Finance Division

Agenda

- Startup Cartography Project (SCP)
  - Motivation and measurement challenge
  - Brief overview of underlying research
  - Included measures and visualization
- Examples of how the SCP has been used to address policy relevant questions

Startup Cartography Project


RJ Andrews


Catherine Fazio


Jorge Guzman


Scott Stern


Yupeng Liu

Research Policy

Supports *open access*

Measuring and Mapping Entrepreneurial Ecosystems

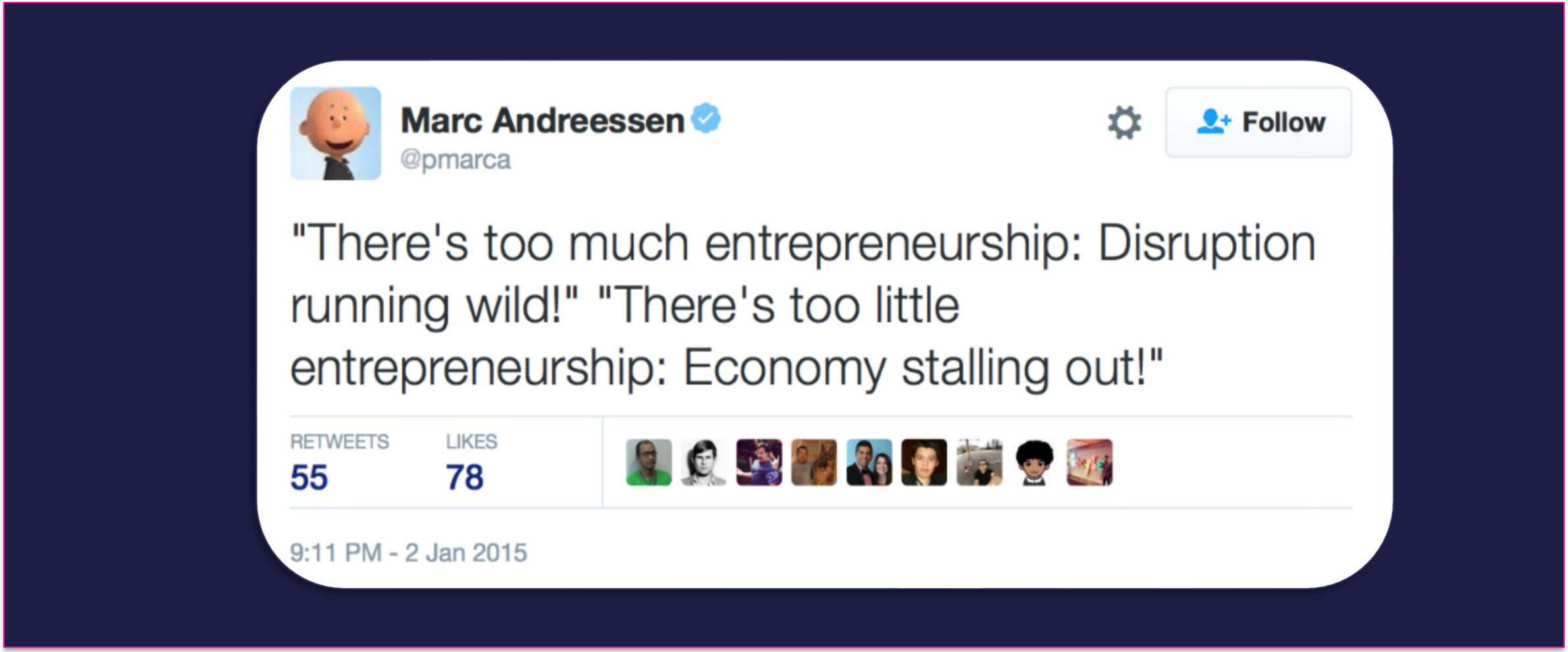
EWING MARION KAUFFMAN FOUNDATION

Can we develop meaningful and actionable (and real-time) metrics for IDE ecosystem assessments?

Measurement Challenge

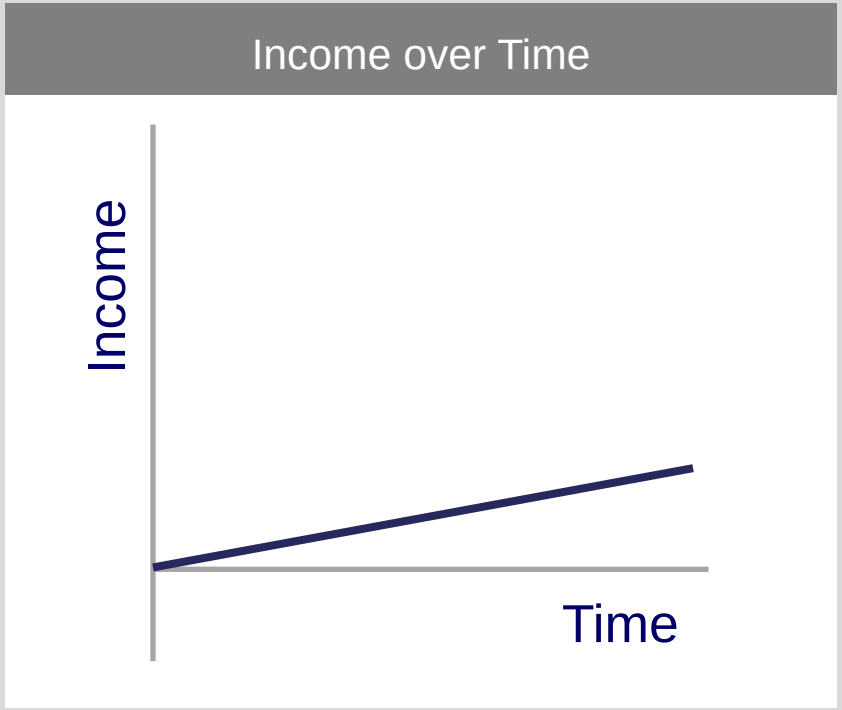
- Skewness of startup growth
- Lagged performance
- Multiple levels of geographic analysis

Traditional Measures Assess the Two Together and Can Lead to Mixed Signals

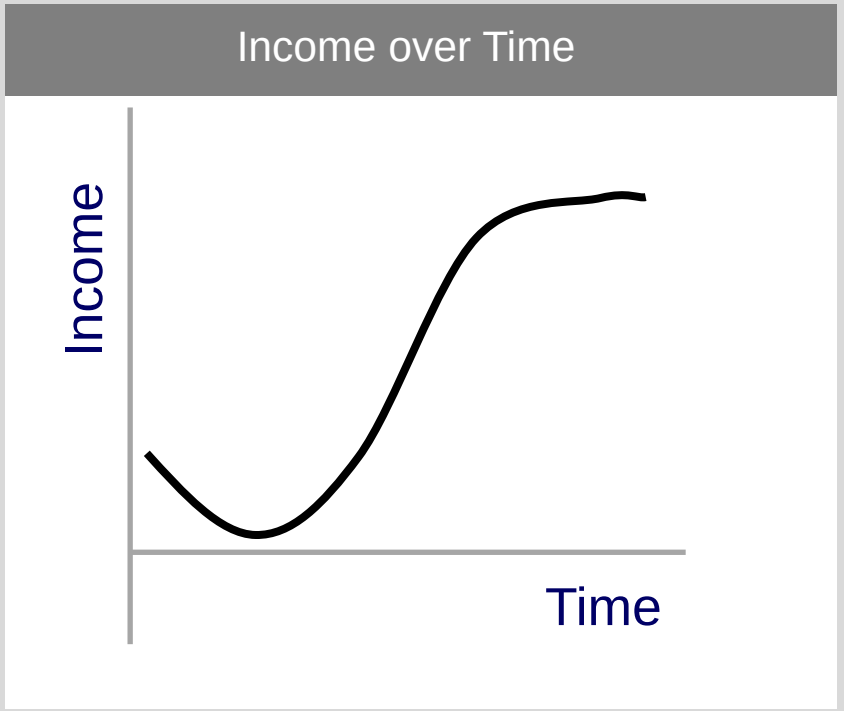


Sorting Startups by Growth Ambition

Main Street Startups



Innovation-Driven Startups



Business Registration

Corporations Division

Business Entity Summary

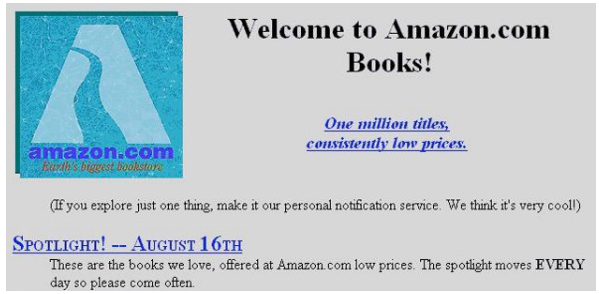
ID Number: 042226590 Request certificate

Summary for: DIGITAL EQUIPMENT CORPORATION

The exact name of the Domestic Profit Corporation: DIGITAL EQUIPMENT CORPORATION
Merged into COMPAQ COMPUTER CORPORATION **on** 12-31-1999
Merged with MAYNARD DEVELOPMENT CO., INC. **on** 06-27-1974 **Merged with** MAYNARD INDUSTRIES, INC. **on** 06-27-1974 **Merged with** APL SOFTWARE SYSTEMS, INC.(PA) **on** 06-27-1975 **Merged with** DEC REALTY TRUST(MA TR) **on** 08-13-1981 **Merged with** COMPAQ MERGER, INC. **on** 06-11-1998
Entity type: Domestic Profit Corporation
Identification Number: 042226590
Date of Organization in Massachusetts: 08-23-1957
Last date certain:
Current Fiscal Month/Day: 12/31 **Previous Fiscal Month/Day:** 06/30
The location of the Principal Office: Address: 40 OLD BOLTON RD. City or town, State, Zip code, Country: STOW, MA 01775 USA

- Practical requirement for ventures seeking meaningful growth.
- Public, comprehensive and comparable over time and location.

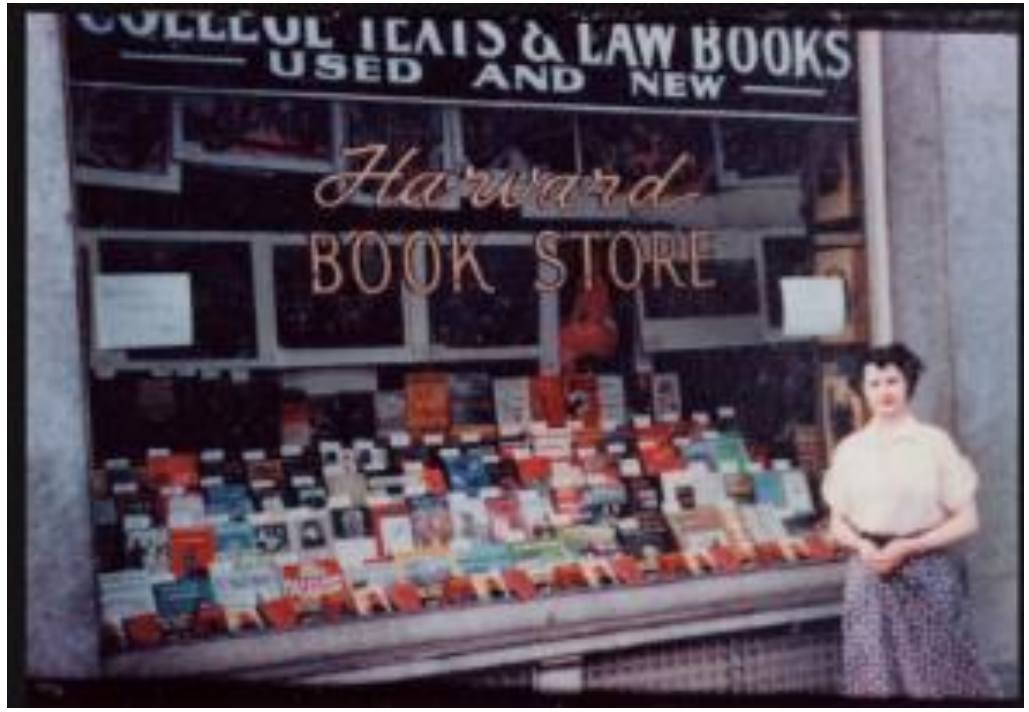
Startup Signatures

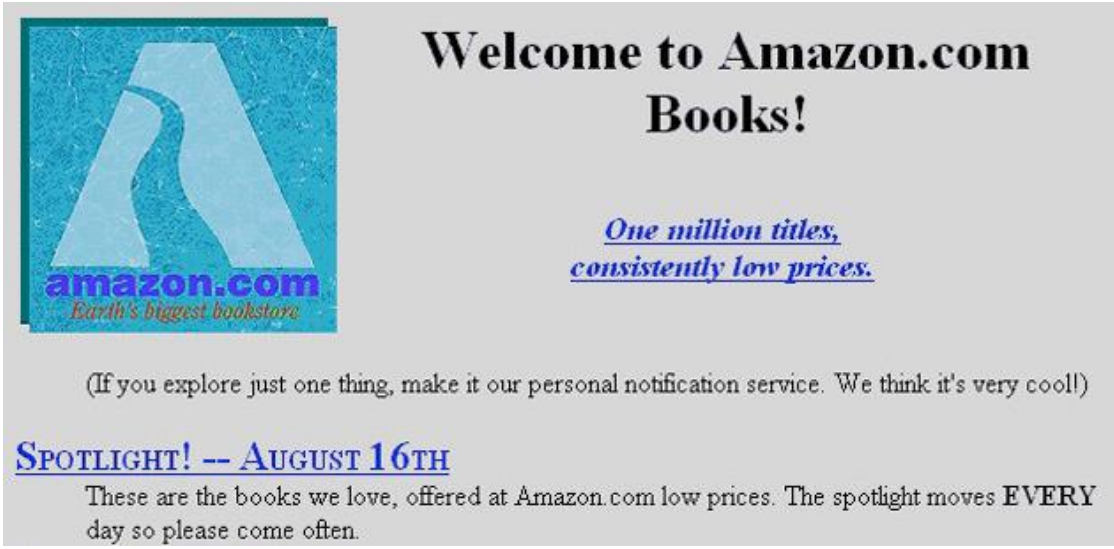


Mapping Signatures to Later Growth Outcomes

Measuring Entrepreneurial Quality: A Predictive Analytics Approach

(Guzman and Stern, 2017)





A Tale of Two Bookstores

Harvard Book Store vs. Amazon at time of founding

Data Coverage

Total observations: 39,460,805

1988 to 2014: All firms registered in 49 US states (excluding Delaware) and Washington D.C.

2014 to 2016: 46 states (excluding Delaware, Illinois, Michigan, South Carolina)
These states account for 99.6% of US GDP in 2014

(Andrews et al., 2022)

How do “digital signatures” of startups predict growth?

Change in the Probability of Growth Academic Model	
Has Short Name	120%
Firm Named after Founder	-70%
Corporation (Not Partnership or LLC)	190%
Trademark in First Year	273%
Patent and No Delaware Registration	2,300%
No Patent and Delaware Registration	1,600%
Both Patent and Delaware Reg.	9,300%
Sectoral Controls	Included
State Controls	Included

(NB: Prediction NOT causal)

(Andrews et al., 2022)

Table 2
Academic Model Predictive Analytics Model of Equity Growth Dependent Variable: Equity Growth Logit model. Incidence Rate Ratios Reported.

	Preliminary Models			Full Model
	(1)	(2)	(3)	(4)
Corporate Governance Measures				
Corporation	3.671***			2.867***
	(0.0776)			(0.0612)
Delaware	26.54***			
	(0.479)			
Name-Based Measures				
Short Name		2.729***		2.228***
		(0.0485)		(0.0415)
Eponymous		0.200***		0.288***
		(0.0112)		(0.0162)
Intellectual Property Measures				
Patent			51.91***	
			(1.556)	
Trademark			7.235***	3.731***
			(0.412)	(0.191)
Patent - Delaware Interaction				
Patent Only				23.58***
				(1.049)
Delaware Only				17.38***
				(0.358)
Patent and Delaware				94.31***
				(3.468)
US CMP Clusters				Yes
US CMP High-Tech Clusters				Yes
N	26,969,231	26,969,231	26,969,231	26,969,231
R-squared	0.135	0.050	0.087	0.184

How do “digital signatures” of startups predict growth?

Change in the Probability of Growth **Policy Model**	
Corporation (Not Partnership or LLC)	100%
Delaware only	2,780%
Patent only	1,783%
Trademark only	309%
Del., Patent, Trademark Interaction	
Delaware and Patent	4,000%
Delaware and Trademark	32,600%
Patent and Trademark	13,700%
Delaware, Patent and Trademark	85,600%

(NB: Prediction NOT causal)

(Andrews et al., 2022)

Table 3
Policy Model Predictive Analytics Model of Equity Growth Dependent Variable: Equity Growth Logit model. Incidence Rate Ratios Reported.

	(1)	(2)	(3)
Independent Effects			
Delaware	28.80***		
	(0.742)		
Patent	18.83***		
	(0.634)		
Trademark	4.087***	4.312***	
	(0.240)	(0.230)	
Delaware, Patent Interactions			
Delaware = 1, Patent = 0		38.66***	
		(1.001)	
Delaware = 0, Patent = 1		81.20***	
		(3.770)	
Delaware = 1, Patent = 1		470.8***	
		(18.35)	
Delaware, Patent, Trademark Interactions			
Delaware = 1, Patent = 0, Trademark = 0			40.20***
			(1.075)
Delaware = 0, Patent = 1, Trademark = 0			96.26***
			(4.448)
Delaware = 0, Patent = 0, Trademark = 1			620.8***
			(22.30)
Delaware = 1, Patent = 1, Trademark = 0			41.53***
			(3.241)
Delaware = 1, Patent = 0, Trademark = 1			326.8***
			(21.00)
Delaware = 0, Patent = 1, Trademark = 1			137.7***
			(23.76)
Delaware = 1, Patent = 1, Trademark = 1			856.9***
			(66.53)
Corporation	1.902***	2.278***	2.445***
	(0.0415)	(0.0547)	(0.0606)
N	26,969,231	26,969,231	26,969,231
pseudo R-sq	0.134	0.138	0.141

Robust standard errors reported in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A New View of the Skew

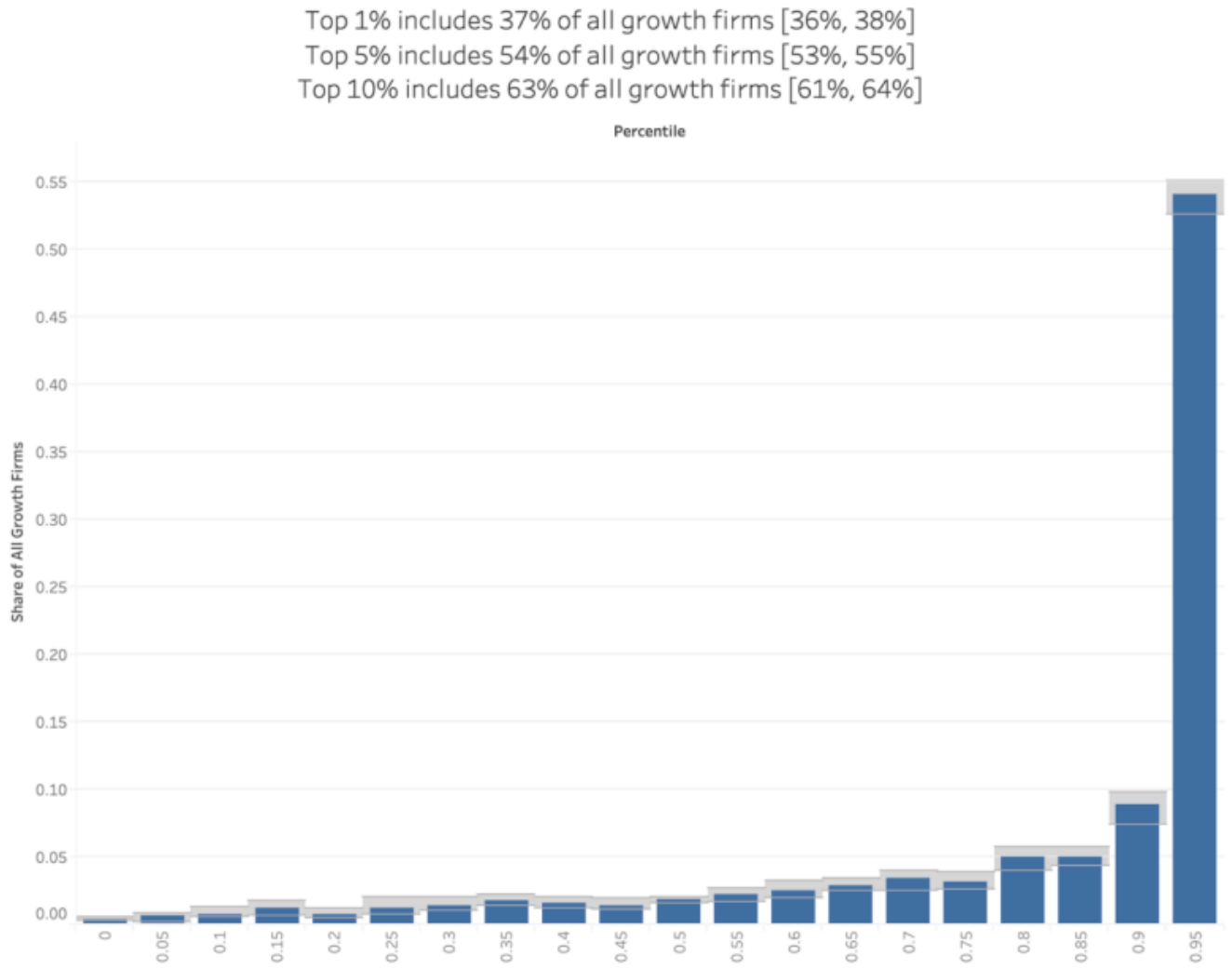


Fig. 1. Validating Entrepreneurial Quality Predictions 10-Fold Out of Sample Test (Academic Model).

(Andrews et al., 2022)

Entrepreneurial Quality Statistics

SFR

Startup Formation Rate (SFR)

Number of companies founded

EQI

Entrepreneurial Quality Index (EQI)

Average estimated quality within a group of start-ups

RECPI

Regional Entrepreneurship Cohort Potential Index (RECPI)

The number of startups within a particular region expected to later achieve a growth outcome

REAI

Regional Entrepreneurship Acceleration Index (REAI)

Estimates the ability of an ecosystem to convert entrepreneurial potential into realized growth events.

(Guzman and Stern, 2017)

New Population-Level Entrepreneurship Indices

- Entrepreneurship Quality Index (EQI). *Average* estimated entrepreneurial quality within a group of start-ups:

$$EQI_{r,t} = \frac{1}{N_{r,t}} \sum_{i \in \{I_{r,t}\}} \hat{q}_{i,r,t}$$

- Regional Entrepreneurship Cohort Quality Index (RECPI). Expected number of growth events within a regional start-up cohort:

$$RECPI_{r,t} = EQI_{r,t} \times N_{r,t}$$

- Regional Ecosystem Acceleration Index (REAI). The ratio of realized vs. expected growth events in a region:

$$REAI_{r,t} = \#GrowthEvents_{r,t} / RECPI_{r,t}$$

- Attributes:
  - Panel or cross-sectional
  - Arbitrary level of granularity
  - Not necessarily geographic in scope

(Guzman and Stern, 2017)

The Startup Cartography Project

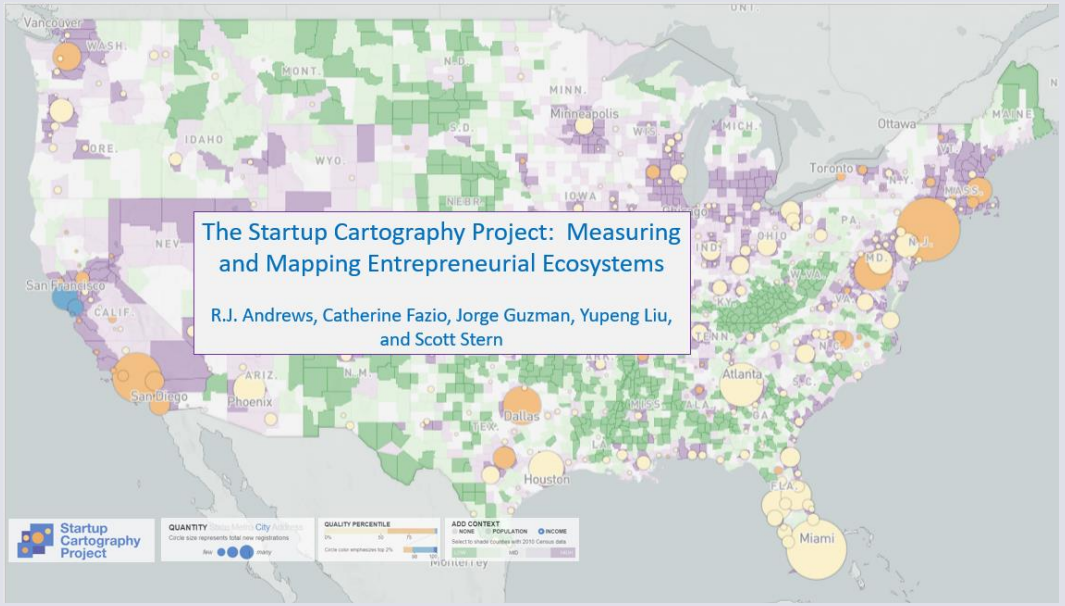
- **Measurement of Entrepreneurial Quality:**
  - Uses predictive analytics and business registration records
  - Constructs measures of quantity, quality, and ecosystem "performance"
  - Develops systematic statistics at multiple levels of analysis (zip code, county, MSA, state, and National) and over time (1988-2016)
- **User Focused Design:**
  1. Visualization of entrepreneurial ecosystems (at multiple geographic levels) and an ability to track entrepreneurial dynamics over time.
  2. Data repository for use in a wide range of research and policy purposes.
  3. Research archive to learn about entrepreneurial quality.

Using the SCP to Address Policy-Relevant Questions

- A New View of the Skew (with Jorge Guzman, Fiona Murray and Scott Stern)
- Measuring and Mapping Entrepreneurial Ecosystems (with RJ Andrews, Jorge Guzman, Yupeng Liu, and Scott Stern)
- Dynamic Impact of State-level R&D Tax Credits on Entrepreneurial Ecosystems (with Jorge Guzman and Scott Stern)
- How COVID Is Changing the Geography of Entrepreneurship (with Jorge Guzman, Yupeng Liu and Scott Stern)

SCP Applications:

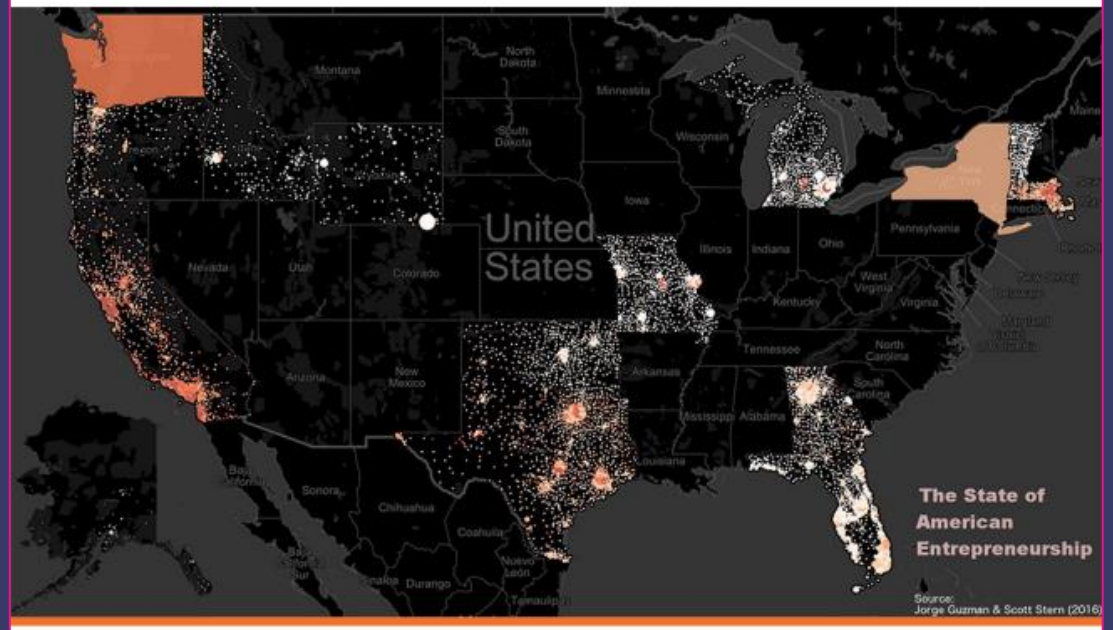
The Power of a New View



Disentangling the Quantity and Quality of Entrepreneurship

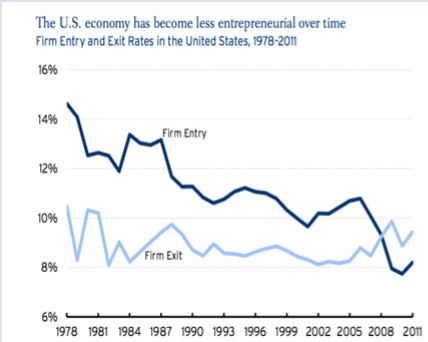
MIT innovation initiative

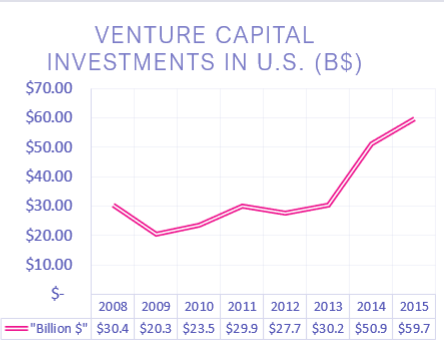
LAB FOR INNOVATION SCIENCE AND POLICY

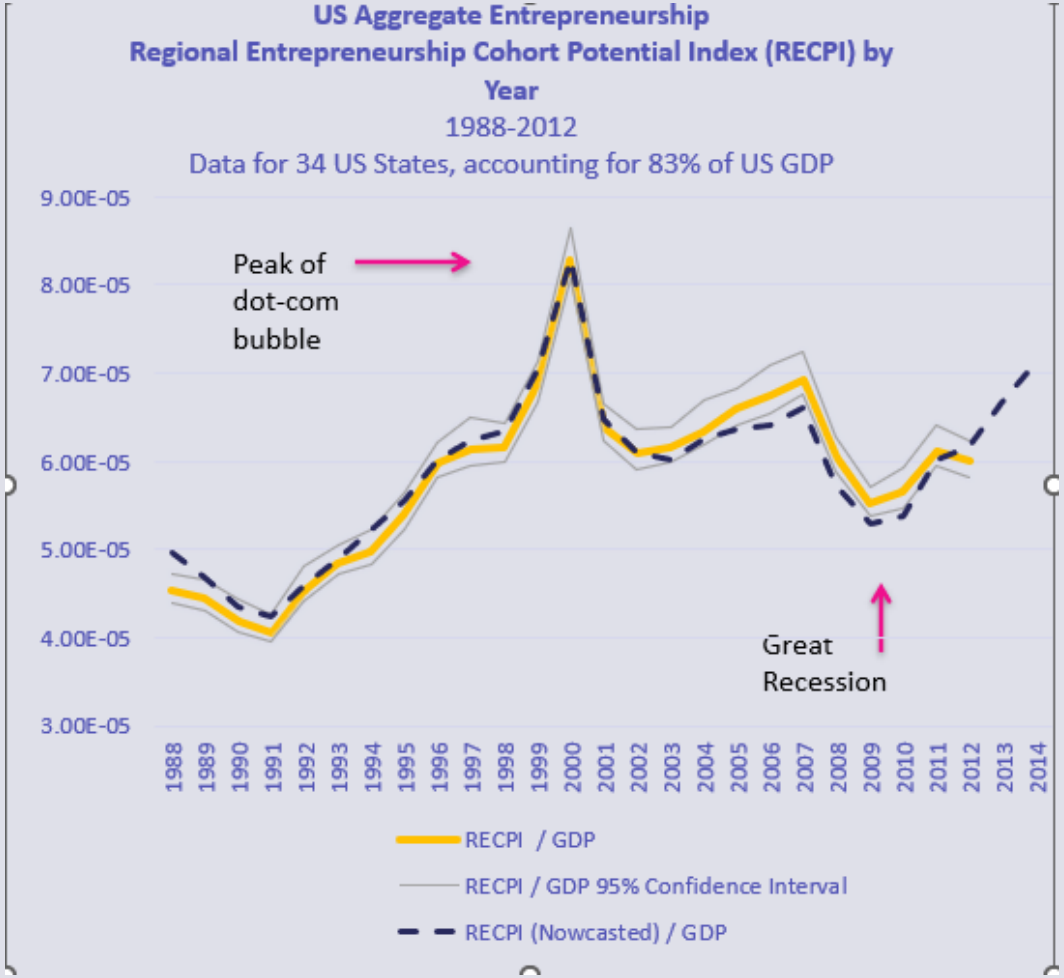


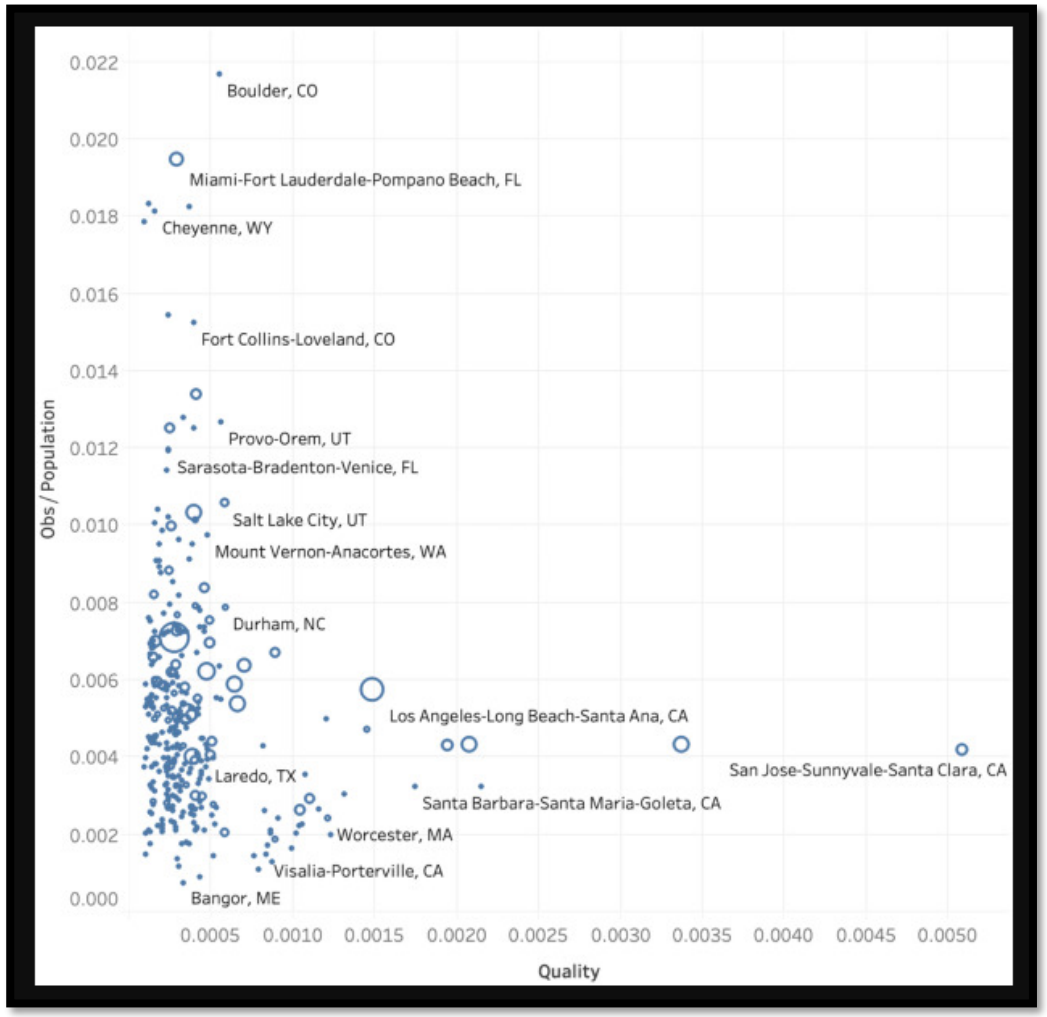
A NEW VIEW OF THE SKEW: A QUANTITATIVE ASSESSMENT OF THE QUALITY OF AMERICAN ENTREPRENEURSHIP

Catherine Fazio, Jorge Guzman, Fiona Murray, Scott Stern









Estimated Average SFR/capita and EQI by MSA

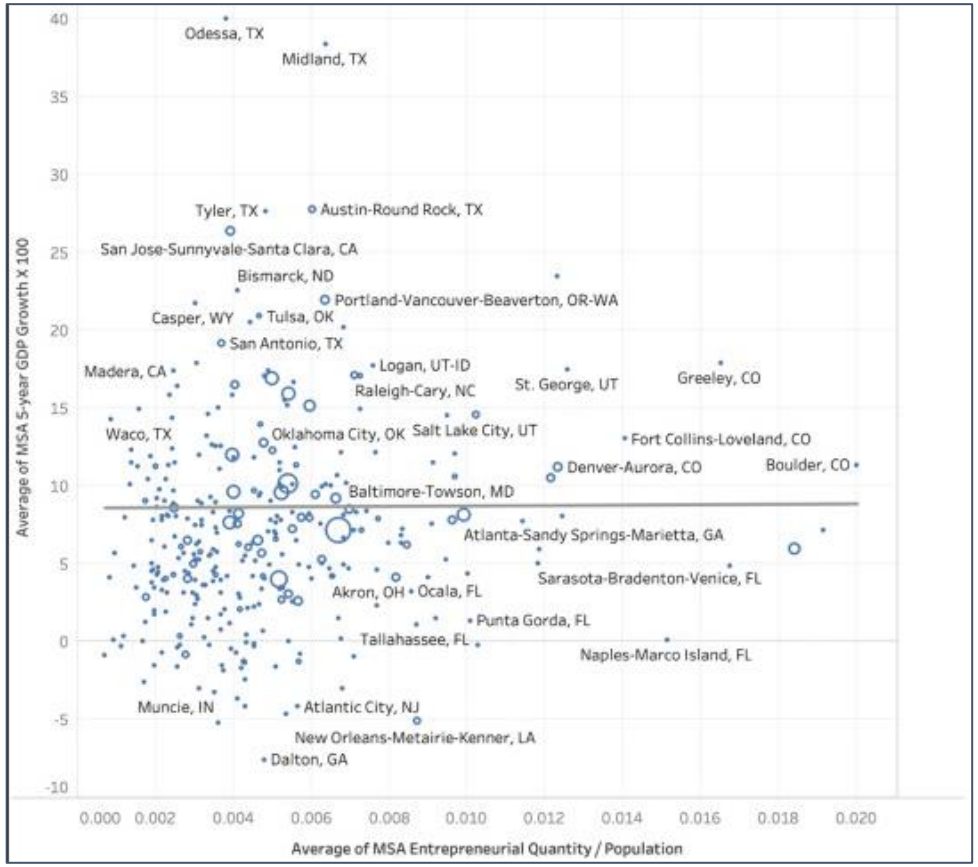
More "Shots on Goal" ≠ More Growth Outcomes

- Most MSAs:
  - low number of new registered businesses *and*
  - low estimated probability of achieving a growth outcome.
- SFR/capita and EQI are *not* highly correlated at the higher range of their respective distributions.
- Key contrasts
  - Silicon Valley region: highest average quality but lower number of startups formed per capita.
  - Boulder, Missoula and Miami: highest range of startups formed per capita, but lowest average quality.

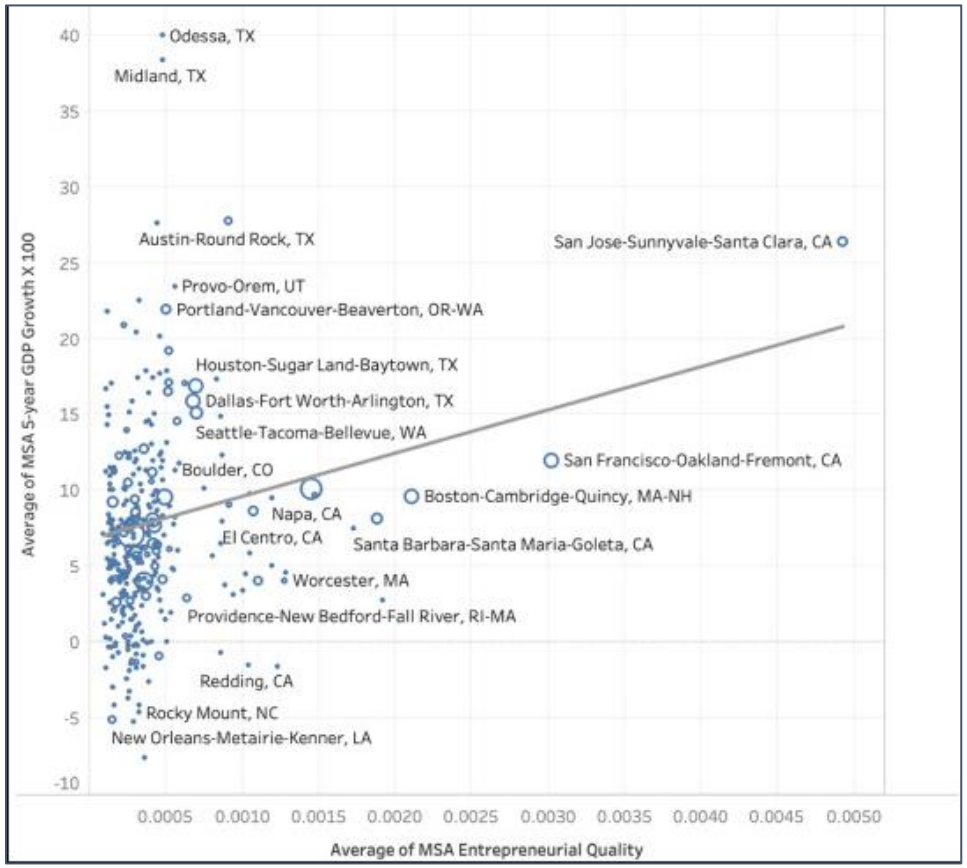
(Andrews et al., 2022)

Quality, not Quantity, Correlates with Growth

Quantity and GDP Growth



Quality and GDP Growth



Figures 3A and 3B, Andrews et al., 2022 (comparisons not causal)

Ecosystem Performance Varies Over Time

- Environment affects ability of startups of same underlying quality to achieve growth outcomes
- Conditional on estimated quality:
  - Startups born in 1995 were 60% more likely to achieve an equity growth outcome.
  - Startups born in 2007 were 2.4 times less likely to achieve a growth event than those born in 1995.

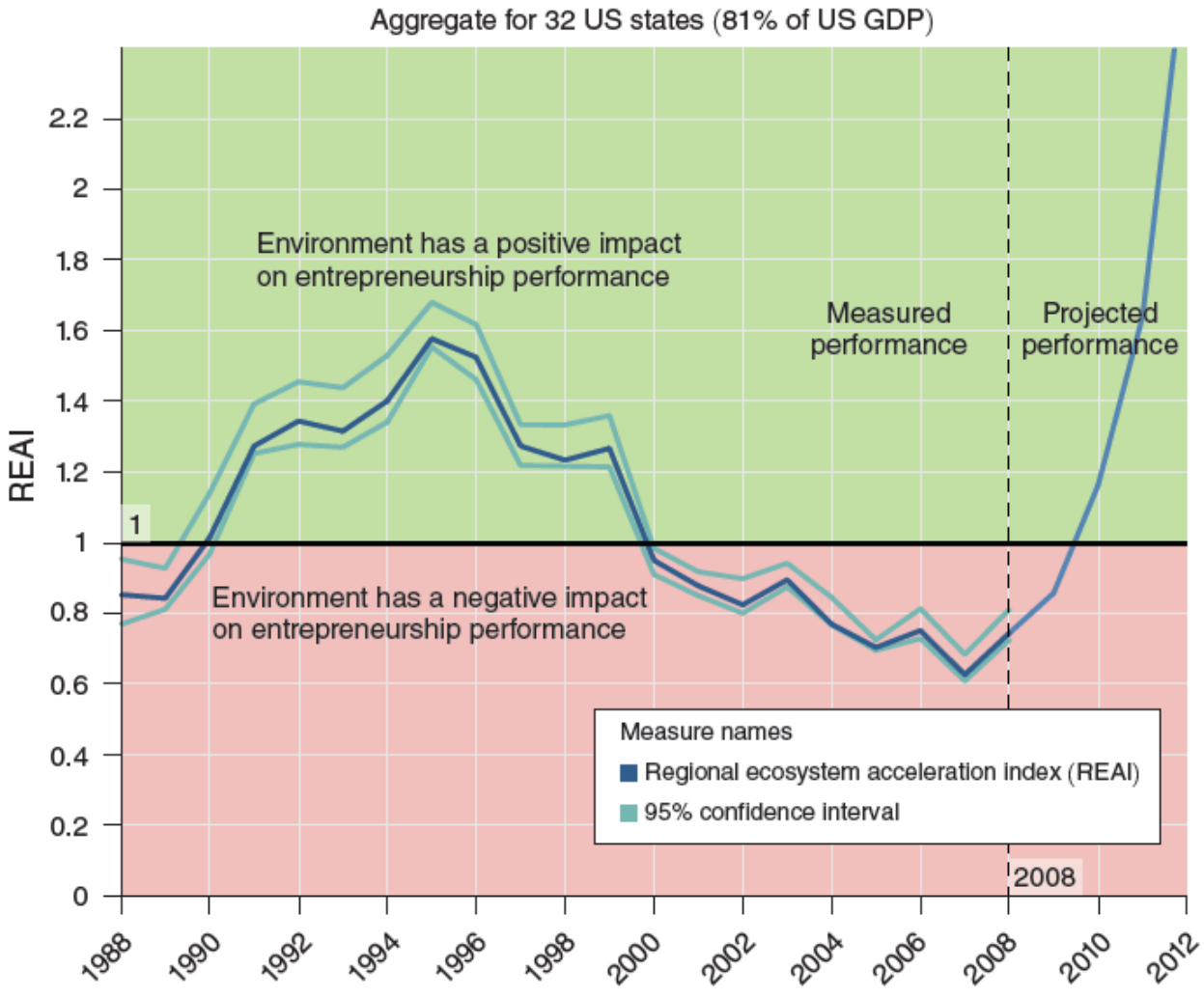
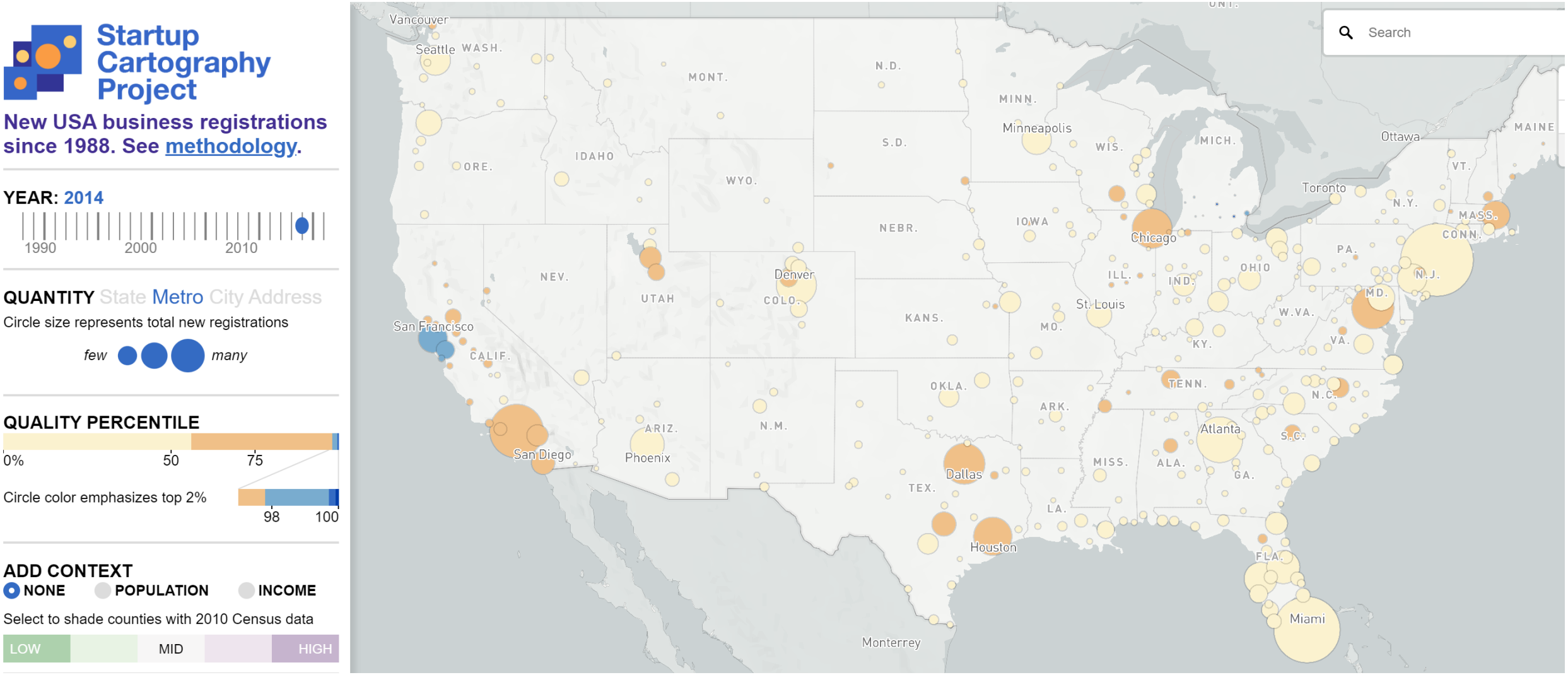


FIGURE 5. REGIONAL ENTREPRENEURIAL ACCELERATION INDEX (REAI)

(Andrews et al., 2022)

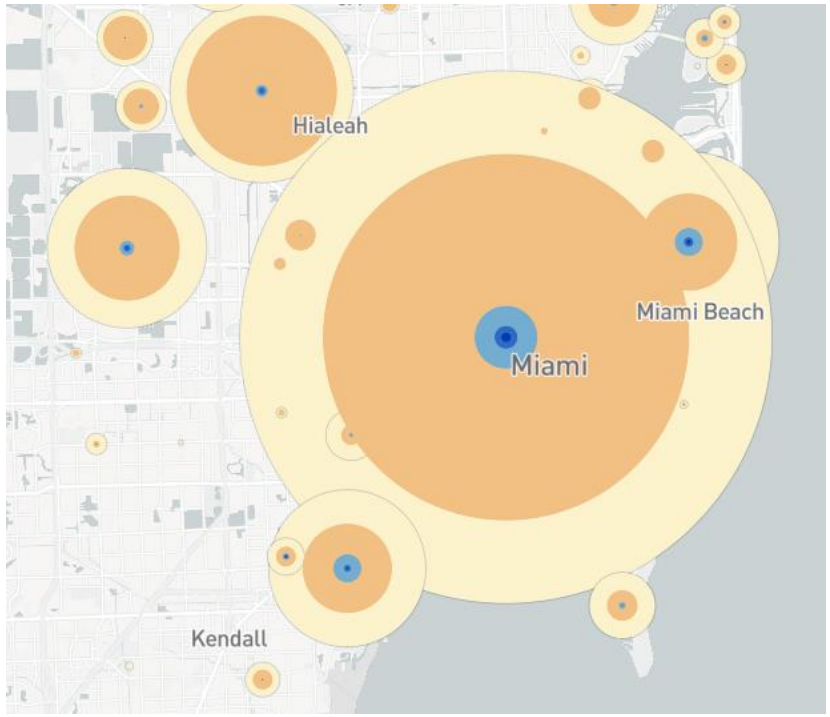
Setting the Table for Shared Ecosystem Assessment: The U.S. Startup Map



(Andrews et al., 2022)

Tree Ring Bubble Design Enables Meaningful Comparisons

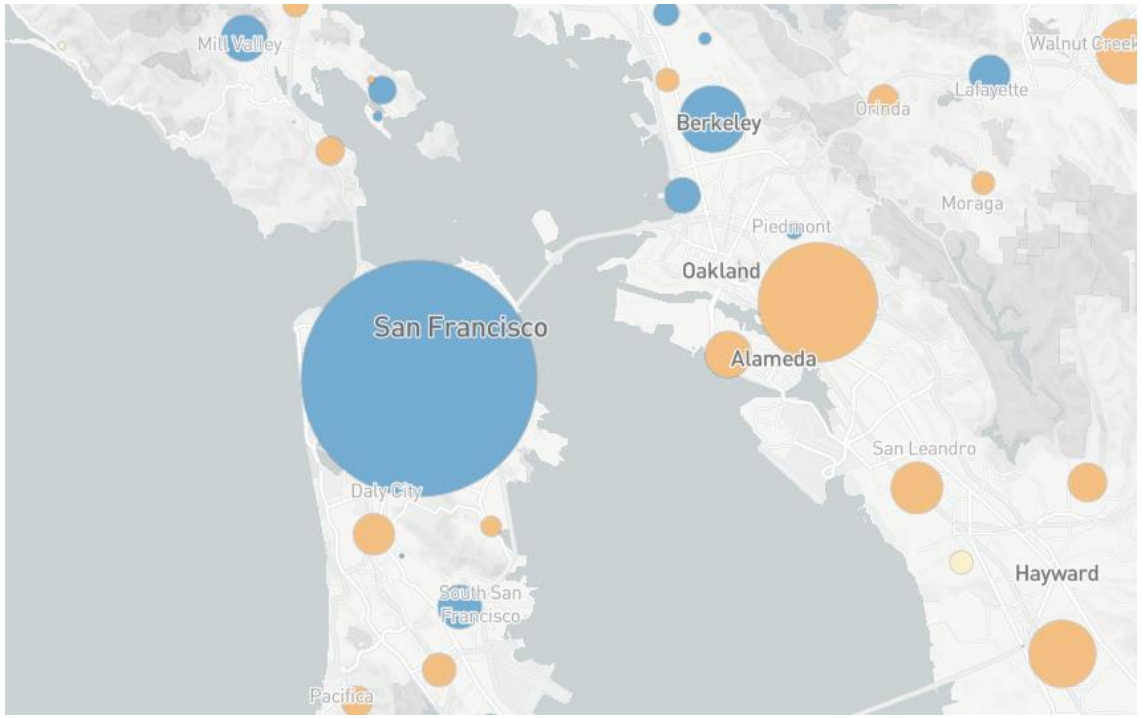
Miami



Quality %: 62.6
Quantity: 44,088
Year: 2016
LLC: 25,081
Corp: 18,332
Delaware: 565
Patent or TM: 91
2+ Measures: 19

Quality %: 99.3
Quantity: 8,321
Year: 2016
LLC: 4,266
Corp: 1,782
Delaware: 2,104
Patent or TM: 46
2+ Measures: 123

San Francisco

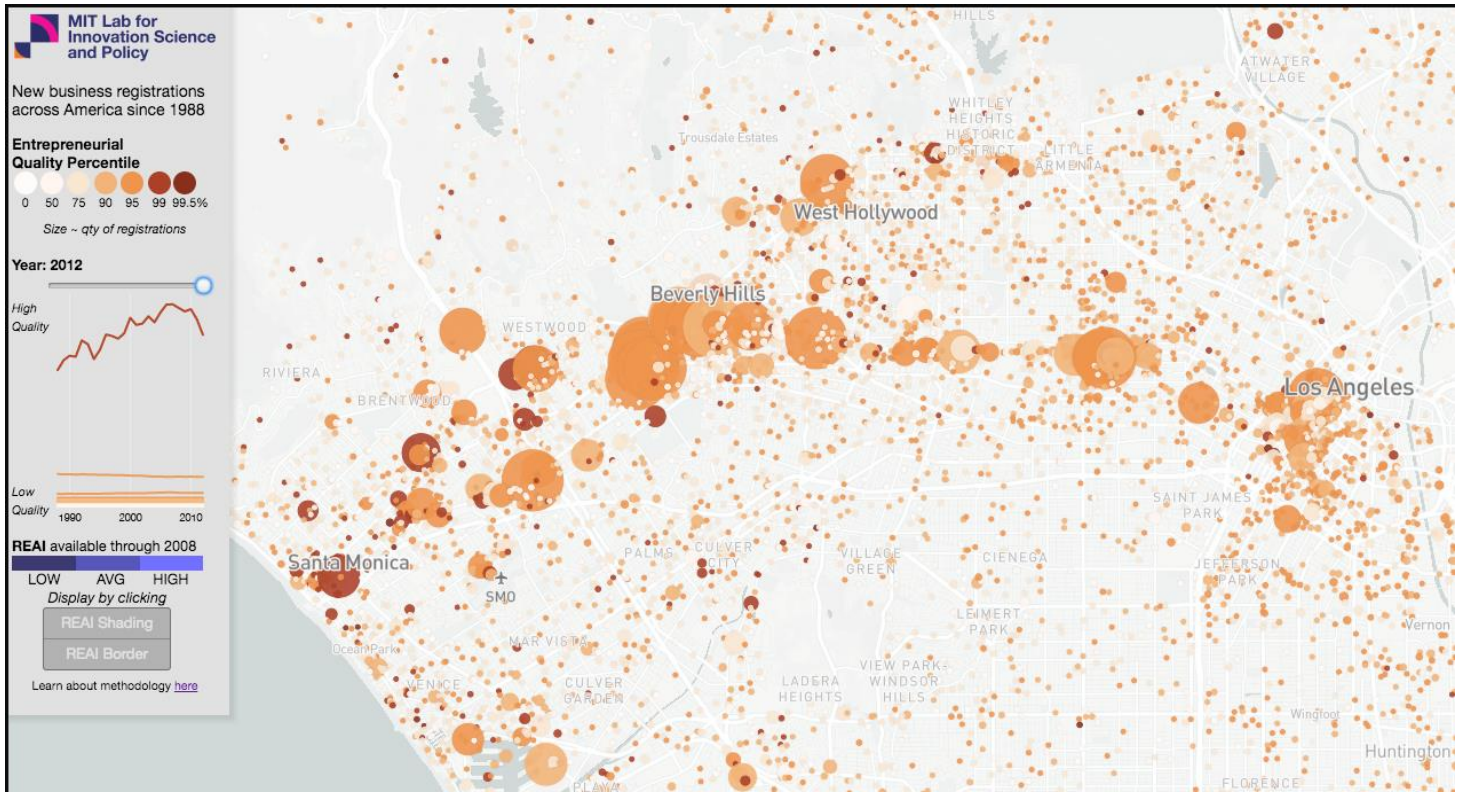


(Andrews et al., 2022)

Potential to See the Impact of City Efforts

Los Angeles

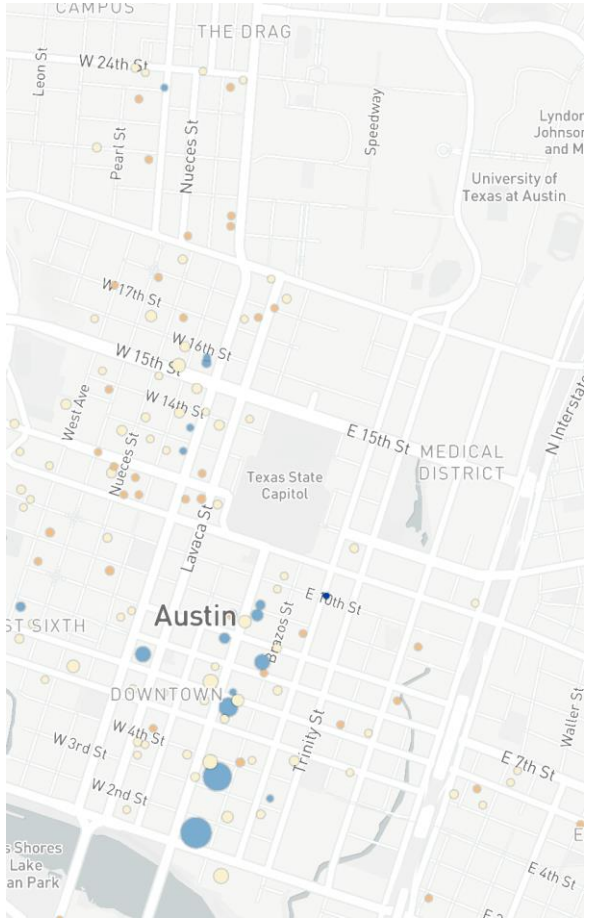
- Visualization shows corridor of higher quality startup formation
- According to then Director of Innovation, location correlates with city programs & efforts
- Provides one indication of impact and informs need for possible public transit link



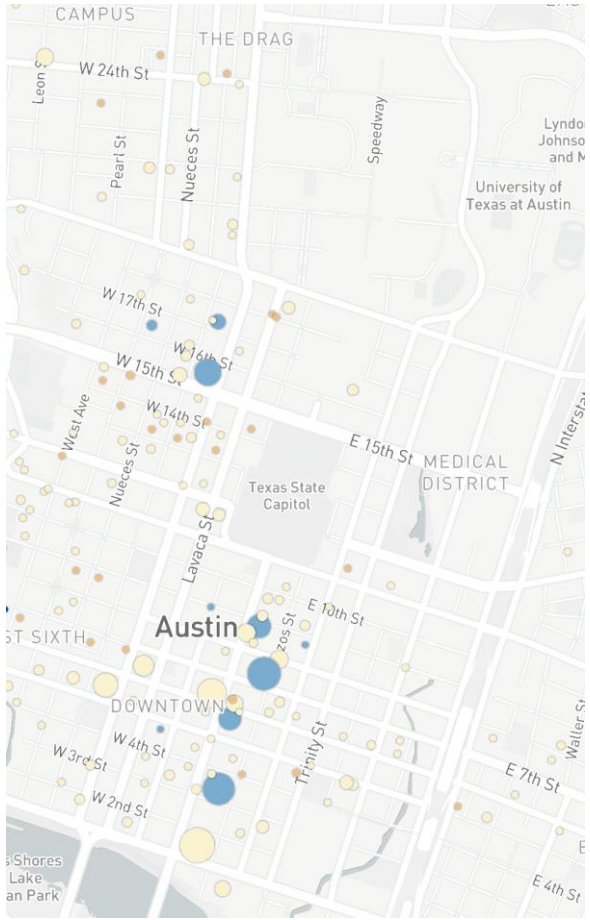
startupcartographyproject.com

Address Level Comparisons Over Time

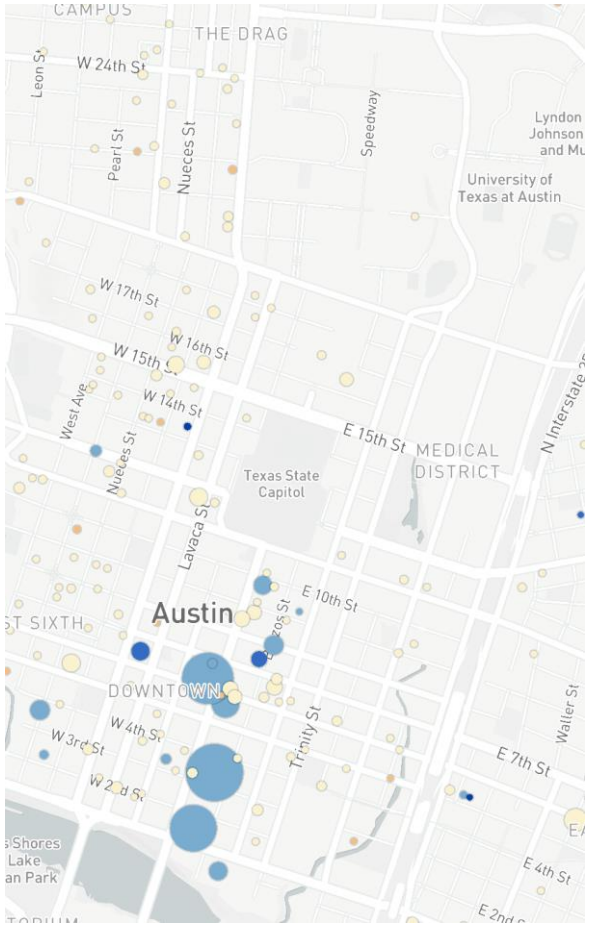
2000



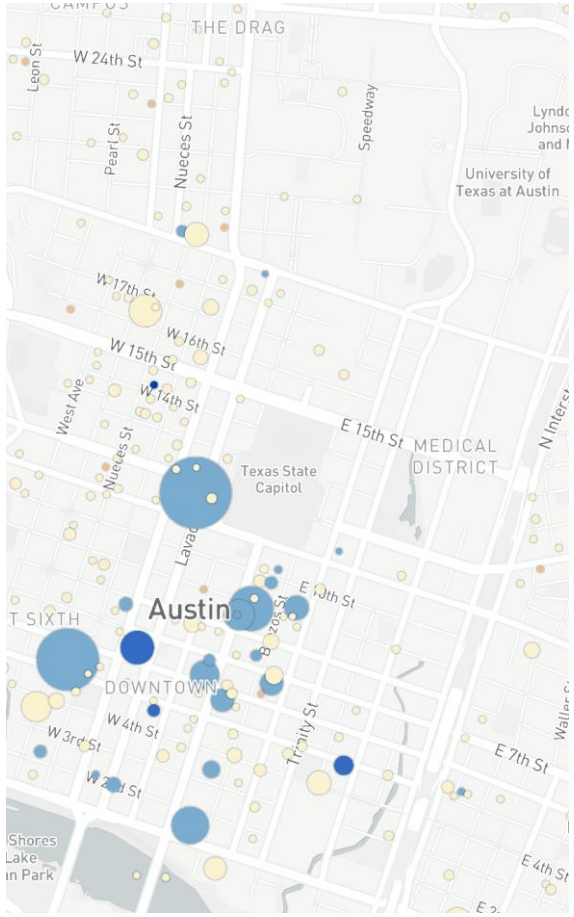
2005



2010



2015



startupcartographyproject.com

University of Texas, Austin Area

U.S. Startup Map: Limitations

- Does not:
  - Track individual startups over time (show which ones survived, thrived, or died)
  - Pick winners
    - Digital signatures are predictive of growth outcomes, not causal determinants of them
    - EQI and RECPI estimates draw power from average across firms in cohort, but do not tell you which startup within a cohort will succeed.
  - Offer NAICS code or industry lens
  - Extend beyond U.S.
- Is not updated in real-time
  - Must collect business registration data from individual states or vendors
  - Some states make business registrations available in real-time for free. Others impose privacy regulations (even though public information), significant delays, and large (for a research budget) fees.

SCP Applications:

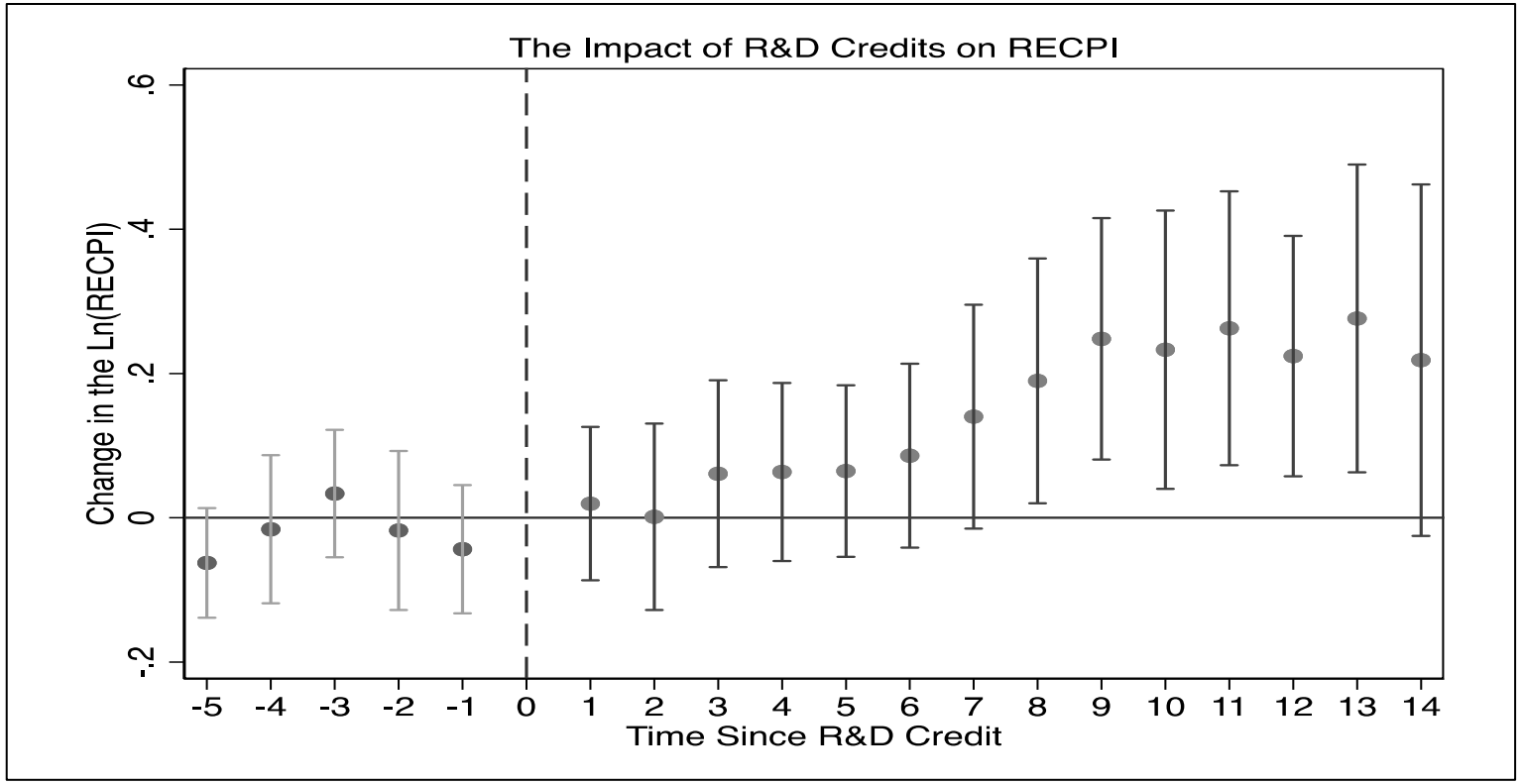
The Impact of Policy

Do Fiscal Incentives Have A Role to Play in Catalyzing High-Growth Potential Entrepreneurship?

Empirical Results

Table 3. The Impact of R&D Tax Credits on Regional Entrepreneurship.

	(1) Ln(Obs)	(2) Ln(RECPI)	(3) REAI
Model 1: Naive model (no controls)			
Has R&D credit	0.477*** (0.102)	0.642*** (0.104)	–0.137** (0.0697)
Model 2: Difference-in-differences (county, year fixed effect)			
Has R&D credit	0.0745* (0.0389)	0.0760** (0.0376)	–0.0265 (0.159)



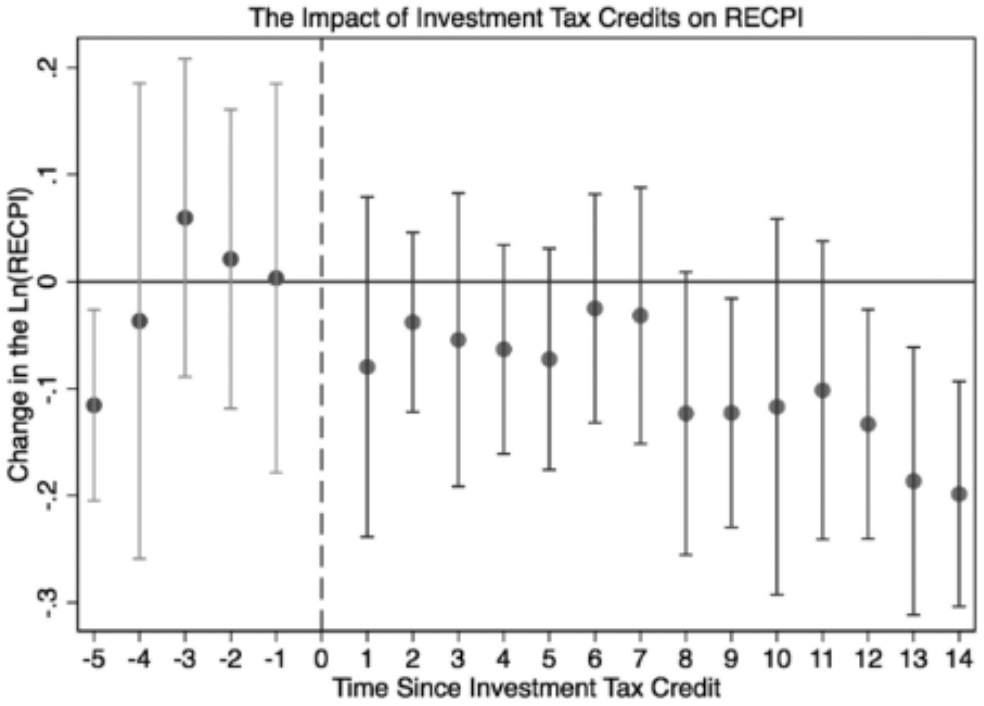
(Fazio et al., 2020)

Contrast: Investment Tax Credits

- Associated with 9% decrease in the quality-adjusted quantity of entrepreneurship.
- Negative trend on RECPI over time of 1.1%/year (12% over 10 years)

Table 4. The Impact of Investment Tax Credits on Regional Entrepreneurship.

	(1) Ln(*Obs*)	(2) Ln(*RECPI*)	(3) *REAI*
Model 1: Naive model (no controls)			
Has investment credit	0.705*** (0.123)	0.352** (0.141)	–0.0586 (0.115)
Model 2: Difference-in-differences (county, year fixed effect)			
Has investment credit	–0.0527 (0.0385)	–0.0912** (0.0392)	0.104 (0.150)



(Fazio et al., 2020)

Fiscal Policy Has Important Role to Play

While designed to help incumbent firms, has important indirect effect on formation rates for high-potential growth start-ups

Structure matters (tax policy can have positive and negative effect on quantity and quality of startup formation in different)

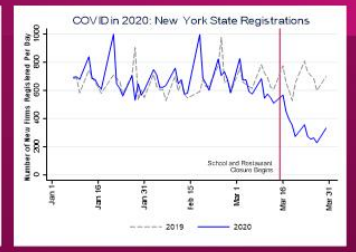
Impact is not immediate, but instead accumulates over time, creating a need for long-term, patient policy.

Other initiatives/measures are needed to support IDEs as they scale. State-level R&D tax credits catalyze formation of high-potential startups, but do not improve those start-ups' performance

SCP Applications:

The Potential for Real-time Insights

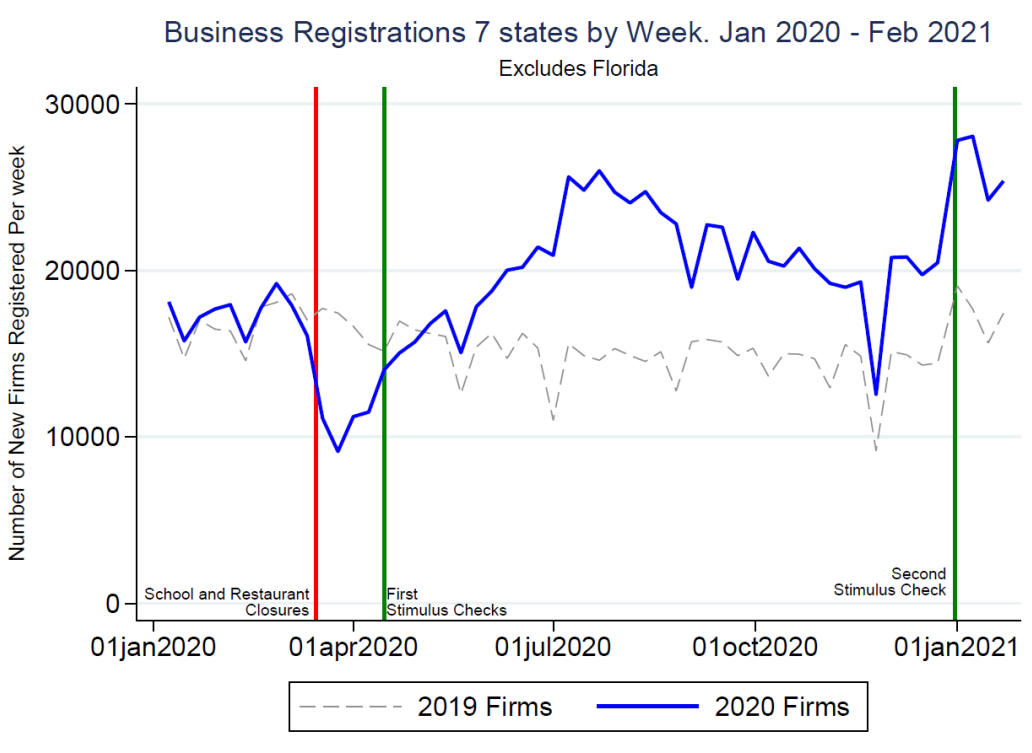
Entrepreneurship in the Age of COVID-19

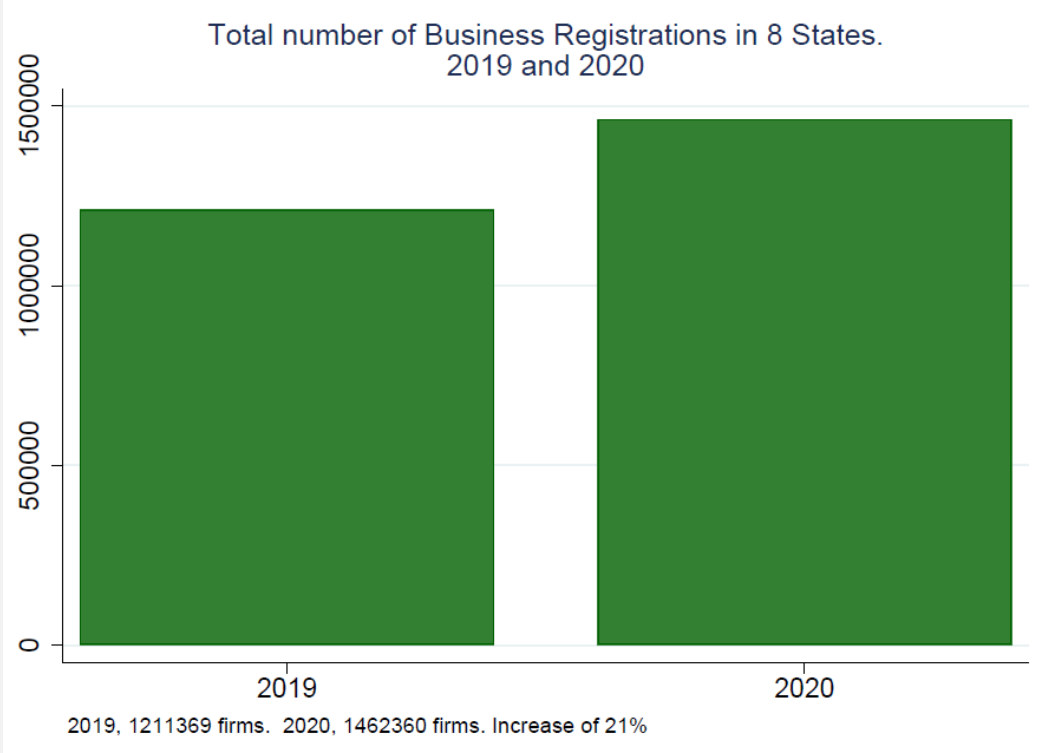


Descriptive (but Granular) Assessment Can Directly Inform Real-Time Policy-Relevant Questions

Marked increase in entrepreneurship correlated with Federal relief packages

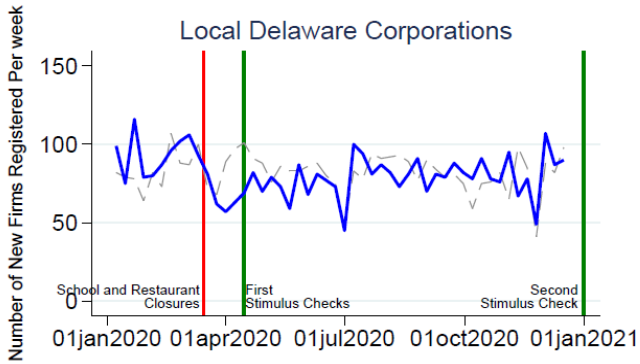
- Lockdowns led to declines in new business registrations
- Recovery and rise beyond 2019 levels followed federal stimulus
- 250,000 *more* new businesses were registered across 8 states in 2020 (vs. 2019)

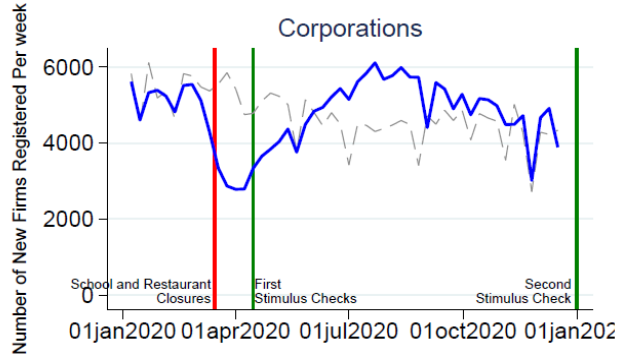


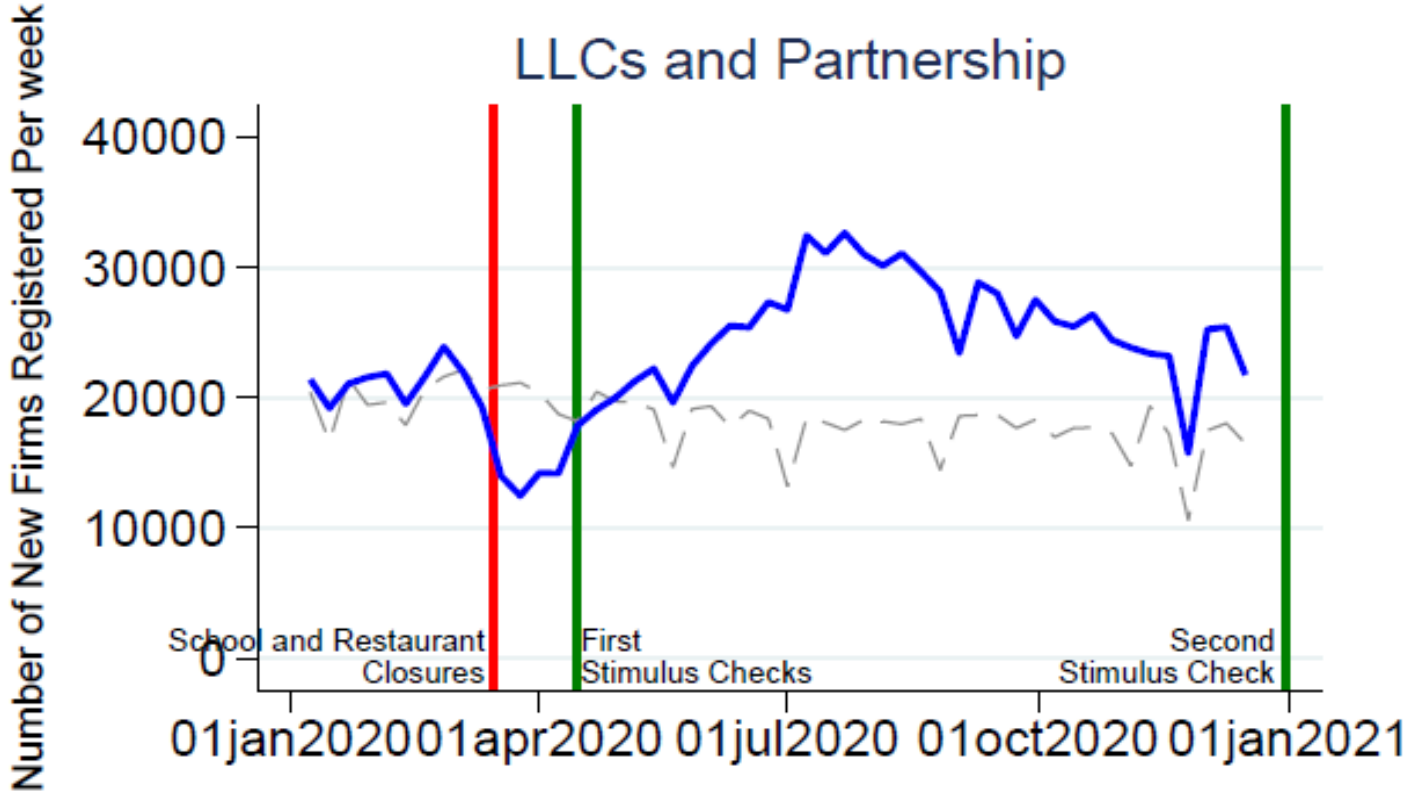


(Fazio et al., 2021)

New local businesses in 8 states drove rebound and recovery in startup formation

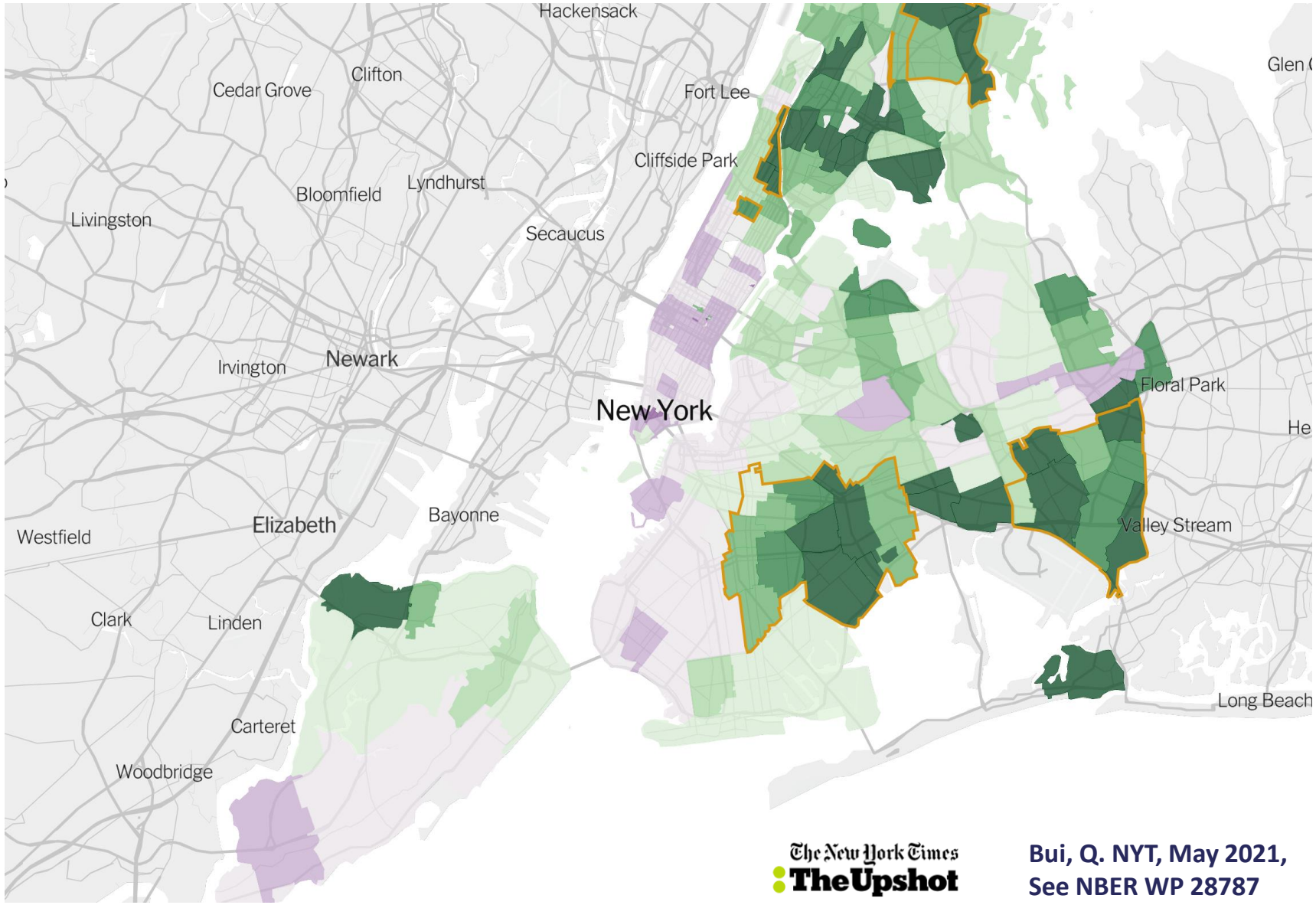


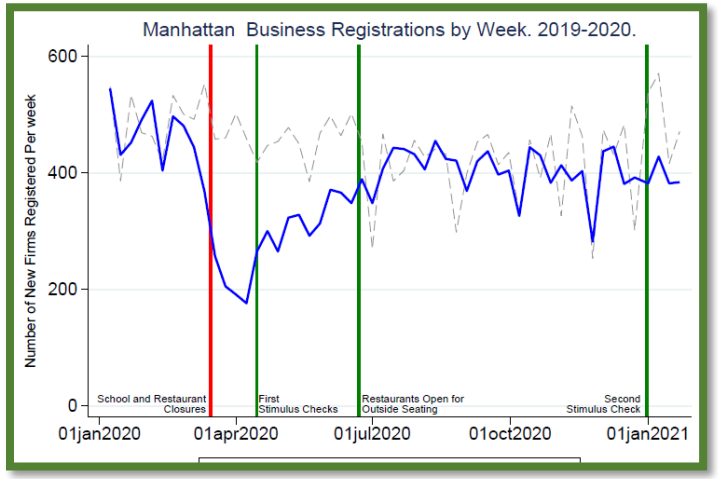


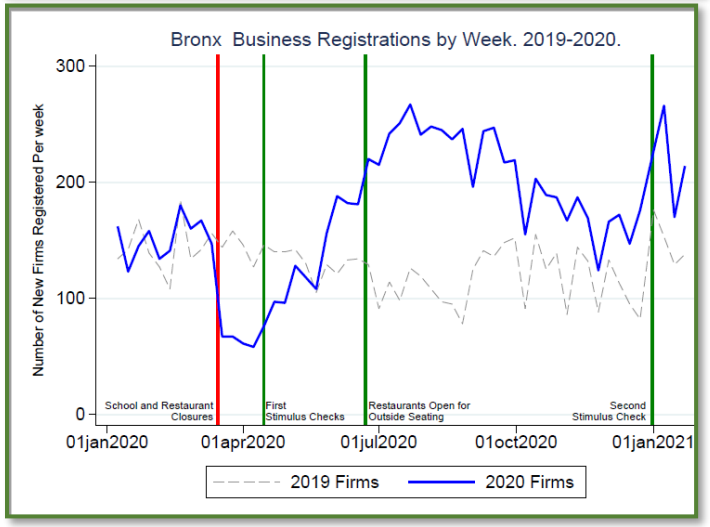


(Fazio et al., 2020)

NYC Case Study: Striking shift out of “traditional” business center (Manhattan) towards Bronx, Brooklyn, etc.







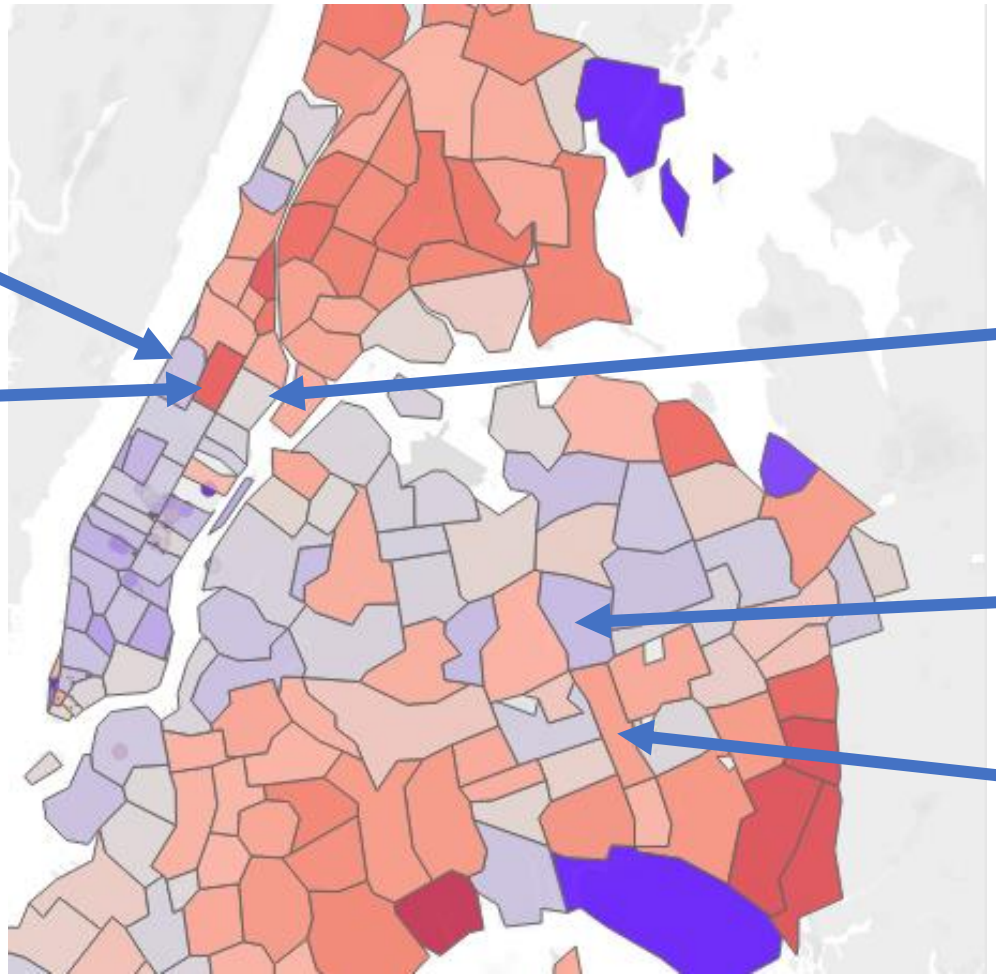
The New York Times TheUpshot

Bui, Q. NYT, May 2021, See NBER WP 28787

Summer Recovery: June

Morningside Heights
Columbia University
(13% black)

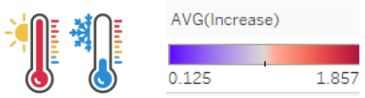
Harlem
(63% Black)



Spanish Harlem
(35% Black, 52% Hispanic)

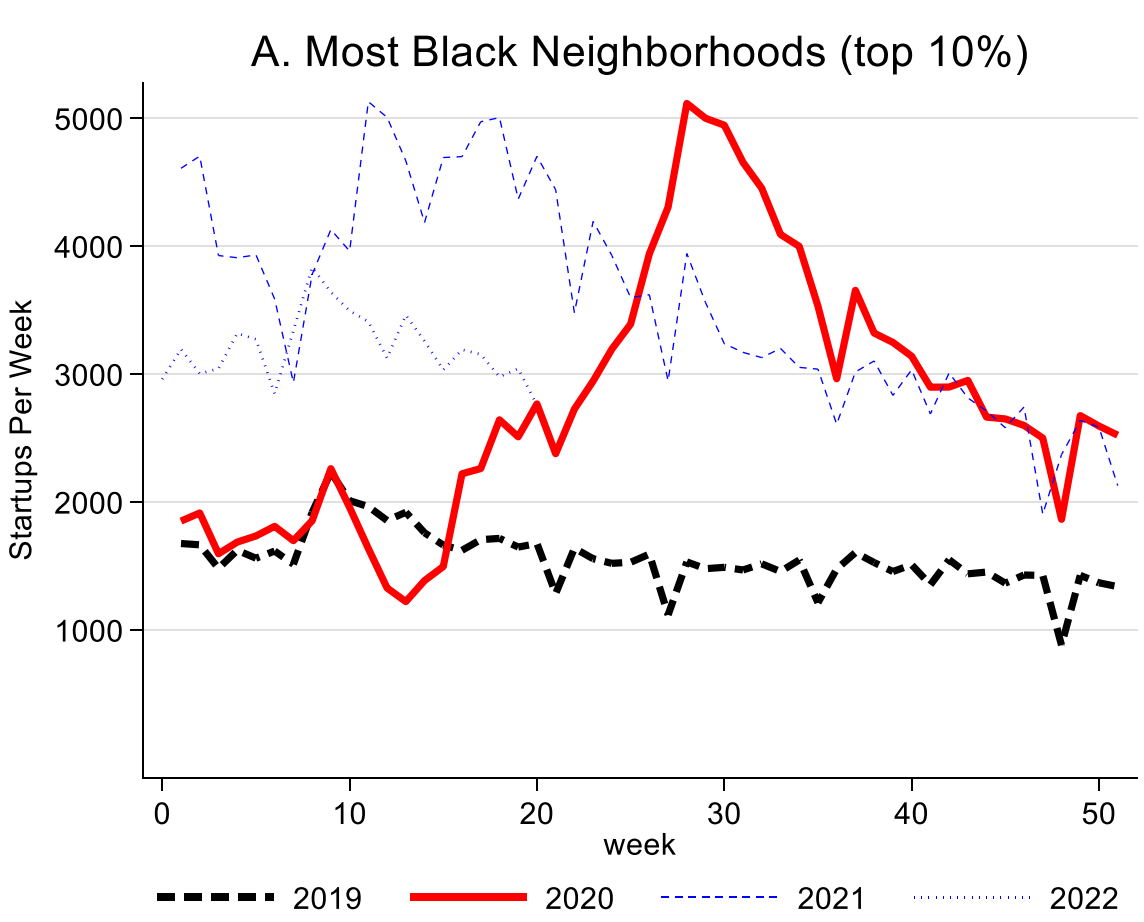
Flushing, Queens
(4% black)

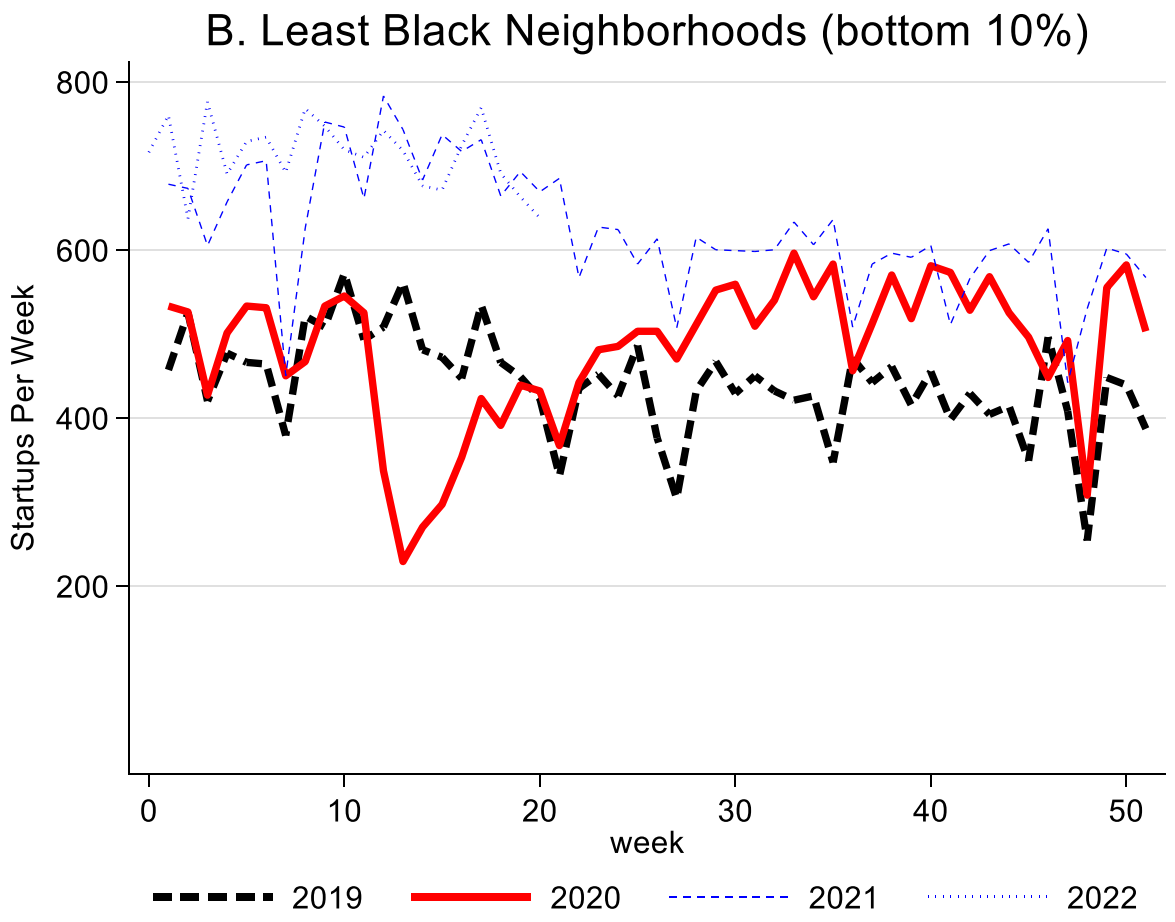
Jamaica, Queens
(48% black)



(Fazio et al., 2020)

Comparing Most Black vs Least Black Neighborhoods



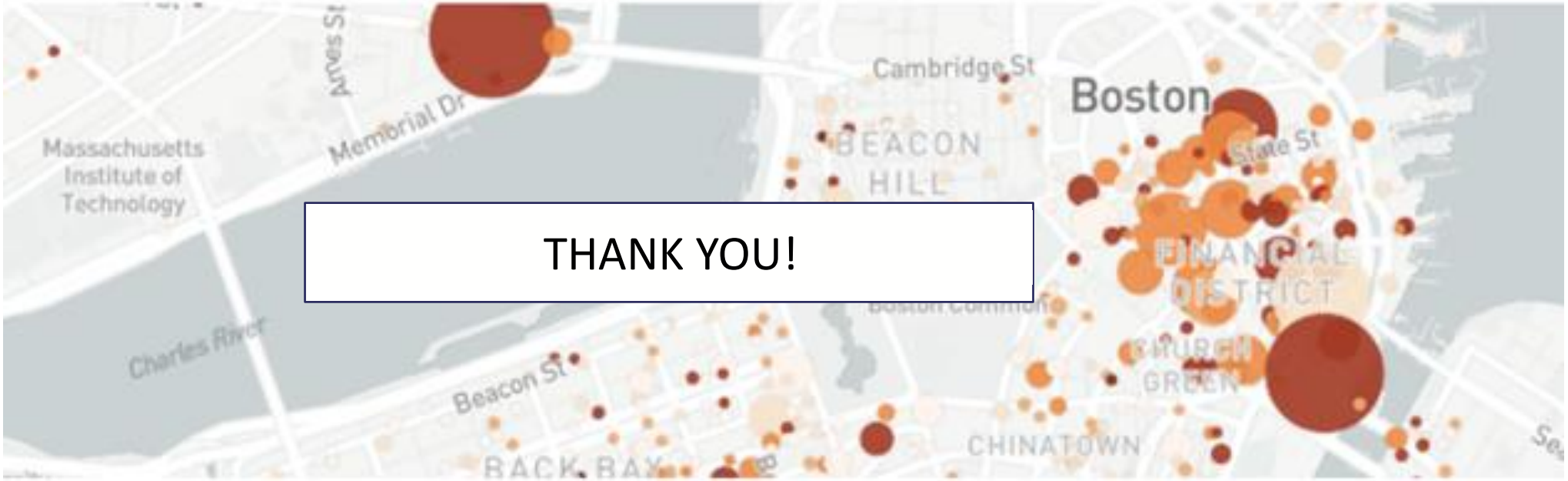


In 2021, high Black neighborhoods had 129% higher entrepreneurship vs 2019, while low Black neighborhoods had 40% higher entrepreneurship vs 2019.

Potential Policy Implications

Observation	Import	Potential Policy Implication
Mainstreet firms led startup surge in wake of COVID	These startups rely on debt (not equity to grow)	Federal programs making low-interest loans available for fledging firms could be fundamental to converting potential to economy-wide growth
In metro regions across US, communities with a greater percentage of Black residents experienced a larger increase in startup formation in the wake of COVID	The uniform distribution of federal relief payments (independent of eligibility criteria) may have played a role in unleashing potential of entrepreneurs otherwise inhibited by discrimination.	Bias in allocation of capital might hinder US ability to fully realize potential gains of entrepreneurship
Changing geography of entrepreneurship highlights the importance of minority business enterprise growth in economic recovery.	Bias in the allocation of critical entrepreneurial inputs may hinder the United States' ability to fully realize potential economic gains associated with the 2020 surge in new business formation.	Initiatives aimed at increasing Black entrepreneurship by bringing knowledge, networking and market access may complement more blunt federal policies by increasing access to capital.

THE STARTUP CARTOGRAPHY PROJECT



THANK YOU!

RJ Andrews

Catherine Fazio

Jorge Guzman

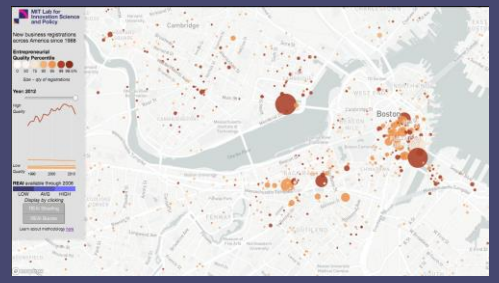
Yupeng Liu

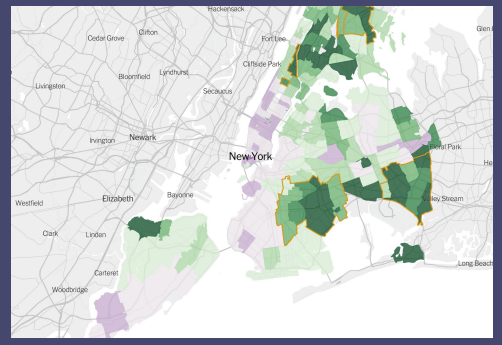
Scott Stern

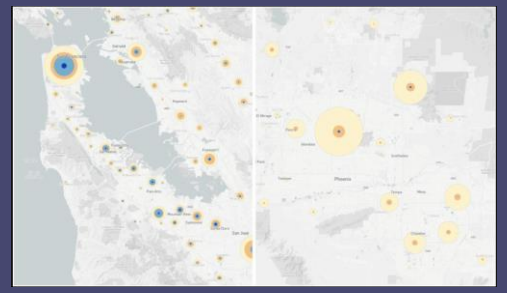
www.startupcartography.com

APPENDIX

SCP Applications



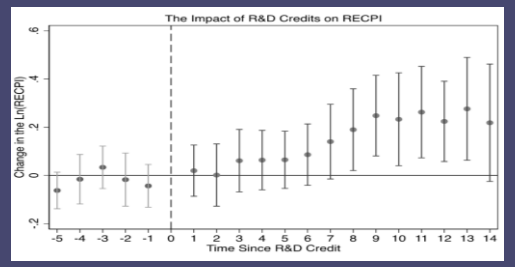


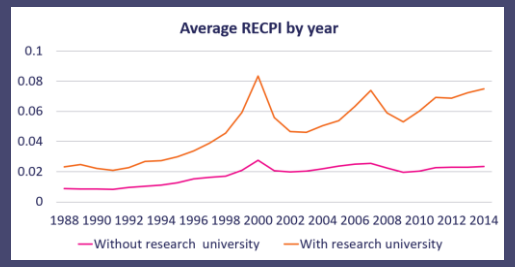


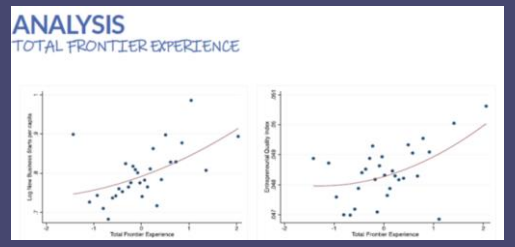
Descriptive, Granular Assessment

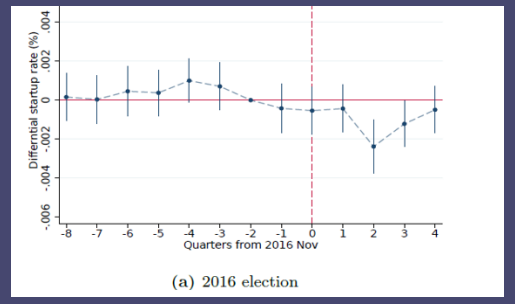
- New View of the Skew (Fazio, Guzman, Murray, Stern 2016)
- U.S. Startup Map & RISE Program (Andrews, Fazio, Guzman, Liu, Stern 2018)
- Changing Geography of Entrepreneurship During COVID (Fazio, Guzman, Liu, Stern 2021)
- Measuring and Mapping Entrepreneurial Ecosystems (Andrews, Fazio, Guzman, Liu, Stern 2022)

SCP Applications





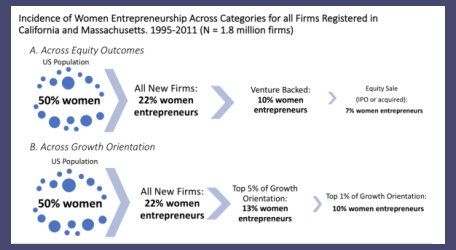


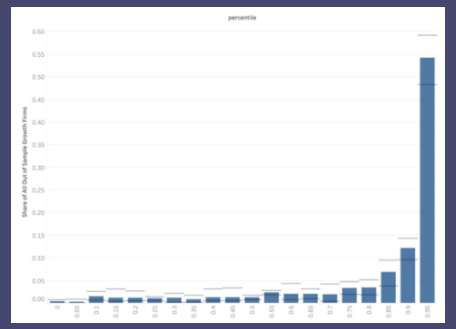


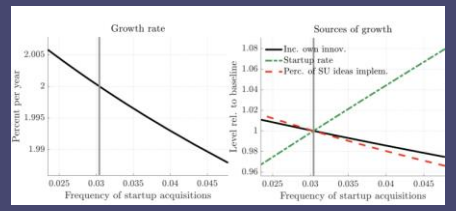
Place-Based Assessments (at Ecosystem, Institutional, Firm and Individual Levels)

- Dynamic Impact of State-level R&D Tax Credits on Entrepreneurial Ecosystems (Fazio, Guzman & Stern 2020)
- University Premium on Innovation Driven Entrepreneurship (Tatari and Stern, 2021)
- Positive Impact of Frontier Culture and Diversity (Barrios, Hochberg, & Macciocchi 2021)
- Impact of H-1B Visas on Entrepreneurial Ecosystems (Guzman, Tareque, & Wang 2022)
- Impact of Partisan Electoral Success on Subsequent SFR (Engelberg, Guzman, Lu, Mullins 2022)

SCP Applications



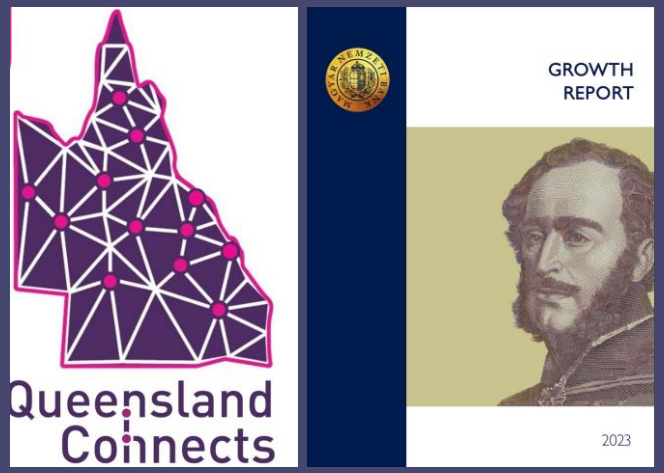


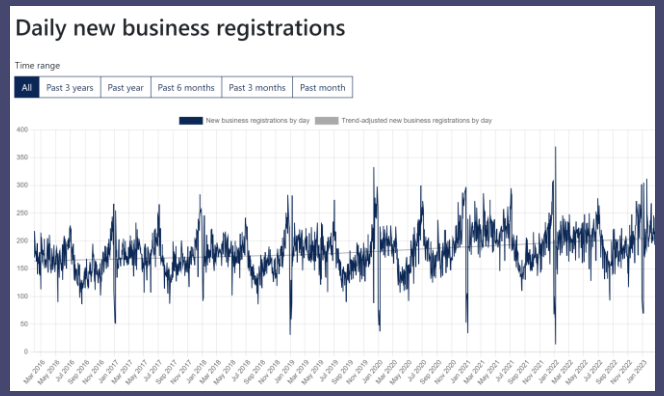


Beyond Place-Based Assessments

- Gender Gap in Entrepreneurship (Guzman and Kacperczyk)
- Venture Capital and Entrepreneurship (Catalini, Guzman and Stern, 2X)
- Entrepreneurial Quality and the Market for Acquisitions (Fons-Rosen, et al)
- Assessment of NIH SBIR Program (Feldman, Stern, et al, 2022)….

SCP Applications





Extending Approach in Other Jurisdictions

- MNB Growth Report, June 2023, Hungary (using ideas building on the SCP to identify “growth firms” of Hungary as driver of economic dynamism
- Startup Monitoring, Switzerland.
- Queensland Connects, Australia (tracking startups, scaleups, innovation-driven enterprises and growth events).

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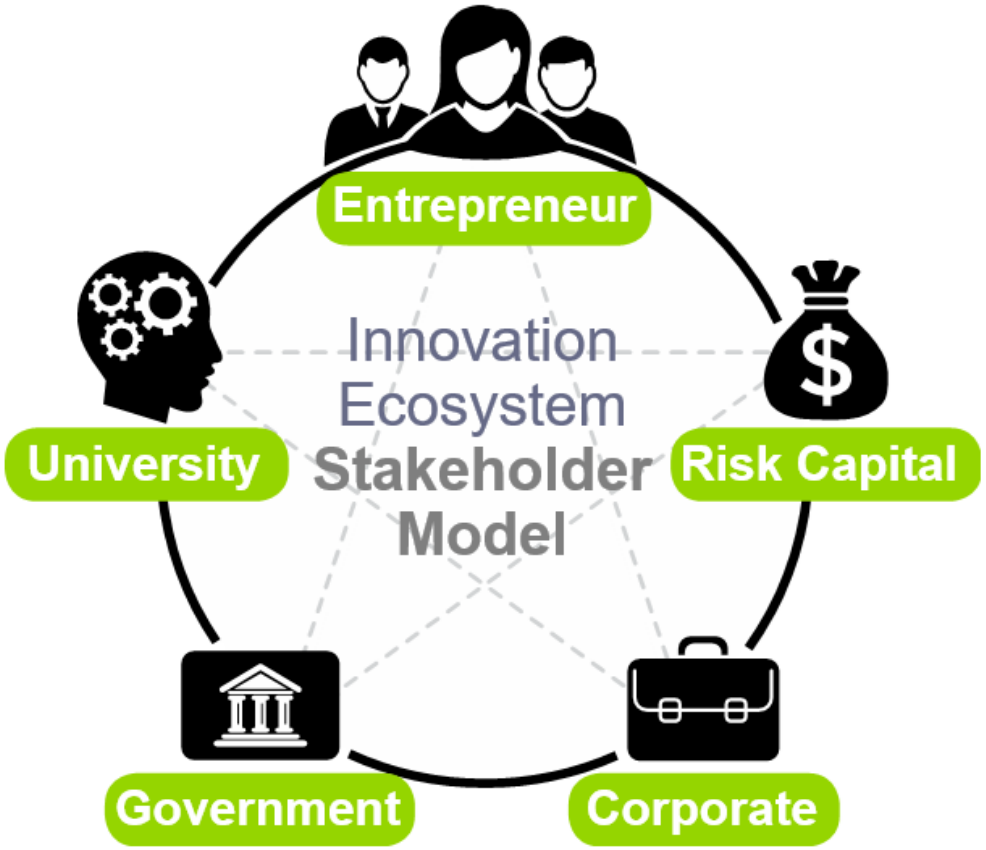
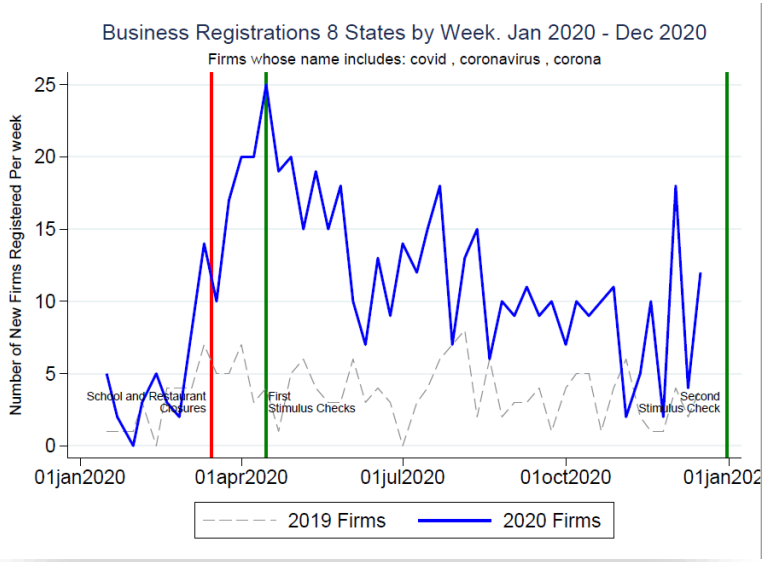
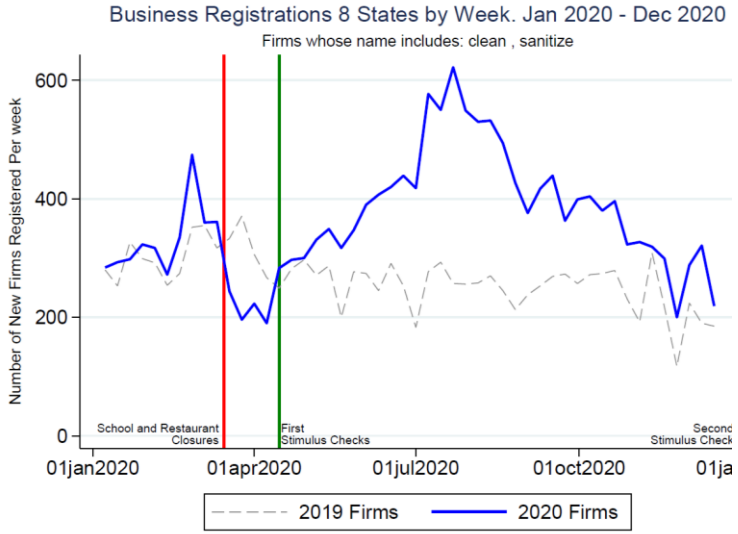
Stakeholders

- No one
  is “in charge” of
  entrepreneurship
- Each stakeholder plays a critical role in success
- Need for shared understanding to align stakeholders and policymakers

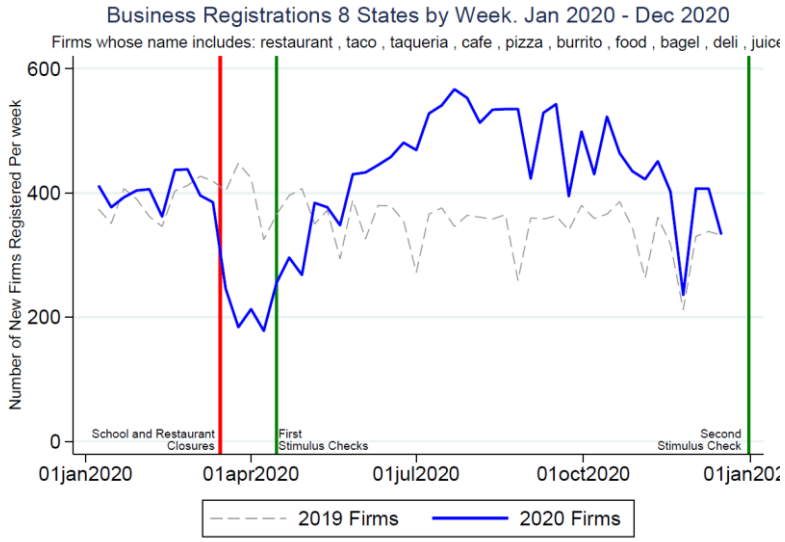




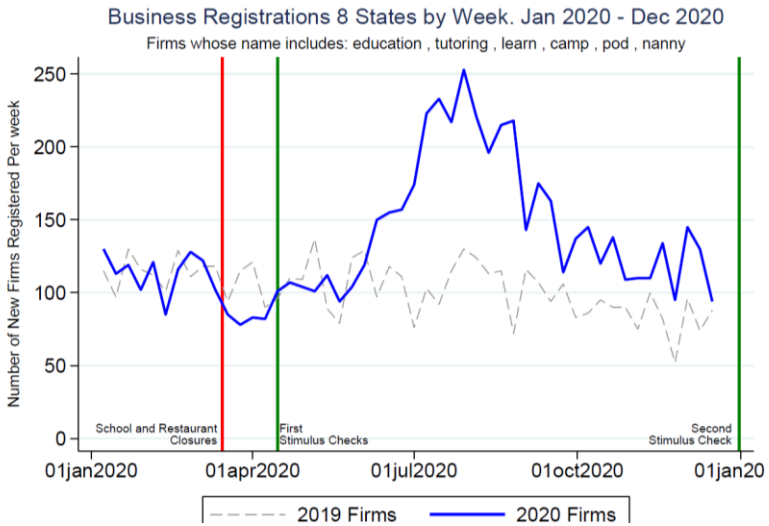
Jump in: COVID Supplies and Services;



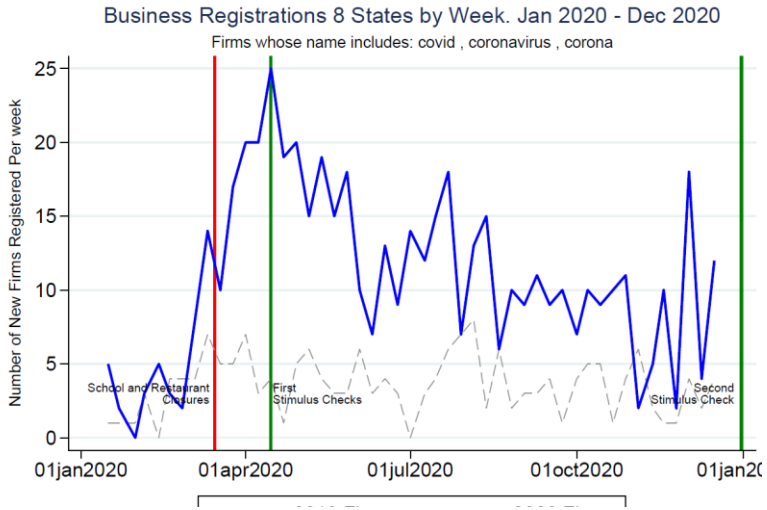
Cleaning and Disinfecting Services



Restaurants



Jump in: Child Care and Education Businesses



as well as Digital and Online

Startup Formation Appears Responsive to COVID Challenges

(Fazio et al., 2021)

Multivariate Regression Analysis

- Confirms Black, wealthy, and wealthy Black neighborhoods led observed increases in startup formation rates relative to 2019
- Controlling for other demographics and either 3-digit or 4-digit ZCTA areas

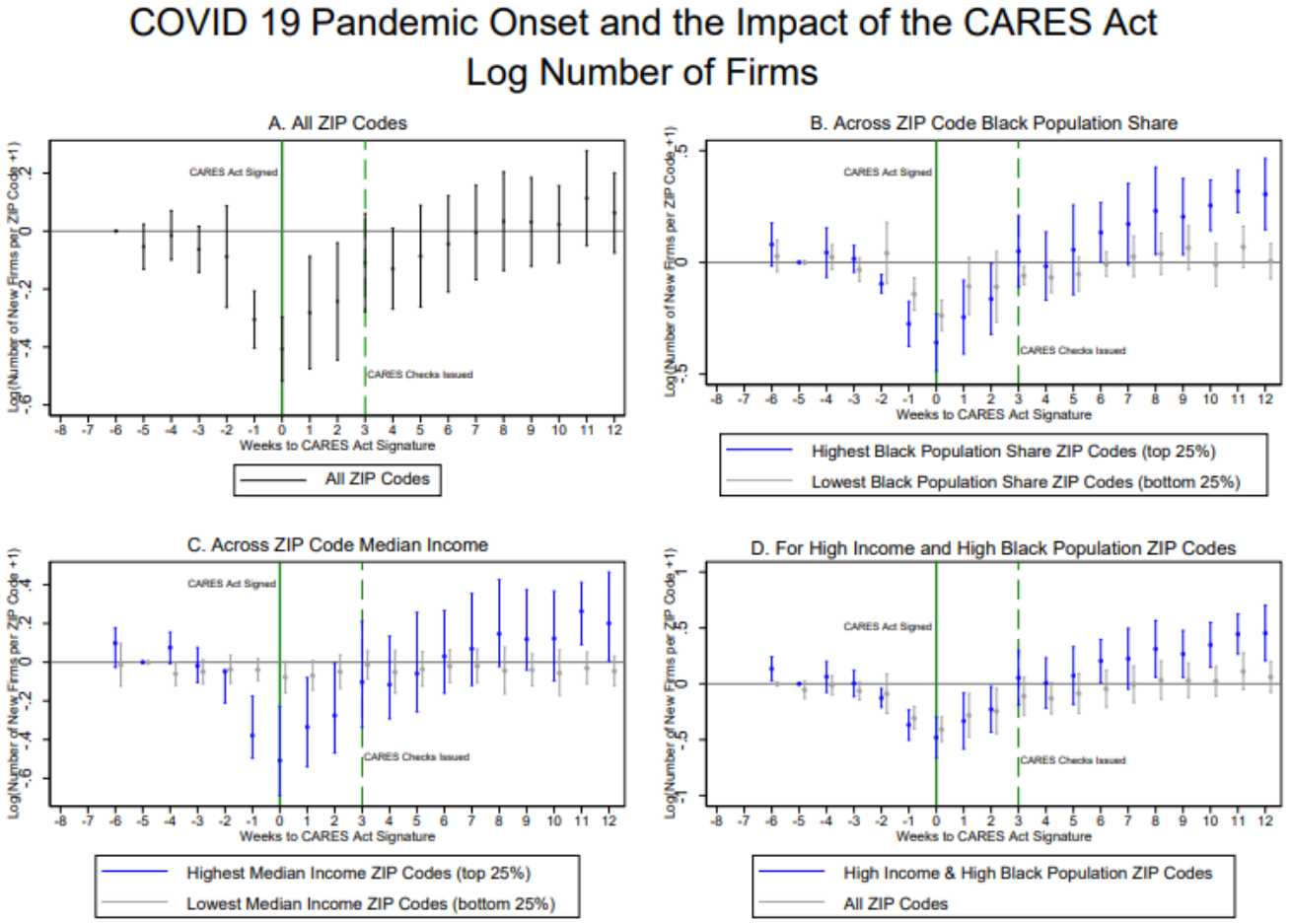
TABLE 3
Local ZIP Code Characteristics and Increase in Entrepreneurship with Controls

	(1) Startup Growth Ratio (Full Year)	(2) Startup Growth Ratio (Full Year)	(3) Startup Growth Ratio (Full Year)	(4) Startup Growth Ratio	(5) Startup Growth Ratio (Full Year)	(6) Startup Growth Ratio (Full Year)
Proportion non-Hispanic Black	0.317***	0.245***	0.231***	0.334***	0.202***	0.186***
	(0.0646)	(0.0377)	(0.0514)	(0.0367)	(0.0392)	(0.0529)
Proportion Hispanic origin	0.00607	0.0434	0.0397	0.0685**	0.0486	0.0446
	(0.0198)	(0.0398)	(0.0498)	(0.0268)	(0.0411)	(0.0504)
Ln(Median Income)	0.967	0.939	1.280	1.232	0.491	0.827
	(0.599)	(0.706)	(1.249)	(0.915)	(0.724)	(1.264)
Proportion non-Hispanic Black # Ln(Median Income)					0.0603***	0.0672***
					(0.0113)	(0.0148)
Persons per square mile	-0.295	0.211	0.317	-0.237	0.177	0.289
	(0.548)	(0.287)	(0.387)	(0.169)	(0.286)	(0.385)
Proportion Bachelor's Degree or Above	-0.0691**	-0.0595*	-0.0642	-0.0514	-0.0502*	-0.0542
	(0.0239)	(0.0270)	(0.0394)	(0.0282)	(0.0246)	(0.0364)
Proportion Below Poverty Level	0.0112	0.00522	0.00258	-0.0189	0.00337	0.00173
	(0.0497)	(0.0371)	(0.0532)	(0.0306)	(0.0382)	(0.0533)
Proportion Owner Occupied Housing	0.0442*	0.0287	0.0183	0.0205	0.0260	0.0130
	(0.0219)	(0.0167)	(0.0170)	(0.0237)	(0.0160)	(0.0143)
Share of Working Age Population	0.00499	-0.0346	-0.0178	-0.0909*	-0.0323	-0.0167
	(0.0411)	(0.0428)	(0.0389)	(0.0413)	(0.0408)	(0.0372)
Log(Population)	0.295	0.0788	-0.235	0.467	0.595	0.274
	(0.756)	(0.942)	(1.426)	(0.751)	(0.997)	(1.520)
First 3 ZIP Code F.E.	No	Yes	No	Yes	Yes	No
First 4 ZIP Code F.E.	No	No	Yes	No	No	Yes
Constant	Yes	No	No	No	No	No
Observations	6919	6914	6774	6638	6914	6774
R^2	0.068	0.124	0.284	0.151	0.128	0.289

OLS Regression. Standard errors clustered by state.
$^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$

(Fazio et al., 2021)

Relationship of CARES Act and the dynamics of the geography of entrepreneurship



(Fazio et al., 2021)