Generative AI and Firm-level Productivity

Evidence from Startup Funding Dynamics

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The transformative power of AI

April 2nd, 2025 - European Central Bank, Frankfurt am Main

In this paper ...

... we provide new empirical and theoretical insights on **the impact of GenAI on firm-level productivity**, in terms of *startup funding* and *employment dynamics*.

... we address the following research questions:

→ Does GenAI increase **startup productivity** and, if so, under which circumstances?

→ What **complementary assets** are needed in order for firms to create and capture value from GenAI?

→ How can firms exploit **valuable but non-exclusive** technological innovation as a source of competitive advantage?

Generative AI to save productivity?

Goldman Sachs

ARTIFICIAL INTELLIGENCE

Generative AI could raise global GDP by 7%

April 5, 2023 Share

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McKinsey & Company

Across 63 use cases, generative AI has the potential to generate $2.6 trillion to $4.4 trillion in value across industries.

Generative AI to save productivity?

FINANCIAL TIMES

Artificial intelligence + Add to myFT

Generative AI set to affect 300mn jobs across major economies

Technology could boost global GDP by 7% but also risks creating 'significant disruption'

A new productivity revolution

The economic benefits of generative AI have only just begun to be felt, say experts. Almost every sector could see gains from using this transformative technology

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Forbes

Unleashing Economic Growth: How Generative AI Is Shaping The Future Of Prosperity

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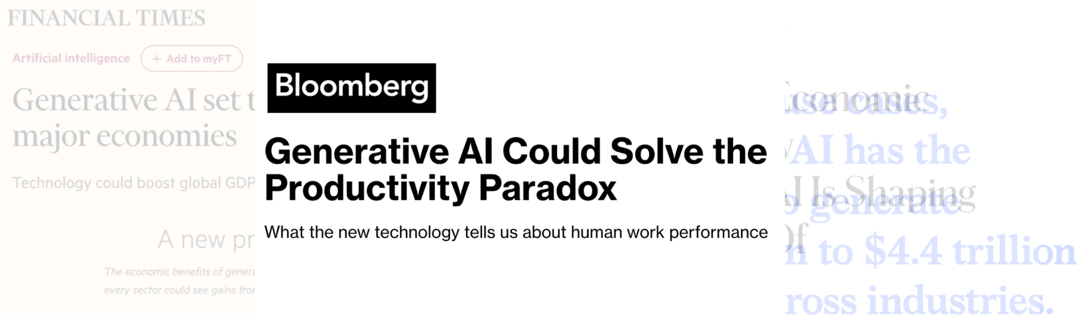

GenAI and productivity - what do we know?

- GenAI is found to boost the productivity of *individuals* by complementing human labor, e.g., in programing, writing, or consulting tasks, ...
  (e.g. Brynjolfsson *et al.*, 2023; Dell'Acqua *et al.* 2023; Noy & Zhang, 2023)
- ... but little is known about its impact in more complex, *organizational* settings.
  (Eisfeldt *et al.*, 2023; Demirci *et al.*, 2025)

→ The effect of GenAI on individual startups is unclear from the *resource-based view*:

- GenAI's task-specific productivity gains may help startups overcome resource constraints, enabling the exploration of business ideas
- GenAI solutions are neither unique, imperfectly imitable, nor controlled by a specific firm, limiting their potential as source of competitive advantage

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Empirical approach

Quasi-natural experiment:

- Identifying event: The release of GitHub Copilot in 2021 as a positive shock to the productivity of software developers.
  → *GitHub Copilot is a GenAI-powered coding assistant*
- Cross-sectional variation: The propensity to respond to the shock depends on how central software development is for a startups' main product or service
  → *Essentially, comparing software-developing and other (software-) startups*

Measurement:

- We measure productivity via funding dynamics, primarily time-to-funding as an early efficiency indicator, and employee counts at funding (Hsu *et al.*, 2007)
- Differences in founding team characteristics (technological and entrepreneurial experience) to assess the role of human resources as complementary assets to GenAI (Colombo & Grilli, 2005; Dencker & Gruber, 2015)

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What we find ...

1. Software-developing startups secure initial funding **20% faster**, while deal sizes remain stable

2. Software-developing startups achieve these funding outcomes with **22% fewer software developers**

3. Effects are driven by startups whose founders have **technological** (e.g. computer science degrees) and **entrepreneurial experience** (e.g. serial founders)

$\Rightarrow$ *Bundling GenAI with complementary human capital can give startups a competitive advantage*

Agenda

1. Data & the empirical setting

2. Estimation strategy, baseline results, and extensions

3. Employment effects and mechanism

4. Implications and conclusion

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Data sources and sample construction

1. Repeated cross-sectional data from Crunchbase
   - → Data on startup, investor, and funding characteristics, incl. deal sizes and timing
   - → Exhaustive sensitivity tests on potential truncation issues (*show*)
2. Snapshot of Revelio Labs employee level data
   - → Highly granular employee-level data on individual characteristics and employment histories, extracted from publicly available professional profiles (mostly LinkedIn)

Sampling: Startups that have raised an initial funding round between Q1 2020 and Q3 2023, from all sectors, headquartered in the US, Canada, or Europe

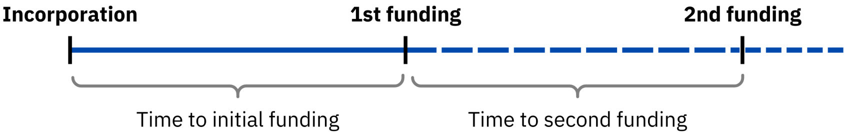
- → Remove startups whose initial round are not early-stage grant or equity investments; cleaning implausible observations following Townsend (2015).

⇒ Final sample: **21 834 startups**, 39 769 investment rounds, 225 508 employees

▸ Sum. stats. ▸ Firm charact. ▸ Deals

Measuring startup productivity via time-to-funding

Measuring productivity via time-to-funding:



- Funding rounds provide some of the first observable data points for evaluating startup performance
- Time-to-funding measures how quickly a startup achieves key milestones required to secure funding (e.g. prototype, customer acquisition) (e.g. Hsu, 2007)

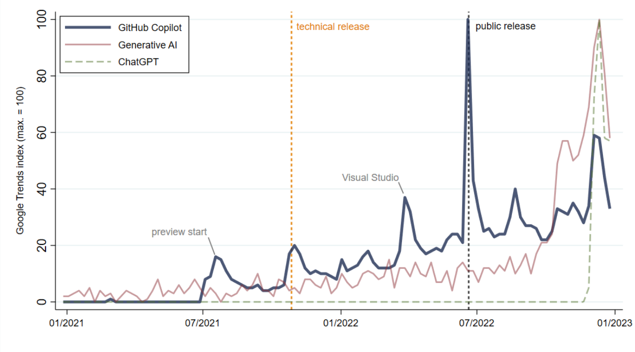
  → *An acceleration in time-to-funding can reflect a productivity increase*

Empirical setting: The release of GitHub Copilot

- Copilot is a GenAI-powered coding assistant developed by GitHub and OpenAI that completes lines of code and generates whole algorithmic solutions
- In February 2023, the share of code generated by Copilot ranged between 46 and 61% for popular coding languages (GitHub, 2023)
- Experimental evidence reports that Copilot leads to an average reduction of 56% in time-to-completion for development tasks (Peng *et al.*, 2023)

Empirical setting: The release of GitHub Copilot

The timeline: Google Search Trends



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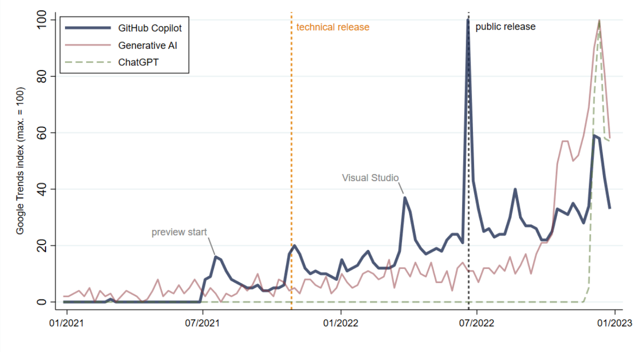

Its properties qualify the GitHub Copilot launch as a quasi-natural experimental setting:

1. The launch is largely unaffected from general trends in GenAI technologies.

Empirical setting: The release of GitHub Copilot

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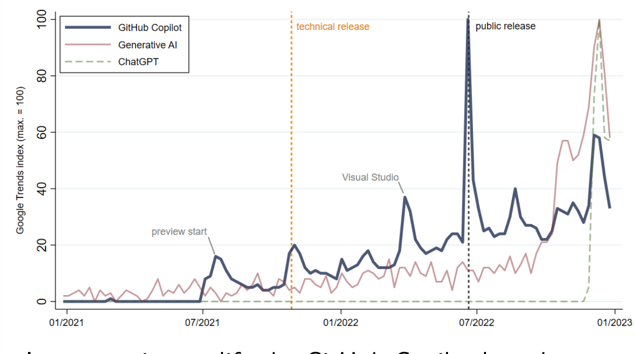
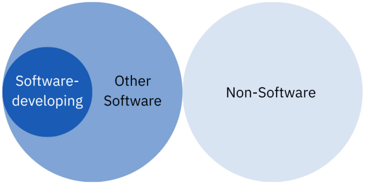


Delineation of treated vs. controls



Its properties qualify the GitHub Copilot launch as a quasi-natural experimental setting:

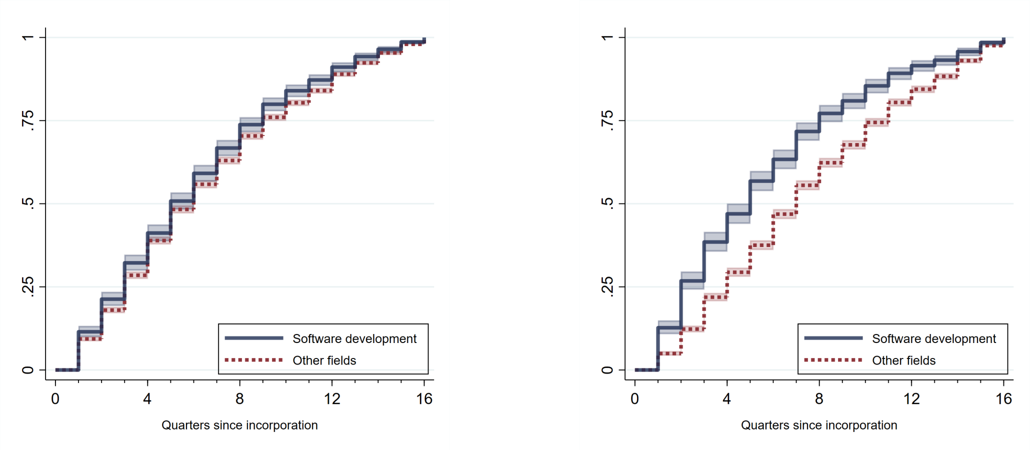
1. The launch is largely unaffected from general trends in GenAI technologies.
2. Unlike other GenAI-related technology shocks, GitHub Copilot has varying effects on startups' productivity, depending on the relevance of software development (*details*).

Descriptive evidence

Cumulative hazard rates: Time-to-funding of software-developing and other startups

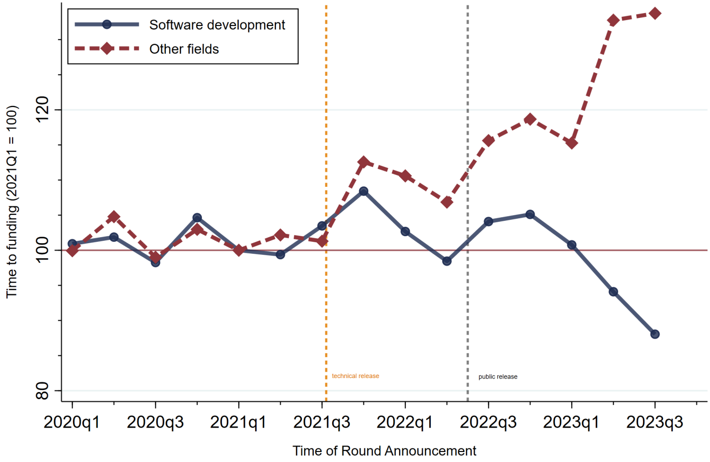
Panel A: Before the GitHub Copilot preview phase

Panel B: After the GitHub Copilot public release



Descriptive evidence

Average time-to-funding, by quarter (indexed)



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Defining the baseline model

The impact of GitHub Copilot on startup productivity as the differential effect on the time-to-funding, comparing software-developing startups with other startups:

$$Y_{ijct} = \beta_1(Developer_i \times Post_t) + \beta X_i + \gamma_t + \delta_c + \mu_j + \epsilon_{ijct}, \tag{1}$$

with

- Y_{ijct}: DV, time-to-funding for startup i, in industry j, in country c, and at time t
- $Developer_i$: Dummy equals one for software- developing startups
- $Post_t$: Dummy equals one for startups that raised initial funding after the Copilot release
- β_1: Average treatment effect
- X_i: Vector of control variables for firm-specific investor characteristics and base variables
- Fixed effects to control for time (γ_t), country (δ_c), and industry (μ_j) specific factors
- ϵ_{ijct}: Error term, standard errors clustered at the startup level

Baseline results

The effect of GitHub Copilot on startups' time-to-funding

Dependent variable:	Time-to-funding					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	-4.793***	-3.815***	-3.843***	-3.073***	-6.189***	-5.360***
	(0.669)	(0.629)	(0.690)	(0.648)	(0.836)	(0.791)
OtherSoftware × Post					-2.107***	-2.178***
					(0.626)	(0.627)
Sample:	Full		Software startups		Full	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	21,834	21,834	16,754	16,754	21,834	21,834
R^2	0.19	0.19	0.18	0.18	0.19	0.19

Baseline results: extensions and robustness tests

Several tests underpin the validity of our main findings:

- Choosing alternative treatment group definitions (*show*)
- Distinguishing between investment types (*show*)
- Placebo tests on regulated industries (*show*)

We also assess several alternative factors that may affect funding:

- Remote labor and Covid-19 (*show*)
- VC market sentiment (*show*)
- ChatGPT release (*show*)

The effect of GitHub Copilot on deal sizes

Dependent variable:	log(*DealSize*)					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	0.097	0.015	0.273**	0.124	-0.046	-0.077
	(0.085)	(0.080)	(0.114)	(0.108)	(0.088)	(0.082)
Sample:	Full		Excluding other software		Software startups	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	14,175	14,175	5,457	5,457	10,936	10,936
R^2	0.33	0.33	0.36	0.36	0.34	0.34

→ Startups raise funding more quickly, but deal-sizes remain stable

The effect of GitHub Copilot in subsequent funding rounds

Dependent variable:	Time-to-funding							
	2nd round				3rd round			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII	(VIII)
Developer × Post	-2.354***	-1.200	-2.312**	-1.276	0.753	1.029	0.453	1.054
	(0.877)	(0.799)	(0.910)	(0.828)	(1.222)	(1.124)	(1.269)	(1.167)
Sample:	Full		Software startups		Full		Software startups	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical	Public	Technical
Additional controls:								
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	12,234	12,234	10,003	10,003	5,701	5,701	4,732	4,732
R^2	0.18	0.18	0.19	0.19	0.21	0.21	0.23	0.23

→ Effects are strongest for earliest stages and vanish at later funding rounds

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Insights from social media, press articles, and aggregate statistics

Chang Kim • 3.+

Currently building something new. Serial entrepreneur (2x ...

3 Monate •

+ Folgen ···

I've recently heard two different stories that illustrate the stark differences in how AI is affecting the job market:

- One startup founder said he $\boxed{\text{laid off two junior engineers.}}$ Now, he's involved in $\boxed{\text{coding himself}}$ (he has a background in software engineering) and uses GPT/Copilot. He mentioned that $\boxed{\text{product development is much faster now}}$ compared to when he had the two junior engineers.

- Out of this year's graduates from a top 50 computer science master's program, $\boxed{\text{only one person received a job offer upon graduation.}}$ One student applied to 60 companies and received zero interview requests—not zero job offers, but zero interviews.

It seems like $\boxed{\text{AI is making experienced, senior professionals more effective}}$ at their jobs, reducing the need for junior employees. But if no one hires juniors, how can anyone become senior?

THE WALL STREET JOURNAL.

Computer-Science Majors Graduate Into a World of Fewer Opportunities

Those from top schools can still get jobs. They are just not all going to Facebook or Google.

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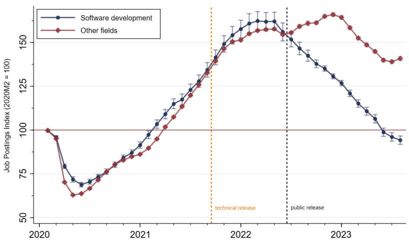
Job postings on *Indeed*, 2020-2023



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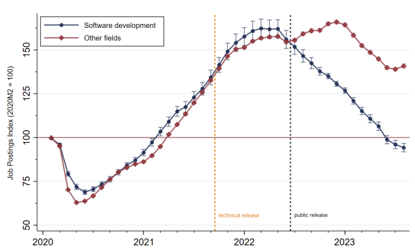
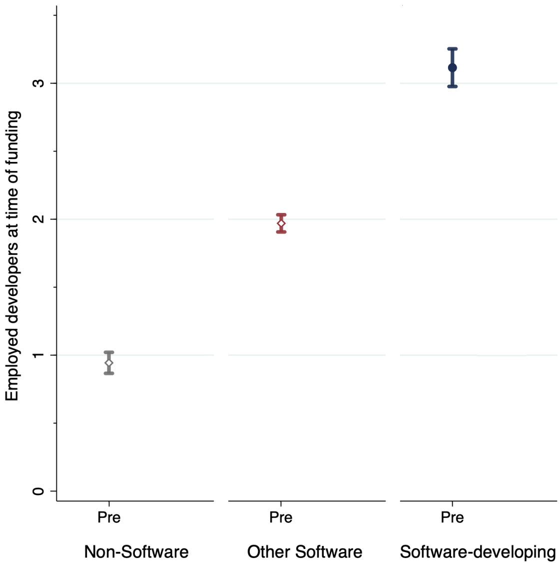


→ Does the release of GitHub Copilot reduce the demand for software developers?

→ Does GenAI make more experienced professionals more effective at their jobs?

Descriptive statistics: Employed software developers at time of funding



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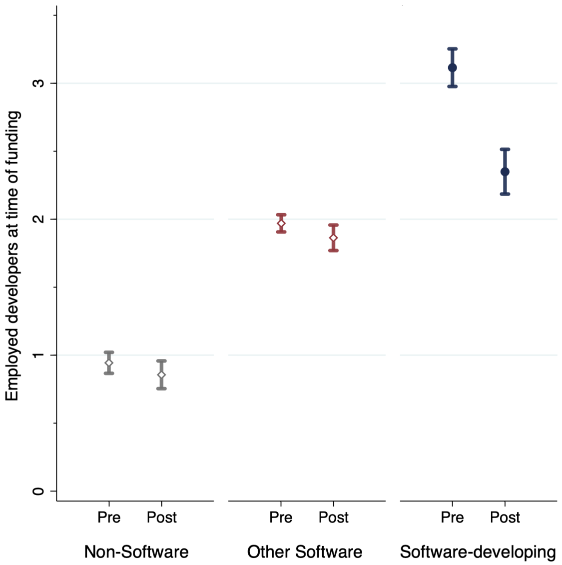

The effect on employed software developers

Dependent variable:	Number of Software Developers					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	-0.568***	-0.427***			-0.630***	-0.436***
	(0.139)	(0.136)			(0.142)	(0.141)
OtherSoftware × Post			-0.050	0.001	-0.052	-0.008
			(0.090)	(0.086)	(0.090)	(0.086)
Sample:	Software startups		Excluding software-developing startups		Full	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	14,139	14,139	15,137	15,137	18,295	18,295
R^2	0.24	0.24	0.24	0.24	0.25	0.25

▸ Time Variations

Founder experience and the productivity effects of GitHub Copilot

Dependent variable:	Time-to-funding							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Developer × Post	-6.796***	-2.040	-6.057**	-1.828	-2.763**	0.605	-4.711**	-2.367
	(2.624)	(1.878)	(2.459)	(2.598)	(1.319)	(2.567)	(2.033)	(1.497)
Experience measure:	Computer degree		Founder age		Crunchbase rank		Serial founder	
Experience (1/0)	= 1	= 0	= 1	= 0	= 1	= 0	= 1	= 0
Additional controls:								
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep. variable:	19.495	22.879	22.643	22.164	19.617	25.496	20.171	23.443
N	958	4,073	1,922	1,699	4,829	4,773	2,855	6,775
R^2	0.34	0.25	0.28	0.33	0.23	0.22	0.25	0.22

→ Effects are driven by startups whose founders have more technological and entrepreneurial experience

→ Successful integration of GenAI depends on the capabilities of the founding team

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Theoretical implications

Can new, generally available technologies - despite being non-rare and imitable - still provide a source of competitive advantage?

- Our results show that, despite lacking some classical properties of valuable assets, GenAI can significantly impact funding dynamics across startups
- Complementarities between founders' human capital (educational & practical experience) and the nature of the new technology determines its firm-specific value

$\Rightarrow$ Valuable but non-exclusive technological innovations *can* provide a source of competitive advantage if firms leverage them as complementary assets to their existing skill set

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Summary and conclusion

We examine the effects of GenAI technologies on startup productivity by exploring the release of GitHub Copilot as a quasi-natural experiment that exogenously affected startups' funding dynamics.

Key takeaways:

1. GenAI has the capabilities to increase productivity at the firm-level
2. Productivity effects are strongest in the earliest stages of startups, when the liabilities of newness and smallnes are strongest
3. Productivity effects are ultimately determined by founders' technological and entrepreneurial experience
4. New non-rival technologies can provide a source of competitive advantage, once combined with human capabilities to form complementary resource bundles

Looking forward to your feedback - Thank you!

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Appendix

Related literature

1. Strategic Management and Entrepreneurship:

- Technology-based resources as a central driver of firms' competitive advantage

  (e.g. Mata *et al.*, 1995; Arora and Nandkumar, 2012; Giustiziero *et al.*, 2023)

  → *GenAI represents a newly available technological resource, but does it yield a source of competitive advantage?*

- The role of founders' human capital in new venture development and growth

  (e.g. Colombo and Grilli, 2005; Unger *et al.*, 2011; Dencker and Gruber, 2015)

  → *We identify founder's technological and entrepreneurial experience as drivers behind GenAI-enabled productivity gains*

- The strategic management of AI in learning, decision-making, and as substitute to human capital

  (e.g. Choudhury *et al.*, 2020; Gaessler and Piezunka, 2023; Krakowski *et al.*, 2023)

  → *We extend the literature from isolated settings (e.g. chess) to the real world*

Related literature

2. The Economics of AI:

- First evidence on the implications of GenAI focuses on the productivity gains of individuals (e.g. Brynjolfsson *et al.*, 2023; Dell'Acqua *et al.*, 2023; Noy and Zhang, 2023)

  → *We analyse firm-level productivity effects*

3. Entrepreneurial Finance:

- The effect of technology shocks (e.g. cloud computing and low-code tools) on startup financing (e.g. Ewens *et al.* 2018; Dushnitsky and Stroube 2021)

  → *We extend prior contributions by exploring a different, though crucially important technology shock*

Summary statistics

	Obs.	Mean	SD	p10	p25	Median	p75	p90
Time-to-funding	21,834	24.468	17.452	5.033	10.833	20.267	35.533	51.700
log(*DealSize*)	14,699	13.586	2.030	10.898	12.206	13.816	15.060	16.002
DealSize (in TUSD)	14,699	3,412	6,307	54	200	1,000	3,470	8,900
Follow-on investment	21,834	0.317	0.466	0	0	0	1	1
Total *DealSize* (in TUSD)	16,402	12,732	87,260	100	300	2,000	6,583	22,401
Developers	21,834	0.165	0.371	0	0	0	0	1
OtherSoftware	21,834	0.776	0.417	0	1	1	1	1
# investors	21,834	2.423	2.932	1	1	1	3	6
Syndicate	18,826	0.305	0.460	0	0	0	1	1
US investors	21,834	0.644	0.479	0	0	1	1	1
European investors	21,834	0.380	0.485	0	0	0	1	1
Remote	21,834	0.615	0.487	0	0	1	1	1
LowPropensity	21,834	0.300	0.458	0	0	0	1	1
Computer Science degree	6,143	0.222	0.415	0	0	0	0	1
Founder rank	10,970	435,486	478,176	49,992	132,923	321,120	648,826	1,008,532
Founder age (since grad.)	4,750	14.760	9.076	4.332	8.006	13.011	20.014	28.019
Founder with exit	10,970	0.084	0.278	0	0	0	0	0
Serial founder	10,970	0.319	0.466	0	0	0	1	1
Founding team size	10,970	1.801	0.909	1	1	2	2	3
Time-to-funding; 2^{nd} round	12,234	32.085	16.755	11.800	18.700	29.667	43.600	56.933
log(*DealSize*); 2^{nd} round	8,519	14.473	2.021	11.562	13.182	14.734	15.847	16.907
Time-to-funding; 3^{rd} round	5,701	38.629	15.749	18.233	26.433	37.700	50.467	61.300
log(*DealSize*); 3^{rd} round	4,126	13.922	2.089	11.842	13.764	15.187	16.497	17.453

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Summary statistics – country distribution

	Obs.	Share (in %)	Cumul. share (in %)
USA	12,217	56.0	56.0
Great Britain	2,540	11.6	67.6
Canada	1,153	5.3	72.9
Germany	1,123	5.1	78.0
France	983	4.5	82.5
Spain	485	2.2	84.7
Switzerland	417	1.9	86.6
Netherlands	400	1.8	88.5
Sweden	365	1.7	90.1
Italy	269	1.2	91.4
Other	1,882	8.6	100.0
Total	21,834	100.0	

back

Summary statistics - firm size distribution

	Obs.	Share (in %)	Cumul. share (in %)
1 - 10	12,188	55.8	55.8
11 - 50	7,097	32.5	88.3
51 - 100	726	3.3	91.7
101 - 250	451	2.1	93.7
251 - 500	101	0.5	94.2
501 - 1,000	44	0.2	94.4
$>$ 1,000	42	0.2	94.6
Unkown	1,185	5.4	100.0
Total	21,834	100.0	

back

Summary statistics - investment types of first deal

	Obs.	Share (in %)	Cumul. share (in %)
Seed	8,438	38.6	38.6
Pre-Seed	6,959	31.9	70.5
VC (series A)	3,060	14.0	84.5
Grants	2,700	12.4	96.9
Angel	460	2.1	99.0
Crowdfunding	217	1.0	100.0
Total	21,834	100.0	

back

Classifying treatment and control groups

Category	*Keywords*	*Example*
Software-developing startups	software-as-a-service, software development kit, machine learning	"world's fastest and most optimal route optimization engine"
Other software startups	e-commerce, webapp, customer relationship management	"an on-demand mobile application that allows consumers to book event vendors in minutes"
Non-software startups	*all other*	"selling of human-grade dog food that is rich in vitamins and minerals"

back

Crunchbase business fields classifying startups

Software-developing startups	"artificial intelligence" "machine learning" "neural network" "deep learning" "algorithm" "saas" "software as a service" "software development kit" "coding" "programming" "script" "natural language processing"
Examples	"focused on simplifying banking by leveraging advanced artificial intelligence techniques"; "world's fastest and most optimal route optimization engine"; "a cloud-based ai platform that helps real estate developers to plan in the early stage of development."
Other software startups (non-developers)	"platform" "software" "application" "application programming interface" "digital" "cloud" "tech" "online" "e-commerce" "database" "webapp" "website" "frontend" "backend" "full-stack" "devops" "paas" "platform as a service" "iaas" "infrastructure as a service" "faas" "function as a service" "virtualization" "automation" "chatbot" "virtual assistant" "analytics" "big data" "data science" "internet of things" "augmented reality" "virtual reality" "mixed reality" "blockchain" "cryptocurrency" "crypto" "smart contract" "server" "microservices" "firmware" "content management system" "customer relationship management" "enterprise resource planning" "integration" "browser extension" "plugin" "interface" "user experience" "user interface" "framework" "library" "version control" "repository" "data visualization" "dashboards" "business intelligence" "virtual machine" "streaming" "encryption" "security" "cybersecurity" "firewall" "virtual private network" "digital transformation" "digital solution"
Examples	"a civic matchmaking tool that matches retirees and those who are about to retire with worthwhile volunteer initiatives"; "an on-demand mobile application that allows consumers to book event vendors for their social events in minutes"; "car rental app platform designed to bring down car ownership and move the full transition to e-mobility forward"
Non-software startups	*all other*
Examples	"selling of human-grade dog food that is rich in vitamins and minerals"; "clinical trial advisory and support services that are founded on a future-ready, flexible, and people-first culture"; "organization of the printing and distribution of 3d printed models for people who are blind"

back

Summary statistics, by industry groups

	Developers		*OtherSoftware*		Non-Software		Differences in means
	Mean	Median	Mean	Median	Mean	Median	Colums I-III
Time-to-funding	20.768	16.6	23.434	19.133	30.017	26.767	-2.666***
log(*DealSize*)	13.650	13.843	13.744	13.931	13.086	13.196	-0.094**
DealSize (in TUSD)	2,854	1,028	3,697	1,122	3,042	538	-842***
Follow-on investment	0.365	0	0.330	0	0.248	0	0.035***
Total *DealSize* (in TUSD)	12,706	2,144	13,807	2,192	9,607	1,152	-1,101
# investors	2.464	1	2.594	1	1.926	1	-0.130**
Syndicate	0.343	0	0.332	0	0.207	0	0.011
US investors	0.647	1	0.645	1	0.640	1	0.002
European investors	0.364	0	0.389	0	0.368	0	-0.024***
Remote	0.994	1	0.649	1	0.242	1	0.345***
LowPropensity	0.164	0	0.285	0	0.441	0	0.121***
Computer Science degree	0.331	0	0.220	0	0.097	0	0.111***
Founder rank	354,462	245,532	428,271	316,614	547,230	446,515	73,809***
Founder age (since grad.)	14.069	12.799	14.872	13.216	15.166	13,674	0.804**
Founder with exit	0.089	0	0.087	0	0.068	0	0.003
Serial founder	0.328	0	0.327	0	0.282	0	0.001
Founding team size	1.921	2	1.792	2	1.708	2	0.129***

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Baseline results - full coefficient table

Dependent variable:	Time-to-funding					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	-4.793***	-3.815***	-5.754***	-5.099***	-3.843***	-3.073***
	(0.669)	(0.629)	(0.849)	(0.803)	(0.690)	(0.648)
Developer	1.835***	2.317***	-0.014	0.660	1.565**	1.960***
	(0.692)	(0.734)	(1.774)	(1.802)	(0.698)	(0.743)
# investors	-0.401***	-0.402***	-0.383***	-0.380***	-0.325***	-0.325***
	(0.039)	(0.039)	(0.079)	(0.079)	(0.040)	(0.041)
US-based investors	3.550***	3.562***	4.029***	4.006***	3.482***	3.505***
	(0.542)	(0.542)	(0.910)	(0.908)	(0.595)	(0.595)
European-based investors	3.384***	3.365***	4.130***	4.044***	2.680***	2.665***
	(0.483)	(0.483)	(0.820)	(0.818)	(0.524)	(0.523)
Constant	22.338***	22.334***	23.841***	23.926***	21.007***	20.995***
	(0.454)	(0.454)	(1.039)	(1.039)	(0.498)	(0.498)
Sample:	Full		Excluding other software		Excluding non-software	
Treatment definition (release):	Public	Technical	Public	Technical	Public	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry groups	Yes	Yes	Yes	Yes	Yes	Yes
N	21,834	21,834	8,521	8,521	16,754	16,754
R^2	0.19	0.19	0.23	0.23	0.18	0.18

back

Robustness Test: Remote work and COVID-19

Dependent variable:	Time-to-funding					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Remote × Post	-1.012	-0.859		0.603	-0.863	
	(0.684)	(0.624)		(1.388)	(1.328)	
Remote × Covid			0.694			0.250
			(1.197)			(2.392)
Sample:	Software startups			Non-software startups		
Post definition:	Public	Technical	-	Public	Technical	-
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	16,754	16,754	16,754	4,662	4,662	4,662
R^2	0.18	0.18	0.18	0.20	0.20	0.20

back

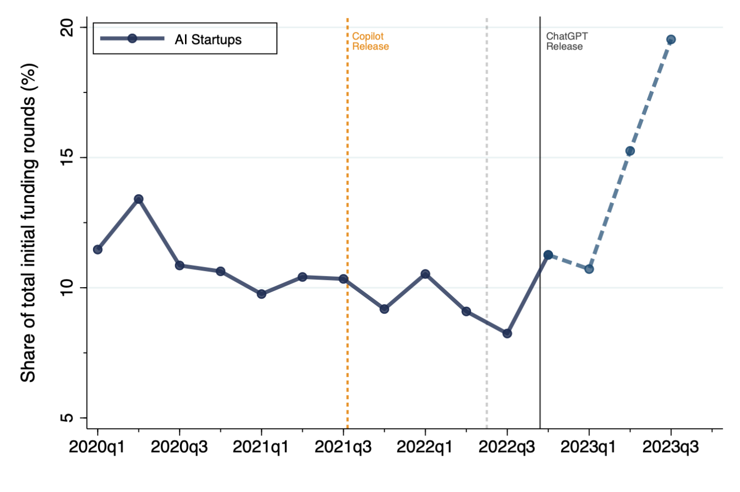
Robustness Test: VC market sentiment

Dependent variable:	Time-to-funding					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × VC sentiment	0.200***	2.373**	-0.133	0.168***	2.380*	-0.801
	(0.039)	(1.206)	(1.005)	(0.041)	(1.247)	(1.045)
Sample:	Full			Software startups		
VC sentiment definition:	Continuous	Hot market	Cold market	Continuous	Hot market	Cold market
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	18,295	18,295	18,295	13,986	13,986	13,986
R^2	0.19	0.19	0.19	0.19	0.19	0.19

back

Robustness test: VC Hype for AI startups

Share of AI startups among total initial funding rounds



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Robustness test: Release of ChatGPT

Dependent variable:	Time-to-funding					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	-2.169***	-2.093***	-2.094**	-1.869**	-2.023***	-1.785**
	(0.836)	(0.661)	(0.865)	(0.712)	(0.743)	(0.767)
Sample (timeframe):	Pre ChatGPT 4.0				Pre initial ChatGPT release	
Sample (firms):	Full		Software startups		Full	Software startups
Post definition (release):	Public	Technical	Public	Technical	Technical	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	18,768	18,768	14,511	14,511	17,092	13,235
R^2	0.18	0.18	0.18	0.18	0.18	0.18

back

Robustness Test: Alternative treated group

Dependent variable:	Time-to-funding							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII	(VIII)
$\text{Developer}^{\text{profile}} \times$ Post	-4.219***	-3.086***	-5.230***	-4.471***				
	(0.642)	(0.605)	(0.846)	(0.802)				
$\text{Software}^{\text{broad}} \times$ Post					-2.434***	-1.573***	-5.747***	-5.135***
					(0.543)	(0.507)	(0.849)	(0.802)
Sample:	Full		Excluding other software		Full		Excluding other software	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical	Public	Technical
Additional controls:								
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	21,834	21,834	8,521	8,521	21,834	21,834	8,521	8,521
R^2	0.19	0.19	0.24	0.23	0.19	0.19	0.23	0.23

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Robustness Test: Controlling for investment types

Dependent variable:	Time-to-funding							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII	(VIII)
$Developer^{profile} \times Post$	-3.720*** (0.644)	-2.955*** (0.599)	-3.265*** (0.664)	-2.606*** (0.617)	-3.008*** (0.674)	-2.359*** (0.575)	-3.120*** (0.697)	-2.468*** (0.643)
Investment types:	All early-stage investment types				Seed and venture capital rounds			
Sample:	Full		Software startups		Full		Software startups	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical	Public	Technical
Additional controls:								
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Investment type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	21,834	21,834	16,754	16,754	18,238	18,238	14,661	14,661
R^2	0.25	0.25	0.24	0.24	0.26	0.26	0.25	0.25

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Placebo test: Regulated industries and GitHub Copilot

Dependent variable:	Time-to-funding					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Biotech × Post	-0.228					
	(1.057)					
Healthcare × Post		0.992				
		(0.830)				
Governmental × Post			4.045			
			(6.534)			
Energy × Post				-2.569		
				(2.329)		
Transportation × Post					2.114	
					(1.560)	
LowPropensity × Post						0.788
						(0.710)
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	16,754	16,754	16,754	16,754	16,754	16,754
R^2	0.18	0.18	0.18	0.18	0.18	0.18

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GitHub Copilot and subsequent funding sizes

Dependent variable:	log(*DealSize*)							
	2^{nd} round				3^{rd} round			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII	(VIII)
Developer × Post	-0.119	-0.005	-0.091	0.018	-0.052	-0.052	-0.096	-0.085
	(0.113)	(0.104)	(0.117)	(0.107)	(0.164)	(0.148)	(0.172)	(0.155)
Sample:	Full		Software startups		Full		Software startups	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical	Public	Technical
Additional controls:								
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8,194	8,194	6,750	6,750	3,943	3,943	3,291	3,291
R^2	0.35	0.35	0.37	0.37	0.44	0.44	0.45	0.45

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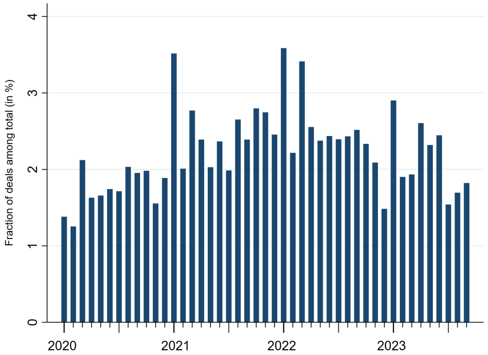
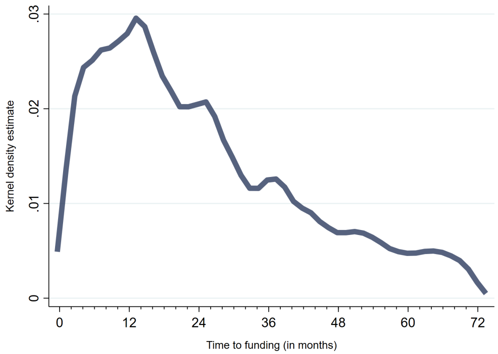
Summary statistics

Panel A: Distribution of initial funding rounds



Panel B: Kernel density distribution



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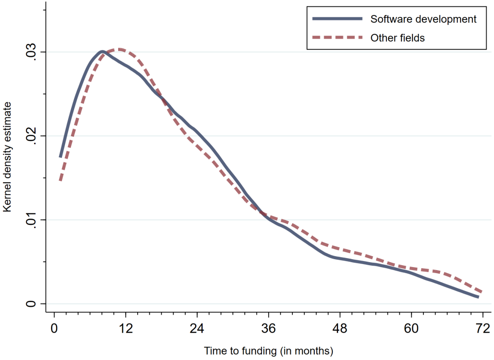
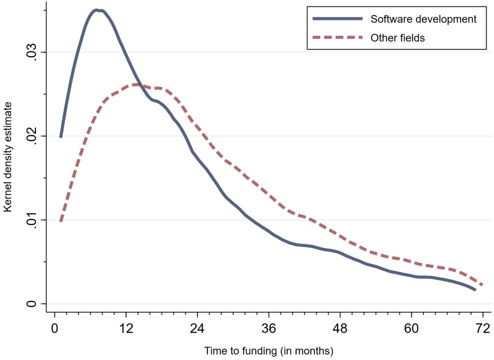
Descriptive statistics: Kernel density estimates

Time-to-funding of software-developing and other startups

Panel A: *Before* the Copilot preview phase



Panel B: *After* the Copilot public release



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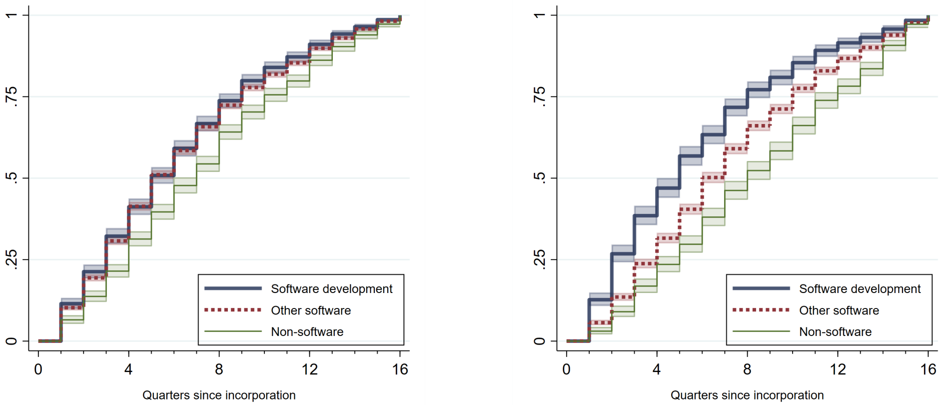
Descriptive statistics: Nelson-Aalen estimates, by industry

Cumulative hazard rates on the time-to-funding, by industry

Panel A: *Before* the Copilot preview phase **Panel B:** *After* the Copilot public release



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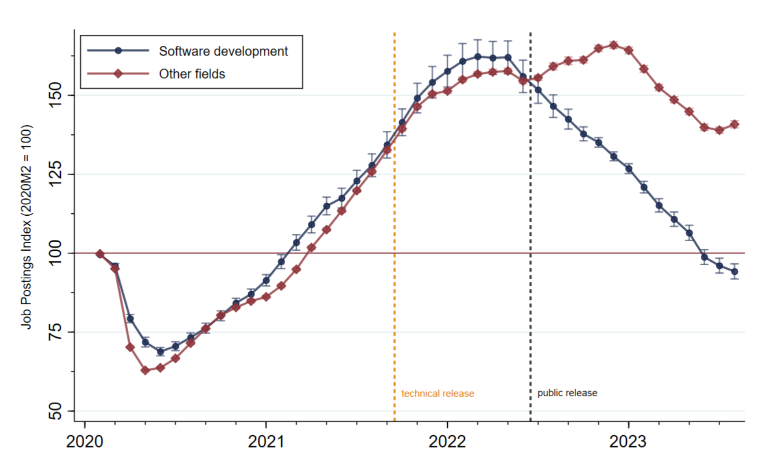
Descriptive insights from job postings

Job postings on *Indeed*



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Mechanism: Log number of software employees at time of funding

Dependent variable:	Log Number of Software Developers					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	-0.165***	-0.143***			-0.190***	-0.157**
	(0.048)	(0.045)			(0.068)	(0.064)
OtherSoftware × Post			-0.027	-0.026	-0.024	-0.022
			(0.059)	(0.055)	(0.059)	(0.055)
Sample:	Software startups		Excluding software-developing startups		Full	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	7,702	7,702	6,759	6,759	8,910	8,910
R^2	0.19	0.19	0.18	0.18	0.19	0.19

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Mechanism: Software employees X quarters after incorporation

		Number of Software Developers		
	Time	Pre	Post	Difference
Developers	1 quarter	1.668	1.092	-0.577***
		(0.107)	(0.079)	(0.139)
	3 quarters	2.796	1.822	-0.974***
		(0.136)	(0.124)	(0.199)
	6 quarters	4.656	2.864	-1.792**
		(0.103)	(0.180)	(0.703)
OtherSoftware	1 quarter	1.180	0.826	-0.355**
		(0.073)	(0.073)	(0.110)
	3 quarters	2.034	1.348	-0.686***
		(0.085)	(0.104)	(0.138)
	6 quarters	3.130	2.004	-1.126***
		(0.124)	(0.124)	(0.124)

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Mechanism: Software employees X quarters after incorporation

	Number of Software Developers					
	(I)	(II)	(III)	(IV)	(V)	(VI)
Developer × Post	-0.311**	-0.275*	-0.545***	-0.394**	-0.352*	-0.356*
	(0.130)	(0.150)	(0.165)	(0.180)	(0.188)	(0.187)
OtherSoftware × Post	-0.132*	-0.117	-0.311***	-0.251**	-0.282***	-0.220*
	(0.078)	(0.092)	(0.099)	(0.115)	(0.108)	(0.116)
Time after incorporation:	1 quarter		3 quarters		6 quarters	
Post definition (release):	Public	Technical	Public	Technical	Public	Technical
Additional controls:						
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	10,617	10,617	10,648	10,648	13,250	13,250
R^2	0.22	0.22	0.25	0.25	0.28	0.28

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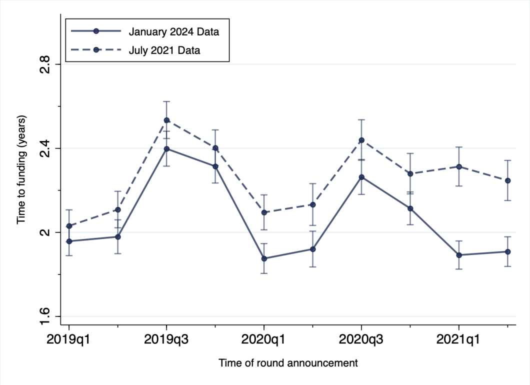
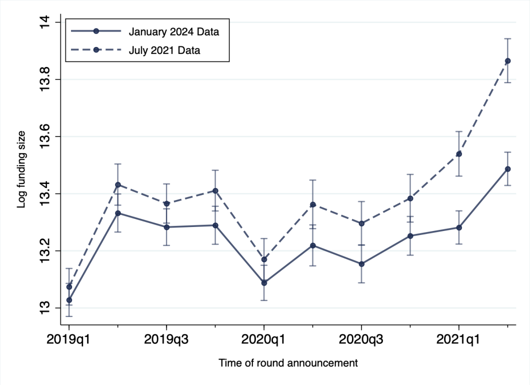
Truncation issues in the Crunchbase data

Comparison of January 2024 and July 2021 data

Panel A: Time to initial funding



Panel B: Log initial funding size



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Crunchbase truncation issues: Quarterly breakdown of funding data

Quarter	# of Rounds		Avg. Size		Median Size		Avg. Time		Avg. Investors	
	Jul'21	Jan'24	Jul'21	Jan'24	Jul'21	Jan'24	Jul'21	Jan'24	Jul'21	Jan'24
2019q1	2479	2862	1.84	1.67	0.48	0.43	2.26	2.20	1.75	1.71
2019q2	2115	2414	2.43	2.22	0.80	0.70	2.30	2.16	2.01	1.95
2019q3	2192	2442	2.32	2.17	0.65	0.60	2.62	2.51	2.00	1.92
2019q4	2137	2421	2.43	2.23	0.76	0.65	2.56	2.48	2.11	2.07
2020q1	2065	2602	2.16	1.93	0.54	0.50	2.31	2.14	2.02	1.97
2020q2	1569	2039	2.37	2.05	0.68	0.53	2.36	2.16	2.16	1.95
2020q3	1724	2278	2.09	1.91	0.62	0.50	2.53	2.37	2.41	2.26
2020q4	1615	2267	2.39	2.03	0.75	0.60	2.42	2.26	2.56	2.42
2021q1	1791	2964	2.74	2.17	1.00	0.60	2.50	2.13	2.68	2.53
2021q2	1655	2922	3.04	2.36	1.26	0.76	2.43	2.10	3.31	2.72
2021q3	185	2983	3.72	2.24	1.82	0.70	3.00	2.45	3.44	2.72
2021q4		3445		2.74		1.00		2.57		3.03
2022q1		3663		2.69		1.00		2.34		2.91
2022q2		3186		2.66		1.00		2.27		3.04
2022q3		2596		2.72		1.00		2.80		3.00
2022q4		2515		2.70		1.00		2.76		3.00
2023q1		2308		2.79		1.00		2.64		2.57
2023q2		2499		2.47		0.60		2.57		2.42
2023q3		1914		2.81		1.00		3.11		2.68
2023q4		1636		3.11		1.31		3.07		2.78

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