

The Ripple Effects of COVID-19 on Emerging Technologies

How the crisis is affecting the startup ecosystem

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Key takeaways

- Venture-backed startups are particularly vulnerable to recessions and economic slowdowns. In addition to the overall drop in demand, startups are unlikely to have significant revenue; they have immature operational infrastructure, and they must rely on outside capital (usually venture) to fund operations and growth.
- While the funding environment for tech startups already appeared to be tightening following WeWork's failed IPO, we expect continued contraction in the current environment as venture investors adjust to working remotely and begin scrutinizing deals more closely.
- During the Great Recession, venture investment declined 28% from the pre-recession peak. However, deal volume was more resilient, falling only 5%. This time around, the growth and maturity of the VC ecosystem and federal stimulus efforts could help mitigate the downturn.
- Across our coverage, we expect the healthtech, foodtech, IoT and mobility tech verticals to be the most significantly affected by the current pandemic. We expect the insurtech and fintech verticals to experience a moderate-to-significant impact, while AI & ML and supply chain tech verticals should experience moderate impact. We expect cloudtech & DevOps and information security tech (infosec) to experience a low impact.
- We expect very early-stage investment activity to remain relatively active and note angel & seed deal count actually increased during the Great Recession. We provide a snapshot of the current funding stage mix (i.e. angel & seed, early- and late-stage) of startups in each vertical.

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Determinants of survivability

Startups are especially vulnerable when the economy weakens. Headed into a recession, VC-backed companies are unlikely to have significant revenue and may not be profitable. These companies will face significant challenges as they struggle to ramp up production, operations and sales functions at a time when demand is weak and customers are scarce. While VC helps fuel these initiatives in normal times, investors tend to be more conservative and scrutinize deals more closely during times of economic contraction.

[Prior research](#) from PitchBook demonstrates that during the Great Recession, not only did venture investment slow, but time between investments expanded while valuations declined, suggesting that even companies that did raise money had to bootstrap longer than they may have otherwise. On the positive side, our research shows that angel & seed-stage deal activity was flat to positive during the recession, and that the [best performing VC vintages](#) were those that invested at the depths of a recession and into a recovery.

While expectations are for the current crisis to have a larger near term economic impact than the Great Recession, the depth and severity of the recession that follows will significantly impact the durability of the startup ecosystem. Were the economy expected to “snap back,” VCs would likely be more willing to backstop current investments in the interim and fund new ventures. A drawn-out recession, however, could have a more widespread impact on VC strategies and portfolio allocations. The nature of the current crisis—a global health pandemic that has shut down entire industries for an indeterminate period—adds incalculable complexity.

Despite this uncertainty, there are several mitigating factors worth noting. First, relative to the last downturn, the current VC industry is larger, better understood and more liquid. Today’s VC ecosystem includes several nontraditional investors such as pension funds, equity hedge funds and corporate VC (CVC); and the development of the secondaries market provides more liquidity opportunities for investors and shareholders. Second, the digital revolution over the past decade will make it easier for new startups to continue operations remotely as well as introduce new products via digital channels. Lastly, unprecedented federal stimulus in the form of working capital loans, as well as an outpouring of support from vendors to relax payment terms and provide free services will help lessen the blow. While the full impact of the crisis is unknowable and is changing fast, we expect near and mid-term impacts to be as follows:

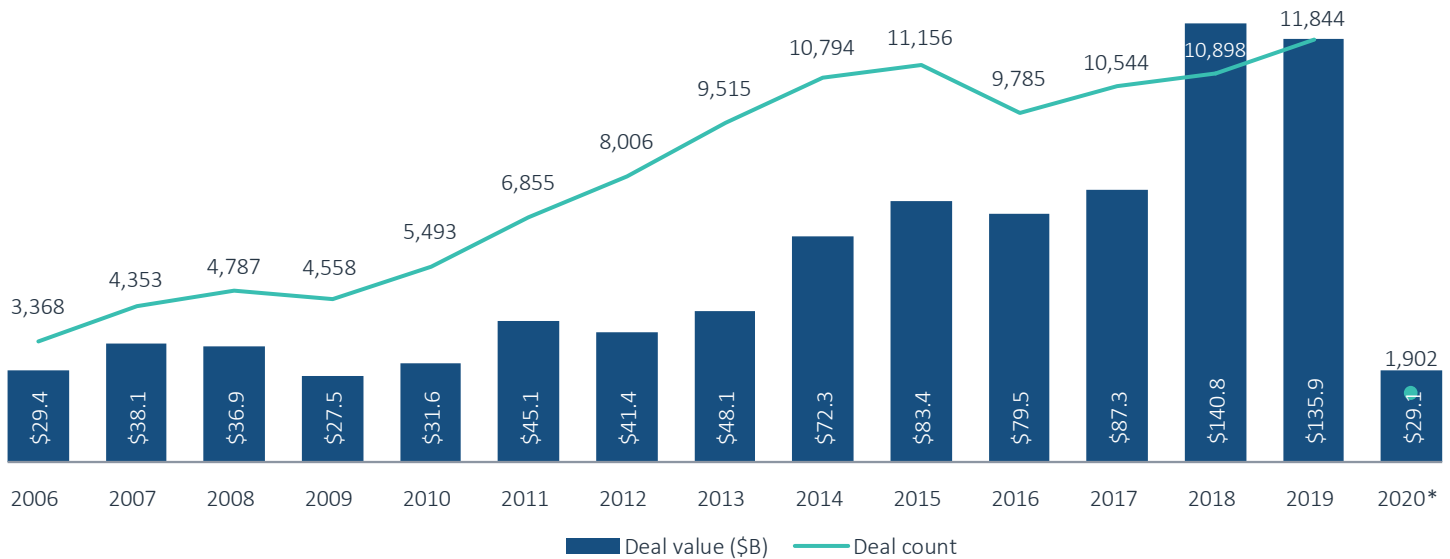
- VCs are more likely to favor enterprise startups that offer longer-term SaaS contracts and easy remote onboarding. Retail transactional businesses may have a harder time finding investors given the massive pullback in consumer activity and the nature of the pandemic keeping people home.
- While non-traditional and crossover venture investors (i.e., pension funds, hedge funds, corporate venture arms) help broaden the capital base, they may be slower to come back to the VC industry given the need to focus on other priorities impacting their portfolios.

- Later-stage startups that have completed many rounds are likely to see the most significant valuation reductions as they are more often valued relative to public markets. These firms will also have to contend with complicated down-round accounting related to liquidation preferences that could make larger deals harder to close. However, these companies will likely have an easier time accessing stimulus-related debt capital or other loans. The “staying private longer” debate is likely to receive more attention as investors focus on whether later-stage startups should have completed an IPO sooner.
- While stimulus efforts could prove to be valuable lifelines for startups, early-stage tech startups may not have the same access to these facilities given lower ability to provide guarantees.

Venture capital during the Great Recession

US venture funding declined 28% during the Great recession from the peak of \$38 billion in 2007 to \$27 billion in 2009. A similar-sized decline from 2019 VC funding levels of \$136 billion implies the industry could shrink by about \$39 billion—larger than the entire market in 2007. While deal value declined, deal count peaked in 2008 and only declined 5% in 2009, implying VCs were still active, though deal sizes were generally smaller.

VC deal activity



Source: PitchBook | Geography: US
*As of March 17, 2020

Across all stages, deal count and deal value generally increased for angel & seed-stage startups but declined for both early- and late-stage startups. This is not surprising considering the much lower average deal size for angel & seed (less than \$1 million) relative to early-stage (less than \$4 million) and later-stage (about \$8 million) deals during the recession. It may also reflect higher failure rates among early- and late-stage startups unable to grow and scale in a weak demand environment. Whereas angel & seed startups may require less funding

to stay afloat during difficult times, later-stage startups have higher cash burn rates that VCs may be less willing to support when hockey stick growth appears less likely.

VC activity during the Great Recession by stage*

DEAL COUNT	2007	2008	2009	DECLINE FROM PEAK
Angel & seed	792	930	1,246	(did not decline)
Early stage	2,130	2,291	1,860	-18.8%
Late stage	1,431	1,566	1,452	-7.3%

DEAL VALUE (\$B)	2007	2008	2009	YOY CHANGE FROM 2008
Angel & seed	\$0.9	\$0.9	\$1.2	(did not decline)
Early stage	\$14.7	\$14.9	\$9.6	-35.1%
Late stage	\$22.4	\$21.2	\$16.6	-26.1%

MEDIAN DEAL SIZE(\$M)	2007	2008	2009	YOY CHANGE FROM 2008
Angel & seed	\$0.8	\$0.6	\$0.5	-33.3%
Early stage	\$4.0	\$3.8	\$3.0	-25.6%
Late stage	\$9.6	\$8.0	\$6.2	-34.9%

Source: PitchBook | Geography: US

*As of March 17, 2020

Note: Peak years are shaded

Coronavirus impacts across PitchBook's Emerging Technology Research coverage

VERTICAL	VC RAISED IN 2019 (\$B)	CRISIS IMPACT
Healthtech & wellness	\$8.6	Significant
Foodtech	\$13.5	Significant
Mobility tech	\$33.5	Significant
IOT	\$7.5	Significant
AI & ML	\$38.3	Moderate
Insurtech	\$6.2	Moderate to significant
Fintech	\$37.7	Moderate to significant
Supply chain tech	\$10.4	Moderate
Cloudtech & DevOps	\$6.2	Low
Infosec	\$6.8	Low

Source: PitchBook | Geography: Global

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Vertical coverage: Retail health and wellness tech

Description: The retail health and wellness tech vertical contains companies that deliver healthcare products and services that are primarily delivered and/or consumed outside of the hospital or physician's office. These companies offer a wide-ranging suite of B2C offerings, including preventative and monitoring tools for consumers, dietary supplements and products that enable the burgeoning "healthcare at home" movement, which allows patients more flexibility and convenience in how they manage personal care (i.e. telemedicine, blood testing, genomic tests).

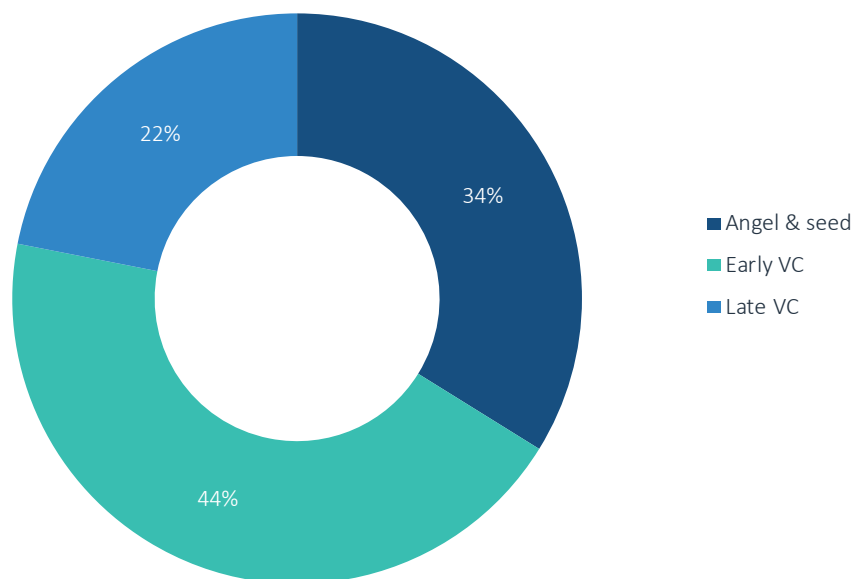
Key product categories: Virtual health, mobile and digital health, biometric wearables & devices, dietary supplements, and OMICS & personalized medicine.
2019 VC raised: \$8.6 billion

Key VC-backed startups: Roman Health, Before Brands, Thrive Global, Mirror, Singular Gemonics, Everly Well, Flo Health

Latest research: [Q4 2019 Emerging Tech Research: Wellness Tech](#) and [Q4 2019 Emerging Tech Research: Healthtech](#)

Coronavirus impact: Significant

Healthtech startup funding mix by stage*



Source: PitchBook | Geography: Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Changing legislation propels telemedicine: Telemedicine startups in the US are experiencing a surge in demand amid the coronavirus outbreak, aided by a push from the federal government to remove restrictions on telehealth services for elderly Medicare patients and health insurers temporarily waiving telemedicine costs. The volume of virtual visits roughly doubled for AI-enabled telehealth platform 98point6, and virtual clinic usage at Amwell (formerly American Well) has surged roughly 40% since the start of the outbreak. Startup Ro said it has seen “significant” growth in coronavirus-related online visits. The coronavirus crisis could catalyze longer-term growth in telehealth as adoption grows, providers encourage its use and customers become more familiar with the technology.

Increased government investment: We expect to see increased government investment in healthcare technology as legislators prioritize public health over lingering privacy concerns. This could boost investment in centralized disease tracking, telemedicine and health records.

Increased scrutiny of PE-led buyouts of nursing facilities: Currently, 70% of US nursing homes are run for profit, and PE activity in the industry has jumped in recent years.¹ The pandemic has put a spotlight on how PE-driven cost-cutting can affect outcomes at nursing facilities. Studies have shown a link between PE buyouts and higher patient to nurse ratios, lower-quality care, declines in patient health outcomes and weaker performance on inspections.²

Surge in demand for mental wellness applications: As pandemic anxieties worsen, mental health startups have experienced increased demand. Average hours spent on mental health and fitness apps spiked about 30% in the US from December 29 to March 1. Headspace experienced double the average amount of inbound requests from members looking for content to help them cope with pandemic-related stress and a 100% increase in corporate clients seeking support for their employees’ mental wellbeing.³ We expect the crisis could help drive longer-term interest among corporate clients to ensure mental health products are available to employees.

Marketplace fitness platforms experience a drop in revenue: As gyms close and consumers practice social distancing, marketplace platforms that connect consumers to workout facilities have experienced a drop in usage. As a result, of the closures marketplace platforms are being forced to allow customers to pause their membership or risk being categorized as having bad consumer service. For example, ClassPass is allowing consumers the option to pause memberships and rollover credit through June 1, 2020.

Increased demand for at-home fitness applications and devices: As gyms around the country close, individuals are forced to transition to at-home workout and fitness devices and applications are gaining traction. Peloton’s stock has outperformed as investors have responded to increased demand for its at-home fitness products. In addition, several workout applications are offering free trials. For example, DownDog is offering free access for everyone until April 1, 2020. While providing free access does not inherently generate

1: “Private-Equity Takeover of Nursing Homes has Reduced Quality of Care at Critical Moment, Research Suggests,” Market Watch, Eleanor Laise, March 14, 2020.

2: Ibid.

3: According to Megan Jones Bell, Headspace’s chief science officer

revenue, it may result in long-term customers in the future. As consumers adopt at-home workouts, they may be slow to move back to the same frequency of gym use after the crisis has passed.

Spike in demand for hospital robotic and remote monitoring device

innovation: Although the pandemic will one day end, we expect it to have major implications on healthcare technology, spurring rapid adoption and innovation of robotics and remote patient monitoring devices. BioIntelliSense's BioSticker wearable sensor, which was released earlier this year, is being used to monitor a patient's respiratory rate, heart rate, and skin temperature, as well as the frequency of their coughing, sneezing and vomiting. Additionally, Providence Regional Medical Center in Everett, WA used a telemedical robot (Vici robot from InTouch Health) to take vitals from and interact with the first diagnosed case of coronavirus in the US. We expect that in the near term, telemedical robots will be used in a select few use cases; however, we have a favorable long-term outlook on the technology which promises to streamline basic diagnostic tasks.

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Vertical coverage: Foodtech

Description: This vertical includes startups that are changing the way food has traditionally been discovered, purchased, delivered, prepared and consumed.

Key product categories: Ghost kitchens, online grocers, apps & marketplaces, delivery robots, and kitchentech and robotics

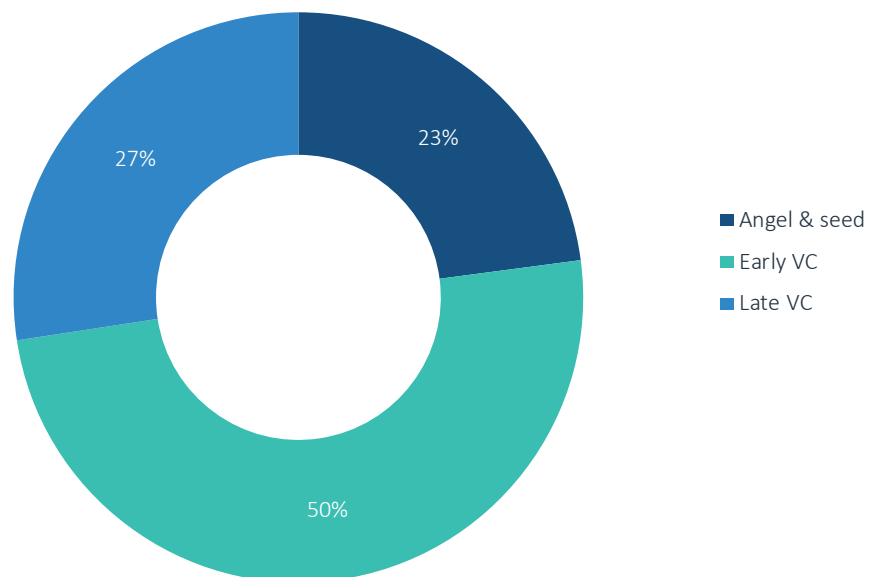
2019 VC raised: \$13.5 billion

Key VC-backed startups: Kitchen United, Boxed, goPuff, Instacart, Doordash, Starship, Picnic

Latest research: [Q4 2019 Emerging Tech Research: Foodtech](#)

Coronavirus impact: Significant

Foodtech startup funding mix by stage*



Source: PitchBook | **Geography:** Global
*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

A clear catalyst for delivery services: Widespread government-mandated restaurant closures and consumer quarantining is driving unprecedented demand for grocery and food delivery services. Startups that could benefit from this spike include Instacart, DoorDash and Drizly. While demand for delivery could recede after the recession, we expect the market will expand permanently as more consumers become accustomed to food delivery. This could increase venture interest across the food delivery ecosystem for technologies that improve the speed, capabilities and efficiency of delivery, such as ghost kitchens, delivery robots and kitchentech.

Ghost kitchen model could become more strategic: Demand for ghost kitchen facilities will likely spike in the short term as restaurants seek to offer delivery services to offset declining in-store business. However, this will likely do little to alleviate current issues facing restaurants, as the ghost kitchen business model is new and not widely available. In the longer term, restaurants may take a more strategic view of ghost kitchens, driving more demand for the service (see our related note [here](#)).

Online grocery could see permanent share gains: The crisis has driven a surge in demand for online grocery services as consumers are told to stay home and self-isolate. Online grocer Farmstead reported 70% growth rates, which the CEO attributed primarily to the current situation in a mid-March interview with The Spoon.⁴ Even shortages of stock and late deliveries will not be enough to deter demand as consumers may have few alternatives, enabling providers to fine-tune business models with less risk of losing customers. While grocery delivery may see permanent market share gains from the crisis, we expect few startups will be able to raise new financings to compete in the space given large providers have significant moat advantages.

Kitchen robotics and automation offer long-term solutions but little immediate impact from crisis: While kitchen automation and robotics could help reduce labor costs, high up-front costs and long implementation means it will likely do little to alleviate the immediate demand issues facing restaurants. Longer-term, we expect investors to remain committed to kitchentech. Automation tech such as pizza making robots could still help scale production and reduce labor costs. This will be most useful for large chain restaurants that are more likely to survive the pandemic and are capable of rebuilding more quickly than for small mom and pop restaurants.

Meal kits to get a temporary boost, but long-term risks remain: Meal kit providers have struggled in recent years as consumer demand has waned. Blue Apron saw net revenue drop 32% in 2019, and its stock price fell from a high of around \$29 to a low of about \$2 in early 2020. After Blue Apron announced the global pandemic is driving an uptick in demand, the stock has rallied to over \$14. The demand for delivery services could breathe life into ailing meal kit companies, providing a second chance to build a more durable product-market fit with consumers. However, we continue to have longer-term doubts about the sustainability of the business and do not expect a resurgence in VC activity.

⁴: "Online Grocer Farmstead Seeing 70 Percent Growth, Doubling Headcount to Keep Up," The Spoon, Chris Albrecht, March 17, 2020.

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Vertical coverage: Mobility tech

Description: This vertical includes companies that provide technologies and services that are disrupting the transportation, automotive and shipping industries. Digital economy, mobile connectivity, electric vehicles and autonomous driving technologies are driving new business opportunities to provide transportation solutions that are lower cost and more convenient for consumers and businesses.

Key product categories: Autonomous vehicles, ridesharing, micromobility, connectivity & fleet management, delivery, electrification, auto commerce, and urban air mobility.

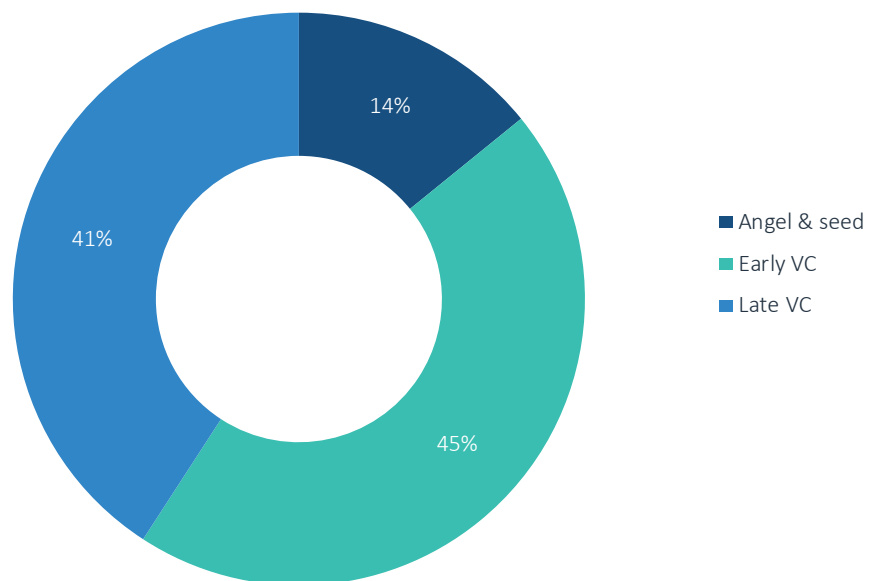
2019 VC raised: \$33.5 billion

Key VC-backed startups: Didi Chuxing, Grab, DoorDash, Bird, Lime

Latest research: [Q4 2019 Emerging Tech Research: Mobility Tech](#)

Coronavirus impact: Significant

Mobility tech startup funding mix by stage*



Source: PitchBook | Geography: Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Mobility hit hard by coronavirus crisis: Before the coronavirus crisis, we observed a pullback in VC investing in mobility due to the vertical's high concentration of capital intensive, money-losing business models. In our Q4 2019 Mobility Tech report, we noted that 2019 saw a pullback in investing as deals declined by 15% and valuations plateaued. With an economic crisis marked by social distancing, the mobility sector faces significant near-term disruption that will affect revenue and delay funding as investors deploy capital in less risky sectors. Automakers, which have been a major driver of capital in the space, have pulled back on investing in mobility startups as they see their core business models completely shut down, with plants closed and consumers holding off on car purchases. We have also heard anecdotally of VCs sharply withdrawing investing in capital expenditure-intensive businesses. In the near term, we expect to see significant declines in both deals and valuations in the space and anticipate many smaller providers will go out of business.

Ridesharing hit by declining trip volumes, increased costs: Social distancing and mandatory quarantines will have a significant negative impact on the already-pressured ridesharing industry. This has already been felt in China with ridesharing giant Didi Chuxing reportedly seeing an over 50% decrease in active users. The company has suspended its service in more than 50 markets. Meanwhile, US ridesharing companies Uber and Lyft have suspended carpool services. In addition to the decline in demand, ridesharing companies face increased costs associated with disinfecting vehicles (some of which could be shouldered by drivers) and paying out sick leave. The ridesharing industry was already facing significant scrutiny from investors over its lack of profitability and regulatory concerns over its contracted workforce, leading to a pullback in investing—deals in the space declined by 55.9% in 2019 and both public and private companies saw significant downward revaluation. We believe ridesharing companies are likely to see further declines in funding activity.

Food delivery could be lifeline for ridesharing: Mobility platforms diversified in delivery are likely to be better insulated from the impact of the coronavirus. Uber CEO Dara Khosrowshahi has indicated he believes the company's Eats segment will see a boost from social distancing as consumers increasingly dine in. Chinese ridesharing app Didi Chuxing has launched a delivery service as a result of increased demand for food delivery in China. Leading food delivery providers such as Uber Eats, DoorDash and Postmates have begun offering contactless food delivery. At the same time, many of these platforms have reduced commissions charged to restaurants and begun offering free delivery services in a bid to draw consumers and mitigate the impacts of restaurants ceasing operations. Although these initiatives should help maintain growth, they will pressure margins in an industry that is already highly unprofitable.

Micromobility to see near-term disruption, could draw commuters from public transit: In the near term, the reduced movement of people presents a headwind to the micromobility (e-bike and e-scooter) industry. Since the crisis began, bikeshare providers in Seattle and San Francisco—two cities with large proportions of tech workers able to tele-work—have seen declines in ridership.⁵ The mayor of Miami has halted scooter rentals due to public health concerns, and micromobility leaders Lime and Bird have suspended operations in dozens of cities in the US and Europe. Lime is reportedly considering layoffs as daily global revenue for scooter rides has declined by 69% and the company

5: "A Surge in Biking to Avoid Crowded Trains in N.Y.C.," *The New York Times*, Winnie Hu, March 14, 2020.

faces a cash crunch.⁶ However, we believe the industry could benefit in the medium term as economic activity picks back up and people return to work. Micromobility could draw urban commuters away from public transit; e-bikes and e-scooters could be a compelling transportation option for those wary of sharing spaces with others. The Chinese market may be a good forward indicator of this trend. Chinese bikeshare operators HelloBike, Mobike and Didi Chuxing reported ridership increases of 150%+ (back to normal levels) as the pandemic stabilized and employees began returning to work.⁷ This is an opportunity for better capitalized providers such as Uber-owned Jump and Ford-owned Spin to gain market share as cash-strapped startups in the space are forced to suspend operations. Many of these startups could be attractive acquisition targets as they face difficulties raising funding going forward. We would not be surprised to see a significant shakeout in the space over the next few months. VC investing in micromobility startups totaled nearly \$2 billion in 2019, a decline of 63% YoY.

Autonomous vehicles to see near-term impact, long-term thesis intact: In the near term, we expect a pullback in investing in autonomous technology as automakers and suppliers reduce spending in the space. Self-driving companies Waymo, Cruise, Argo.AI, and Pony.AI have already suspended testing due to coronavirus concerns. As with the broader mobility space, we expect reduced investment in autonomous vehicle technologies from VCs and financial investors. This pullback will primarily affect earlier-stage providers with lower market share, shorter cash runways and fewer established partnerships. We would not be surprised to see a significant shakeout of the tail-end of this fragmented industry. As this occurs, Alphabet with its established balance sheet, relatively insulated core business and already formidable lead over competitors, could be well-positioned to gain market share, increasing its lead in testing and potentially acquiring technologies at significant discounts. We believe lower oil prices could catalyze sales of luxury vehicles utilizing Level 2/3-focused sensors. With that said, lower gas prices reduce economic incentives to automate driving, and this could curtail investment in Level 4/5-focused applications. Longer term, we continue to view adoption of autonomous vehicle technology as a stable secular trend and maintain our favorable long-term outlook on the space.

Electrification to see negative near-term impact: We expect to see a near-term decline in sales of electric vehicles (EVs) as consumers sharply reduce spending on high-cost discretionary expenditures. The first echoes of this have been felt in China. Chinese EV maker Nio announced that it expects both revenue and deliveries to decline 50%-60% YoY in Q1 2020, well below analyst estimates. Looking beyond the near-term impact, lower oil prices reduce the relative affordability of electric vehicles and lessen economic incentives to electrify commercial fleets. As electric vehicle models tend to be higher-price relative to their internal combustion engine (ICE) counterparts, we expect a pullback in consumer demand for these vehicles. Meanwhile, commercial fleet operators are unlikely to make large capital investments into electrification during this period of uncertainty. These factors are likely to negatively affect the funding environment for electric vehicle startups as strategic (automakers) and financial investors reduce investing. As a result, electric vehicle adoption could be delayed over the near to medium term. However, as with autonomous vehicles, we continue to view adoption of electric vehicle technology as a stable secular trend and maintain our favorable long-term outlook on the space.

6: "Scooter Giant Lime Preparing Layoffs as Rider Numbers Collapse," Bloomberg, Nate Lanxon and Candy Cheng, March 21, 2020.

7: "The Coronavirus is Bringing Bike Sharing Back in China," Abacus News, Xinmei Shen, March 4, 2020.

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Vertical coverage: Internet of things (IoT)

Description: Technology that connects physical places and things to the internet for data collection and analytics. This vertical includes connected healthcare devices.

Key product categories: Connected healthcare, smart cities, connected mobility, industrial internet of things (IIoT)

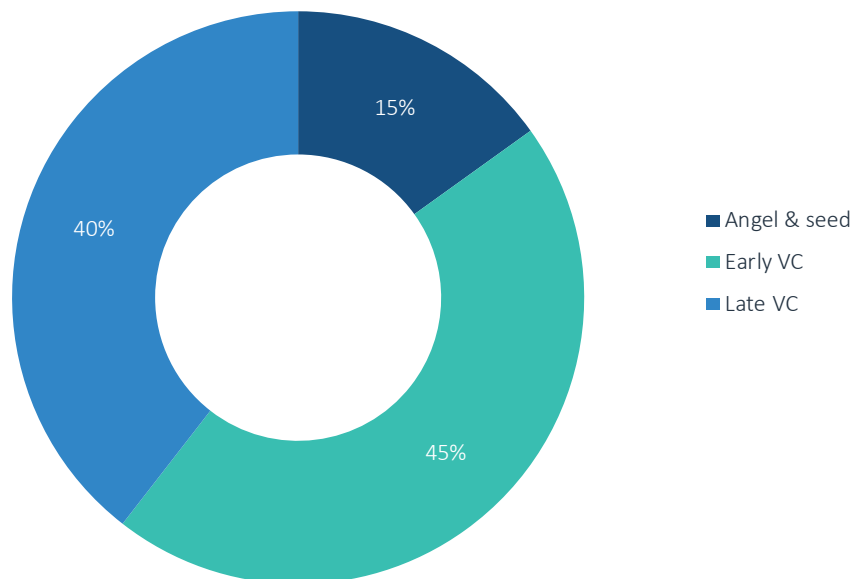
2019 VC raised: \$7.5 billion

Key VC-backed startups: SenseTime, Royole, Horizon Robotics, Terminus Technologies, Samsara, Proteus Digital Health, C3.ai, Sigfox, ASR Microelectronics

Latest research: [Q4 2019 Emerging Tech Research: Internet of Things](#)

Coronavirus impact: Significant

IoT startup funding mix by stage*



Source: PitchBook | **Geography:** Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Mainstream industrial IoT (IIoT) adoption to be pushed out by several years:

IIoT vendors have been developing enhanced value propositions to overcome the historical high failure rate of IoT projects. Implementation problems including cybersecurity and integration with legacy systems have limited the demand for emerging IoT solutions, and the share of enterprises adopting IoT across their organization has remained below 20%, according to a Bain survey of industrial companies.⁸ We believe industrial companies are likely to cut costs in 2020 because of decreased demand from COVID-19, resulting in fewer long-term investments made in IoT projects with questionable ROI. IoT projects that can deliver demonstrable cost savings through reduced employee hours and improved workforce efficiency may be expanded at enterprises that already have confidence in their effectiveness.

Remote patient monitoring to supplement overstretched healthcare systems:

In addition to telehealth, remote patient sensors can provide analytics of biomarkers related to COVID-19. The limitations of global healthcare systems to treat low-risk patients could make remote monitoring both a valid personal and clinical response. Remote patient monitoring startups have received VC investment from leading medical device suppliers, including Medtronic, and several startups are targeting COVID-19 symptom detection, including Vivify Health, HGE Health and BioIntelliSense. A mass deployment of remote patient monitoring devices during this global health crisis could lead to a longer-term use of the technology for both prevention and treatment.

Smart cities platforms to enhance pandemic response: Governments in China and South Korea are using phone apps to control population movement and track infected patients. In South Korea, infected population tracking apps are based on a data hub under development in the city of Daegu. In China, cities including Hangzhou and Shenzhen collaborated with tech giants Ant Financial, Alibaba and Tencent on infection tracking and community spread management. In the US, neighborhood social network Nextdoor has partnered with the World Health Organization, the Centers for Disease Control and Prevention and local authorities to pass information to residents and has developed community collaboration features for assistance with shopping, childcare and hobbies during a time of social distancing. While these measures may not be continued once the pandemic is contained, we believe that public-private partnerships may develop further public health management platforms going forward and may be a boon for smart cities platforms.

Corporate investors in IoT startups to pull back: We believe that CVC investors are a core part of the IoT VC ecosystem due to their strategic interests in advancing sensor-based technologies. Intel, Qualcomm, Sony and Samsung were among the most active VC investors in 2019. Enterprise cost-cutting is likely to flow through to R&D budgets and ultimately corporate investment budgets for CVC programs without committed capital. All IoT segments are likely to be affected by decreased CVC activity, especially IoT software, IIoT and connected buildings.

8: "Unlocking Opportunities in IoT," Bain & Company, Ann Bosche, et. al., 2018.

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Vertical coverage: Artificial intelligence & machine learning

Description: Artificial intelligence (AI) is the area of computer science that focuses on creating intelligent machines that make decisions based on predictive models. Machine learning (ML) is a subfield of AI that aims to give computers the ability to learn iteratively, improve predictive models and find insights from data without being explicitly programmed.

Key product categories: AI in healthcare, AI in financial services, industrial AI, robotic process automation

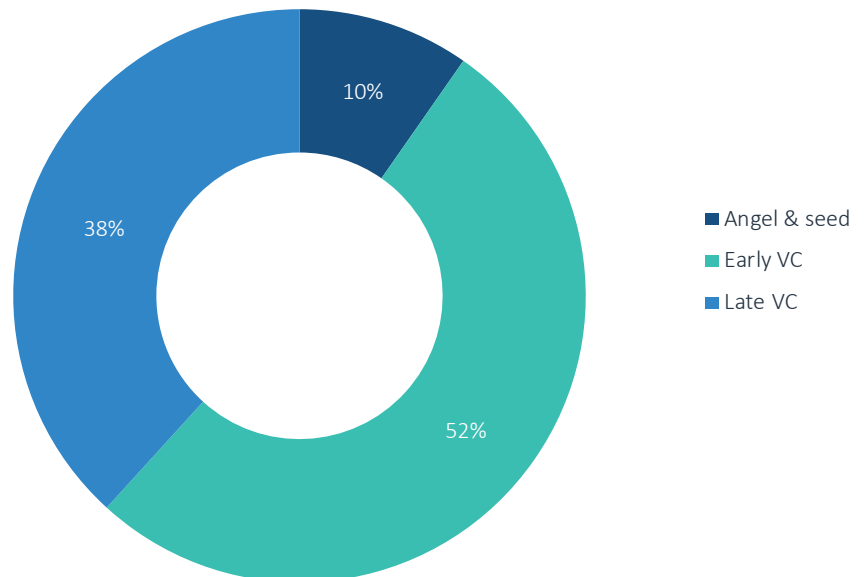
2019 VC raised: \$38.3 billion

Key VC-backed startups: UiPath, Automation Anywhere, Babylon Health, Livongo, DataRobot

Latest research: [Q3 2019 Emerging Tech Research: Artificial Intelligence & Machine Learning](#)

Coronavirus impact: Moderate

AI & ML startup funding mix by stage*



Source: PitchBook | **Geography:** Global
*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Automation timelines to be accelerated: AI's ability to streamline workforces is a long-term trend that will likely be accelerated due to enterprise cost-cutting as a result of the economic slowdown. The motivation to make investments in this area has been enhanced by the labor restrictions from COVID-19 and will be further enhanced by the encouragement of shareholders to cut costs as the current crisis unfolds. Manufacturing and physical retail have been hit particularly hard by the virus itself and we believe enterprises have increased their inquiries into AI-enabled robotics capabilities, particularly in China. Looking ahead, we believe that job cuts will be inevitable among large enterprises and may be cushioned by increasingly prevalent Robotic Process Automation and AI assistants for sales support, marketing optimization and routine back-office tasks.

AI in healthcare to grow in preparation for future public health risks: AI has been deployed in the detection, diagnosis and treatment of COVID-19 and we believe the virus demonstrates the need for improved AI in healthcare. Several AI models were able to detect the outbreak of COVID-19 in Wuhan based on natural language processing of government healthcare reports and news releases, including those of VC-backed startups BlueDot and Metabiota. The accuracy of the models' predictions of COVID-19's spread weakened over time but proved to be valid alerts. Over the past three months, numerous AI-powered diagnostics have been developed based on CT scan data, including those from Huawei, Ping An and Alibaba. These approaches claim to reduce the time to analyze CT scans for COVID-19 diagnosis to mere seconds. Further, AI is being used in the development of vaccines by multiple biotechnology companies. We believe that COVID-19 has demonstrated the validity of AI-based pandemic response and may catalyze changes in regulations around medical data sharing between companies, healthcare providers and governments for AI training purposes. That shift would unlock numerous opportunities in diagnostics and drug discovery.

AI-first startups to be encouraged by market downturn: We believe that AI-first software startups have suffered from a perception that their gross margin profiles are inferior to those of SaaS startups with lower customization and data requirements. The decrease in growth for SaaS startups in 2020 may encourage investors to look to AI-first business models with lower gross margins but higher business value and "winner take all" potential. Early-stage investors may be more patient with the time and cost needed for seed-stage startups to develop AI models given the economy will likely take a long time to recover from the pandemic. Economic downturns tend to reveal which solutions provide the best solutions to customer pain points, and we believe that AI-first software platforms are likely to win out over rules-based approaches in the long term.

ROBERT LE Senior Analyst, Emerging Technology
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Vertical coverage: Insurtech

Description: Startups in this space either sell insurance directly to customers or sell technology and services to the insurance industry.

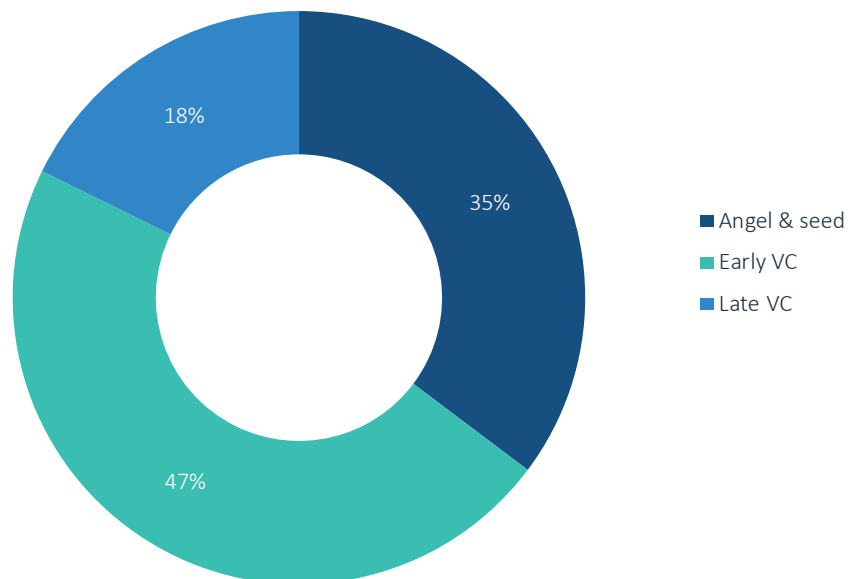
Key products categories: Direct: Property & Casualty, Health & Life, Commercial; Technology enablers: Customer acquisition, underwriting, claims management

2019 VC raised: \$6.2 billion

Key VC-backed startups: Zenefits, Gusto, Root Insurance, Oscar, Bright Health, Lemonade, Wefox, Devoted Health

Coronavirus Impact: Moderate to significant

Insurtech startup funding mix by stage*



Source: PitchBook | **Geography:** Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Accelerated demand for claims automation and disease modeling: Insurers will likely see a significant ramp in claims due to the COVID-19 crisis, a probable catalyst to drive adoption of claims automation and fraud management technology. This nature of this health crisis is also likely to spur interest in risk analytics technologies that incorporate disease and outbreak data to help underwrite policies. Startups such as Metabiota help insurers model infectious disease outbreaks with real-time surveillance data and could drive huge benefits to insurers early in an occurrence.

Life insurers feel immediate impact: Dropping interest rates can have a significant impact on a life insurers' ability to meet future obligations and adds risk to the business model. A potential unexpected increase in early payouts for life insurance policies also threatens cash flows. Longer term, the life insurance industry will likely prove durable, but startups including Laddar and Ethos will likely struggle in the current environment.

Renewed debate on public insurance option: COVID-19 has renewed focus on the shortcomings of the US health care system, which could renew efforts to establish a public insurance option—a clear competitive risk to private health insurers.

ROBERT LE Senior Analyst, Emerging Technology
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Vertical coverage: Fintech

Description: This vertical includes companies that provide financial services through online and other digital channels to consumers and businesses. Key product categories: Lending, capital markets, banking, payments, investments

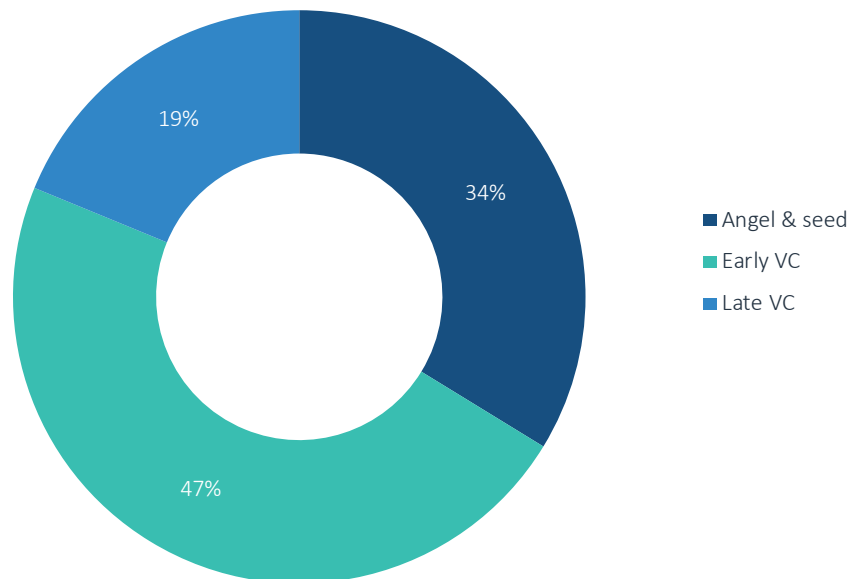
2019 VC raised: \$37.7 billion

Key VC-backed startups (post-money valuation): Stripe, Ripple, Chime, Revolut, Toast, SoFi, N26, TransferWise

Latest research: [Q4 2019 Emerging Tech Research: Fintech](#)

Coronavirus impact: Moderate to significant

Fintech startup funding mix by stage*



Source: PitchBook | Geography: Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Digital payments benefit from germ-conscious consumers: Digital and mobile payments should get a boost as consumers, especially in the US, rethink cash handling and entering PINs. This could also drive more adoption of and demand for tap and pay cards. We expect an increased adoption of mobile payments with biometric authorization, which is already native within newer Apple and Android phones.

Money transfer services to track macroeconomic contraction: We expect remittances to slow considerably in this environment as closed borders decrease migration and job losses mount. Remittance providers such as TransferWise and Remitly will be adversely impacted by this contraction. Institutional money transfer providers like Payoneer and Flywire will also feel the negative impacts as disrupted global supply chains slow cross-border transactions. We expect these services to pick back up as the crisis softens.

Robo-advisors and digital brokerages face cyclical test: The falling stock market will lead to reduced AUM for fintech investment providers. A large portion of revenues for these providers come from AUM fees and/or interest on uninvested cash. Robo-advisors—which emerged during the bull market cycle—are facing their first significant test on how they perform during a downturn. Digital brokerages, such as Robinhood, are already struggling as unprecedented trading volumes have led to outages, which could drive customers to incumbent providers.

Current monetary policies hamper neobanks and fintech lenders: Near-zero interest rates decrease the ability of neobanks to offer high-yield deposit accounts—an important differentiator in recent years as incumbent banks have largely maintained low interest rates. While some neobanks such as Varo and Chime have sought to maintain high APY accounts, the spread over incumbents is likely to diminish. This will also reduce contribution margins. In addition, fintech lenders will see competitive interest rates offers become less of a differentiator as stimulus efforts pump low interest loans through traditional bank channels. As credit markets tightened up, traditional lenders will benefit from having a larger more established customer base with a [stronger credit profile](#).

Increased credit defaults and tighter securitization market: Business shutdowns and increased unemployment will likely drive substantial credit defaults and losses for fintech companies focused on small business and consumer lending. These providers will see significantly reduced loan volume as the securitization market locks up and as fewer customers meet credit criteria.

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Vertical coverage: Supply chain tech

Description: This vertical includes companies that provide technologies and services that are changing how domestic and global supply chains are managed and operated. The emerging digital economy is stressing the traditional global supply chain in new and unexpected ways, driving demand for better visibility across delivery and supply channels, quicker shipping capabilities and the ability to source products on-demand.

Key product categories: Enterprise supply chain management software, freight technology, warehousing technology and last-mile delivery services.

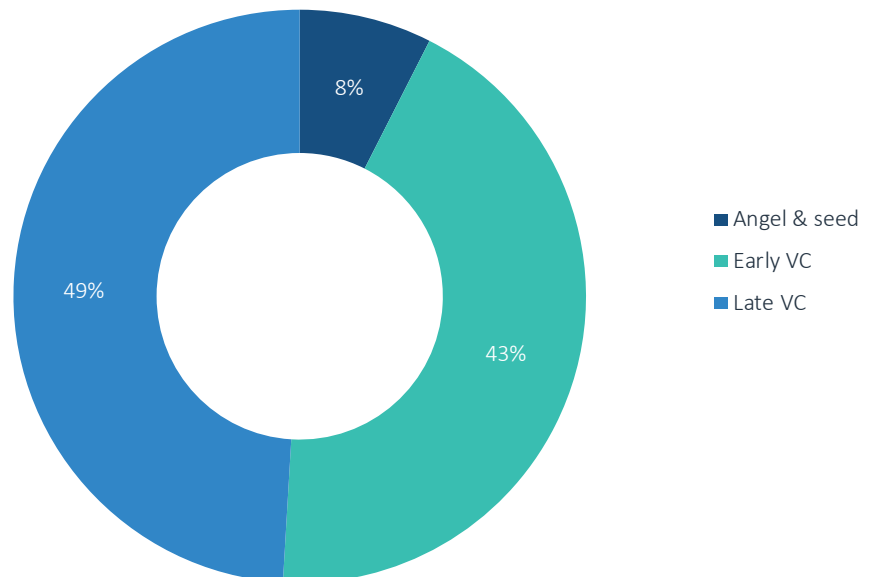
2019 VC raised: \$10.4 billion

Key VC-backed startups: Resilinc, Project44, Flexe, Fetch Robotics, Realtime Robotics

Latest research: [Q4 2019 Emerging Tech Research: Supply Chain Tech](#)

Coronavirus impact: Moderate

Supply chain tech startup funding mix by stage*



Source: PitchBook | Geography: Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Coronavirus crisis could catalyze long-term investing in supply chain tech: As with other sectors, we expect coronavirus associated disruptions to negatively affect supply chain tech deal activity in the near term as VCs adopt a “wait and see” mentality. In the long term, we see a relatively low risk of firms significantly pulling back on investing in their supply chains due to this crisis. In fact, we

believe coronavirus-related supply chain disruptions are highlighting the need for supply chain technologies that can help ensure business continuity and mitigate the impacts of economic shocks. The current crisis could catalyze long-term investment in emerging supply chain technologies as companies seek to diversify their value chains.

Risk management and freight tech startups could see boost: In the long term, we expect companies to increase investments in technologies that expand supply chain visibility—the ability of management teams to track the journey of parts, components and products from manufacturing to delivery. Risk management platforms such as Resilinc, Elementum, DHL Resilience360 and Interos offer data analytics and real-time monitoring services that enable companies to identify and react quickly to anomalies. Startups providing visibility into the movement of finished goods could also benefit. Freight platforms such as Project44, FourKites, MacroPoint, 10-4 Systems and Shippeo provide valuable visibility into where high-value goods are in transit, streamlining processes and reducing friction in the supply chain.

Warehousing startups could also prove helpful: Retail and medical supply chains have come under duress as consumer demand for household items and physician visits increase. Flexible on-demand warehousing marketplaces such as Flexe, Stord, Darkstore and Spacefull can help retailers and inventory-heavy companies during periods of fluctuating demand. These providers enable companies to proactively stockpile inventory as needed without making prohibitively large investments in warehousing space. These platforms can help add flexibility and scalability for small businesses, enterprises and other shipping intermediaries so they can maintain steady operational performance during periods of fluctuating inventory demand.

Autonomous tech ensures continuity of labor: In the near term, we expect the industrial automation industry to face headwinds as companies pull back on capital expenditure-heavy projects. However, in the long term, we believe companies will seek to invest in robots and autonomous technologies that can help maintain continuity of operations during labor shortages, reducing disruptions to the flow of goods to consumers. Providers of subscription-based, full-service solutions—such as Locus Robotics, Mobile Industrial Robotics and RightHand Robotics—as opposed to individual unit sales should be better positioned to serve the needs of capital constrained customers.

Last-mile delivery apps could see increase in demand: We expect online delivery applications to see a boost from social distancing, as seen in several Chinese cities. Chinese online grocery and food delivery apps Dada, Meituan and Elema have seen major surges in demand as government quarantining measures went into effect.⁹ We expect a similar dynamic to play out in the US and Europe in the near term as consumers increasingly choose to dine in. This could provide a revenue tailwind to providers such as DoorDash, Uber Eats, Instacart, Postmates and others. With that said, many of these platforms have reduced commissions charged to restaurants and begun offering free delivery services in a bid to draw consumers and mitigate the impacts of restaurants ceasing operations. These initiatives are likely to pressure margins in an industry that is already highly unprofitable.

9: "Contactless Delivery, Online Grocery Shopping and Other Ways Home-Bound Chinese are Trying to Get Food and Stay Safe," CNBC, Evelyn Cheng, February 6, 2020.

PAUL CONDRA Lead Analyst, Emerging Technology
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Vertical: Cloudtech & DevOps

Description: This vertical includes startups focused primarily on the opportunity to provide products and services that help developers and IT teams build, run and manage software applications. The rush to create more digital IP within organizations is driving investment in developer capabilities, creating demand for better digital tools.

Key products categories: Communication and collaboration tools, software building tools, software deployment and management tools, and IT management tools.

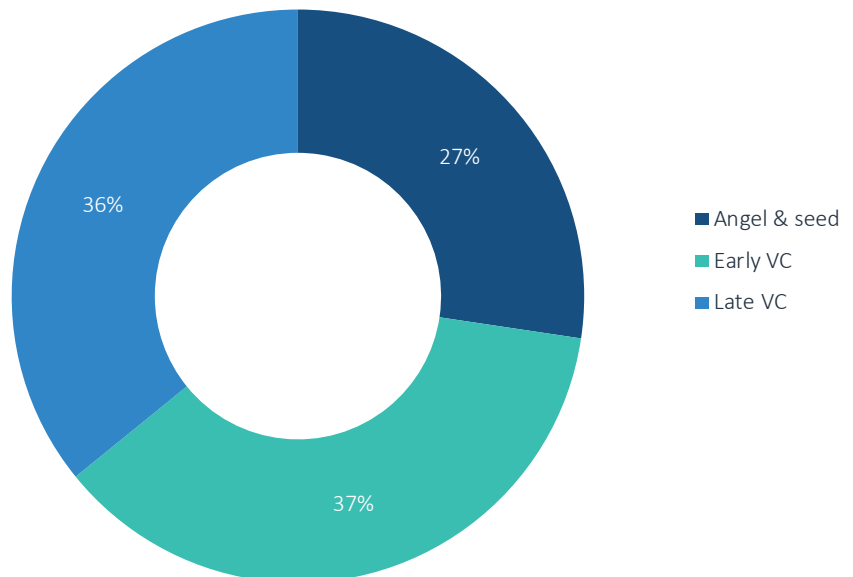
2019 VC raised: \$6.2 billion

Key VC-backed startups: HashiCorp, Asana, Sysdig, UiPath, Gitlab

Latest research: [Q4 2019 Emerging Tech Research: Cloudtech: DevOps](#)

Coronavirus impact: Low

Cloudtech & DevOps startup funding mix by stage*



Source: PitchBook | Geography: Global
*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

DevOps insulated from near-term impacts: DevOps is likely one of the more insulated industries from the near-term supply and demand shocks affecting the global economy. Software development initiatives are likely to remain mission critical and quickly changing demand environments could cause firms to increase investment in current digital products or pivot to new ones, particularly those involved in online commerce.

Economic slowdown could moderately reduce demand: A potential longer-term recession could tighten budgets, reduce headcount growth of DevOps teams and drive current teams to rely more on open source tools, reducing spend on VC-backed paid tools. The overall pullback in industry conferences could also reduce sales opportunities. However, we expect digital initiatives to remain core drivers of enterprise spend over the long term.

Work from home could benefit DevOps: From a continuity perspective, DevOps workers tend to be highly mobile and able to work remotely with little disruption. The need for organizations to develop work-from-home capabilities could drive short- and long-term demand for DevOps collaboration and communication tools as well as IT automation tools that help scale infrastructure. In fact, infrastructure automation provider HashiCorp closed a \$175 million round in mid-March as the crisis was unfolding. DevOps teams that now must work remotely may also see increased value in centralized code repository and deployment tools, or CI/CD tools that help automate the management of software development.

Focus on freemium opportunities: SaaS providers are ramping up giveaways to help existing customers and attract new users. We view this as a wise long-term strategy that carries relatively little cost for providers. Zoho (collaboration tools), Microsoft Teams, Webex, LogMeIn, Zoom, and Atlassian, among others have all made certain products free since the start of the crisis.

Data protection remains critical focus: As DevOps teams work remotely, this will put further stress on efforts to ensure data protection and security as more information travels through cloud data centers.

BRENDAN BURKE Senior Analyst,
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Vertical coverage: Information security

Description: This vertical includes vendors of technology and services that protect enterprises from digital threats to business operations. The information security (infosec) industry evolves constantly in response to emerging threats, generating innovation opportunities for legacy vendors and startups alike.

Key product categories: Network security, endpoint security, application security, identity & access management, and security operations

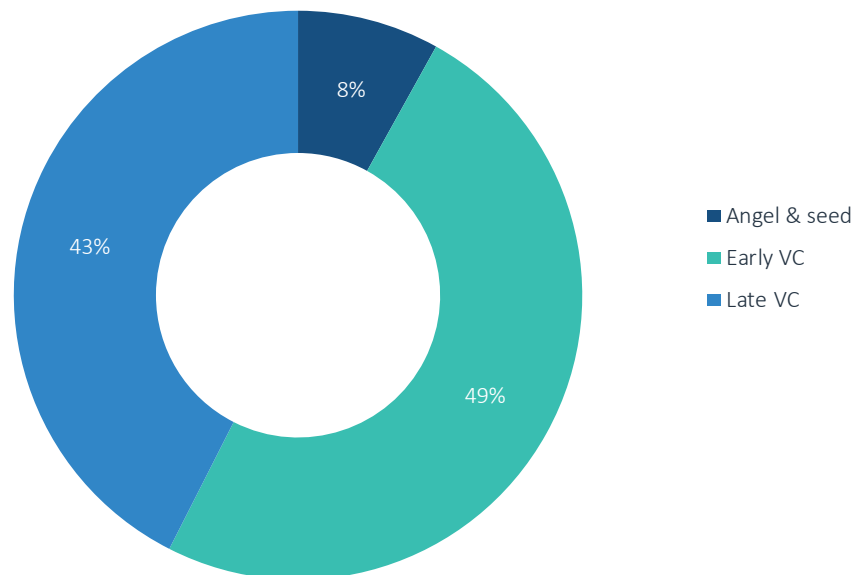
2019 VC raised: \$6.8 billion

Key VC-backed startups: Tanium, Netskope, Cybereason, Pango, Sumo Logic, Illumio

Latest research: [Q4 2019 Emerging Tech Research: Information Security](#)

Coronavirus impact: Low

Infosec startup funding mix by stage*



Source: PitchBook | **Geography:** Global

*As of December 31, 2019

Note: Includes companies that have raised VC funding since January 1, 2017

Infosec spending likely to be affected by low growth in IT spending in 2020:

IDC has reduced its IT spending forecast for 2020 from 5% in January to 1%, with guidance that it may be further lowered. Information security is a subset of IT spending and may decrease in parallel, though we believe that legacy security appliances such as firewalls will be impacted more heavily than cloud-native security offerings. Given the existing challenges to growth for some incumbents including McAfee and Symantec, we expect infosec incumbents to exhibit low or flat growth during calendar year 2020. Unprofitable market leaders including CrowdStrike, Palo Alto Networks, Okta and Zscaler may face pressure to cut costs in the short term but we believe they have sufficiently strong balance sheets and customer relationships to maintain growth. Likewise, late-stage private companies that have raised VC recently should benefit from the continued need of enterprises to protect their assets and we believe they will maintain their growth.

Advanced phishing tools required for distributed workforces: Given the high degree of concern around COVID-19, hackers have created new phishing attacks, which refer to fraudulent communications intended to steal data or install malware. A prominent version of these phishing attacks is disguised as a COVID-19 tracker, mimicking popular resources such as the Johns Hopkins COVID-19 map. We believe that the anti-phishing market is mature but that existing tools do not utilize predictive analytics to determine zero-day phishing attacks. Because of the increase in distributed workforces, we believe that enterprises may adopt advanced anti-phishing capabilities offered by emerging startups including Ironscales, Avanan and Inky.

Product churn likely to increase: Because of budget uncertainty, we believe that organizations will be more likely to replace existing systems with lower-cost or more holistic platforms. There is already an industry trend toward consolidation of information security toolchains and we believe this slowdown could accelerate it. Endpoint security platform SentinelOne has offered its platform to remote workers for free and can take advantage of this trend given its ability to integrate cloud, on-premise and edge device security with one endpoint security solution. Further, the increasing availability of open source security tools may accelerate the transition to developer-led security, shifting infosec budgets toward application security and tools offered by public cloud hosts.

PE firms to expand platform strategies: The economic slowdown has already decreased the private valuations of some startups. Given their lower growth, we believe infosec startups will be required to raise VC at lower valuations or pursue a sale. Already in late 2019, we saw a shakeout in IoT security in which startups accepted flat or decreased M&A valuations relative to their prior private valuations. PE buyers have consistently targeted cybersecurity companies and we believe that the platform strategies adopted by Thoma Bravo, Bain Capital and Vista Equity Partners could be enhanced to build comprehensive security platforms and replicated by other PE firms.