PitchBook

EMERGING TECH RESEARCH

Supply Chain Tech

Q4 2020

Contents

Contact

RESEARCH

Asad Hussain, Senior Analyst, Emerging Technology
asad.hussain@pitchbook.com
206.480.1378

analystresearch@pitchbook.com

DATA

Matthew Nacionales Data Analyst

DESIGN

Kelilah King and **Megan Woodard**

This Emerging Technology Research report is updated on a quarterly basis to reflect changes in venture capital deal activity and other market related updates deemed valuable by the research analyst. The previous quarterly report can be accessed **here**.

Q4 2020 news and updates

VC ACTIVITY

- In Q4 2020, supply chain tech companies based in North America and Europe raised $4.1 billion in VC across 151 deals, marking an increase in deal value of 20.8% QoQ and 48.6% YoY.
- Downstream logistics drove supply chain VC deal activity as investors made large bets on middle- and last-mile technologies.
- Enterprise supply chain management & warehousing tech startups are seeing surges in VC investment as investors deploy capital toward technologies digitizing supply chains.

Q4 2020 DEAL ACTIVITY

- Autonomous delivery robot startup **Nuro** raised a $500.0 million Series C led by T. Rowe Price, valuing the company at $5.0 billion (a 1.92x valuation step-up).
- Digital freight brokerage **Uber Freight** raised a $500.0 million Series A led by Greenbriar Equity Group, valuing the business unit at $3.3 billion.
- Grocery delivery app **Instacart** raised a $200.0 million Series H led by D1 Capital Partners and Valiant Capital Partners, valuing the company at $17.7 billion (1.27x step-up).
- Self-driving trucking startup **TuSimple** raised a $350.0 million Series E led by Steve Girsky and VectoIQ, potentially setting the company up for a public market debut in 2021.
-

NEWS

- The global automotive industry is facing a semiconductor chip shortage, heightening concerns over American dependence on foreign supply chains and increasing calls to incentivize domestic battery production as the industry shifts to electric.
- Strong global trade demand is stretching capacity and driving up freight rates as container shipping faces bottlenecks.
- Supply chain software startup **E2open** debuted on the public markets through a reverse merger with a special purpose acquisition company (SPAC) at a $2.6 billion valuation.

KEY TRENDS

- As consumer demand for home delivery increases, last-mile delivery services continue to be a focal point of corporate and VC investment, highlighting the need for automated, contactless delivery technology.
- COVID-19 and the rise of e-commerce has led to an acceleration in decentralized fulfillment, which refers to the use of smaller microfulfillment centers in urban locations or within retailers to enable faster delivery.
- Supply chain risk management and visibility startups are gaining traction as the pandemic augments the need for data analytics and real-time monitoring services.

Executive summary

Today's global supply chain is a highly fragmented industry that includes a sprawling ecosystem of disparate providers, each at different stages of technological maturity. We view this as a compelling backdrop for new entrants seeking to address gaps in the status quo and see areas of growth across the value chain, including procurement, inventory management, freight, warehousing, fulfillment, and last-mile delivery.

The COVID-19 pandemic has strained global supply chains and led to significant mismatches in supply and demand. Assembly and manufacturing plants have faced shutdowns, causing production delays and shortages of global goods. Nonessential goods have been stuck in limbo, with retailers unable to accept deliveries. Grocers have struggled to keep household goods on shelves. These disruptions have highlighted the need for technologies that can help ensure business continuity and mitigate the impacts of economic shocks. Additionally, businesses involved in global trade are demanding better visibility across delivery and supply channels, quicker shipping capabilities, and the ability to source product on-demand to reflect real-time conditions at the consumer level.

Startups are rising to the occasion, developing software and data services to address these pressing needs. Investors, in turn, have put substantial amounts of venture funding to work to both modernize and disrupt this industry. In 2020, VC investors funneled approximately $12.6 billion into supply chain technology startups in North America and Europe across 555 deals. This Emerging Tech Research report provides an overview of the supply chain technologies benefiting from these venture infusions, the subsectors emerging in each segment of the industry, and opportunities for growth in each market.

Key takeaways

Pandemic continues to disrupt automotive supply chains: Over a year into the COVID-19 pandemic, the global automotive industry continues to face supply chain disruptions. Microchip shortages from suppliers such as TSMC have caused global automakers such as GM, Volkswagen, and Honda to delay car shipments and shut down factories. As a result, the automotive industry stands to lose as much as $61 billion in revenue in 2021, according to AlixPartners.[1] Despite this impact, automakers seem unwilling to adjust their just-in-time manufacturing models. Instead, we believe they will increasingly invest in technologies to help digitize and map their supply chains. For example, BMW has started testing Honeywell's quantum computing systems to help it time component purchases to reduce production disruption. Volvo and Daimler have begun working with **Circulor**, a startup utilizing blockchain to track purchasing data. Going forward, we believe the automotive industry will be a key end-market for supply chain data technology companies.

Risk management gains traction: The COVID-19 pandemic has heightened the need for data analytics and real-time monitoring services that can improve supply chain visibility and reduce risk exposure. Companies providing these services, such as **Elm Analytics**, **Interos**, **Resilinc**, and **Riskmethods**, have seen an uptick in venture financing. We expect investment into supply chain risk management platforms to increase as management teams seek to guard against potential supply chain shocks, including pandemics, geopolitical disruption, natural disasters, and local events such as fires and labor strikes. Startups providing effective end-to-end solutions to identify threats, assess impacts, and mitigate risk should be well-positioned to succeed.

Evolving expectations for delivery: As the market for delivery expands, we expect consumer expectations for delivery services to continue to increase. The pandemic has significantly increased demand for next-day and same-day delivery, with consumers increasingly seeking even same-hour delivery. In 2020, convenience item delivery rose 346%.[2] A similar shift is occurring with package placement, or "last-meter" delivery, as providers seek to reduce package thefts and food spoilage. **Amazon**, Walmart, and Target have launched in-home delivery of groceries, prescriptions, and other goods using smart locks and smart cameras. Startups such as **Sojourn** AI leverage computer vision and augmented reality on mobile and wearable devices to help couriers and drones place packages and items in precise spots.

Warehousing tech seeing surge: Warehousing tech startups attracted a record $1.0 billion of VC investment in 2020, up 26.1% YoY. Investor interest has grown in warehousing technologies, such as decentralized fulfillment centers and automation, that can reduce labor costs and improve e-commerce delivery times. COVID-19 has led to increased investment in automation technologies that can augment human workers, improve warehouses safety, and ensure continuity of operations. Despite an increase in activity, we maintain our view that warehousing tech is relatively underinvested compared to other segments within supply chain tech, and we anticipate the segment will see continued growth going forward.

Supply chain as a service is catching on: We continue to see growing enthusiasm for service-based solutions that help companies turn fixed expenditures into variable costs.

1: "Carmakers Face $61 Billion Sales Hit from Pandemic Chip Shortage," Bloomberg, Katrina Nicholas et al., January 27, 2021.
2: "DoorDash Leads Surge in Delivery Orders from US Convenience Stores," Financial Times, Dave Lee, January 28, 2021.

KEY TAKEAWAYS

Warehouse marketplaces Flexe and Stord offer on-demand, subscription-based solutions that find warehouse space for retailers with immediate need for short-term storage. Industrial autonomous robot startups, such as **Locus Robotics**, **Mobile Industrial Robots**, and **RightHand Robotics**, allow customers to rent robots via subscriptions as opposed to individual unit sales. These "as-a-service" offerings enable access to modern industrial technologies without large capital expenses and ongoing maintenance costs, so users can focus more on their core business. We expect subscription-based services will continue to play a more prominent role in industrial tech.

Lower-cost sensors to drive supply chain automation: We expect low-cost lidar providers to experience significant demand over the next few years, displacing existing camera-based perception systems. Historically, the high cost of lidar has kept the market from expanding beyond roughly $1 billion in annual sales. However, new providers such as Ouster and Sense Photonics are developing new, low-cost technologies such as digital flash lidar, which will likely spur adoption relative to existing camera-based perception solutions. We see a variety of use cases for lidar within supply chains, including automating mobile warehouse robots and forklifts, tracking the movement of workers and packages within fulfillment centers, and automating heavy equipment in construction and mining applications.

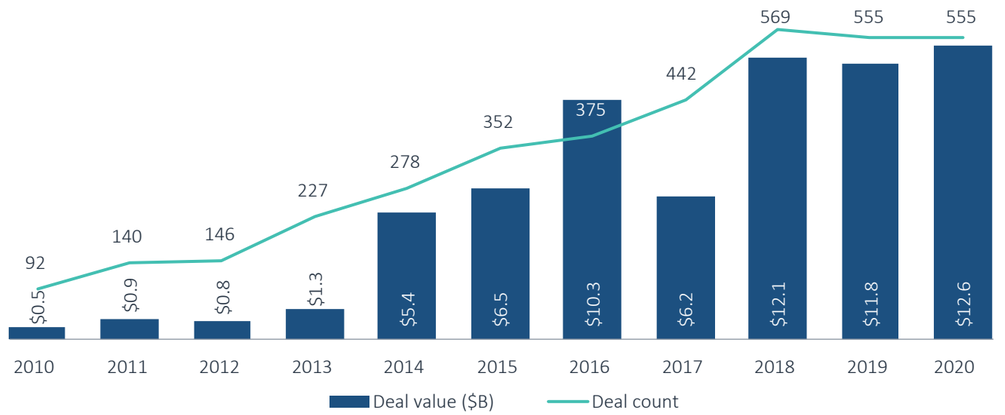
Self-driving enablers are attractive acquisition targets: We view autonomous trucking companies such as **PlusAI**, **Embark Trucks**, and **Kodiak Robotics** as attractive acquisition targets for incumbent freight & logistics providers and other technology companies. In our view, lower valuations for these companies are at odds with the potentially broader and more near-term market opportunity available to automating logistics. As with software-focused startups, we view asset-light technology providers more favorably than startups attempting to operate autonomous fleets, as evidenced by Starsky's failure to find a buyer and subsequent shutdown. We expect investors will remain active in the space given the likelihood that discounted valuations could persist for some time. Validating this prediction, in December 2020 **Nuro** acquired **Ike Robotics** for an undisclosed amount (the company was last valued at $250 million).

VC activity

VC investment in supply chain tech showed strength in 2020. Supply chain tech startups raised $12.6 billion in VC investment across 555 deals in 2020, up 6.5% YoY in terms of value. In Q4 2020, supply chain tech companies raised $4.1 billion, up 20.8% QoQ and 48.6% YoY. Downstream logistics companies received a significant share of total VC invested in the quarter as investors deployed capital into delivery services as well as middle-mile and last-mile autonomous vehicle technology. Major VC deals in the quarter include **Nuro**'s $500.0 million Series C led by T. Rowe Price, valuing the company at $5.0 billion (a 1.92x valuation step-up); **Uber Freight**'s $500.0 million Series A led by Greenbriar Equity Group, valuing the business unit at $3.3 billion; **Instacart**'s $200.0 million Series H led by D1 Capital Partners and Valiant Capital Partners, valuing the company at $17.7 billion (1.27x step-up); and **TuSimple**'s $350.0 million Series E led by Steve Girsky and VectoIQ.

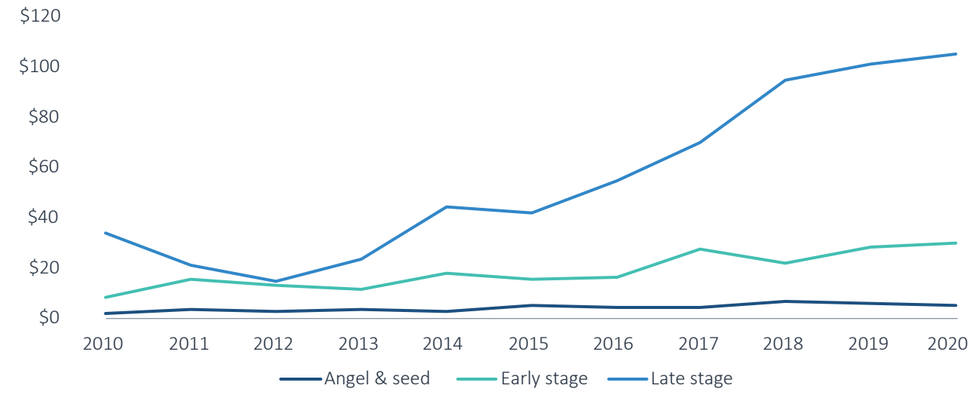
Valuations for early-stage supply chain tech startups continued their trend upward. In 2020, the median pre-money valuation for early-stage supply chain tech startups increased 3.4% YoY to $30.0 million. Meanwhile, the median pre-money valuation for late-stage supply chain tech companies increased 4.3% YoY to $105.6 million. The increase in late-stage valuations was partially driven by late-stage "winners" in the delivery space benefiting from a surge in demand for e-commerce and food delivery services, which has attracted more venture investment as a result.

Figure 1. SUPPLY CHAIN TECH VC DEAL ACTIVITY



Source: PitchBook | Geography: North America & Europe

Figure 2. MEDIAN SUPPLY CHAIN TECH VC PRE-MONEY VALUATION ($M) BY STAGE

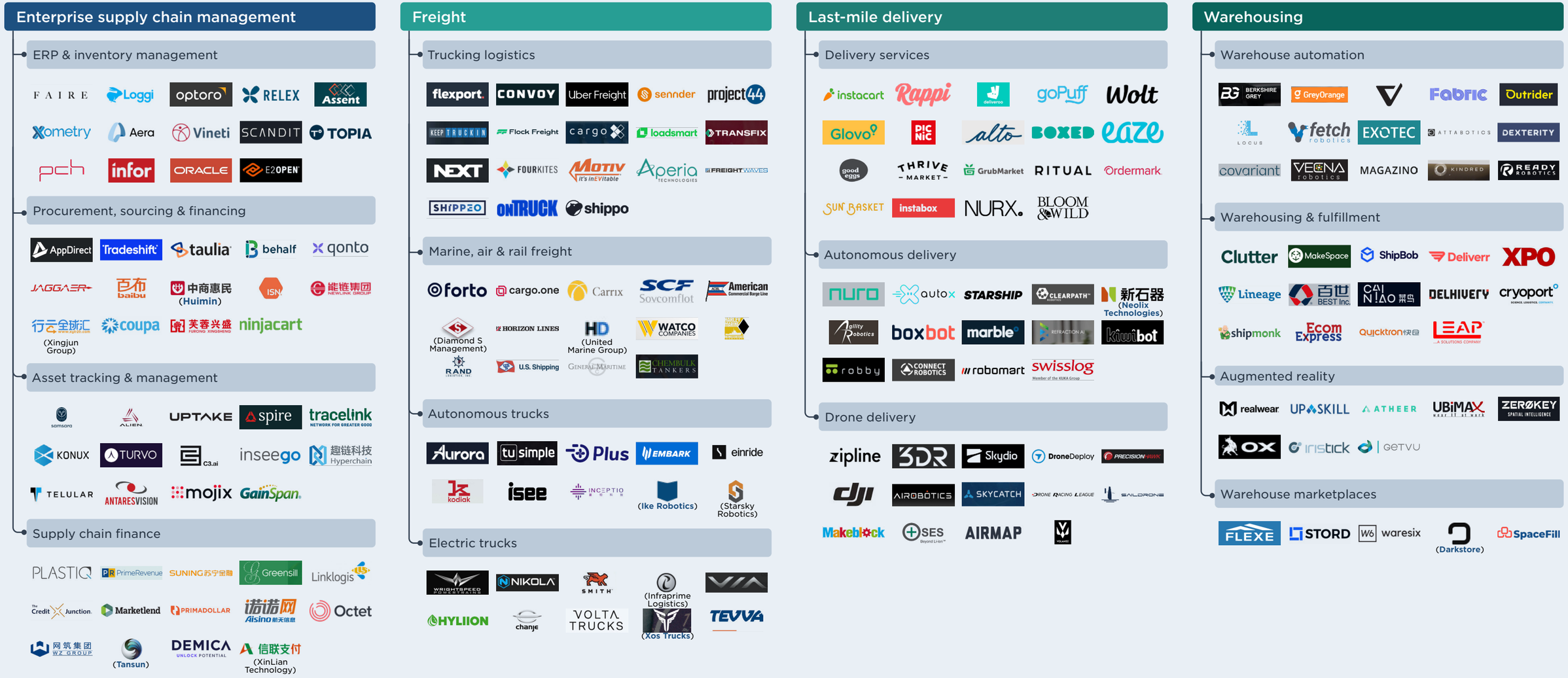


Source: PitchBook | Geography: North America & Europe

Supply chain tech VC ecosystem market map

Click to view interactive market map on the PitchBook Platform

Market map is a representative overview of venture-backed or growth-stage providers in each segment. Companies listed have received venture capital or other notable private investments.



SEGMENT DEEP DIVE

Enterprise supply chain management

Overview

Supply chain management (SCM) software helps companies manage all aspects of their supply chain processes, including transactions, vendor relationships, and inventory management. SCM can improve a company's ability to manage complex supply chain relationships by providing real-time insights that can enhance customer service, forecasting, and financial management. Subsegments include:

ERP & inventory management: Software platforms providing enterprise resource planning with integrated SCM services (including providers of inventory management software).

Asset tracking & management: Providers of hardware and software platforms enabling companies to track and manage assets and improve asset visibility.

Procurement, sourcing & financing: Software platforms enabling raw materials procurement, sourcing and payment processing solutions.

Supply chain finance: Companies helping buyers access credit lines to preserve cash and improve settlement times with sellers.

Traditional supply chains consist of a linear process though which raw materials are procured by suppliers, sold to producers, manufactured into finished goods, and sent to distributors to be packaged and delivered to customers. Enterprise SCM software has traditionally operated in the channels between each linear step, facilitating processes such as planning, ordering, and confirming. Separate systems are often used between adjacent parties on the value chain to exchange information, such as orders and returns. These systems are often not integrated to other processes in the supply chain, making data and information sharing difficult. For example, producers shipping to distributors are

likely to have little visibility into deliveries, customer satisfaction, or other useful insights. Similarly, retailers with real-time consumer insights often have difficulty relaying that information to suppliers and distributors. This friction can increase costs and result in missed opportunities.

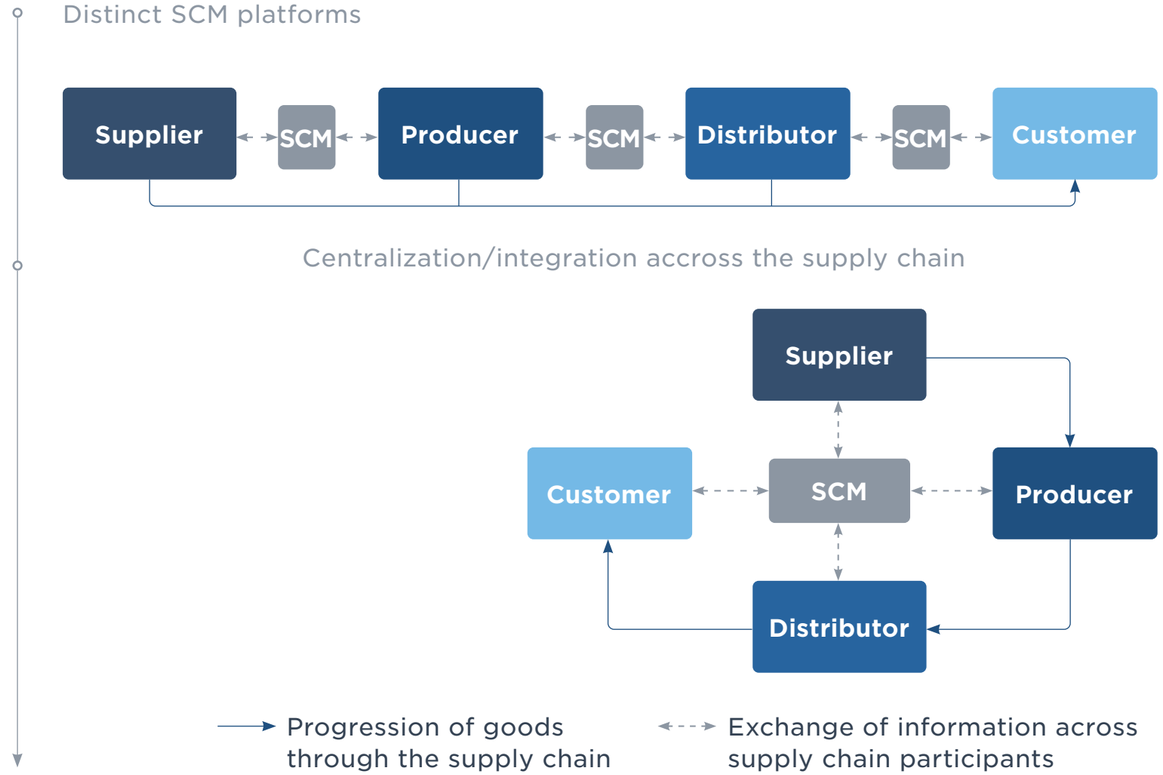
Emerging SCM software consists of connected networks where a central hub helps orchestrate and coordinate data related to supply, demand, inventory, and capacity. By utilizing a connected ecosystem, enterprises at all stages of the value chain can more quickly respond to changes in the production or distribution process, changes in demand, or other external factors affecting the value chain.

Industry drivers

- Increased demand for flexibility and visibility enabling quicker response times to supply chain shocks
- Global demand for cost reduction across the supply chain
- Shift toward digital centralized networks offering increased data visibility and transparency
- Fragmented industry ripe for consolidation and disruption opportunities
- Relatively low-tech incumbent providers, creating room for new technologie

Figure 3.

The SCM shift toward connected networks



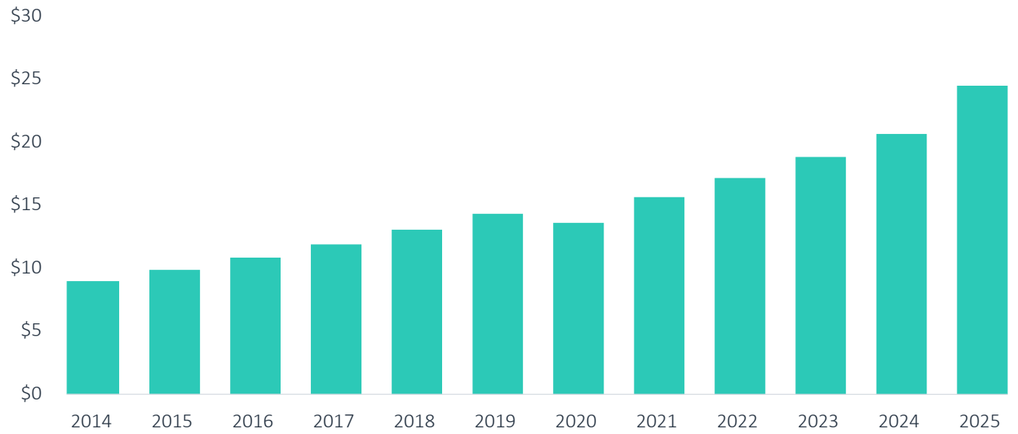
Market size

We forecast global sales of SCM software to grow to $24.5 billion in 2025 from $13.6 billion in 2020. We expect the adoption of procurement, ordering, inventory management, and supply chain planning software digitizing and de-siloing supply chain data to be the key drivers of increased growth in the industry. Despite the COVID-19 pandemic, we believe this subsector is relatively insulated and will see a low risk of companies significantly altering or pulling back on SCM spending.

Business model

SCM software helps companies manage multiple interconnected SCM processes, such as procurement, asset tracking, inventory management, and capacity planning. These cloud-based subscription software solutions help enterprises improve and accelerate analysis and decision making, which reduces costs, improves service levels, and supports growth.

Figure 4. ENTERPRISE SUPPLY CHAIN MANAGEMENT MARKET SIZE ($B)



Source: Internal PitchBook estimates

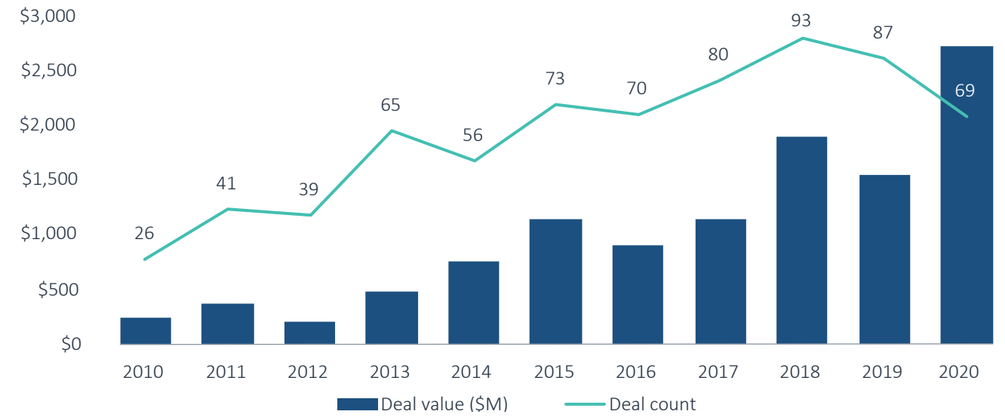
COMMON INDUSTRY KPIS

- Users under license
- Average order value
- Return percentage
- Refund/warranty rate
- Inventory turns
- Reject ratio
- Quality assurance (QA)

VC activity

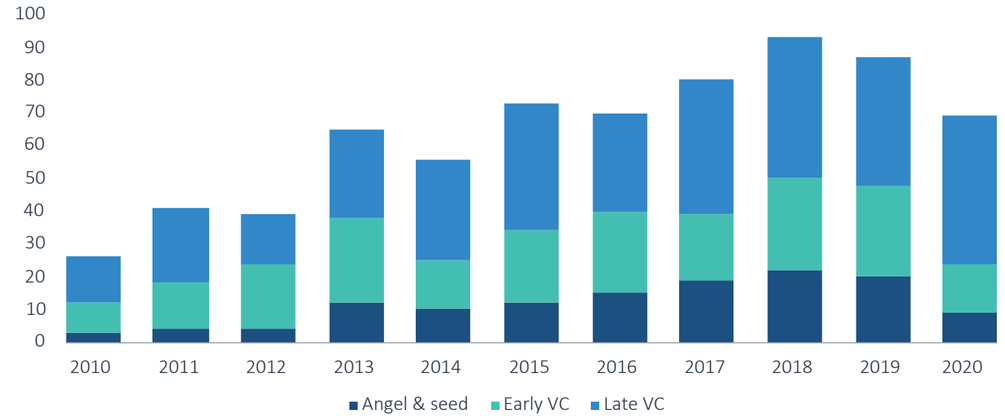
We have noted significant interest among investors for companies that help improve the visibility, flexibility, and resilience of supply chains so enterprises can source more effectively, better manage risk, and navigate sudden supply chain shocks. This has led to record VC investment in enterprise supply chain management (SCM) in 2020, a trend we believe will likely continue. Venture investment into enterprise SCM technology totaled $2.7 billion in 2020, up 75.9% YoY. In Q4 2020, VC investment in the segment reached $660.5 million, up 31.2% QoQ and 67.9% YoY. Top deals in Q4 include **Faire**'s $170.0 million Series E led by Sequoia, valuing the company at $2.6 billion (a 2.4x valuation step-up); **Zenoti**'s $160.0 million Series D, valuing the company at $1.3 billion (a 2.5x step-up), and **Project44**'s $100.0 million Series D led by Insight Partners, valuing the company at $600.0 million (a 1.79x step-up).

Figure 5. ENTERPRISE SUPPLY CHAIN MANAGEMENT VC DEAL ACTIVITY



Source: PitchBook | Geography: North America & Europe

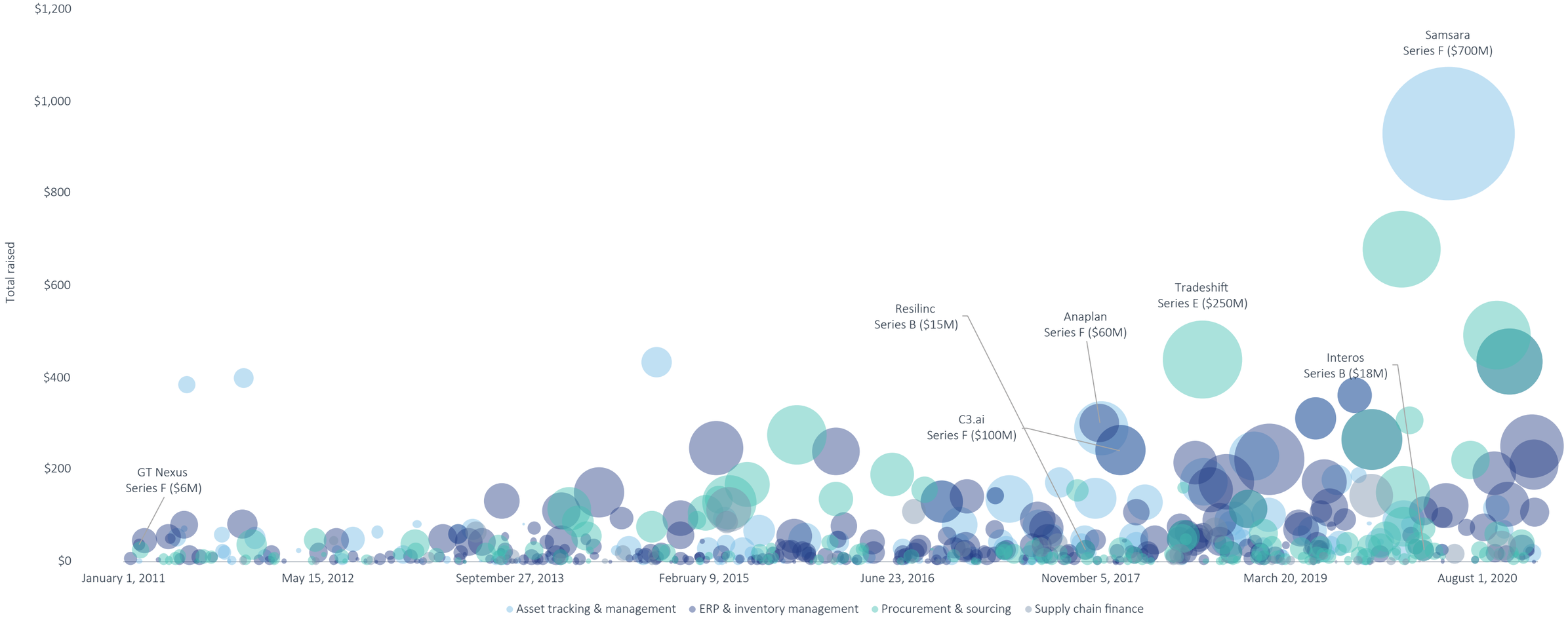
Figure 6. ENTERPRISE SUPPLY CHAIN MANAGEMENT VC DEALS (#) BY STAGE



Source: PitchBook | Geography: North America & Europe

Figure 7.

Enterprise supply chain management VC landscape ($M)



Source: PitchBook | Geography: North America & Europe

Note: The left axis indicates total VC raised as of deal date. Bubbles indicate amount raised.

ENTERPRISE SUPPLY CHAIN MANAGEMENT

Figure 8.

Notable enterprise supply chain management VC deals

COMPANY	CLOSE DATE	SUBSEGMENT	STAGE	DEAL SIZE ($M)	LEAD INVESTOR(S)	VALUATION STEP-UP*
Faire	October 19, 2020	ERP & inventory management, procurement & sourcing	Late-stage VC	$170.0	Sequoia Capital	2.40x
Zenoti	December 15, 2020	ERP & inventory management	Late-stage VC	$160.0	Advent International	2.54x
Project44	December 21, 2020	Trucking logistics, ERP & inventory management	Late-stage VC	$100.0	Insight Partners	1.79x
Vineti	October 13, 2020	ERP & inventory management	Late-stage VC	$78.0	Cardinal Health	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 9.

Notable enterprise supply chain management VC exits

COMPANY	CLOSE DATE	SUBSEGMENT	EXIT TYPE	EXIT SIZE ($M)	ACQUIRER OR INDEX	VALUATION STEP-UP*
C3.ai	December 9, 2020	Asset tracking & management, ERP & inventory management	IPO	$3,374.6	The Capital Group Companies, BlackRock	1.02x
Anaplan	October 12, 2018	ERP & inventory management	IPO	$1,804.4	NYSE	1.28x
Zuora	April 12, 2018	ERP & inventory management	IPO	$1,295.1	Steven Xi	N/A
Synovos	December 15, 2020	ERP & inventory management	M&A	$145.0	Electrocomponents	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

ENTERPRISE SUPPLY CHAIN MANAGEMENT

Figure 10.

Key VC-backed enterprise supply chain management companies

COMPANY	TOTAL VC RAISED ($M)*	SUBSEGMENT
Samsara	$930.0	Asset tracking & management
Tradeshift	$679.5	Procurement & sourcing
AppDirect	$492.7	Procurement & sourcing
Faire	$435.4	ERP & inventory management, procurement & sourcing
Alien Technology	$434.2	Asset tracking & management
Uptake	$290.0	Asset tracking & management
Zenoti	$251.0	ERP & inventory management
RELEX Solutions	$222.3	ERP & inventory management

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

ENTERPRISE SUPPLY CHAIN MANAGEMENT

Figure 11.

Key enterprise supply chain management incumbents

COMPANY	EV/TTM REVENUE*	EV/TTM EBITDA*
SAP	5.4x	19.4x
Oracle	5.7x	13.0x
Infor Global Solutions	N/A	N/A
Blue Yonder (Arizona)	N/A	N/A
Manhattan Associates	11.0x	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Opportunities

First-mile solutions: Although the bulk of venture dollars has historically gone toward middle-mile and last-mile applications, we see significant opportunity in the first mile of supply chain, which we regard as being relatively underinvested. We define the first mile as encompassing ordering & purchasing, procurement, and import & export customs processes. We see a strong opportunity for startups to digitize and streamline workflows in this space. Most startups in this space focus on solutions for specific workflows, such as supply chain finance and increased tracking and visibility. First-mile platforms **Mercado Labs** and GTNexus, the latter of which was acquired by Infor for $675.0 million in 2015, digitize the entire ordering process for both suppliers and buyers.

Supply chain orchestration: Supply chain orchestration involves the integration of multiple systems into a centralized platform accessible to multiple parties, such as suppliers and distributors. Current management teams are more data-driven than in the past, relying on data to make more informed decisions. However, in many cases, the lack of end-to-end supply chain visibility complicates a management team's ability to accurately forecast inventory and stocking levels. In addition, third parties outside of an organization often cannot gain access to siloed data. Supply chain orchestration platforms help combine disparate systems, enabling management teams to more efficiently coordinate product launches across the supply chain and respond to demand shifts. For example, a chipmaker selling to two different computer manufacturers might use a supply chain orchestration platform to share select data between all three parties in order to boost delivery speed and minimize costs. Key providers include **Elementum**, Infor Business Solutions, **Kinaxis**, JDA Software Group, **Anaplan**, **Oracle** (SCP Cloud), and **SAP** (IBP). They compete with smaller companies offering human capital-intensive services such as outsourced spreadsheet aggregation.

Inventory management software: Inventory management software helps companies optimize inventory levels to improve demand forecasting and planning. We view this as a fundamental challenge for many businesses, as 43% of small businesses either use a manual process to track their inventory or do not track it at all.[3] Similarly, 55% of small businesses either do not track assets or use manual processes. Inventory management software providers such as **Stitch Labs** and **TradeGecko** equip small and medium-sized businesses with web- and mobile-based inventory management platforms.

Wholesale marketplaces: Online wholesale marketplaces such as **Faire** and **Tundra** mitigate inventory risk for retailers. These marketplaces facilitate online transactions and leverage predictive analytics to forecast demand, enabling retailers to reduce the time and money spent on identifying and sourcing goods. Wholesale marketplaces have seen increased interest from investors. In October 2019, **Faire** raised a $150.0 million Series D led by Lightspeed and Founders Fund, valuing the company at $1.0 billion.

IoT technologies, including radio frequency identification (RFID) for asset tracking: We believe secure asset tracking represents a significant potential growth opportunity for investors. "Retail shrinkage," or loss of inventory due to shoplifting, theft, or administrative errors, has had a significant impact on profits across the retail industry. According to the Sensormatic Global Shrink Index, inventory shrinkage cost retailers almost $100 billion annually,[4] a significant portion of which was due to inventory

3: State of Small Business Report, Wasp Barcode Technologies, 2017
4: "2018 Sensormatic Global Shrink Index," Tyco Retail Solutions & PlanetRetail RNG, February 2018

mismanagement. RFID-based systems that can be actively or passively read by proximity sensors enable large amounts of inventory to be more efficiently and reliably tracked. Key VC-backed providers include **Alien Technology**, **Eximia**, **Omni-ID**, and **Mojix**.

Blockchain technology: Several startups are focused on using blockchain technology to trace the origin and status of assets throughout a supply chain. Providers in this segment combine hardware components such as RFID chips or IoT-enabled sensors with blockchain software to connect physical goods to decentralized tracking systems. Products and services include dispute resolution systems for trade financing, triggering smart contracts at product checkpoints, certifying sustainability/fair sourcing of products, monitoring temperatures of sensitive assets (such as medications) and tracking food-born illnesses. These services can increase trust and transparency while cuttingcosts. Key companies in this space include **Filament**, Everledger, and **Chronicled**. Other blockchain solutions such as Eka and **Hyperchain** focus on automating manual and paper processes while distributing data across network participants. IBM has launched a blockchain network dubbed Trust Your Supplier, which aims to diminish procurement and supplier onboarding costs by shifting manual processes such as identity verification and document tracking to the network. **Amazon** has patented a distributed ledger-based system for authentication of consumer goods. With demand for essential products rising, we anticipate investment into blockchain-based supply chain tracking technologies to rise going forward.

Supply chain finance: Supply chain finance, also known as reverse factoring, reduces the risk of supply chain disruption and enables buyers and suppliers to optimize working capital. Supply chain finance primarily helps buyers access credit lines to preserve cash and improve settlement times with sellers. Supply chain finance infrastructure became severely tested during the pandemic as many cash-constrained companies faced liquidity issues.[5] While financing can help improve the liquidity of the supply chain ecosystem, it also requires risk management to ensure healthy leverage ratios are maintained. Key VC-backed companies providing supply chain finance solutions include **Taulia**, **PrimeRevenue**, and **PrimaDollar**.

Procurement software: Procurement software companies such as **Taulia**, **Baibu**, and **supplyFORCE** assist in raw materials procurement, sourcing, and payment processing. By providing digital solutions with predictive analysis, procurement software providers enable on-demand procurement, where enterprises can sync with suppliers to increase or decrease production almost instantaneously in response to shifts in demand, minimizing deadweight loss and friction in the system.

Environmental and regulatory compliance: Investors are increasingly focused on evaluating a business' environmental, social and governance criteria (ESG). This is of utmost concern when it comes to procurement, sourcing, and other supply chain activities where environmental impact can be significant and visibility is minimal. Companies such as **EcoVadis** and **Assent Compliance** rank businesses in terms of environmental impact, sustainability, ethics, and human rights, while also helping them comply with regulatory requirements. Modern supply chain technology enables ESG review by providing more transparency into procurement and sourcing practices.

5: "Supply Chain Finance Grows Amid Pandemic, But Faces Stark Risk Warnings," S&P Global, Sanne Wass, June 8, 2020.

Considerations

Incumbent competition and exit opportunities: VC-backed providers of SCM compete with large enterprise software incumbents, including **SAP** and **Oracle**. These companies typically offer large bundled product suites often deeply entrenched within large organizations and Fortune 500 companies, leaving little room for startups to gain share in the market. Regardless, incumbents can also provide exit opportunities for late-stage startups. For example, **IQMS** was acquired by Dassault Systems in early 2019 for $430.4 million as part of a strategy to obtain cloud-based enterprise management technology.

Reluctance to adopt new technologies: Large established companies that have made material investments in legacy technologies may be reluctant to replace them, while small regional players may lack the resources to adopt new systems. These companies may rely on low-tech processes that use standard office applications such as Word and Excel, and they may lack sophisticated transportation management systems or supply chain-focused technology. The reputation-based nature of the supply chain industry poses another complicating factor; longstanding relationships are more likely to guide vendor selection than cutting-edge technology. This can make it difficult for new entrants to penetrate the market.

Technology fatigue: Potential customers in the space are subject to heavy marketed, and separating the noise from what is useful can be difficult. In our view, successful providers must demonstrate that they can help companies generate a real ROI. We believe providers that can leverage Big Data techniques to improve visibility and predictive analysis are more likely to succeed in the space.

Outlook

Risk management startups to see boost from coronavirus crisis: We expect investments into technologies that enhance supply chain visibility will mount as management teams seek to enhance their ability to track the journey of parts, components, and products from manufacturing to delivery. Risk management platforms such as **Resilinc**, **Elementum**, DHL Resiliance360, **Riskmethods**, and **Interos** offer data analytics and real-time monitoring services that enable companies to identify and react quickly to anomalies. In January 2020, **Interos** and **Riskmethods** raised $17.5 million and $9.4 million, respectively, reflecting heightened investor interest in this subsector. In July, **Mercado Labs** raised $2.5 million in a deal led by Ironspring Ventures, suggesting interest is likely to continue into the future.

Biggest opportunity in orchestration and inventory management software: We see a substantial growth opportunity in SCM software that can help management teams make more informed, data-driven decisions and orchestrate corporate strategies across supply chain vendors. We also view inventory management technologies that incorporate IoT and blockchain as having significant runways for growth. **Alien Technology** and **Filament** represent attractive acquisition targets for large incumbents seeking to gain access to these disruptive technologies.

SEGMENT DEEP DIVE

Freight

Overview

Freight startups provide technologies and solutions focused on improving the global transport of physical goods. Subsegments include:

Trucking logistics: Platforms and services targeting the commercial trucking industry. Technologies include:

- Digital freight brokerage platforms
- Visibility software
- Freight forwarding tools

Self-driving trucks: Startups enabling self-driving or driver-assistance capabilities for long-haul trucks.

Electric trucks: Startups enabling the electrification of freight through manufacturing battery-electric or hydrogen-electric trucks and powertrains.

The trucking industry comprises 70% of freight tonnage in the US and generates approximately $800 billion in annual revenue.[6] Current freight operations largely consist of established relationships between shippers (companies shipping the product) and carriers (trucking and other freight companies). Traditionally, shippers select carriers based on established relationships—a process that works reasonably well but is beset with limited product-tracking ability, low pricing transparency, and scheduling conflicts that can lead to higher costs in the supply chain.

6: "American Trucking Trends 2019," American Trucking Associations, 2019.

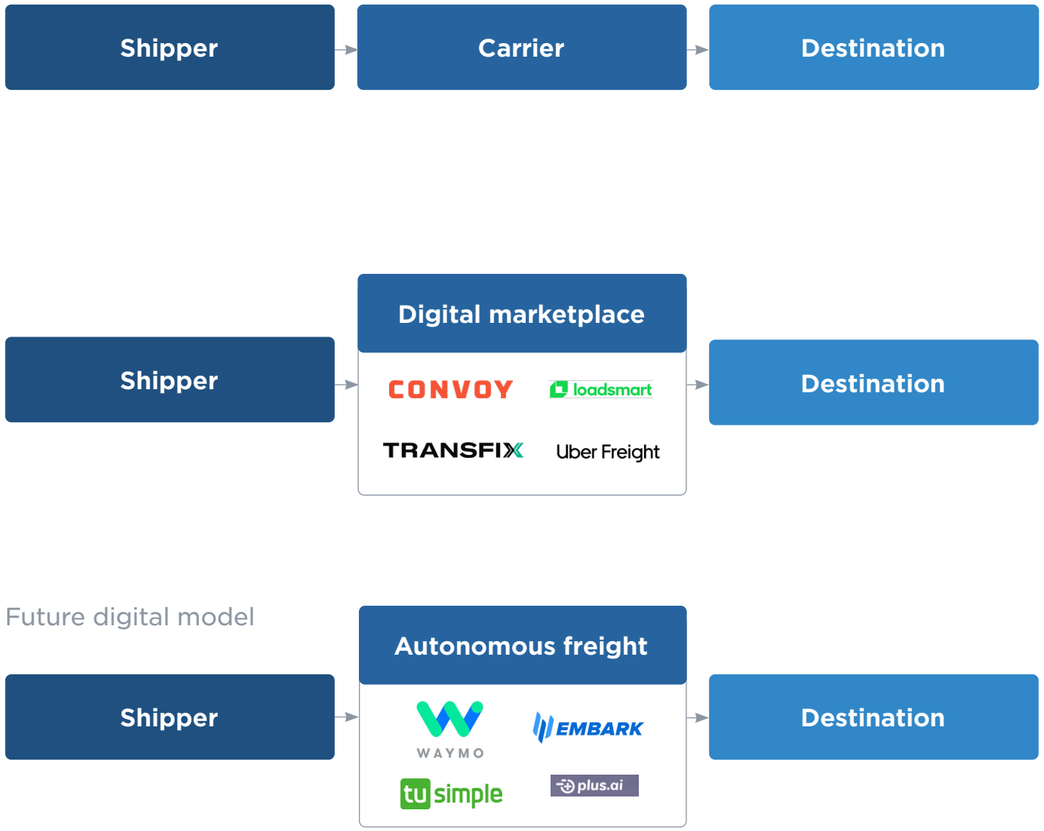
Emerging freight brokerages are using modern supply chain technology to address these inefficiencies. Companies such as **Convoy**, **Uber Freight**, and **Transfix** provide digital marketplaces that improve the ability to match shipping demand with carrier supply. Visibility platforms such as **FourKites** and **project44** provide real-time tracking data and predictive analysis for load arrivals. Lastly, the longer-term adoption of electric and autonomous trucks could dramatically reduce maintenance, service and labor costs for freight companies.

Industry drivers

- Large market provides a stable growth backdrop for service providers despite cyclicality in freight markets
- Labor, downtime, incident, fuel, and maintenance costs increasing incentives to electrify and automate
- Fragmented provider landscape provides consolidation and disruption opportunities
- Need among industry participants to integrate legacy information systems
- Relatively low-tech incumbents create opportunity for new technologies

Figure 12.

Evolution of freight



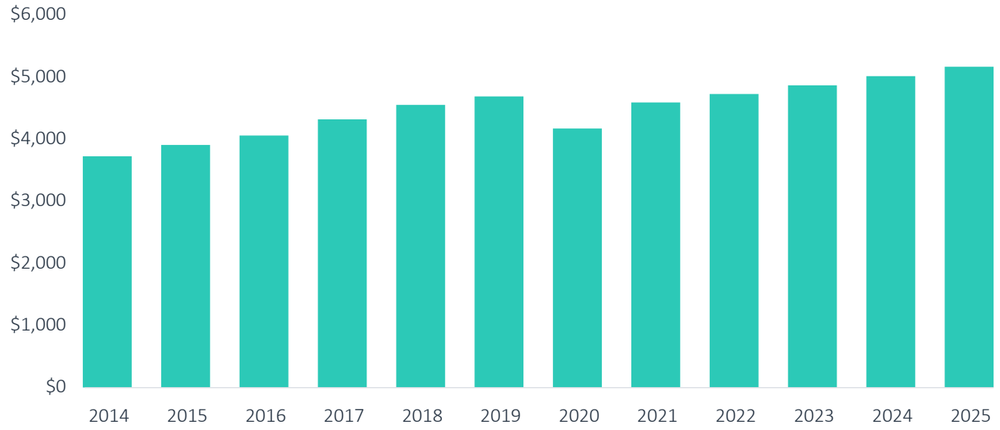
Market size

Startups providing digitized and automated solutions targeting the global freight industry serve a large and underpenetrated addressable market. We estimate the net revenue generated from the global freight industry totaled $4.2 trillion in 2020 and forecast this figure to grow to $5.2 trillion in 2025. 2020 saw a major impact from the COVID-19 pandemic, with certain shipment volumes such as automotive and imports dropping significantly, while food and other essential supplies saw surges.

Business model

Software platforms in the freight tech space typically monetize by collecting a fee for every transaction. Self-driving companies in this space monetize by selling or licensing technology to fleet managers, OEMs, and technology companies.

Figure 13. FREIGHT MARKET SIZE ($B)



Source: Internal PitchBook estimates

COMMON INDUSTRY KPIS

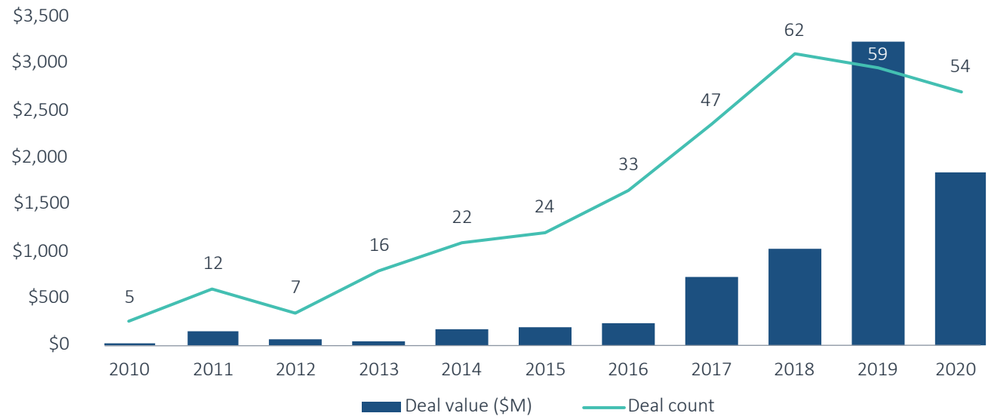
- Shipment cost
- Shipment velocity
- Shipment visibility
- Shipment service
- Gross merchandise volume (GMV)
- Percentage capacity used
- On time pickup %
- Loss and damage claims %
- Custom order cycle time
- Fuel efficiency
- Labor productivity
- Maintenance expenses
- Loading times

VC activity

Venture investment into freight tech startups waned in 2020 with $1.8 billion invested into North American and European companies, marking a 42.9% decline YoY. Despite a tepid first three quarters, freight tech startups raised a strong $1.5 billion in Q4 2020, up a significant 1301.4% QoQ and 146.5% YoY. Top freight tech deals in Q4 2020 include **Uber Freight**'s $500.0 million Series A led by Greenbriar Equity Group, valuing the business unit at $3.3 billion; **TuSimple**'s $350.0 million Series E led by Steve Girsky and VectoIQ; **Flock Freight**'s $113.5 million Series C led by SoftBank, valuing the company at $463.5 million (a 1.63x valuation step-up); and **PlusAI**'s $100.0 million Series C from Guotai Junan International and Hedosophia.

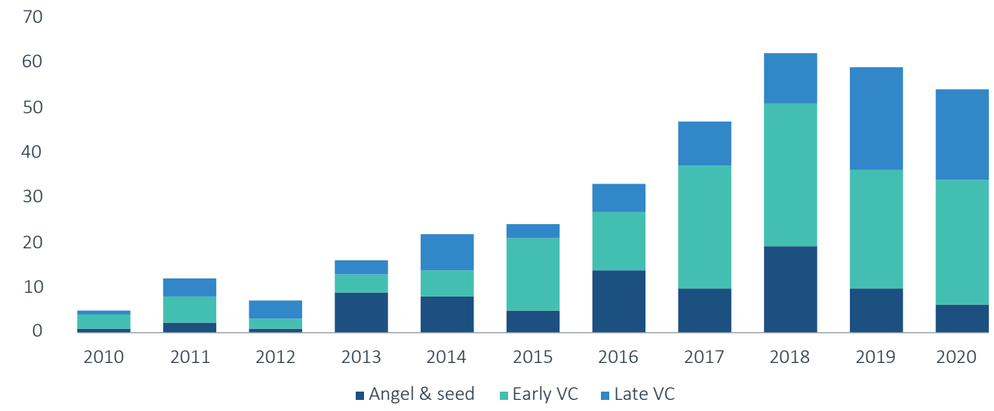
Despite the strong performance in Q4, we believe diminished VC deal activity in freight tech for the total year reflects two major trends: increased skepticism that VC-backed digital freight brokerage apps can establish profitable businesses without resorting to price reductions and preference among investors for asset-light enterprise software over asset-heavy, capital-intensive transportation startups. Since 2019, VC investors appear to have less appetite for hardware-focused freight startups, one example being the closing of self-driving trucking company **Starsky Robotics** earlier in 2020 after it was unable to raise more capital. Even as venture investors pull back from the freight tech space, PE appears to be moving in, as evidenced by BlackRock and Greenbriar's participation in major digital freight brokerage funding rounds.

Figure 14. FREIGHT VC DEAL ACTIVITY



Source: PitchBook | Geography: North America & Europe

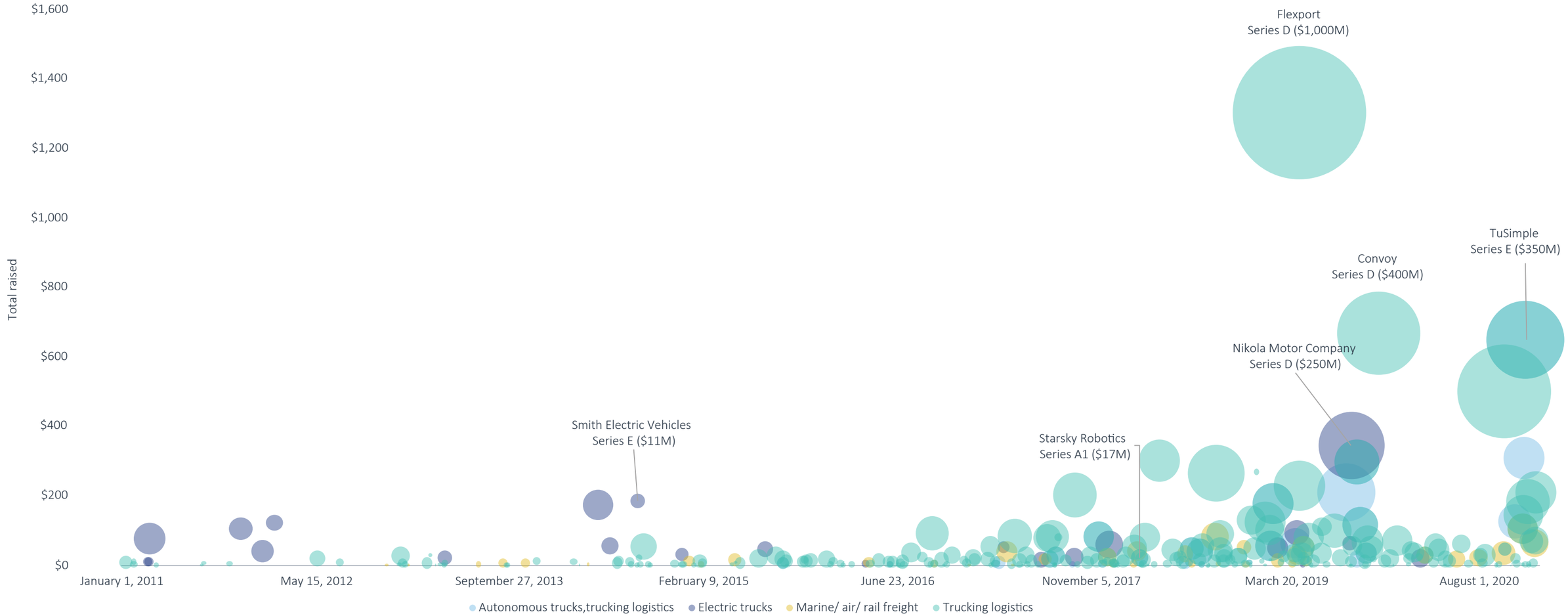
Figure 15. FREIGHT VC DEALS (#) BY STAGE



Source: PitchBook | Geography: North America & Europe

Figure 16.

Freight VC landscape ($M)



Source: PitchBook | Geography: North America & Europe

Note: The left axis indicates total VC raised as of deal date. Bubbles indicate amount raised.

FREIGHT

Figure 17.

Notable freight VC deals

COMPANY	CLOSE DATE	SUBSEGMENT	STAGE	DEAL SIZE ($M)	LEAD INVESTOR(S)	VALUATION STEP-UP*
Uber Freight	October 2, 2020	Trucking logistics	Early-stage VC	$500.0	Greenbriar Equity Group	N/A
TuSimple	November 25, 2020	Autonomous trucks, trucking logistics	Late-stage VC	$350.0	Steve Girsky, VectoIQ	N/A
Flock Freight	November 23, 2020	Trucking logistics	Late-stage VC	$113.5	SoftBank Investment Advisers	1.63x

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 18.

Notable freight VC exits

COMPANY	CLOSE DATE	SUBSEGMENT	EXIT TYPE	EXIT SIZE ($M)	ACQUIRER OR INDEX	VALUATION STEP-UP*
Kuebix	January 9, 2020	Trucking logistics	M&A	$22.0	Trimble	N/A
Riskpulse	January 9, 2020	Marine/air/rail freight	M&A	$201.1	Columbia Capital, Resilience360, Dhl International, Greenspring Associates	N/A
Kontainers	June 10, 2020	Marine/air/rail freight	M&A	N/A	Descartes Systems Group	N/A
Everoad	June 9, 2020	Trucking logistics	M&A	$11.4	Sennder	N/A
Nikola	June 3, 2020	Electric trucks	SPAC	$3,300.0	VectoIQ Acquisition Corp	N/A
Hyliion	October 1, 2020	Electric trucks	SPAC	$1,100.0	Tortoise Acquisition Corp	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 19.

Key VC-backed freight companies

COMPANY	TOTAL VC RAISED ($M)*	SUBSEGMENT
Flexport	$1,301.9	Trucking logistics
Convoy	$668.0	Trucking logistics
TuSimple	$647.9	Autonomous trucks, trucking logistics
Uber Freight	$500.0	Trucking logistics
PlusAI	$310.0	Autonomous trucks
KeepTruckin	$229.3	Trucking logistics
Project44	$210.5	Trucking logistics, ERP & inventory management
Flock Freight	$184.5	Trucking logistics

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 20.

Key freight incumbents

COMPANY	EV/TTM REVENUE*	EV/TTM EBITDA*
XPO Logistics	1.1x	14.9x
J.B. Hunt Transport Services	1.6x	12.5x
Amazon.com	4.7x	36.4x
Daimler	1.2x	10.0x
Uber	7.2x	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Opportunities

Digital freight brokerage: Digital brokerage platforms automate the process of connecting supply chain intermediaries (e.g. connecting shippers to freight companies). These platforms disrupt traditional relationship-based cargo-matching, which often depends on manual processes such as faxing documents to arrange shipments.

Digital freight brokerages can help improve price transparency and reduce shipping costs by promoting more efficient cargo handling. With cost of labor accounting for approximately 65% of the typical freight broker's expenses, digital solutions that automate manual processes can pass savings along to customers (shippers and carriers).[7] Whereas traditional freight brokerages typically charge a take rate in the mid-teens, digital freight brokerage net revenue margins hover in the low single digits.[8]

Key digital freight brokerage providers include **Convoy**, **Uber Freight**, **uShip**, **Transfix**, **Trucker Path**, **Arrive Logistics**, and **Loadsmart**. These companies are pressuring incumbent freight brokers to pour capital into digital technologies to keep pace with emerging startups. J.B. Hunt launched its own digital freight marketplace named Carrier 360 that services more than $500 million in freight. **XPO Logistics** debuted its own offering and expects future transactions to rely on a mix of brokers and automation. **Amazon** also entered the market in early 2019 with its own digital freight offering in a bid to offset a tight trucking market. According to **FreightWaves**, differentiation from these incumbent providers comes from integration capabilities in drayage and final mile, along with exception management to limit errors in shipment statuses.[9]

7: "Convoy Eliminates Human Intervention in Load-Matching," FreightWaves, Brian Straight, February 5, 2019
8: "Digital Freight Brokerage Growth to Accelerate Sharply Over Next Five Years," FreightWaves, John Paul Hampstead, March 2, 2019
9: "Breaking: Amazon's Digital Freight Brokerage Platform Goes Live," FreightWaves, John Paul Hampstead, April 26, 2019

Freight forwarding: Freight forwarders provide many middle-man functions for importers and exporters, from handling paperwork to identifying shippers and warehouse space. We see a sizable opportunity for more digitization and automation within the global freight forwarding industry, which is estimated at over $140 billion.[10] According to the Boston Consulting Group, automating manual processes could drop industry back-office and operations costs by up to 40%.[11] These manual processes include lengthy offline quotation and booking processes, filling out shipping documents, and antiquated methods of conveying documents such as personal handoffs and faxes. Digital freight forwarders digitize and automate these processes and offer additional services such as maximizing route efficiency for shipping and tracking cargo. Key providers in the space include **Flexport**, **Freightos**, **Forto**, and **ZenCargo**.

Visibility software: Supply chain visibility software provides real-time tracking and data analytics tools for shippers. This can be a crucial value-add for companies shipping high- value goods. Prior to the rise of this technology, shippers would often have minimal visibility into arrival times for loads. Supply chain visibility platforms enable shippers to receive real-time updates and predictions for loads arriving early, on time or late, which helps to streamline operations. Visibility software also helps enterprises better understand critical failure points, enabling them to reduce costly returns, which typically make up 15% of ecommerce volumes. Mobile app integration enables users to view additional delivery data and can capture signatures. Key providers in the visibility space include **project44**, **FourKites**, Clearmetal, MacroPoint (acquired by Descartes), 10-4 Systems, and **Shippeo**.[12]

10: "Global Freight Forwarding 2017," Ti (Transport Intelligence), June 2017.
11: "Banks Can Outsmart the Competition With Intelligent Operations," Boston Consulting Group, Derek Hayes, et. al, September 19, 2019.
12: "Project44 Bags Amazon and Walmart," Freight Waves, John Paul Hampstead, August 2019.

FREIGHT

We see growth opportunities for these companies to serve a relatively untapped carrier market. The next stage of growth includes penetrating the intermodal market (i.e. drayage trucking, rail), which is in the early stages of telematics adoption. Although this category overlaps with SCM software providers, companies highlighted are primarily used by shippers.

Electric trucking: We believe the use of medium-size and heavy electric trucks could increase by 15x by 2025 as favorable operating economics drive adoption. Relative to traditional diesel-powered trucks, electric trucks offer several benefits including reduced fuel costs, up to 20% lower maintenance costs given fewer moving parts to service, less specialized equipment and labor needs, longer warrantied lifetimes, and steadily declining battery costs. Key companies developing truck electrification technology include Tesla, Nikola, **Hyliion**, Hyzon Motors, **Wrightspeed Powertrains**, **VIA**, and XOS Trucks (formally Thor Trucks). Notably, in June 2020 US state California announced that it will require all new trucks sold in the state to be zero-emissions. Whereas some providers are focusing on battery electric powertrains, others such as Nikola, **Hyliion**, and Hyzon Motors are focusing their efforts on developing hydrogen fuel cell-based powertrains. It remains to be seen how competitive fuel cell technology will be in electrifying freight compared to battery electric options. Barriers to hydrogen fuel cell adoption include the need for capital-intensive infrastructure rollouts. Nevertheless, the technology could have advantages over batteries owing to inherent technical advantages related to energy density.

Key companies developing truck electrification technology include Daimler, Tesla, Nikola, **Wrightspeed Powertrains**, **VIA**, Volvo, and XOS (formally Thor Trucks).

Autonomous vehicles for middle mile transport: We believe autonomous solutions targeting B2B middle-mile logistics present a compelling investment opportunity. Middle-mile transport refers to the movement of goods to, from, and among warehouses or shipping facilities in urban and rural locations. Unlike using autonomous vehicles for consumer transport, transporting commercial goods isn't beholden to customer expectations about passenger experience, has lower safety hurdles, and is not as sensitive to delays. Moreover, many of these vehicles operate on fixed routes as opposed to dynamic routes, which decomplicates routing for AI-based systems. Often these routes are in closed-off locations away from the public—such as on shipyards or docks—where collision risks are lower. These environments enable lower success thresholds relative to consumer applications of autonomous vehicles, increasing the likelihood of adoption over a shorter time horizon. Walmart, which pioneered the retail hub-and-spoke distribution model, is now working to automate its last-mile logistics network through a partnership with startup Gatik AI.

Automating long-haul trucking: The automation of long-haul trucking could help combat wage pressure and driver shortages. In 2018, driver wages and benefits comprised 43% of per-mile average marginal costs, up from 35% in 2014.[13] The relative simplicity of automating highway driving compared to urban driving will accelerate deployment of this technology. Walmart is reportedly working to automate its logistics network through a partnership with startup Gatik AI. Volvo is also targeting this market with a cabless, fully autonomous Vera truck. Daimler Trucks, which acquired Torc Robotics in 2019, is also investing heavily in the space. Key VC-backed companies in the long-haul trucking space include **Aurora** Innovation, **TuSimple**, **Embark Trucks**, **Kodiak Robotics**, **PlusAI**, and **Ike**

13: "Walmart's Kickstarting a $1 Trillion Driverless Delivery market," Bloomberg, Keith Naughton and Matthew Boyle, June 19, 2019

Robotics (acquired by **Nuro**). These startups compete with more established technology companies and automakers such as Waymo, Volvo, and Daimler.

Financial market platforms: The high volume of commodity freight shipping and the ability to forecast prices creates an opportunity for derivative products to hedge against price changes. **FreightWaves** is leveraging its role as an industry media and data hub to sell trucking freight futures products for key routes between major cities. In 2019, the company launched a financially settled futures market based on trucking spot rates that trades on commodities-focused Nodal Exchange. This instrument enables hedging in a historically volatile market, giving shippers and trucking companies more control over shipping costs and price risk. **FreightWaves** has built a digital media presence around this platform, providing news and analyst coverage on trends in supply chain and logistics. As the freight industry becomes more connected and digitized, platforms such as **FreightWaves** are well positioned to benefit.

Blockchain for maritime shipping: Blockchain initiatives such as TradeLens and the Global Shipping Business Network (GSBN) could improve transparency and reduce costs for overseas shippers. Five of the world's six largest oceangoing carriers (Maersk, CMA CGM SA, Mediterranean Shipping Co., Hapag-Lloyd AG, and Ocean Network Express) have joined TradeLens, a blockchain platform launched by Maersk and IBM, to provide increased transparency into goods tracking, improve data sharing, and trim the cost of paperwork in the maritime supply chain.[14] Several other large ocean-shipping companies (including PSA International, Shanghai International Port Group, CMA CGM SA, and Yang Ming Marine Transport Corporation) have joined a blockchain consortium from China-

14: "Shipping Blockchain Initiative Gathers Steam," The Wall Street Journal, Costas Paris, July 2, 2019

Figure 21.

Recent self-driving valuations

SELF-DRIVING CARS		
WAYMO	$30.0B	March 2, 2020
cruise	$19.0B	May 7, 2019
MOBILEYE An Intel Company	$15.3B	April 1, 2018
Uber ATG	$7.3B	April 18, 2019
ARGO AI	$7.3B	June 1, 2020

Source: PitchBook

owned COSCO. Accenture is also reportedly developing its own blockchain platform for the shipping industry.

Considerations

Substantial investment needed to scale: We believe digital brokerage startups such as **Uber Freight** and **Convoy** have achieved significant success; both companies are generating run-rate annual revenues in the hundreds of millions of dollars. However, we believe that achieving strong network effects and reaching profitability will require each company to grow considerably larger in both geographic scale and breadth of service offerings. Taking meaningful market share from incumbents is likely to require materially more near-term investment.

Unsustainable growth strategies: **Amazon**'s new digital freight brokerage platform has reportedly been undercutting market prices by 26%-33%.[15] VC-backed startups and relatively new entrants such as **Uber Freight** have adopted similar strategies to attract new shippers to their platforms. In our view, this strategy is likely to be unsustainable during periods where access to cheap capital is limited. Given the current downturn, we anticipate the industry will be forced to become more rational with pricing. In this scenario, new entrants risk losing market share to larger competitors and incumbent carriers that are able to sustain these types of discounts.

Large and established competition: Although startups kickstarted the transition to digital freight brokerage, they risk being outcompeted by incumbent carriers investing heavily in their own capabilities. These companies include legacy providers such as C.H.

15: "Breaking: Amazon's Digital Freight Brokerage Platform Goes Live," FreightWaves, John Paul Hampstead, April 26, 2019

Figure 22.

Recent self-driving valuations

SELF-DRIVING TRUCKS		
Aurora	$3.1B	September 9, 2019
tusimple	$1.1B	September 17, 2019
plus.ai	$1.0B	August 21, 2019
EMBARK	$520.0M	September 25, 2019
Ike	$250.0M	February 5, 2019

Source: PitchBook | Geography: Global | *Internal estimates
Note: Waymo is also reportedly testing its technology on long-haul trucks.

Robinson, Echo Global Logistics, **XPO Logistics**, and J.B. Hunt, which have the resources to aggressively compete with smaller rivals and develop similar technologies. Many large shippers are making the transition to digital and developing inhouse transportation management software (TMS) capabilities to receive and route freight orders. For example, in early 2019, **XPO Logistics** launched a service called XPO Connect that enables shippers to book and track shipments online.[16] J.B. Hunt has its own freight brokerage service which books over $500 million in freight annually, and **Amazon** entered the market in early 2019 with its own digital freight offering in a bid to offset tightness in trucking capacity slowing its growth rate.[17]

Unproven model in autonomy: Among all the segments within freight, we believe autonomy may represent the most difficult market for startups. This subsegment requires massive upfront investment to develop complicated and sophisticated technology that may be many years away from working in the real world. Pioneers in the space are also very well funded. Alphabet-owned Waymo is currently piloting autonomous trucks and is among the best-positioned companies in the space. Daimler is sourcing technology from Waymo while also developing its own self-driving technology in partnership with lidar startup Luminar. VC-backed companies **TuSimple** and **PlusAI** were last valued at $1.2 billion and $1.0 billion, respectively. Chinese mobile app platform Manbang, which was last valued at $6.5 billion, is reportedly making investments in freight autonomy. **Uber**, which was at one time a competitor through its $700 million acquisition of Otto, has dropped out of the race, likely due to pressure to trim losses. **Starsky Robotics**, a key competitor in the space, has wound down its asset-heavy trucking operations after difficulties raising VC funding. We believe companies developing autonomous technologies that do not rely on fleet operations are better positioned to succeed, especially as investors increasingly favor software-focused, asset-light startups.

Potential customers slow to change and have limited ability to invest: Large enterprises that could benefit the most from automated solutions may be resistant to adopt new technologies or may lack capital to invest. While automated services could slash costs for large shippers, many of these companies lack the infrastructure to integrate with digital platforms. These low-margin companies have limited ability to invest in new technologies, while global trade uncertainty and tariffs are adding additional pressures. We believe the relationship-based culture of this business is another obstacle to adoption as long-standing relationships tend to dictate business decisions.

Outlook

Self-driving trucks to capture more freight tech investment: We view autonomous trucking companies such as **TuSimple**, Embark, and **Kodiak Robotics** as attractive investment opportunities. In our view, lower valuations for these companies are at odds with the more near-term market opportunity available to automating logistics, given lower technological and regulatory hurdles. We expect investors will remain active in the space and predict that an increasing proportion of large deals in the freight tech space will go to self-driving trucking companies. In-progress deals include **PlusAI** raising $60.0 million of venture funding in a deal led by Guotai Junan International and **TuSimple** planning an early 2021 IPO at a valuation of up to $7.0 billion.

16: "XPO Logistics Joins Push to Digital Freight Booking," Wall Street Journal, Jennifer Smith, April 11, 2018
17: "Breaking: Amazon's Digital Freight Brokerage Platform Goes Live," FreightWaves, John Paul Hampstead, April 26, 2019

Pandemic highlights need for visibility software: We expect the current downturn to catalyze investment into freight visibility platforms such as **project44**, **FourKites**, MacroPoint, 10-4 Systems, and **Shippeo**, which provide valuable visibility into where high-value goods are in transit, thereby streamlining processes and curtailing friction in the supply chain.

Favor software intermediaries over asset-holding models: We view asset-light software companies with subscription pricing models more favorably than businesses with high variable-cost components. SaaS businesses are likely to have a steadier recurring revenue stream that could prove more resistant to downturns. Startups such as **Haven** serve as software-focused intermediaries that match shippers and cargo without holding inventory. This reduces liability and should limit downside risk.

Increased M&A activity: We expect increased acquisition activity in the freight brokerage space as the industry faces pressure to price more rationally. Large incumbents such as **Amazon**, J.B. Hunt, and Echo Global Logistics are likely buyers as they gain traction with their in-house solutions. In the long term, we anticipate the tail end of the digital freight brokerage space to consolidate as the current downturn has an impact primarily on smaller, less profitable startups.

Self-driving enablers are attractive acquisition targets: We view autonomous trucking companies such as **PlusAI**, **Embark Trucks**, and **Kodiak Robotics** as attractive acquisition targets for incumbent freight & logistics providers and other technology companies. In our view, lower valuations for these companies are at odds with the potentially broader and more near-term market opportunity available to automating logistics. As with software-focused startups, we view asset-light technology providers more favorably than startups attempting to operate autonomous fleets, as evidenced by **Starsky Robotics**' failure to find a buyer and subsequent shutdown. We expect investors will remain active in the space given the likelihood that discounted valuations could persist for some time. Validating this prediction, in December 2020, **Nuro** acquired **Ike Robotics** for an undisclosed amount (the company was last valued at $250.0 million).

SEGMENT DEEP DIVE

Warehousing

Overview

The warehousing industry has experienced strong growth in recent decades. Warehouse employment rose 187% from 1990 to 2019, while total non-farm employment rose 40%.[18] Demand for warehousing space is strong; 183 million square feet of new warehousing space was built in 2017, a sizable increase compared to the 100 million annual average over the past decade, according to CBRE.[19]

While economic growth partially fueled this expansion, it also reflects important technological evolutions that continue to alter the supply chain ecosystem. Walmart's hub-and-spoke approach set the standard for big-box retail in the late 20th century, enabling the company to become one of the largest global retailers ever. This was followed by **Amazon**'s fulfillment center model, which helped facilitate the rise of ecommerce and the ongoing push for same-day delivery. More recently, the rise of dropshipping and the stitching together of third-party warehousing services, such as Shopify's fulfillment network, is empowering small individual retailers to compete on a global scale. Subsegments include:

Warehousing & fulfillment: Startups providing sorting, packaging and shipping services for retailers and enterprises
Automation & micro-fulfillment: Startups providing robotic and automation technologies for warehouses and fulfillment centers
Warehouse marketplaces: Startups helping enterprises with excess inventory find available warehouse space
Augmented reality: Startups developing augmented reality solutions for warehousing applications

18: Employees on Nonfarm Payrolls by Industry, Sector, and Selected Industry Detail." United States Bureau of Labor Statistics, accessed August 7, 2020
19: "Cold Storage Space: One Size Does Not Fit All," CBRE, n.d.

Walmart played a key role in the early stages of warehousing innovation. The company's innovative (at the time) hub-and-spoke distribution system has been critical to its ability to service its global branch network. Under this model, distribution centers operate as hubs that provide inventory for multiple stores. Distribution centers are not designed for long-term storage, but as short-term holding locations where goods are categorized and sorted for distribution to Walmart branches. Some items spend as little as 45 minutes in warehouses before being shipped to a branch where inventory has run out. Key innovations of this system included the use of Walmart's own fleet, which reduces freight and delivery costs relative to using third-party providers; and an integrated inventory tracking system, which enables a real-time view of inventory levels across stores.

While hub-and-spoke models worked well in a physical retail world, ecommerce changed the game entirely. Whereas Walmart's success depended on its ability to make a large selection of goods available in convenient locations, online retail eliminated these constraints, allowing retailers to sell virtually anything. From a supply chain perspective, this has shifted the focus from the complicated logistics of product curation and stocking, to the adjacent—though equally as complicated—logistics of fulfillment and consumer delivery.

Amazon's rise to the forefront of ecommerce has largely reflected the company's ability to provide the best online shopping experience in terms of product search, quick delivery, and easy returns. To accomplish the quick delivery part of this equation, the company turned Walmart's hub-and-spoke model on its head. Instead of a closed internal sourcing and delivery ecosystem, **Amazon** opened its retail platform up to third-party providers, including sellers, freight, and delivery services, creating a virtual marketplace for these functions. This gave rise to **Amazon**'s fulfillment centers, which act as product hubs that coordinate the delivery of goods directly to consumers by leveraging a network of third-party product suppliers and delivery services.

While **Amazon** has dominated the ecommerce landscape, it has also provided a model for startups seeking to help traditional and small to medium-size retailers compete. Several companies have emerged that are focused on providing large scale shipping management and fulfillment services for small-scale businesses and other legacy retailers. These include **ShipBob** and **ShipHawk**. Others include **Flexe** and Stord, which are creating marketplaces for outsourced warehousing; **Fetch Robotics** and **Fabric** are creating automated micro-fulfillment centers of the future.

Industry drivers

- Emerging need to manage inventory for real-time changes in demand
- Demand from smaller retailers for tech and services, enabling them to compete with large retailers
- Ongoing efforts to reduce shipping and delivery costs
- New technologies enabling real-time tracking and better mapping of items in transit
- Improving robotics technology
- Increasing demand for quicker delivery times and just-in-time inventory

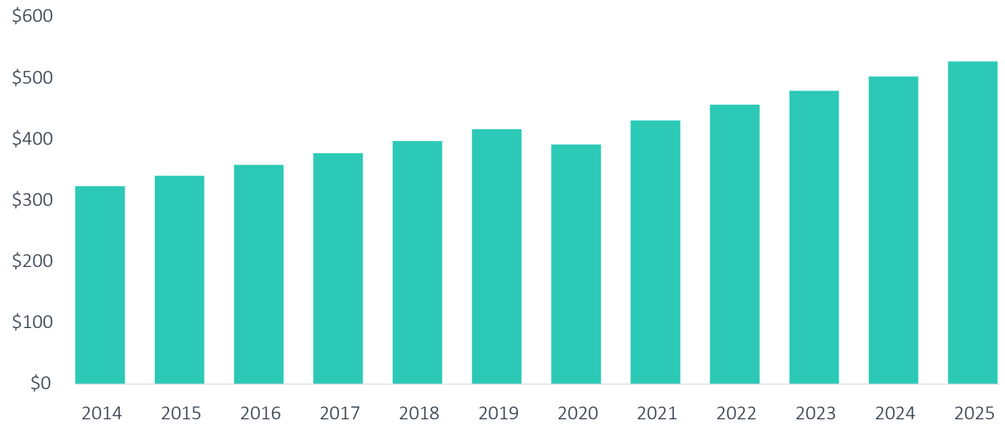
Market size

We estimate the net revenue generated from the global warehousing & fulfillment industry totaled approximately $391.8 billion in 2020 and forecast this figure to grow to $527.3 billion in 2025. Although the current downturn could reduce spending on capital-intensive projects in the near term, we expect increases in ecommerce volumes and heightened demand for automated warehousing robots to be key drivers of market growth in this segment over the long term.

Business model

Companies that provide sorting, packaging, and shipping services typically charge for these services on a per-package basis. Robotics and micro-fulfillment companies typically monetize by selling autonomous robots on a per-unit basis, though an increasing number are transitioning to a full-service subscription-based model.

Figure 23. WAREHOUSING MARKET SIZE ($B)



Source: Internal PitchBook estimates

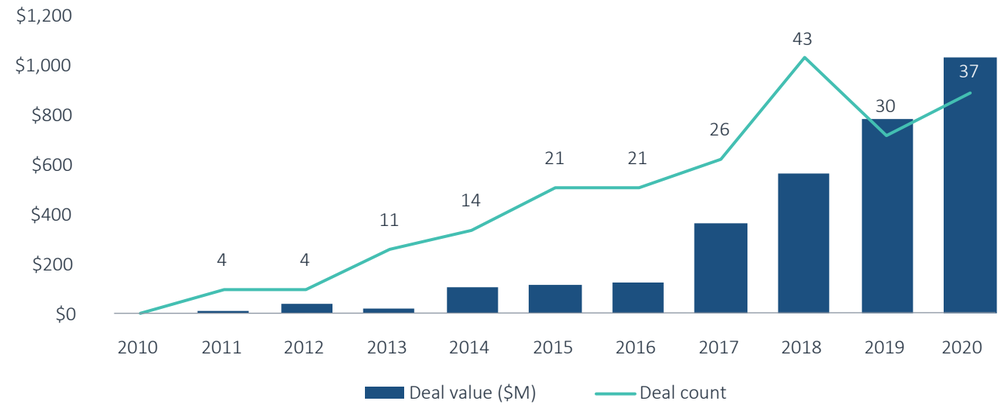
COMMON INDUSTRY KPIS

- On-time shipping
- Order cycle time
- Dock-to-stock time
- Inventory accuracy (receiving and order fulfillment)
- Recordable incident rate (RIR)

VC activity

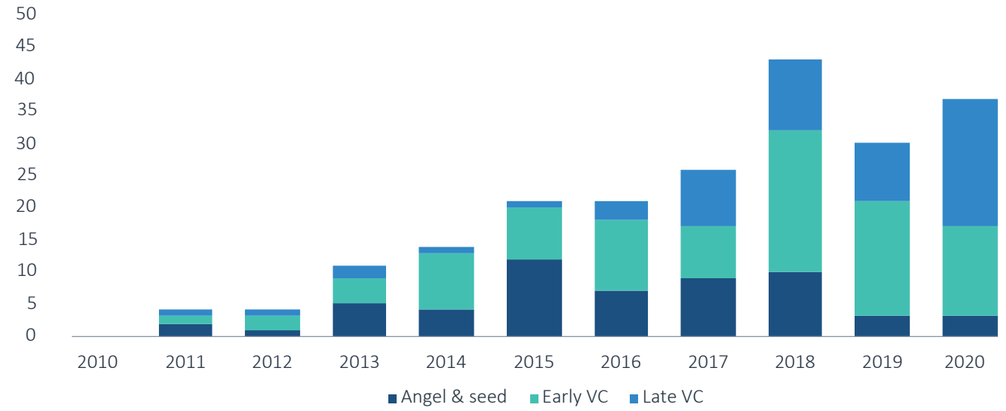
Warehousing tech startups continued to attract substantial investment in 2020, raising a record $1.0 billion in VC through the end of the year, up 31.6% YoY. Despite a strong year overall, activity was relatively muted in the fourth quarter with $112.0 million in VC investment, down 71.2% QoQ and 34.7% YoY. Notable deals in Q4 include **Outrider**'s $65.0 million Series B led by Koch Disruptive Technologies; **STORD**'s $31.0 million Series B led by Founders Fund, valuing the company at $191.0 million (a 3.56x valuation step-up); and **Caja Robotics**' $12.0 million late-stage VC round led by New Era Capital Partners. These deals showcase growing investor interest in warehousing technologies such as micro-fulfillment, automation, and flexible marketplaces that can reduce labor costs, improve e-commerce delivery times, and increase supply chain resiliency. We maintain our outlook that warehousing tech is relatively underinvested compared to other segments within supply chain tech, and we anticipate the segment will see continued investment growth going forward.

Figure 24. WAREHOUSING VC DEAL ACTIVITY



Source: PitchBook | Geography: North America & Europe

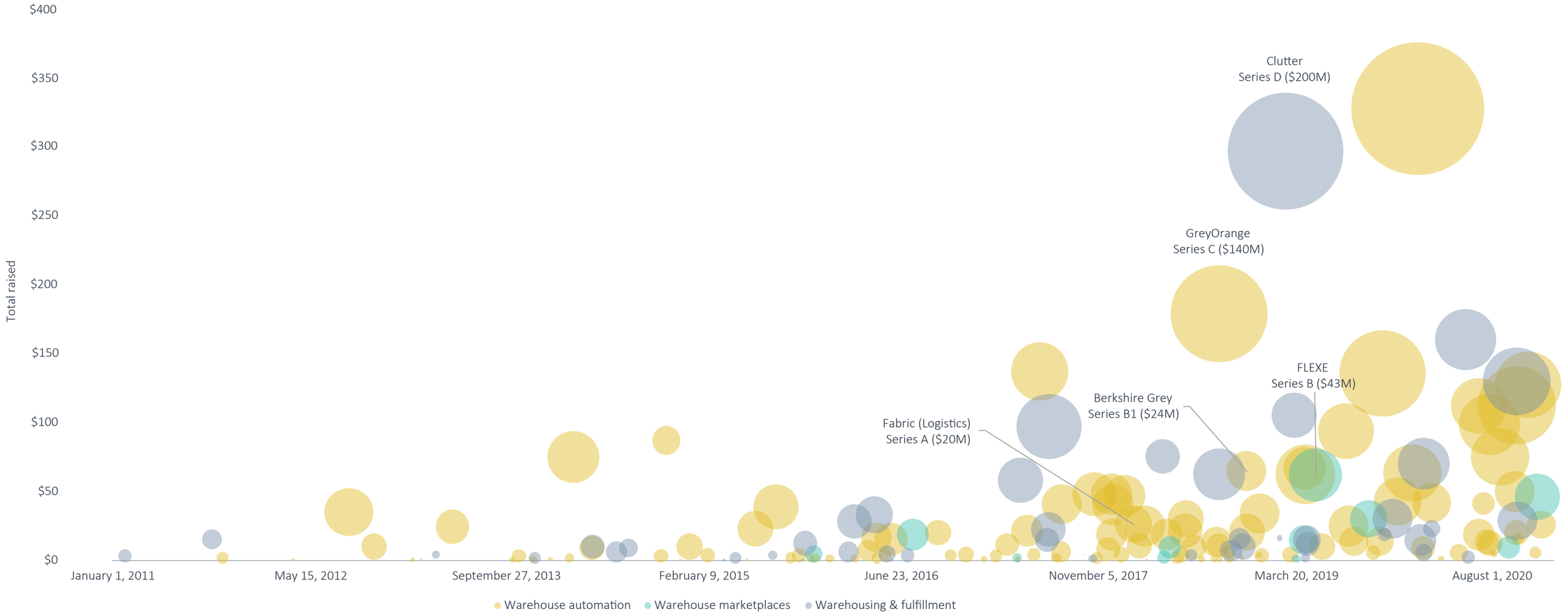
Figure 25. WAREHOUSING VC DEALS (#) BY STAGE



Source: PitchBook | Geography: North America & Europe

Figure 26.

Warehousing VC landscape ($M)



Source: PitchBook | Geography: North America & Europe

Note: The left axis indicates total VC raised as of deal date. Bubbles indicate amount raised.

Figure 27.

Notable warehousing VC deals

COMPANY	CLOSE DATE	SUBSEGMENT	STAGE	DEAL SIZE ($M)	LEAD INVESTOR(S)	VALUATION STEP-UP*
Outrider	October 28, 2020	Warehouse automation, autonomous trucks	Early-stage VC	$65.0	Koch Disruptive Technologies	1.36x
STORD	November 19, 2020	Warehouse marketplaces	Late-stage VC	$31.0	Founders Fund	3.56x
Caja Robotics	November 30, 2020	Warehouse automation	Late-stage VC	$12.0	New Era Capital Partners	N/A
Pickle Robot	November 13, 2020	Warehouse automation	Seed round	$2.0	N/A	1.40x
Realtime Robotics	October 2, 2020	Warehouse automation	Early-stage VC	$2.0	N/A	1.28x

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 28.

Notable warehousing VC exits

COMPANY	CLOSE DATE	SUBSEGMENT	EXIT TYPE	EXIT SIZE ($M)	ACQUIRER OR INDEX	VALUATION STEP-UP*
6 River Systems	October 17, 2019	Warehouse automation	M&A	$394.0	Shopify	2.63x
CANVAS Technology	April 10, 2019	Warehouse automation	M&A	$100.0	Amazon.com	N/A
PeopleVox	February 21, 2020	Warehousing & fulfillment	M&A	$24.1	Descartes Systems Group	1.29x

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 29.

Key VC-backed warehousing companies

COMPANY	TOTAL VC RAISED ($M)*	SUBSEGMENT
Berkshire Grey	$327.6	Warehouse automation
Clutter	$297.2	Warehousing & fulfillment
GreyOrange	$178.9	Warehouse automation
MakeSpace	$160.6	Warehousing & fulfillment
Vicarious	$137.0	Warehouse automation
Fabric (Logistics)	$136.0	Warehouse automation
ShipBob	$130.1	Warehousing & fulfillment
Outrider	$127.2	Warehouse automation, autonomous trucks

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 30.

Key warehousing incumbents

COMPANY	EV/TTM REVENUE*	EV/TTM EBITDA*
Dhl International	N/A	N/A
Amazon.com	4.7x	36.4x
XPO Logistics	1.1x	14.9x
United Parcel Service	2.1x	17.9x
Microsoft	11.0x	22.6x

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Opportunities

Fulfillment technologies: Much of **Amazon**'s ability to provide industry-leading delivery services can be attributed to its investments in warehousing, fulfillment, sorting, and delivery stations. Emerging warehousing technology startups such as such as **ShipBob**, **Delhivery**, and **ShipMonk** are emulating **Amazon**'s model to provide smaller retailers with products and solutions to help them compete with **Amazon** and Walmart. In addition to typical fulfilment services such as warehousing, packing, and shipping, **ShipBob** offers software that integrates with multiple parties on the supply chain to provide visibility into inventory. Utilizing digital fulfillment software enables enterprises to reduce fulfillment costs and errors, increase transparency, and improve the customer experience. In this way, warehousing and fulfillment technology can provide a competitive edge to help close the gap between smaller retailers and large incumbents.

Digital marketplaces for warehouse space: Warehousing operations account for approximately 20% of all logistics costs,[20] and as enterprises face pressure to streamline their cost structures, many are looking to reduce this spend. While third-party logistics (3PL) providers, such as DHL, **XPO Logistics**, and Ryder Supply Chain Solutions can provide flexible on-demand warehouse space, their operational models are often outdated, involving phone calls, faxing, and traditional relationship-based activities. Emerging digital platforms, such as VC-backed **Flexe**, Stord, and **Darkstore**, create digital marketplaces for external warehouse space. These companies provide a flexible logistics solution for asset-intensive enterprises struggling to place inventory. For example, **Flexe** helps match customers (which include Ace Hardware and Staples) with local warehouse space for excess inventory. 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. Digital marketplaces also increase price transparency and allow for more consumption-based spend.

Automation of micro-fulfillment centers: We see micro-fulfillment as a strong growth opportunity for autonomous technologies that can automate manual warehouse functions. Rising ecommerce volumes and increased demand for faster delivery has led many enterprises to build small warehousing and fulfillment centers close to urban locations. These micro-fulfillment centers enable quicker delivery via the use of last-mile delivery couriers. Yet these centers typically cost more to operate (i.e. higher labor and real estate costs), creating an opportunity for providers of robotic and automation services to help cut costs. According to ABI Research, over 4 million commercial robots will be installed in 50,000 warehouses by 2025, up from around 4,000 robotic warehouses last year.[21] Private companies will be key to this transformation. For example, **RightHand Robotics** has developed a robotic arm to pick and place physical goods at warehouses. **Exotec Solutions** provides automated warehouse robots that can move up and down racks to pick boxes from shelves and bring them to workers. **GreyOrange** has developed scalable and modular robot systems that can be used to transport, store, and pick goods in warehouses. **Realtime Robotics** has invented a processor that can effectively react to obstacles intercepting robotic motion plans without being bogged down by wading through a conventional decision tree. We believe the adoption of autonomous mobile robots (AMRs) and additional autonomous warehousing technologies will see growth

20: "Design and Control of Warehouse Order Picking: A Literature Review," European Journal of Operational Research, René De Koster, et al., 2006

21: "50,000 Warehouses to Use Robots by 2025 as Barriers to Entry Fall and AI Innovation Accelerates," ABI Research, March 26, 2019

over the long term as enterprises seek to reduce labor costs. Additionally, we believe autonomation will increasingly provide a source of competitive advantage for warehouses during pandemic conditions by enabling greater social distancing. More automation should allow warehouses to operate with fewer staffing disruptions during outbreaks and help attract talent drawn to safer working conditions.

Augmented reality: We believe augmented reality technology used in warehousing applications could be a key early-stage investment opportunity. Processes such as picking products from shelves, which currently accounts for 55%-60% of the cost of warehousing operations, could benefit significantly from wearable augmented technology. Warehousing workers of the future could utilize augmented reality glasses to pick and sort automatically labeled goods more quickly and at lower error rates, driving down warehousing costs. Augmented reality glasses could also improve other processes in the warehouse, such as optimizing routes and seamlessly confirming orders. Key startups working on augmented reality specifically for warehousing include **RealWear**, **Upskill**, **Atheer**, **Ubimax**, **Getvu**, and **Oculogx**. These companies compete with AR companies, such as Magic Leap and Unity, as well as the consumer and enterprise AR efforts of incumbent technology companies, such as Facebook, Microsoft, and Apple. Magic Leap, which has reportedly pivoted from consumer to enterprise applications, raised $350.0 million in May 2020, a sign that investor interest in enterprise AR continues to be robust.

Considerations

Automation in early stages: We believe the high cost of deploying autonomous technology in warehousing is a deterrent to adoption. For example, **Amazon**'s CartonWrap machines reportedly cost an average of $1 million each. Additionally, robots can break down, leading to less productivity and unanticipated repair costs. In the medium term, we believe warehouse operators may prefer to invest in alternative technologies such as augmented reality. With that said, in the long term we expect the cost of automating warehouses to continue to decline, which should spur adoption.

Industry-wide inertia: Large established companies with significant sunk costs in legacy technologies and processes may be slow to adopt new technologies and processes. Many of these companies likely use in-house logistics processes for warehousing and fulfillment or rely on established relationships with regional or incumbent outsourced third-party logistics providers. This relationship-based culture could be hard to unseat and may represent a major obstacle to adoption.

Large existing competitors: Well-funded incumbents with established logistics networks are leveraging their market position to outcompete newer entrants. Third-party fulfillment services are dominated by large companies such as **FedEx** (**FedEx** Fulfillment), **Amazon** (Fulfillment by **Amazon**), and Rakuten (Rakuten Super Logistics). This makes it more difficult for startups such as **ShipBob** and **ShipMonk** to compete. UPS has entered the warehouse marketplace space with its Ware2Go product, which competes with startups **Flexe** and Stord. Large technology companies such as Facebook, Microsoft, and Apple are also developing augmented reality solutions to enter the enterprise market, presenting a potential risk to emerging startups in the space such as **Ubimax**. Finally, large technology companies such as **Amazon** and IBM are developing automated warehouse solutions.

Outlook

Opportunity for both early- and late-stage investment: Within the warehousing and fulfillment space, late-stage deals represent most of the total VC raised since 2008. We believe both early- and late-stage companies in the space are seeing strong interest from investors, as the competitive landscape for disruptive technologies such as outsourced warehousing, micro-fulfillment solutions, and automation is relatively immature. We expect investment in both early-stage and late-stage applications to rise over the next few years as consumer demand for faster delivery services continues to grow, necessitating flexible warehouse and fulfillment solutions.

The decentralization of fulfillment: COVID-19 and the associated spike in demand for delivery has led to an acceleration in decentralized fulfillment, which refers to the use of smaller fulfillment centers in urban locations or within retailers. These fulfillment centers tend to be located closer to end consumers, enabling a significant improvement in delivery speeds. We expect the decentralization of fulfillment to persist and continue driving strong investment in micro-fulfillment and warehouse automation technologies.

Tech-enabled warehousing to see long-term growth: During the height of the pandemic, distribution centers prioritized essential freight such as food and medical supplies. Additionally, retailers that were shut down were unable to accept deliveries. This led to nonessential freight items such as furniture and large electronics becoming stuck in trucks and ports. As a result, demand for tech-enabled warehousing services spiked as retailers needed alternative means to store and track nonessential goods. We expect these newly formed relationships could prove sticky as retailers seek to mitigate the risk of future supply chain shocks.

Expect growth in on-demand storage: Consumer-focused on-demand storage providers could expand into the B2B warehousing space. Startups such as **Clutter** and **MakeSpace** currently offer on-demand storage for consumers. In some cases, these startups own and operate warehousing facilities. In early 2019, **Clutter** branched out into B2B storage services, leveraging its consumer expertise for storing items that don't fit well together to serve the needs of businesses with excess, differently sized inventory. On-demand storage is an attractive market given local competitors are often low-tech with limited inventory-tracking capabilities. Additionally, relative to other warehousing business models such as fulfillment, on-demand storage businesses require fewer workers and might not face as much pandemic-related disruption owing to health-related social distancing concerns.

Demand for warehouse robotics as a service to rise: Robots and autonomous technologies can help maintain continuity of warehouse operations during labor shortages and are likely to be areas of continued investment. Startups that have secured partnerships with large retailers include **Kindred AI**, which has partnered with Banana Republic, and **RightHand Robotics**, which has partnered with Walmart. Providers of subscription-based, full-service solutions—such as **Locus Robotics**, Mobile Industrial Robotics, and **Vicarious**—are likely to have more success penetrating smaller enterprises with more limited capex budgets. Recurring subscription models will also likely prove a more attractive model for investors seeking steady cash flows.

SEGMENT DEEP DIVE

Last-mile delivery

Overview

Last-mile delivery providers focus on hyper-local delivery services that provide retailers with a unique way to deliver products to customers in short time periods. Subsegments include:

Delivery services: This includes delivery platforms such as **Uber** Eats, **DoorDash**, and **Postmates**, which contract with couriers to deliver food, groceries and other goods on-demand.

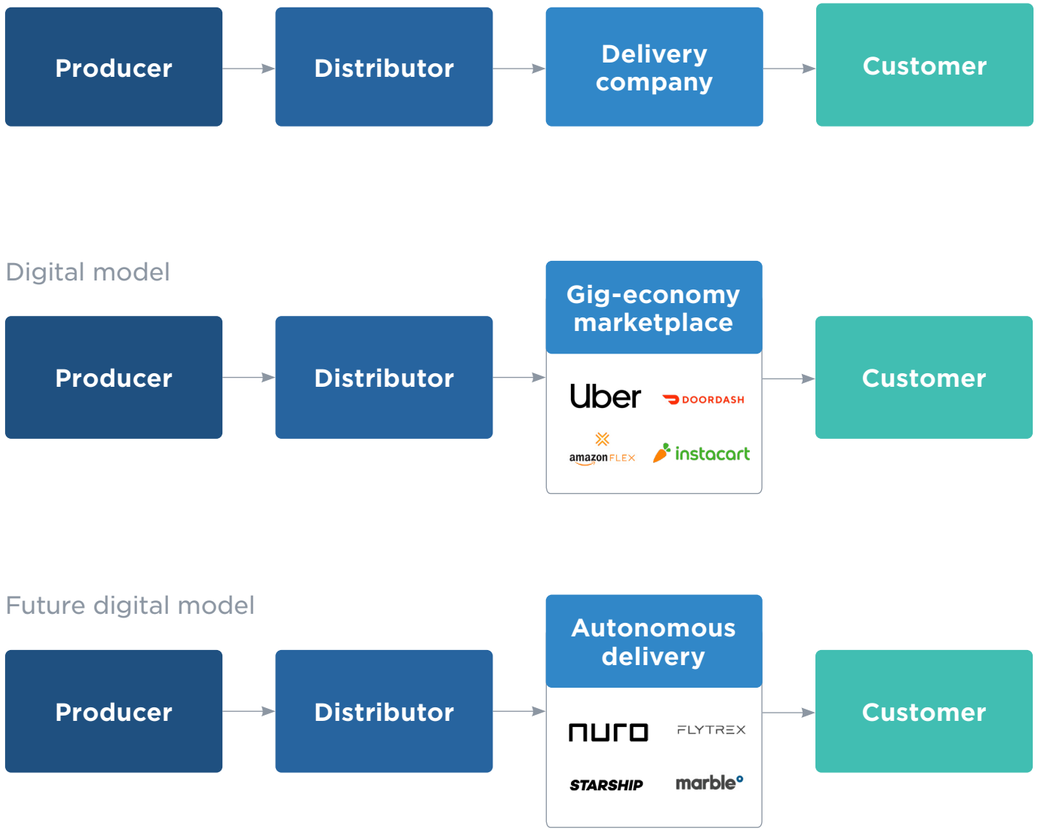
Automated delivery: This includes autonomous delivery companies such as **Nuro** and **Starship** Technologies, which are developing robotic solutions to deliver goods without the need for a courier.

Industry drivers

- Expansion in demand for parcel and food delivery services
- Pandemic-induced need for socially distant delivery services
- Ongoing consumer demand for increased speed and visibility into deliveries
- The rise of the gig-economy expanding the supply of flexible labor
- Improvements in self-driving technology paving the way for autonomous delivery robots and vehicles

Figure 31.

Evolution of last-mile delivery



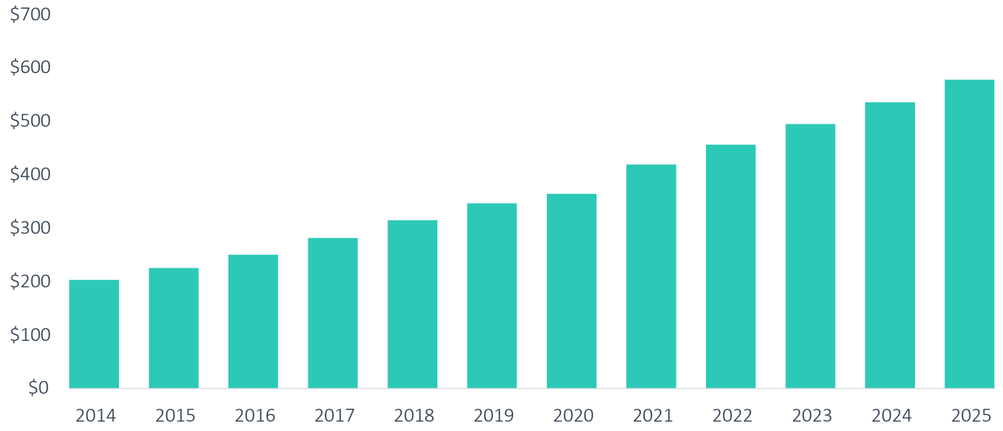
Market size

We estimate global revenue from last-mile delivery services reached approximately $346.8 billion in 2020 and forecast this to grow to $578.8 billion by 2025. We expect consumer adoption of online food delivery to be one of the key drivers of increased growth in the industry. Although e-commerce volumes will likely be affected by reduced consumer spending, we anticipate the online food, grocery, and essential goods delivery industries will see a boost. Social distancing could expand adoption and attract more users, meaningfully expanding the market for online food and grocery delivery.

Business model

Last-mile delivery providers focus on hyper-local delivery services that give retailers a unique way to deliver products to customers in short time periods. This includes food delivery platforms such as **Uber** Eats, **DoorDash**, and **Postmates**, which contract with couriers to deliver food and groceries on-demand. These platforms tend to monetize by taking a commission of the gross transaction, in addition to charging an additional delivery fee or service charge to the diner. A percentage of these earnings are then distributed to the couriers. Additionally, some platforms such as Meituan charge fees to restaurants for more favorable app placement.

Figure 32. LAST-MILE DELIVERY MARKET SIZE ($B)



Source: Internal PitchBook estimates

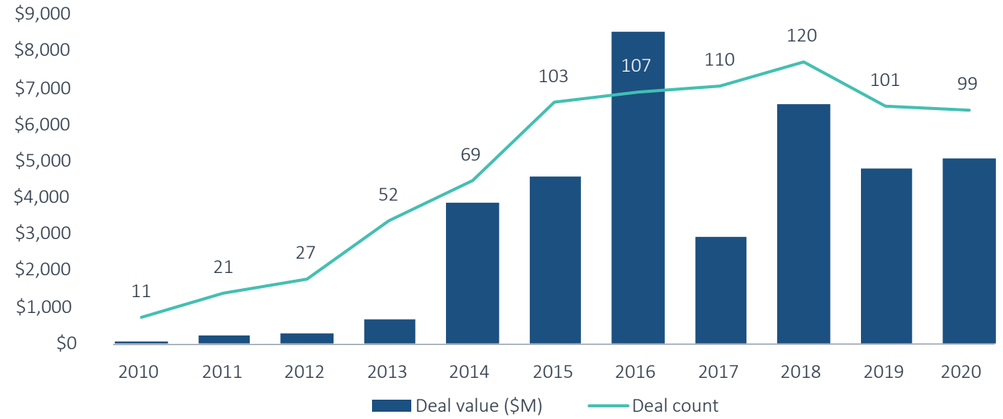
COMMON INDUSTRY KPIS

- Gross merchandise volume (GMV)
- Ecommerce conversion rate
- Average order value (AOV)
- Customer lifetime value (LTV)
- Monthly active users (MAU)
- Market penetration %
- On-time delivery %

VC activity

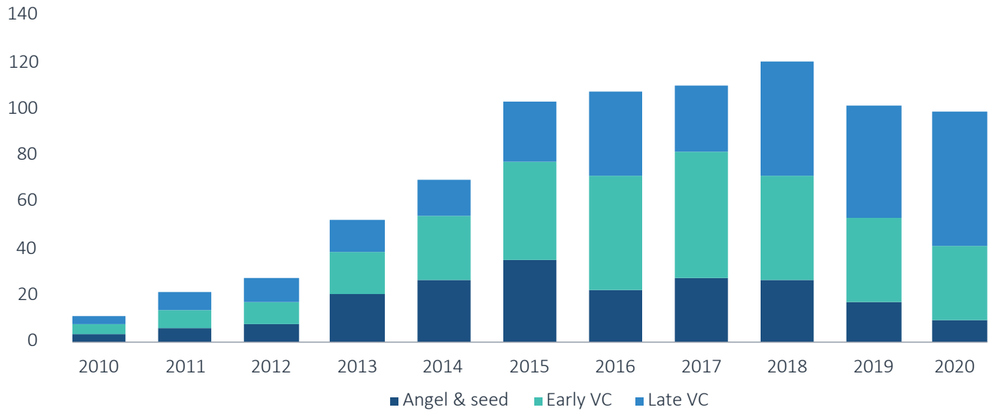
Last-mile delivery VC deal value in North America and Europe totaled $5.1 billion in 2020, up 5.5% YoY, continuing the trend of strong late-stage funding in the segment. In Q4, VC investment totaled $1.5 billion, down 12.8% QoQ but up 19.4% YoY. Standout deals in the fourth quarter include **Nuro**'s $500.0 million Series C led by T. Rowe Price, valuing the company at $5.0 billion (a 1.92x valuation step-up); **Instacart**'s $200.0 million Series H led by D1 Capital Partners and Valiant Capital Partners, valuing the company at $17.7 billion (1.27x step-up); and **OrderMark**'s $120.0 million Series C led by SoftBank. The quarter was also marked by the successful IPO of food delivery company **DoorDash** (NYSE: DASH), which debuted at a valuation of $32.4 billion before soaring to a market cap of over $60 billion on its first trading day. Late-stage VC deals continue to dominate capital deployed to the segment, reflecting the relative maturity of VC-backed companies operating in the last-mile delivery space. Given the favorable tailwinds surrounding last-mile delivery, we expect venture funding activity to remain elevated in the future.

Figure 33. LAST-MILE DELIVERY VC DEAL ACTIVITY



Source: PitchBook | Geography: North America & Europe

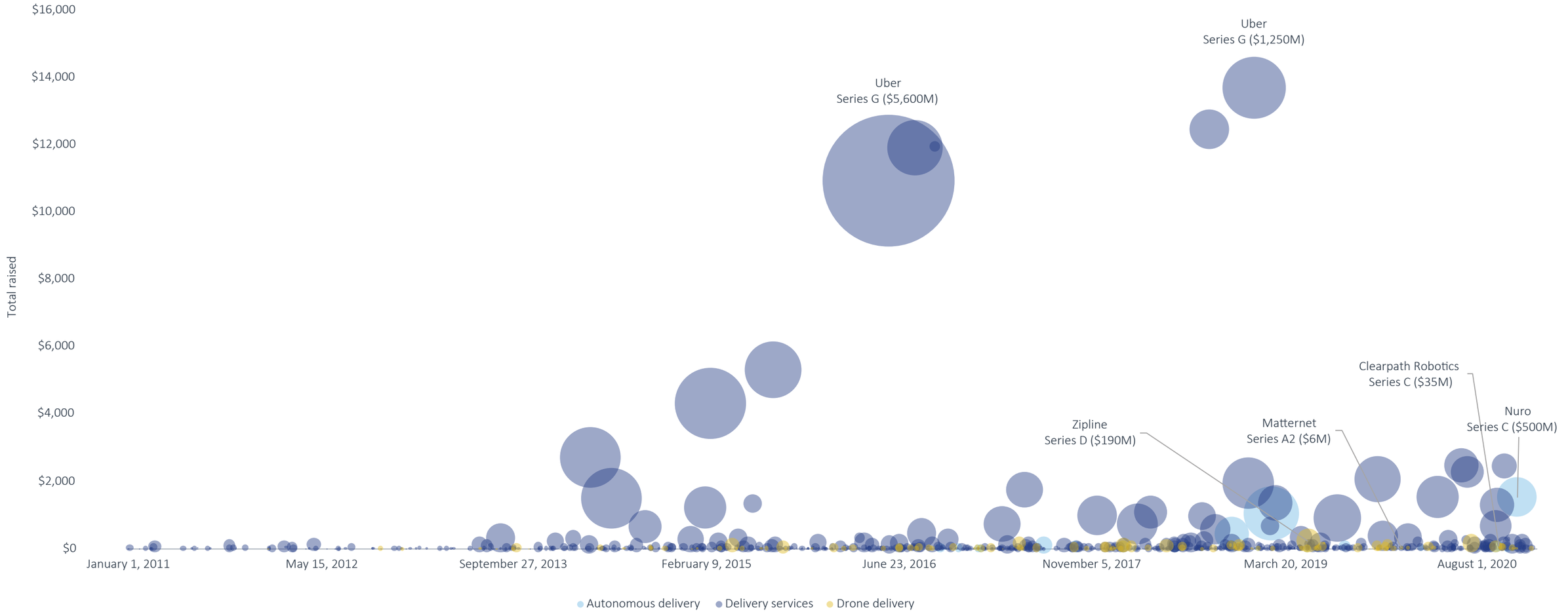
Figure 34. LAST-MILE DELIVERY VC DEALS (#) BY STAGE



Source: PitchBook | Geography: North America & Europe

Figure 35.

Last-mile delivery VC landscape ($M)



Source: PitchBook | Geography: North America & Europe

Note: The left axis indicates total VC raised as of deal date. Bubbles indicate amount raised.

Figure 36.

Notable last-mile delivery VC deals

COMPANY	CLOSE DATE	SUBSEGMENT	STAGE	DEAL SIZE ($M)	LEAD INVESTOR(S)	VALUATION STEP-UP*
Nuro	November 9, 2020	Autonomous delivery	Late-stage VC	$500.0	T. Rowe Price	1.92x
Instacart	October 8, 2020	Delivery services	Late-stage VC	$200.0	D1 Capital Partners, Valiant Capital Partners	1.27x
OrderMark	October 27, 2020	Delivery services	Late-stage VC	$120.0	SoftBank Group	4.00x
Good Eggs	November 23, 2020	Delivery services	Late-stage VC	$80.0	Glade Brook Capital Partners	N/A
HungryPanda	November 30, 2020	Delivery services	Late-stage VC	$70.0	Kinnevik	N/A
GrubMarket	October 5, 2020	Delivery services	Late-stage VC	$90.0	N/A	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 37.

Notable last-mile delivery VC exits

COMPANY	CLOSE DATE	SUBSEGMENT	EXIT TYPE	EXIT SIZE ($M)	ACQUIRER OR INDEX	VALUATION STEP-UP*
DoorDash	December 9, 2020	Delivery services	IPO	N/A	NYSE	1.81x
Freshly	October 30, 2020	Delivery services	M&A	$459.0	Nestlé USA	4.46x
Cornershop	July 6, 2020	Delivery services	M&A	$2,650.0	Uber	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 38.

Key VC-backed last-mile delivery companies

COMPANY	TOTAL VC RAISED ($M)*	SUBSEGMENT
Instacart	$2,469.8	Delivery services
Deliveroo	$1,550.8	Delivery services
Nuro	$1,532.0	Autonomous delivery
goPuff	$1,284.7	Delivery services
Glovo	$665.6	Delivery services
Picnic	$385.7	Delivery services
Alto	$357.5	Delivery services

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 39.

Key last-mile delivery incumbents

COMPANY	EV/TTM REVENUE*	EV/TTM EBITDA*
Amazon.com	4.7x	36.4x
FedEx	1.3x	13.2x
United Parcel Service	2.1x	17.9x
Grubhub	4.2x	N/A
Uber	7.2x	N/A

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Opportunities

Food delivery: The rapid rise of food delivery platforms (e.g., **Grubhub**, **DoorDash**, and **Uber** Eats) has had a profound impact on the restaurant industry, with incumbent delivery-based companies such as pizza franchises feeling the pressure as more restaurants take share of the food delivery pie. According to **Uber**, the home food delivery market has grown at a CAGR of 77% since 2013, well above the growth rate of the consumer food service market.[22] In much the same way that ecommerce took share from physical retail, we believe food delivery may be taking share from traditional eat-in restaurants. Research shows millennials give more favor to convenience when making food-related shopping purchases than other generational cohorts, leading to greater usage of delis, carry-out, fast food, and food delivery services.[23] We see food delivery as an attractive, mature market and are more positive on established companies such as **Uber** Eats, **DoorDash**, **Postmates**, **Instacart**, GoPuff, and **Deliveroo** relative to newer entrants, given their scale and capital advantages.

Combined mobility and food delivery platforms: Ridesharing companies are leveraging their platforms to provide food delivery services. While this includes **Uber** with its fast-growing **Uber** Eats service, we see continued opportunity for global ridesharing platforms **Grab**, **Gojek**, and Ola to capture market share, and we expect more late-stage investment in these businesses. We see long-term benefits to the mobility-as-a-service strategy, as bundling services has the potential to expand the addressable market and create a source of competitive advantage relative to more pure-play applications. Similar to how **Amazon** monetized its user base across several services (e.g., video, grocery, AWS, etc.), we believe ridesharing providers could replicate such platforms in the transportation world. This could allow providers to further leverage their existing driver networks and drive synergies by optimizing driver utilization between ridesharing and food delivery.

Delivery robots: Delivery robots have the potential to dramatically reduce costs across the delivery supply chain (e.g., wages for drivers and couriers) while also improving automobile energy efficiency and traffic congestion levels. Startups developing robots to capture this market include **Nuro**, **Postmates**, **Zume**, **Starship** Technologies, **Clearpath Robotics**, **Boxbot**, **Kiwibot**, and Marble. In addition, large incumbents such as **Amazon** and **FedEx** are developing their own in-house delivery robots.

Delivery drones: The use of drones for air delivery of smaller packages presents another alternative. Companies working on drone-enabled delivery include **Zipline** International, **Matternet**, **Flirtey**, **Sojourn** AI, and **Flytrex**. Although we see the largest market for drone delivery as serving ecommerce needs for residential areas, some drone-focused startups have found their niche targeting more underserved communities. Silicon Valley-based **Zipline** International utilizes a fleet of drones to deliver blood, plasma, and medicine to remote clinics in East Africa. While we believe autonomy and drone delivery could have significant potential, both technologies are likely to face significant regulatory hurdles and a long adoption curve as consumers adjust to these new experiences.

Delivery management software: Delivery management software helps inventory-heavy enterprises manage local deliveries and integrate with third-party carriers. Features include real-time dispatching, managing, and tracking of packages, establishing proof of delivery, and collecting signatures.

22: "Form S-1 Registration Statement: Uber Technologies, Inc.," SEC, April 11, 2019.
23: "Food Purchase Decisions of Millennial Households Compared to Other Generations," US Department of Agriculture, December 2017.

Some providers also enable enterprises to integrate with third-party delivery services such as UPS and **FedEx**. Delivery management software providers tend to target small and medium-sized businesses that seek to reduce time and cost associated with delivery, increase capacity, and improve the customer experience. Delivery management software providers include **GetSwift**, **MetaPack**, **Bringg**, **FarEye**, **WorkWave**, and **LogiNext**.

Considerations

Food delivery margins structurally low: Food delivery is a structurally low-margin business as services are relatively commoditized and undifferentiated. Customer incentives intended to expand market share further pressure profitability. For example, **Uber** Eats has a take-rate below its corporate average, reflecting the heavy use of incentives. Similarly, prior to its recent acquisition, **Grubhub** has seen margin pressure due to increased marketing spend and competitive pressure from companies such as **DoorDash** and **Uber** Eats. While the market for food delivery is large, consumer price sensitivity and the competitive landscape may permanently impede margin expansion, limiting returns for investors.

Large investment capital needed to grow market share: Food delivery startups need massive infusions of capital to grow and face heightened competition from incumbent ridesharing companies that already have greater scale and capital advantages. With food delivery commissions roughly half that of ridesharing, **Uber** has depended heavily on its higher-margin businesses along with outside funding to finance its aggressive expansion into food delivery. Similar to other companies in the space, **Uber** also relies on heavy subsidies and promotional activity, further pressuring margins. Other ridesharing companies that have moved into food delivery include **Grab**, **Gojek**, and Ola.

Labor regulation and minimum wage rules: Regulatory changes seeking to increase benefits and labor protections for gig-economy workers could present a margin headwind for last-mile delivery service companies. For example, a 2019 California law that has since been overturned entitled gig-economy workers to receive a minimum wage and greater labor protections. Similar legislation could be proposed in other states within the US such as Washington and New York. Such legislation could put negative pressure on last-mile delivery company margins.

Partner risk: After **Amazon** acquired Whole Foods, it eventually terminated the grocer's deal with **Instacart** to provide grocery delivery. Presumably, **Amazon** intends to provide Whole Foods delivery through its own app. This highlights the partner risk inherent to delivery services as the competitive interests of providers and retailers have the potential to become misaligned. Autonomous last-mile delivery stalled by setbacks: Although deep learning has enabled material progress in autonomous driving, the technology still has its shortcomings. While deep learning is excellent at categorizing objects or scenarios it has seen, it struggles to contextualize objects and scenarios it hasn't categorized. For example, placing small stickers on a stop sign can sometimes cause an autonomous vehicle to fail to recognize the sign and consequently not stop.[24] We believe UK autonomous vehicle startup Wayve may have a novel approach to machine learning that could give it an edge in the market. Whereas large technology companies train vehicles by using rules, large datasets, and sophisticated sensory equipment, Wayve uses limited amounts of data with a greater focus on machine learning. These kinds of novel approaches will be key to solving issues surrounding the limitations of deep learning technology and ultimately enabling commercialization.

24: "Robust Physical-World Attacks on Deep Learning Models," arXiv, Kevin Eykholt, et. al, April 10, 2018

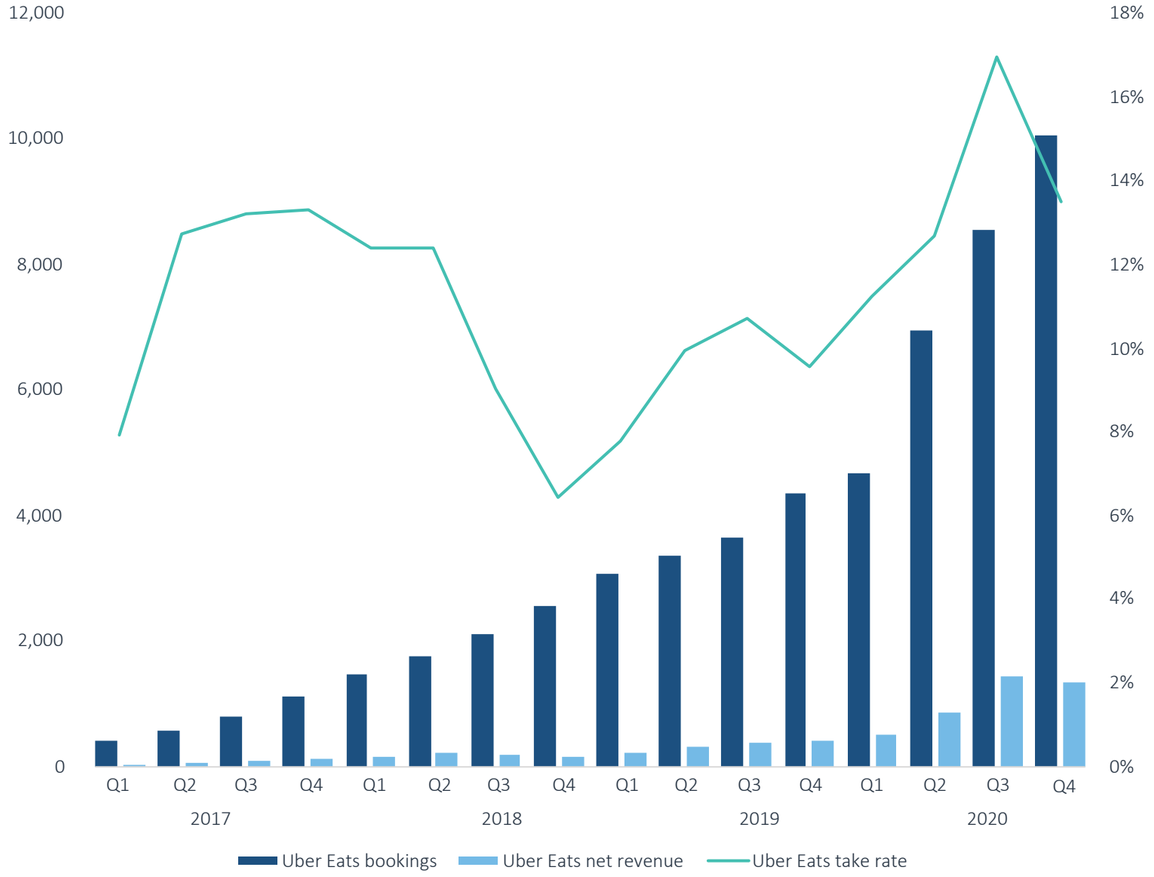
Outlook

Evolving expectations for delivery: As the market for delivery has expanded, we expect consumer expectations for delivery services to continue to increase. The pandemic has driven the demand for next-day and same-day delivery to new heights, and created burgeoning demand for same-hour delivery, with leaders such as **DoorDash**, GoPuff and **Uber** seeing a 346% YoY increase in convenience item delivery in 2020.[25] An adjacent shift is happening with package placement; we believe the last meter of delivery will become a focal point of investment as providers seek to reduce package thefts and food spoilage. Part of this may be driven by the shift to in-home delivery. **Amazon**, Walmart, and Target have launched in-home delivery of groceries, items, and prescriptions, enabled by smart-locks and smart-cameras. Enablement technologies such as **Sojourn** AI, which leverages computer vision and AR on mobile and wearable devices to help couriers and drones place packages and items in precise spots, will be key to this shift.

Large M&A to continue to make industry viable: The North American restaurant delivery market has consolidated to three major players: **DoorDash**, **Uber** Eats-**Postmates**, and **Just Eat Takeaway-Grubhub**. We have long maintained that consolidation is necessary for the online food delivery industry to achieve sustainable margins. In 2019, **Uber** acquired grocery delivery startup **Cornershop**, and **DoorDash** acquired food delivery competitor Caviar. In early 2020, European competitors **Just Eat** and Takeaway.com finalized their merger. In June 2020, **Just Eat Takeaway** acquired **Grubhub** for $7.3 billion, and in July 2020, **Uber** announced an agreement to acquire **Postmates** for $2.7 billion.

Figure 40.

Uber Eats bookings and revenue ($M)



Source: **Uber**

25: "2021 Edison Trends U.S. Convenience Store Delivery Sales Report," Edison Discovers, January 28, 2021.

LAST-MILE DELIVERY

New entrants to keep pressure on margins: While the **Uber** Eats-**Postmates** tie up could lead to more rational pricing, **Just Eat Takeaway**'s entrance into the North American market could be a setback. **Grubhub** had been losing share due to its limited cash availability to invest in expansion relative to **Uber** and **DoorDash**. If **Just Eat Takeaway**, a well-funded, outside competitor, gains a foothold in the North American market, the company could cut into **Uber** and **DoorDash**'s growth plans and potentially put downward pressure on pricing and margins in the space, delaying the industry's path to profitability.

Fees could come under pressure as restaurants struggle: Online food delivery platforms are facing scrutiny over restaurant fees that can range from 10% to 40% of gross transactions. Lawmakers across the US have proposed capping these fees to the 10%-15% range, which would likely put pressure on growth and margins. Several cities in California and New York have already mandated fee caps. Additionally, we expect lawmakers will continue to pass legislation limiting the use of contracted workers, another threat to margins to the extent drivers receive more pay.

COVID-19 could catalyze investment in autonomous delivery vehicles and drones: Prior to this crisis, investors and management teams primarily viewed autonomous delivery as a means to reduce delivery costs. The pandemic has revealed a new use case: increasing safety for consumers and helping providers ensure service continuity when human drivers may not be available. Startups that may benefit from this trend include autonomous robot providers **Nuro**, **Starship**, and **Refraction AI**; automated delivery van providers Gatik. AI and Arrival; and drone companies such as **Zipline**, **Flytrex**, and **Flirtey**. Autonomous delivery pilots that are underway include the partnership between CVS and **Nuro** for prescription deliveries in Houston, Texas in the US. CVS has also partnered with UPS Flight Forward, a drone-focused subsidiary of UPS working with drone startup **Matternet** to deliver medical supplies to retirement communities in Florida in the US.

Zipline has begun leveraging its drone delivery technology, previously used in Africa, to provide personal protective equipment and essential medical supplies to US hospitals. Grocery-focused delivery platforms could see uplift: We expect reduced restaurant traffic to provide a long-term uplift to the grocery industry. Key factors driving this shift include lower prices per quantity of food relative to restaurant orders, reduced movement of people into urban areas as more people work from home permanently, and improvement in grocery delivery and curbside pickup services, which hastens market adoption. Beneficiaries of this trend include delivery platforms focused on grocery and convenience items, such as **Instacart** and GoPuff. For more detail on the delivery technologies involved in the grocery industry, see our Q2 analyst note **Delivery Technologies Are Reshaping the Grocery Industry**.

Data will drive differentiation: Critics of ridesharing and food delivery claim consumers will opt for the lowest-priced option, yet we believe delivery and other mobility-oriented platforms can successfully differentiate themselves by leveraging user data to create curated experiences. For example, many companies are identifying demand for specific foods in certain neighborhoods (for example, the rise of "cloud kitchens"). The ability to store payment, address, contact information, and order history also adds stickiness and can help drive network effects.

Supplemental materials

Select company profiles

FLEXE
The Marketplace for Warehouse Space

Business overview

Developer of an online marketplace designed to provide warehousing space on-demand. The company's marketplace solves inventory overflow and fulfillment needs by connecting retailers and brands requiring warehousing and fulfillment services to warehouse operators who have it. This helps enterprises expand their distribution networks by accessing affordable warehouse space in key markets. **Flexe** turns the process of purchasing warehousing space, which has traditionally been a fixed cost, into a variable cost. This business model better serves the capital needs of retail customers. We see increasing demand for outsourced warehousing and fulfillment services as inventory-heavy enterprises look to reduce costs and streamline operations.

Leadership

Co-founder & CEO: Karl Siebrecht
Co-founder & COO: Edmond Yue
Co-founder & CTO: Francis Duong

Competitors

Stord, **Flowspace**, **Darkstore**, **Amazon**, UPS (Ware2Go)

Financing history

Raised to date: $64M over four deals
Most recent round: $43M Series B (May 2019)
$193M post-money valuation

Ownership

Activate Capital Partners, Redpoint Ventures, Madrona Venture Group, among others

RIGHTHAND
ROBOTICS

Business overview

Developer of integrated robotic piece-picking solutions designed to be simple to integrate and adaptable to improve the utilization of various customer workflows such as sorting batch-picked items, picking items from an ASRS, inducting items to a belt sorter and order quality assurance, enabling businesses to reduce the cost of order fulfillment in electronics, apparel, grocery, pharmaceuticals and many other industries. We believe **RightHand Robotics**'s subscription-based robotics as a service (RaaS) business model is well positioned to gain share among middle-market customers. This improves affordability for smaller enterprises and enables them to shift large, one-time purchase costs that would normally count as capex to smaller, more easily digestible operating expenses. This also reduces RightHand's dependence on cyclical changes in customer CapEx budgets and improves the resiliency of its revenue stream.

Leadership

Co-founder, president & board Member: Leif Jentoft Ph.D
Co-founders & board members: Lael Odhner & Yaroslav Tenzer Ph.D
Co-founder: Robert Howe

Competitors

Geek+, **Boston Dynamics**, **Fetch Robotics**, **GreyOrange**, CommonSense Robotics, among others

Financing history

Raised to date: $41.7M over nine deals
Most recent round: $7.5M convertible debt round (July 2020)

Ownership

Menlo Ventures, Playground Global, GV, among others

Select company analysis

mercado

Business overview

Mercado Labs provides an import management system (IMS) that that improves sourcing, procurement, and logistics for small and mid-tier importers. The company's cloud-based platform provides procurement and ordering features such as vendor vetting, quoting, and visibility, while providing expertise in cross-border customs, tariffs, and currencies. Additionally, the **Mercado** platform moves disparate workflows associated with imported orders spanning multiple companies on to a single platform generating, monitoring, and recording the lifecycle of orders, with particular emphasis on the first 120 days.

In our view, investors should view **Mercado** Labs similarly to GTNexus, which provides an international supply chain management platform for larger enterprises—the company was ultimately sold to Infor for $675.0 million. With its focus on mid-tier importers, **Mercado** Labs serves a large, underserved market and is among a select group of providers focused on digitizing the "first-mile" of the supply chain, which is ripe with costly inefficiencies and complexities and highly dependent on antiquated processes and workflows.

15+ employees

Leadership

Co-founder & CEO: Rob Garrison

Competitors

GT Nexus, **Shippio**, **Moselle**, NextLinx

Financing history

Raised to date: $5.7M over three deals

Most recent round: $2.5M seed round (July 2020)

$11.0M post-money valuation

Ownership

Ironspring Ventures, Supply Chain Venures, LiveOak Venture Partners, Amplifier (Berlin), Schematic Ventures, Story Ventures, Capital Factory

Select company analysis

SOJOURN

Business overview

Sojourn develops an augmented reality solution that creates maps in spatial environments to enable precise delivery of food and packages. Through **Sojourn**'s mobile app, consumers can precisely mark designated dropoff points using augmented reality. This information is then transmitted to couriers through the app, which can then place food, packages, and prescriptions in secure designated locations. Longer term, **Sojourn** expects its software to be utilized in assisting contactless robotic and drone delivery.

In our view, **Sojourn** represents a key enablement technology for the future of delivery. As the market for delivery has expanded, we expect consumer expectations for delivery services to continue to increase. The pandemic has driven the demand for next-day and same-day delivery to new heights and created burgeoning demand for same-hour delivery. An adjacent shift is happening with package placement; we believe the last meter of delivery will become a focal point of investment as providers seek to reduce package thefts and food spoilage. Part of this may be driven by the shift to in-home delivery, which will be enabled by smartlocks and smart-cameras.

6+ employees

Leadership

Co-founder & CEO: Sven Mesecke

Co-founder & COO: Matt Freie

Competitors

N/A

Financing history

Raised to date: $0.5M seed round

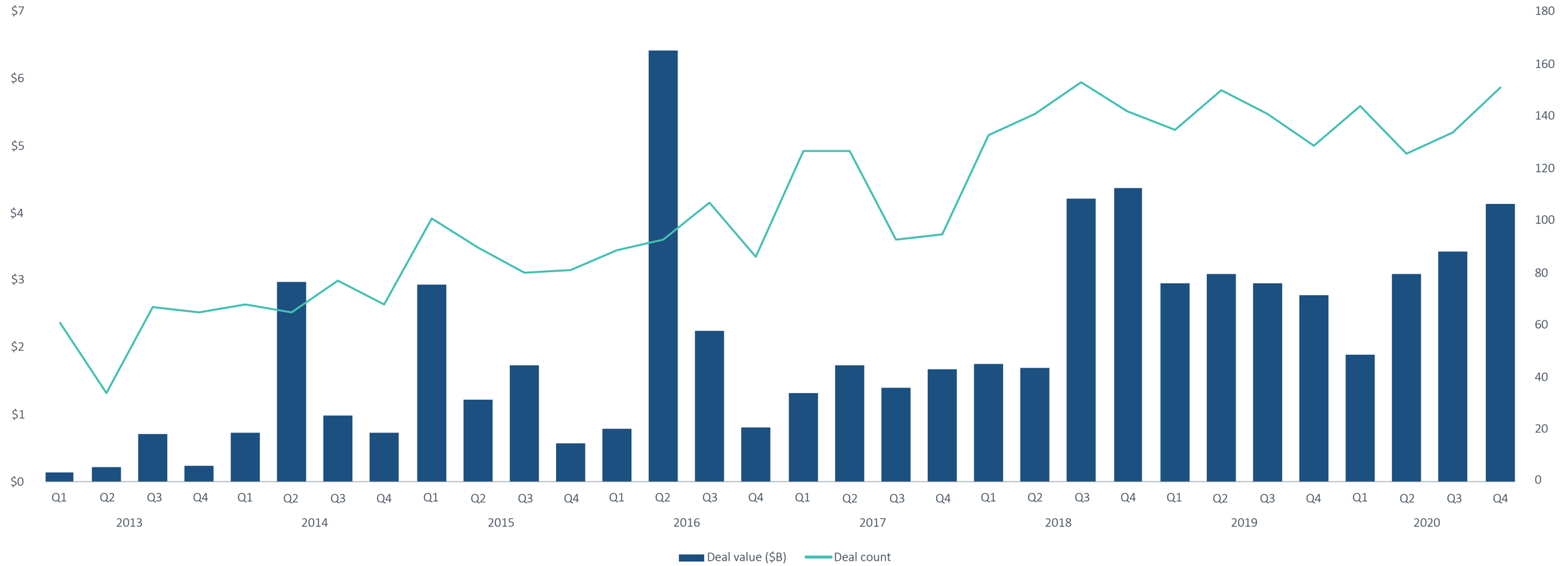
Ownership

Ascend Venture Capital, undisclosed investors

Additional VC data

Figure 41.

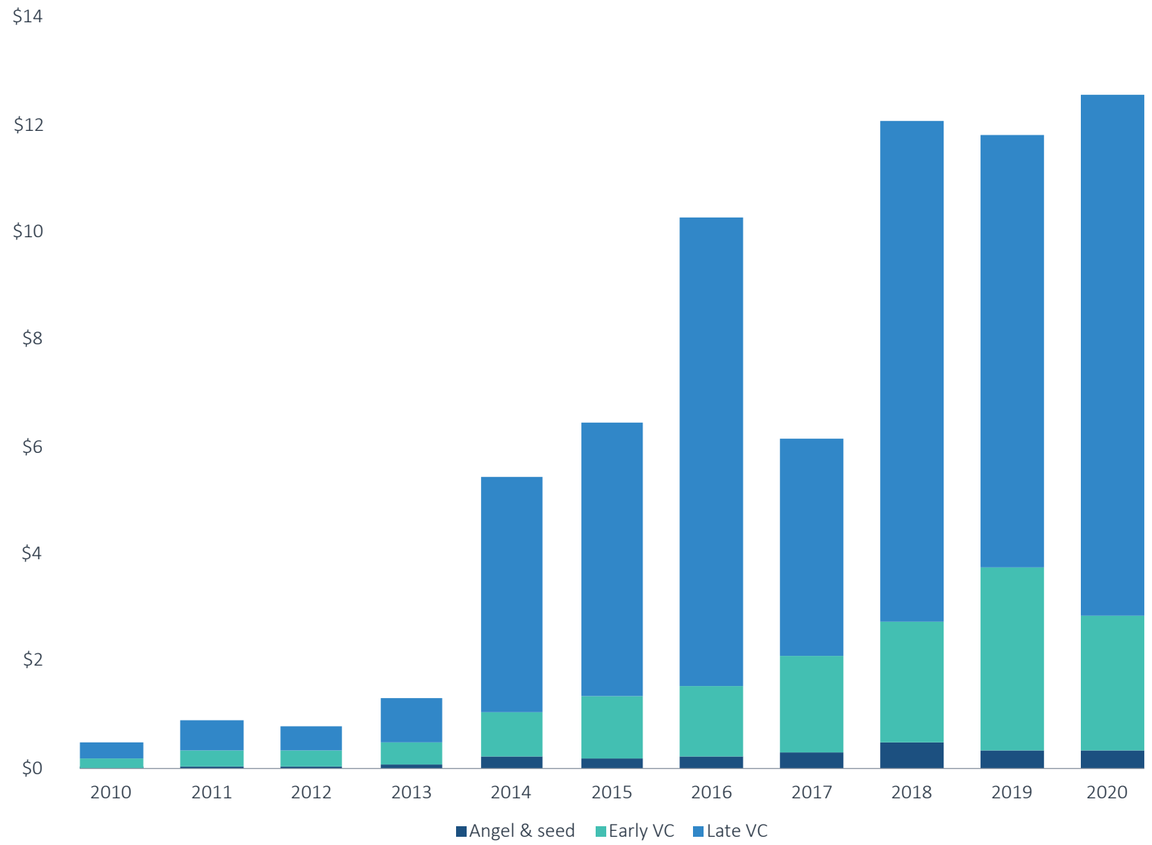
Supply chain tech VC deal activity



Source: PitchBook | Geography: North America & Europe

Figure 42.

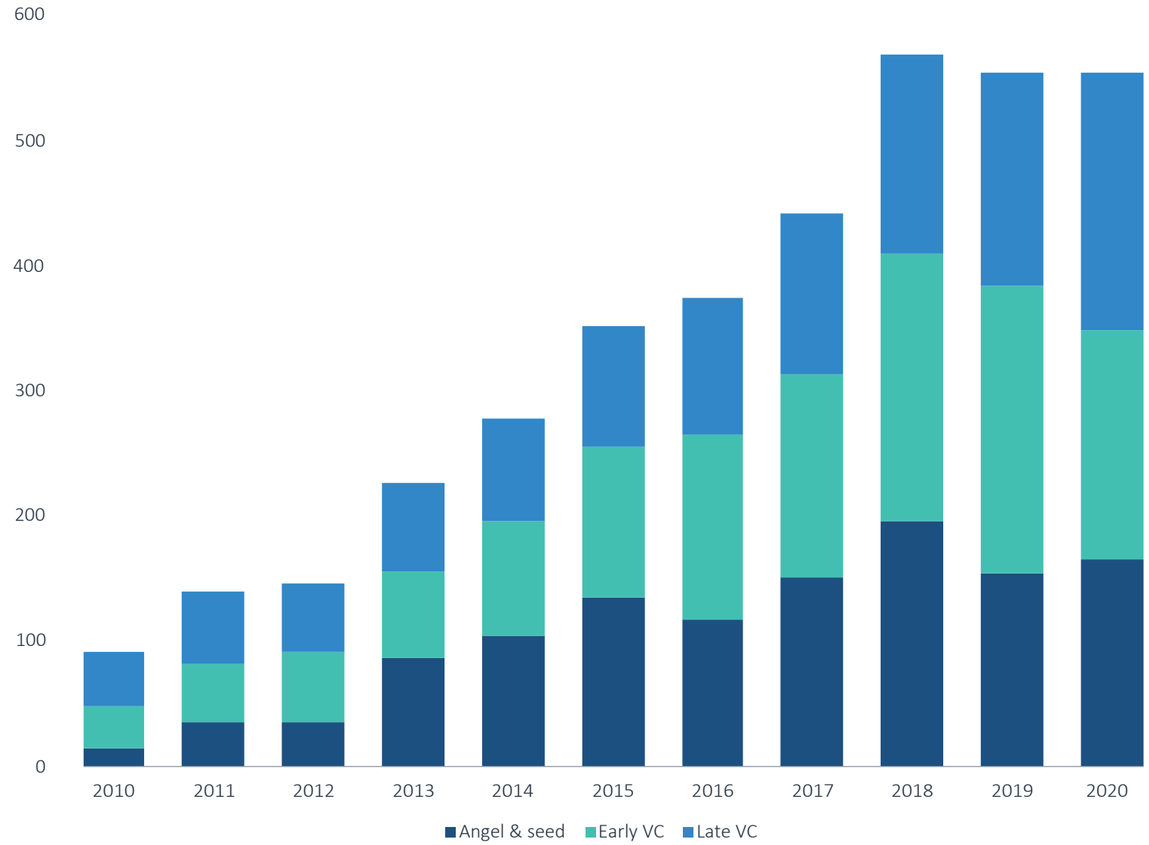
Supply chain tech VC deals ($B) by stage



Source: PitchBook | Geography: North America & Europe

Figure 43.

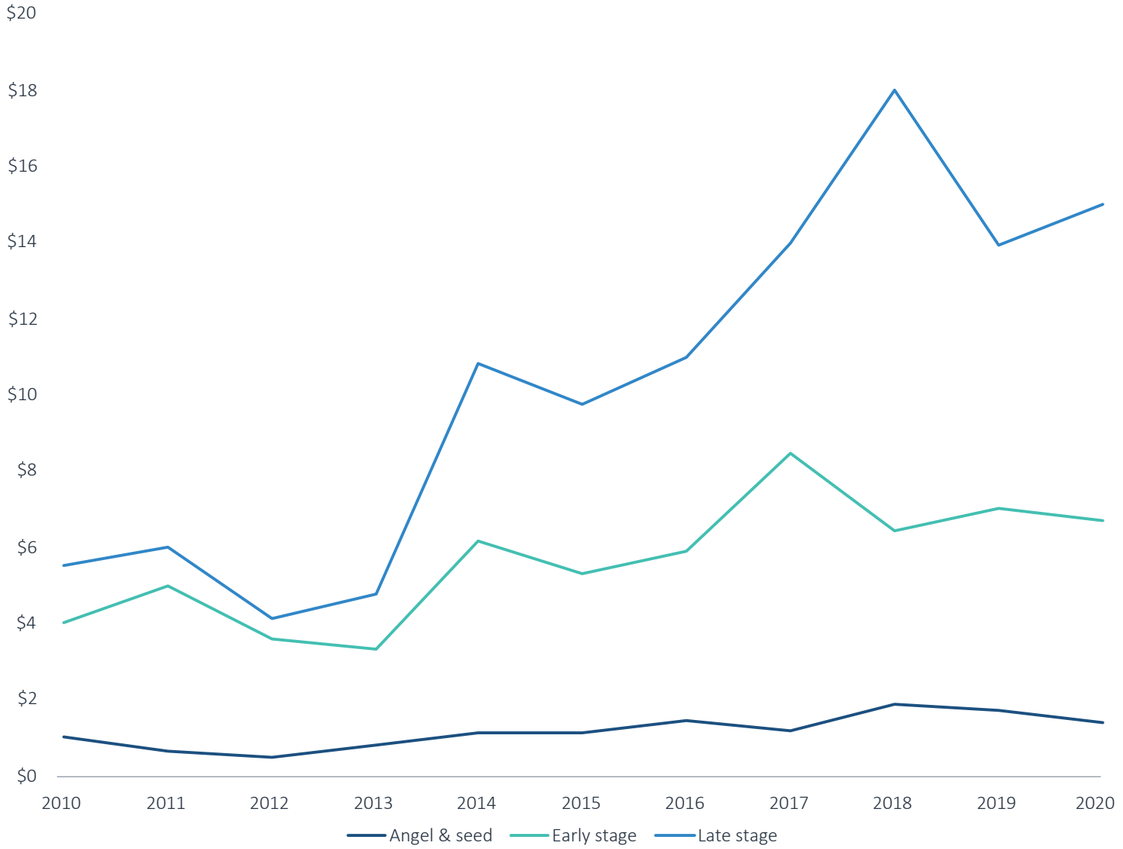
Supply chain tech VC deals (#) by stage



Source: PitchBook | Geography: North America & Europe

Figure 44.

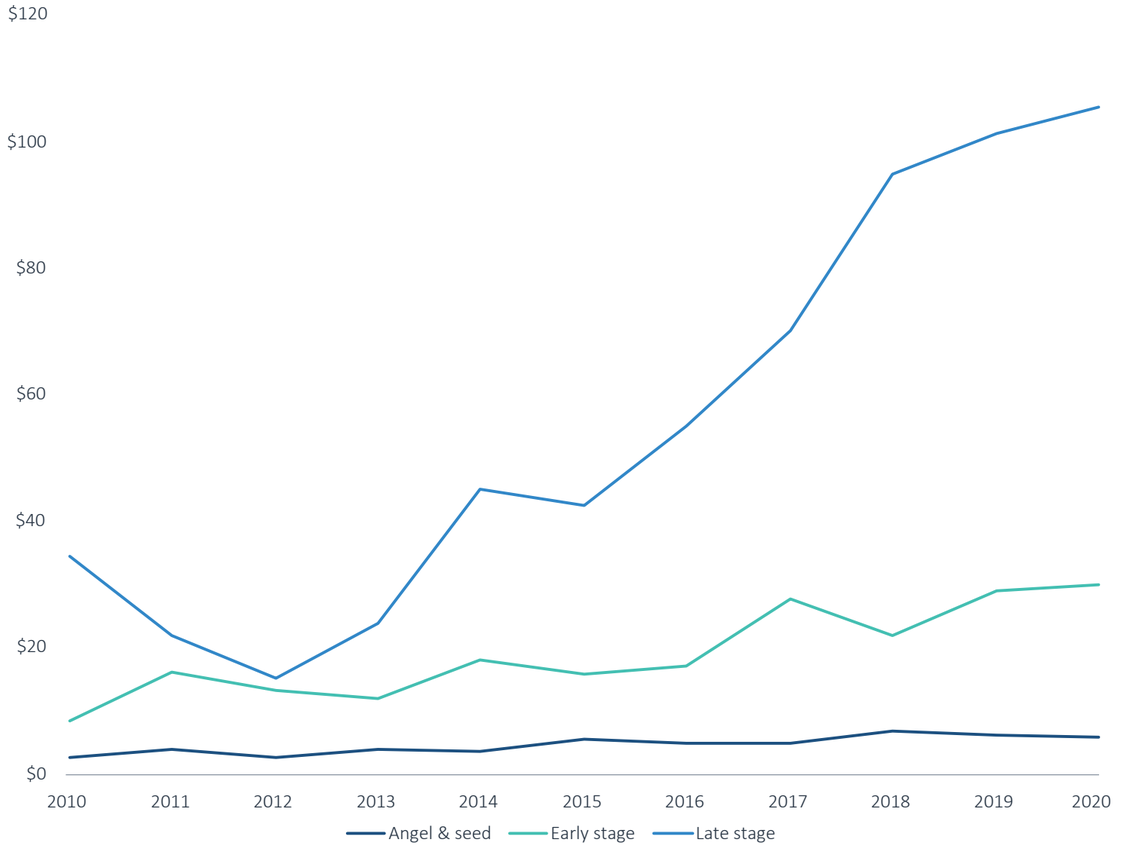
Median supply chain tech VC deal size ($M) by stage



Source: PitchBook | Geography: North America & Europe

Figure 45.

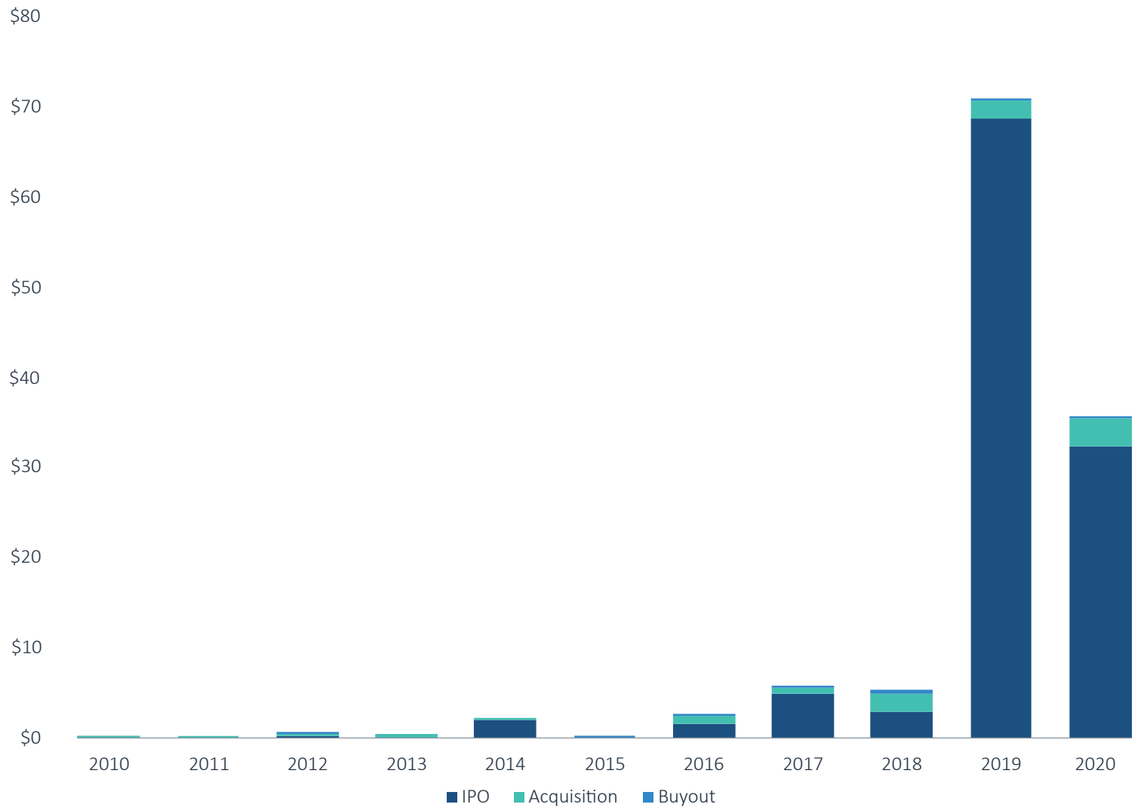
Median supply chain tech VC pre-money valuation ($M) by stage



Source: PitchBook | Geography: North America & Europe

Figure 46.

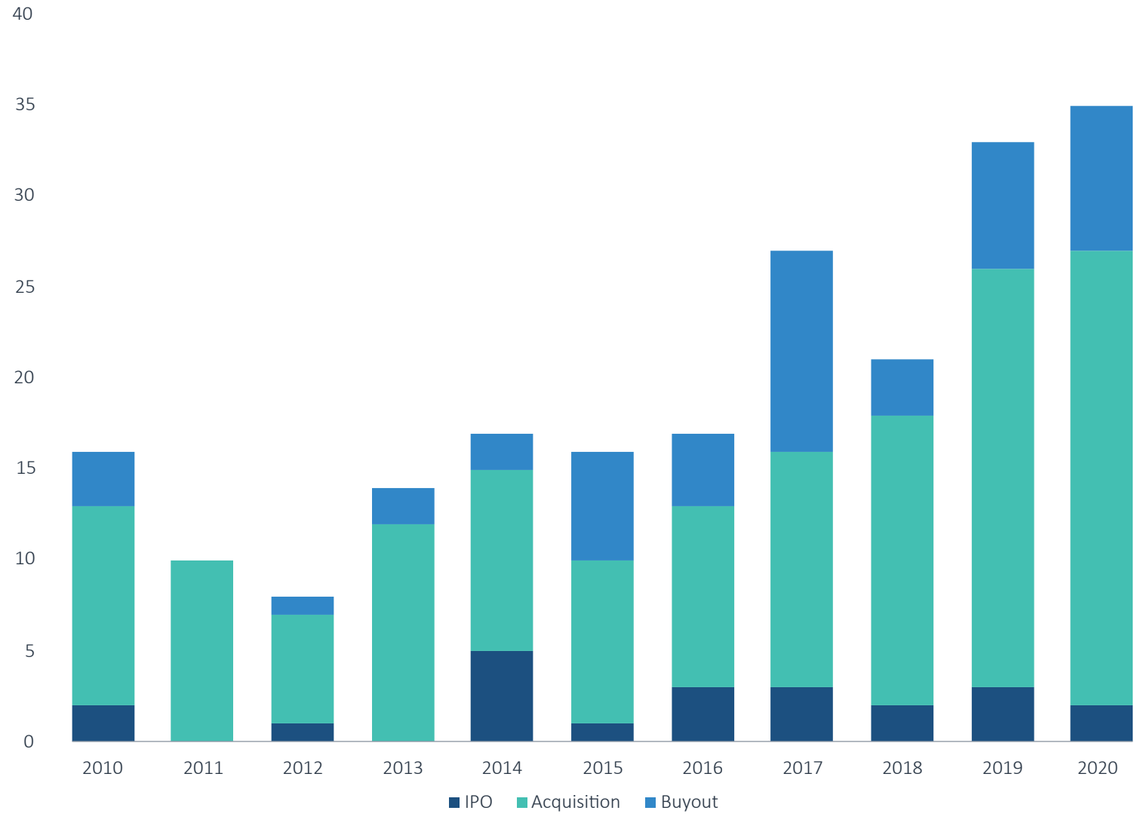
Supply chain tech VC exits ($B) by type



Source: PitchBook | Geography: North America & Europe
Note: This chart excludes **Uber**.

Figure 47.

Supply chain tech VC exits (#) by type



Source: PitchBook | Geography: North America & Europe

Figure 48.

Top 10 VC investors in supply chain tech by deal count since 2018*

INVESTOR NAME	DEAL COUNT
8VC	22
Alumni Ventures Group	21
Lightspeed Venture Partners	18
Enterprise Ireland	18
Khosla Ventures	17
Flight Ventures	16
Schematic Ventures	16
Dynamo Ventures	15
Sequoia Capital	15
Prologis Ventures	14

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Figure 49.

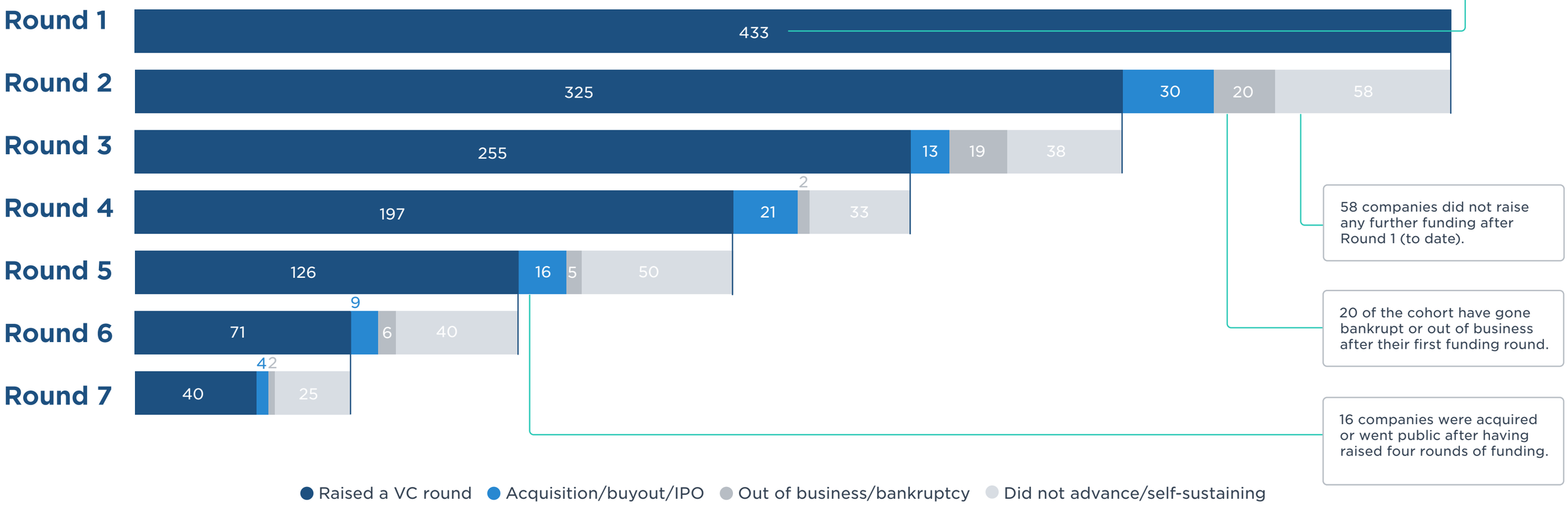
Top 10 VC-backed supply chain tech companies by total VC raised to date ($M)*

COMPANY	VC RAISED TO DATE ($M)*	SEGMENT
Instacart	$2,469.8	Delivery services
Deliveroo	$1,550.8	Delivery services
Nuro	$1,532.0	Autonomous delivery
Flexport	$1,301.9	Trucking logistics
goPuff	$1,284.7	Delivery services
Samsara	$930.0	Asset tracking & management
Tradeshift	$679.5	Procurement & sourcing
Convoy	$668.0	Trucking logistics
Glovo	$665.6	Delivery services
TuSimple	$647.9	Autonomous trucks, trucking logistics

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

Supply chain tech VC funnel

This VC funnel uses PitchBook data to analyze the VC funding life cycle by highlighting, by round, the number of firms that successfully raised a subsequent round, exited (through acquisition or IPO), went out of business or did not have a further liquidity event.



Buyers list

Figure 50.

Strategic buyers (corporations, holding companies & private companies)

Strategic buyers in this space tend to be large incumbent logistics and supply chain incumbents. Rather than developing in-house, they tend to partner or outright acquire key technologists in the space.

INVESTOR NAME
Amazon
Descartes Systems
DSV
E2Open
Echo Global Logistics
Infor Global Solutions
Oracle
SAP
Target
UPS
Walmart
XPO Logistics

Source: PitchBook

Figure 51.

Financial buyers (PE groups)

PE investors in the space generally favor end-to-end enterprise solutions that solve pain points for their customers' supply chains. This contrasts with the niche focus of technologists in the venture world. Profitable growth, margin improvement, and capital efficiency are key KPIs for investors in this space.

INVESTOR NAME	DEAL COUNT SINCE 2009*
Accel-KKR	8
Kohlberg Kravis Roberts	7
Golden Gate Capital	6
Insight Partners	6
Summit Partners	5
Thoma Bravo	5
ABS Capital Partners	5
Klass Capital	5
New Mountain Capital	5
LLR Partners	4

Source: PitchBook | Geography: North America & Europe | *As of December 31, 2020

About PitchBook Emerging Tech Research

Independent, objective and timely market intel

As the private markets continue to grow in complexity and competition, it's essential for investors to understand the industries, sectors, and companies driving the asset class.

Our Emerging Tech Research provides detailed analysis of nascent tech sectors so you can better navigate the changing markets you operate in—and pursue new opportunities with confidence.

Additional research

Agtech
Alex Frederick
alex.frederick@pitchbook.com

Artificial Intelligence & Machine Learning
Brendan Burke
brendan.burke@pitchbook.com

Cloudtech & DevOps
Paul Condra
paul.condra@pitchbook.com

Fintech
Robert Le
robert.le@pitchbook.com

Foodtech
Alex Frederick
alex.frederick@pitchbook.com

Health & Wellness Tech
Kaia Colban
kaia.colban@pitchbook.com

Information Security
Brendan Burke
brendan.burke@pitchbook.com

Insurtech
Robert Le
robert.le@pitchbook.com

Internet of Things (IoT)
Brendan Burke
brendan.burke@pitchbook.com

Mobility Tech
Asad Hussain
asad.hussain@pitchbook.com

Supply Chain Tech
Asad Hussain
asad.hussain@pitchbook.com