

Supply Chain Tech

2Q 2019





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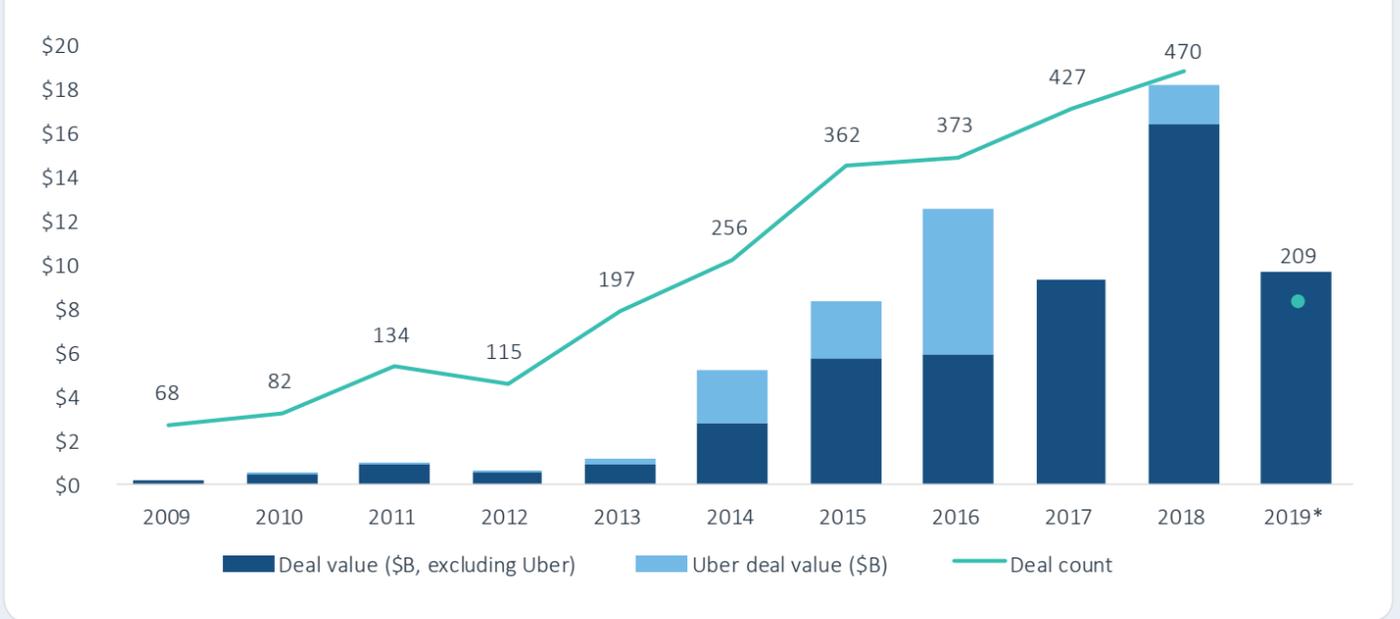
Executive summary

The growth of the global middle class and the expansion of the digital economy has had a significant impact on global trade. According to the WTO, B2C and B2B ecommerce totaled close to \$28 trillion in 2016, a nearly 40% increase from \$19 trillion in 2012 and a roughly 10% annualized growth rate—by far exceeding the roughly 3% global GDP growth over that same period.¹ This growth reflects not only the expansion of the world’s middle-income populations, but also the rise of the digital economy, which we believe is powering commerce-at-scale and adding more velocity to the global economy. We believe this growth is putting new pressures on the traditional global supply chain as it seeks to service this rising demand. Specifically, 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.

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. Significant venture funding has been put to work to both modernize and disrupt this industry. In 2018, VC investors deployed approximately \$16.4 billion into supply chain technology services across 470 deals, and 2019 is on pace to be a record year for the segment. This report provides an overview of the technologies benefiting from VC investment and highlights emerging subsectors and opportunities for growth.

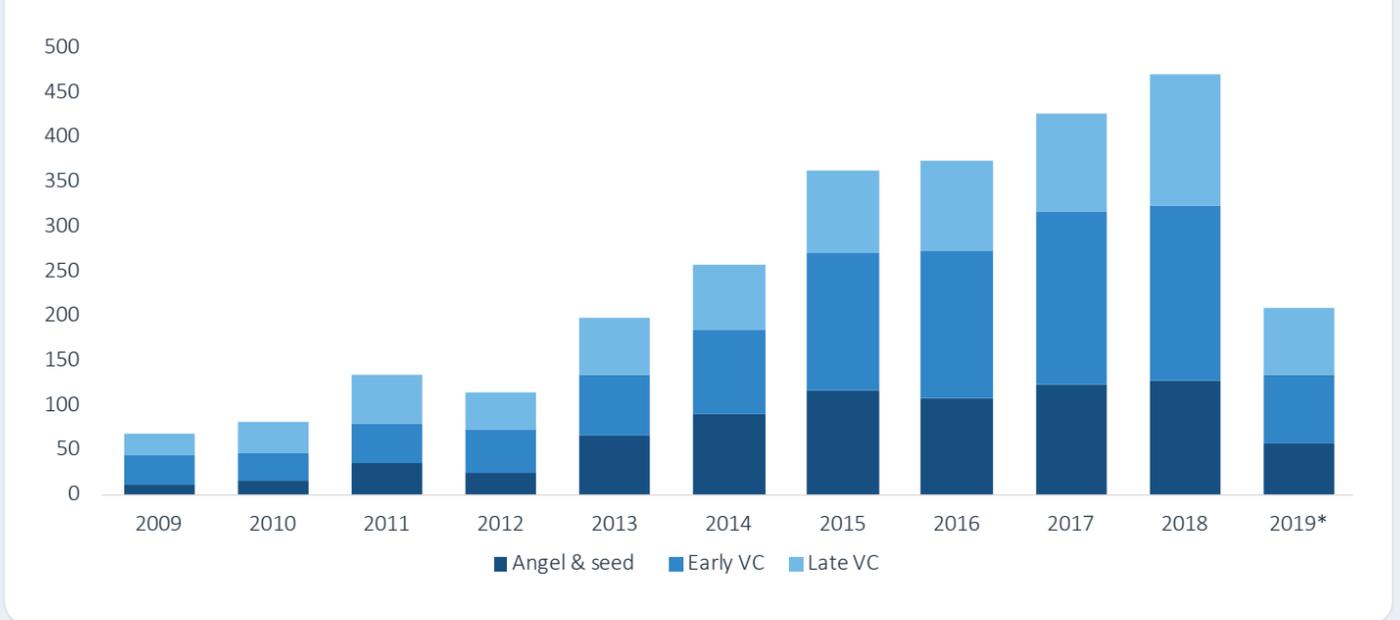
¹: “World Trade Statistical Review 2018,” World Trade Organization, 2018

Figure 1. SUPPLY CHAIN TECH VC DEAL ACTIVITY



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 2. SUPPLY CHAIN TECH VC DEALS (#) BY STAGE



Source: PitchBook | Geography: Global | *as of June 30, 2019



Supply chain tech market map



Companies included are VC-backed, segmented by primary use case and sorted by total capital raised.



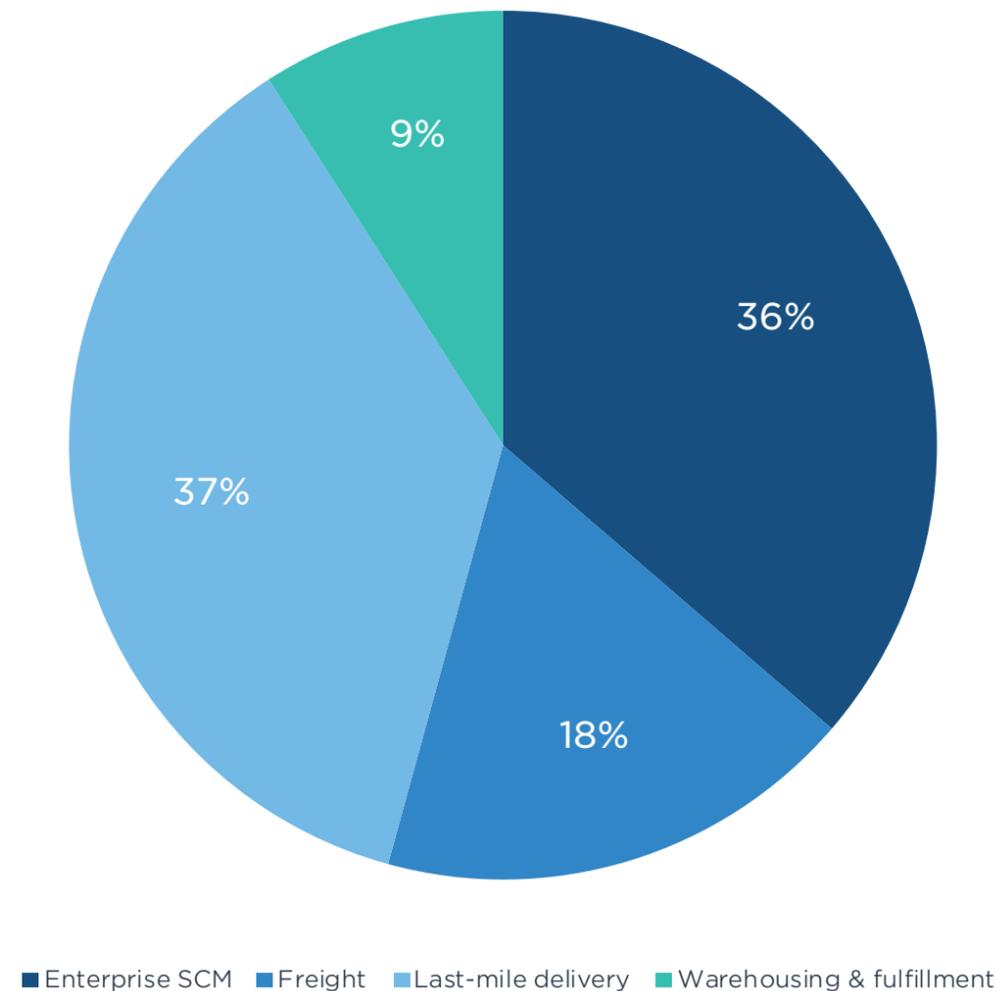
Key takeaways

Unbundling of monolithic processes: While the supply chain is often thought of as a single system that connects products to end consumers, we see an emerging trend toward microsupply-chain services, where specific functions and processes are isolated and optimized to work independently from the whole. These single systems can then be selectively used together to provide optimal services based on the needs of shippers, merchants and consumers. New entrants in the enterprise supply chain and logistics space are heavily focused on providing best-in-class point solutions along the value chain, such as brokering shipping contracts, RFID-based asset tracking or outsourced warehousing.

Connectivity and digitization: Enterprises have traditionally outsourced logistics operations such as freight, warehousing and delivery through inefficient, siloed, relationship-based contracts. Emerging supply chain platforms are providing digitized solutions that provide increased connectivity, visibility and predictive analysis to improve delivery speeds, reduce costs and enhance service outcomes across the supply chain. We view this as a long-term secular shift in supply chain infrastructure that will reshape the industry for the next several years.

Automation and robots: We believe automation presents a significant labor cost reduction opportunity across operations, freight, warehousing and last-mile delivery. This includes automation of logistics processes, such as payments, invoicing, real-time inventory updates, asset tracking and exception management, as well as automation of machinery, such as warehousing robots, delivery robots, drones and self-driving trucks. Within logistics processes, we see major automation and digitization opportunities in freight in the form of digital freight brokerage and visibility solutions. Within the world of automated machinery, we see a secular trend toward the Robotics-as-a-Service (RaaS) business model, which better serves the capital needs of middle-market customers.

Figure 3.
Supply chain tech VC deals (#) by subsector (2008-1H 2019)



Source: PitchBook | Geography: Global | *As of June 30, 2019



Segmentation

Enterprise supply chain management

Enterprise supply chain management (SCM) software enables processes such as financial management, procurement, sourcing and inventory management, while also automating various other back-office functions such as record keeping and data entry. This allows customers to run their businesses more effectively and efficiently. VC-backed companies in this space primarily compete with large technology companies such as SAP, FIS Global, Oracle, Fiserv and Intuit.

Freight

This segment includes companies focused on providing software and services to providers within the freight ecosystem, including trucking, rail, ocean and air freight. These products use tracking capabilities, automated spot quotes and pricing updates to provide customers with a holistic, real-time view of their supply chains. Digital freight forwarders such as **Flexport**, **Freightos** and **FreightHub** rely heavily on data obtained from cloud-based platforms to move freight globally. Digital freight brokerages such as **Convoy**, Uber Freight and **uShip** provide marketplaces connecting shippers to cargo. Autonomous vehicle startups such as **TuSimple**, **Ike Robotics** and **Starsky Robotics** are developing technologies to enable autonomous trucking. Startups in this space compete with large incumbent logistics providers such as C.H. Robinson, XPO Logistics and Echo Global Logistics as well as self-driving truck technology developers such as **Waymo** and Volvo.

Warehousing & fulfillment

This segment includes companies that store, pack and ship inventory for other companies. Third-party warehousing & fulfillment software platforms such as **Flexe** and **ShipBob** help enterprises store inventory and offer sorting, packaging and shipping services. Micro-fulfillment and automation companies such as **CommonSense Robotics** and **Takeoff Technologies** operate automated small warehouses in urban locations that enable speedy last-mile delivery. Startups in the warehousing & fulfillment space compete with large corporate incumbents such as Amazon (FBA), FedEx (FedEx Fulfillment) and Walmart.

Last-mile delivery

This segment includes companies that offer technologies and services enabling last-mile delivery to consumers. Last-mile delivery is synonymous with the rise of food delivery platforms such as Uber EATS, **Instacart** and **Postmates**, which contract with couriers to deliver food and groceries on-demand. Meanwhile, autonomous delivery companies such as **Nuro**, **Starship Technologies** and **Boxbot** are developing solutions to deliver goods without the need for a courier. Startups in the last-mile delivery space compete with large corporate incumbents such as Amazon, FedEx, UPS and DHL.

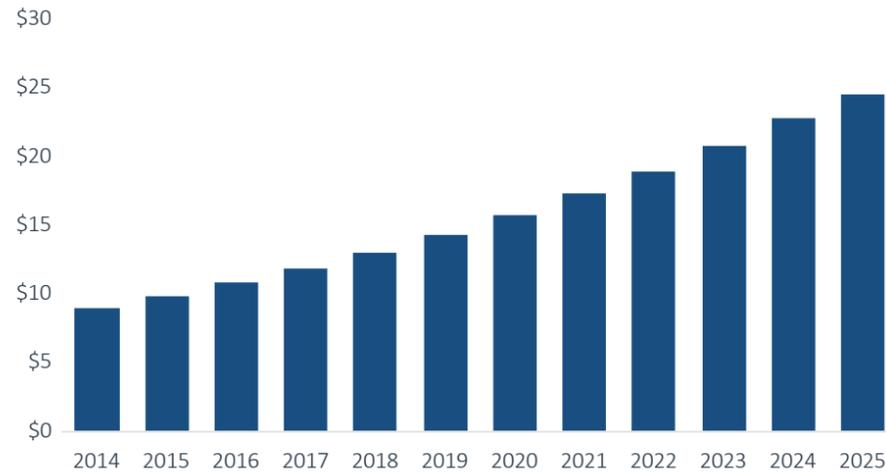
SEGMENT DEEP DIVE

Enterprise supply chain management



ENTERPRISE SUPPLY CHAIN MANAGEMENT

Figure 4. MARKET SIZE (\$B)



Source: Allied Market Research, internal PitchBook estimates. Note: This represents total revenue generated by sales of supply chain management software.

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.

KPIS

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

KEY PROVIDERS



NOTABLE DEALS

Anaplan

October 2018
\$264M IPO

Post-money valuation:
\$2.07 billion

IQMS
Manufacturing ERP

January 2019
\$425M M&A

Acquired by:
Dassault Systemes

INDUSTRY DRIVERS

- Global demand for cost reduction across the supply chain
- Shift toward digital centralized networks offering increased data visibility and transparency
- Trend toward unbundling services and specializing on key parts of the value chain, such as procurement or asset tracking
- Fragmented industry ripe for consolidation and disruption opportunities
- Relatively low-tech incumbent providers, creating room for new technologies

KEY INVESTORS





ENTERPRISE SUPPLY CHAIN MANAGEMENT

Overview

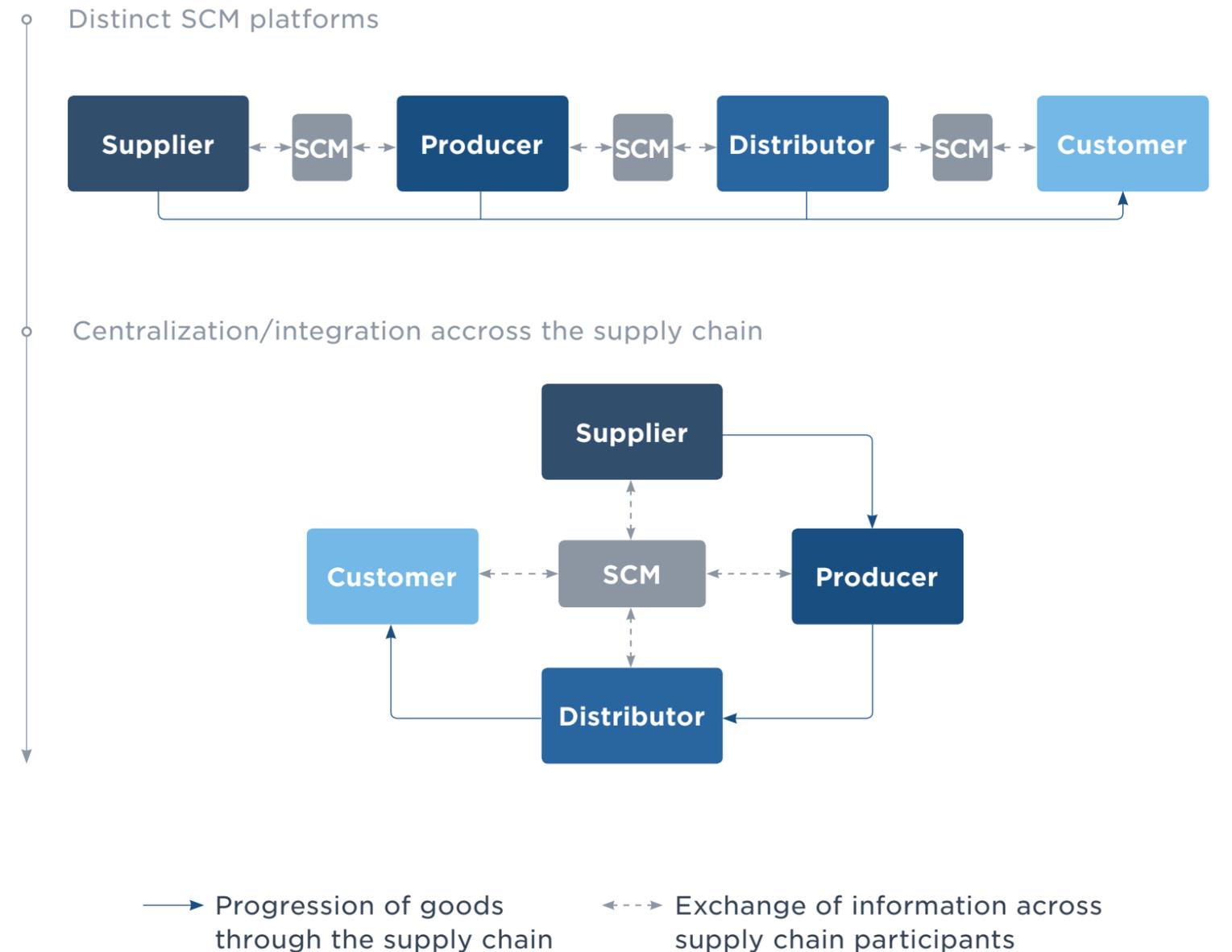
The legacy supply chain model is a linear process through which raw materials are procured by suppliers, sold to producers, manufactured into finished goods and sent to distributors where they are packaged and ultimately delivered to customers for consumption.

Enterprise SCM software has traditionally operated in the channels between each linear step, facilitating processes such as planning, ordering and confirming. Each time, separate software solutions are used between adjacent parties on the value chain to exchange information, such as orders and returns. These solutions often have little integration and are on different networks, making data and information sharing difficult. For example, once a producer has shipped its product to a distributor, it has little visibility into deliveries, customer satisfaction or other useful insights. Producers that collect data about shifting demand trends often have difficulty in effectively relaying that information to suppliers and distributors. These shortfalls create friction in the system and can increase costs or reduce top-line performance for enterprises.

The main thematic shift we see in enterprise SCM is a change from this legacy linear supply chain model toward a connected network, where a central hub helps orchestrate and coordinate supply, demand, inventory and capacity-related data across multiple channels. This can make the entire value chain more integrated and transparent, helping reduce costs, drive efficiencies and increase customer satisfaction. By utilizing a connected ecosystem, enterprises at all stages of the value chain can better respond to changes in the production or distribution process, increases or decreases in demand and other external events that could affect the value chain.

Figure 5.

The SCM shift toward connected networks





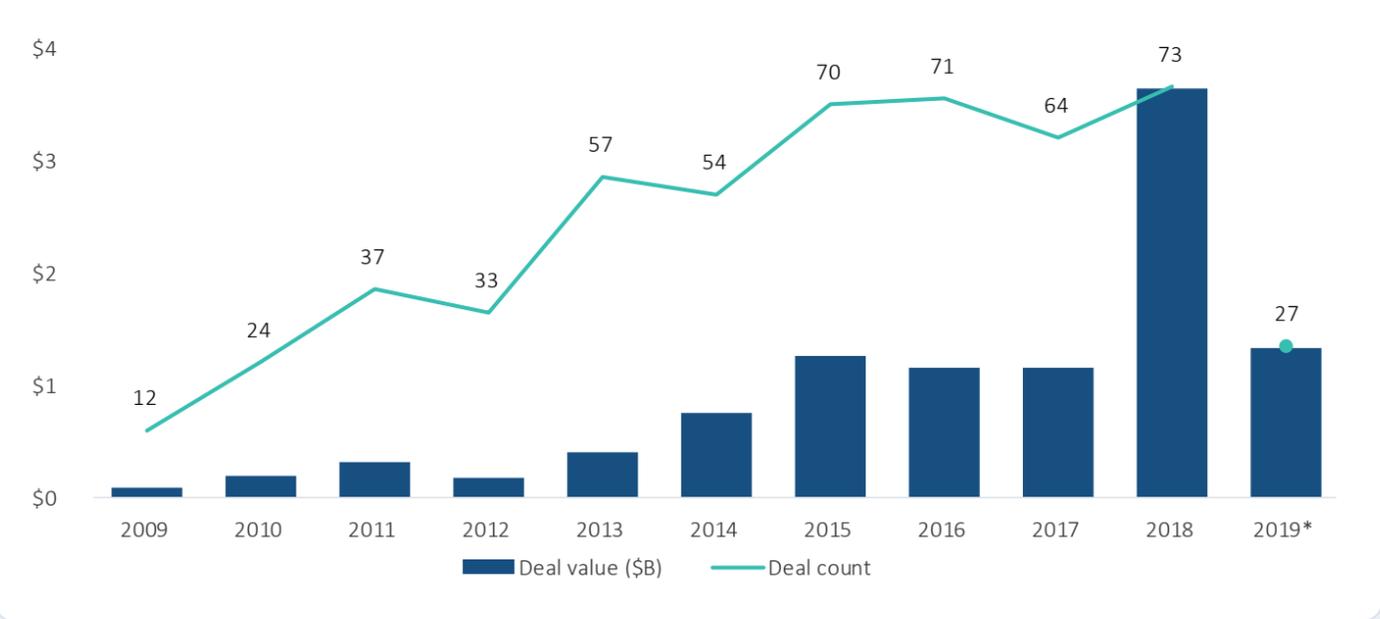
ENTERPRISE SUPPLY CHAIN MANAGEMENT

Since 2015, VC investment in enterprise management companies has remained fairly steady. 2018 was a standout year with almost \$3.6 billion deployed into the space. Major deals of that year include construction procurement platform **Katerra**, which raised a \$999 million Series D, and Chinese logistics service company **Huitongda**, which raised \$720 million in corporate VC funding from Alibaba. We expect VC deal activity in 2019 to moderate from 2018's highs but remain at elevated levels.

Opportunities

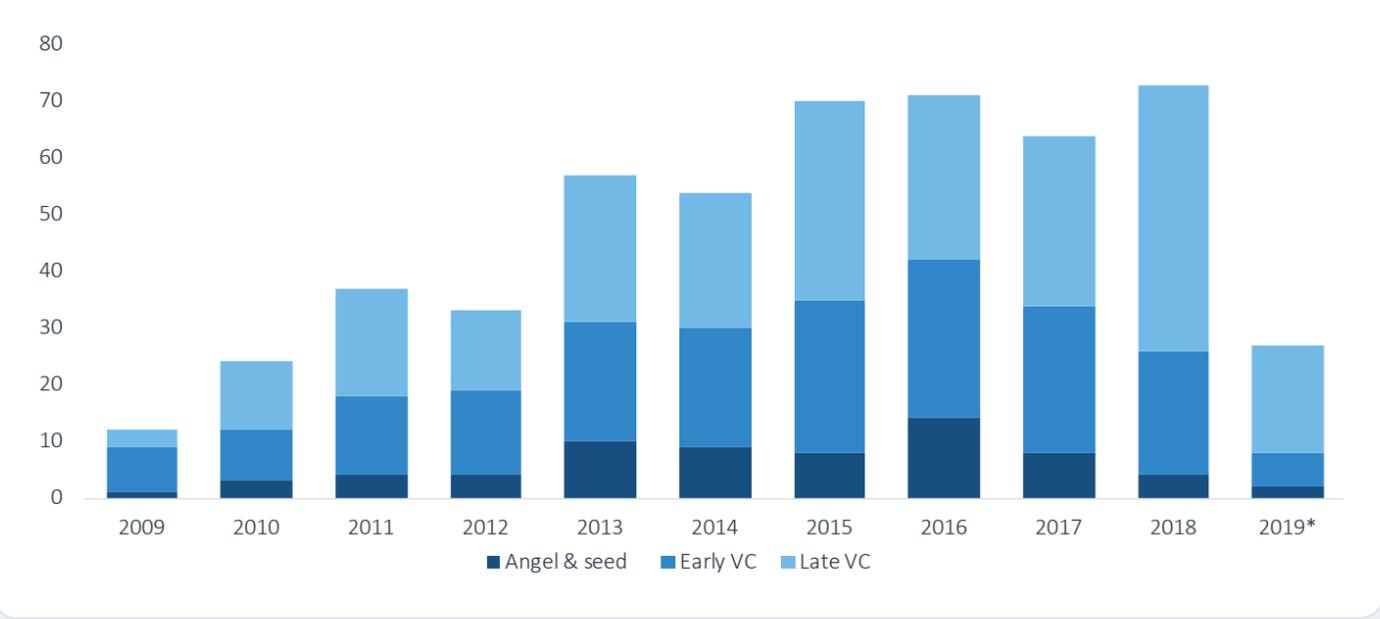
Supply chain orchestration: Supply chain orchestration involves integrating and standardizing siloed data so it can be transferred to shared platforms accessible to multiple parties, such as suppliers and distributors. Today's management teams are more data-driven than in the past and increasingly rely on supply chain data to make more informed decisions. In many cases, however, the lack of end-to-end supply chain data complicates a management team's ability to accurately forecast inventory and stocking levels. In addition, third parties outside of an organization often cannot access siloed data. Supply chain orchestration platforms enable 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, thereby increasing delivery speed and reducing costs. Key providers include **Elementum**, **Infor Business Solutions (GT Nexus)**, 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.

Figure 6. ENTERPRISE SUPPLY CHAIN VC DEAL ACTIVITY



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 7. ENTERPRISE SUPPLY CHAIN VC DEAL COUNT (#) BY STAGE



Source: PitchBook | Geography: Global | *As of June 30, 2019



ENTERPRISE SUPPLY CHAIN MANAGEMENT

Inventory management software: Inventory management software helps companies optimize inventory levels and improve demand forecasting and planning. We view this as a fundamental challenge for many businesses as 43% of small businesses either do not track their inventory or they use manual processes.² Similarly, 55% of small businesses either do not track assets or they use manual processes. The upward trend in the US inventory turnover may also be an indicator that companies need better inventory management capabilities. Inventory management software providers such as **Stitch Labs** and **TradeGecko** equip small and medium-sized businesses with web- and mobile-based inventory management platforms.

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,³ a significant portion of which was due to inventory 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** and **Mojix**.

Blockchain technology: Several providers are beginning to offer 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.

Services include providing dispute resolution for trade financing, triggering smart contracts at product checkpoints, certifying sustainability/fair sourcing of products, monitoring temperatures of sensitive assets (i.e. medications) and tracking food-borne illnesses. These services can increase transparency and reduce the costs related to tracking inventory while also increasing trust among intermediaries. Key companies in this space include **Filament**, **Everledger** and **Chronicle**. Other blockchain solutions such as **EKA** and **Hyperchain** focus on automating manual and paper processes while distributing data across network participants. Finally, IBM has launched its own network dubbed Trust Your Supplier, which aims to reduce procurement and supplier onboarding costs by shifting manual processes such as identity verification and document tracking to the network.

Supply chain finance: Supply chain finance providers such as **PrimeRevenue**, Artis Trade Systems and **Linklogis** provide tools and processes designed to optimize the cash flow needs of suppliers and buyers. This enables suppliers to receive payments in advance and allows buyers to alter or extend payment terms. Providers accomplish this by serving as an intermediary between suppliers and buyers or by offering reverse factoring services.

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.

²: “State of Small Business Report,” Wasp Barcode Technologies, 2017

³: “2018 Sensormatic Global Shrink Index,” Tyco Retail Solutions & PlanetRetail RNG, February 2018



ENTERPRISE SUPPLY CHAIN MANAGEMENT

Environmental and regulatory compliance: Investors are increasingly aware of the impact companies may have on society and the surrounding environment. 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. These concerns have heightened focus on evaluating a business's environmental, social and governance criteria (ESG). 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.

Considerations

Incumbent competition and exit opportunities: VC-backed providers of SCM compete with large enterprise software incumbents, including SAP and Oracle. These firms 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 \$425 million as part of a strategy to obtain cloud-based enterprise management technology.

Reluctance to adopt new technologies: Large established companies that have made significant investments in legacy technologies may be reluctant to replace them, while small regional players may lack the resources to adopt new systems. These companies often rely on low-tech processes based in standard office applications such as Word and Excel with minimal use of sophisticated transportation management systems or supply chain-focused technology.

Another complicating factor is the reputational nature of this industry, where longstanding relationships are more likely to drive business relative to cutting-edge technology, making it difficult for new entrants to penetrate the market.

Technology fatigue: Potential customers in the space are heavily marketed to 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

Trend toward late-stage deals; funding to remain elevated: An increasing proportion of VC funding in SCM has gone toward late-stage deals over the past few years. We believe this trend reflects the maturation of the segment, especially compared with more nascent segments such as freight, which is a laggard on the technology curve.

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 better 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.

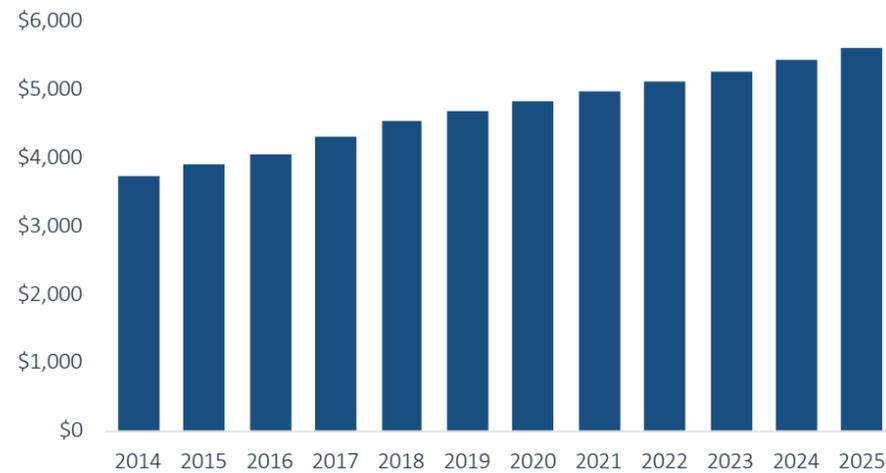
SEGMENT DEEP DIVE

Freight



FREIGHT

Figure 8. MARKET SIZE (\$B)



Source: American Trucking Association, Transparency Market Research, internal PitchBook estimates. Note: This represents total revenue generated by global trucking, air and marine freight industries.

BUSINESS MODEL

Freight companies transport physical goods around the globe. These companies primarily focus on trucking, rail, oversea shipping and over-air shipping.

Services include logistics solutions, transportation of physical goods, platform services that can match shippers to carriers, and autonomous vehicle technology such as self-driving trucks.

KPIS

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

KEY PROVIDERS



NOTABLE DEALS



August 2015
\$1.8B M&A

Sold to:
UPS



May 2019
\$1B late-stage VC

Investors:
SoftBank, etc.

INDUSTRY DRIVERS

- Global demand for cost-effective transportation relatively insulated from cyclical, providing a stable growth backdrop for service providers
- Persistent driver shortages driving demand for new solutions
- Fragmented provider landscape providing consolidation and disruption opportunities
- Need among industry participants to integrate legacy information systems
- Relatively low-tech incumbent providers creating opportunity for new technologies

KEY INVESTORS





FREIGHT

Overview

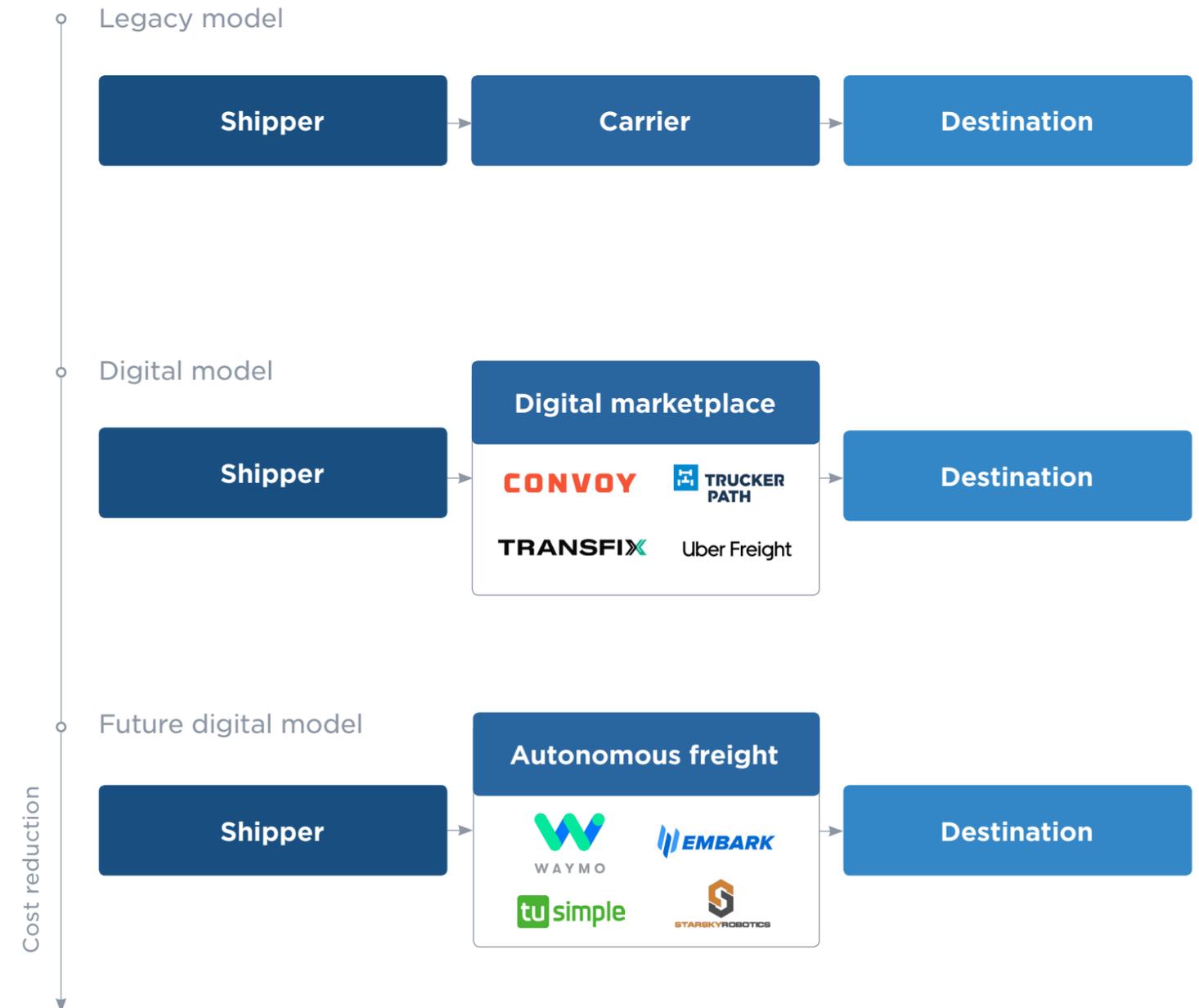
Freight is a key component of the global supply chain. Every year, trillions of dollars' worth of physical goods are transported by road, air and overseas routes. Within this industry, we see significant opportunity for new business models focused on the potential to disrupt on-road transportation logistics, which chiefly includes the trucking industry.

The trucking industry comprises 70% of freight tonnage in the US and generates over \$700 billion in annual revenue.^{4,5} Current freight operations largely consist of established relationships between shippers (companies shipping the product) and carriers (trucking and other freight companies). Typically, a shipper will use a limited number of carriers based on relationships cultivated over many years. Although this process works reasonably well, it is inefficient in many ways and results in limited product tracking ability, a lack of pricing transparency and scheduling conflicts, which often increase costs in the supply chain.

New technologies have created an opportunity for digital freight brokerages that can address these inefficiencies and help reduce freight costs, improve shipping speed and provide improved visibility for high-value goods. Companies such as **Convoy**, Uber Freight and **Transfix** have built 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. Over the long term, we see additional opportunities in the adoption of electric and autonomous trucks, which could dramatically reduce maintenance, service and labor costs.

4: "American Trucking Trends 2018," American Trucking Associations, 2018
5: "How Many Trucking Companies in the USA?" US Special Delivery, February 23, 2017

Figure 9.
Evolution of freight





FREIGHT

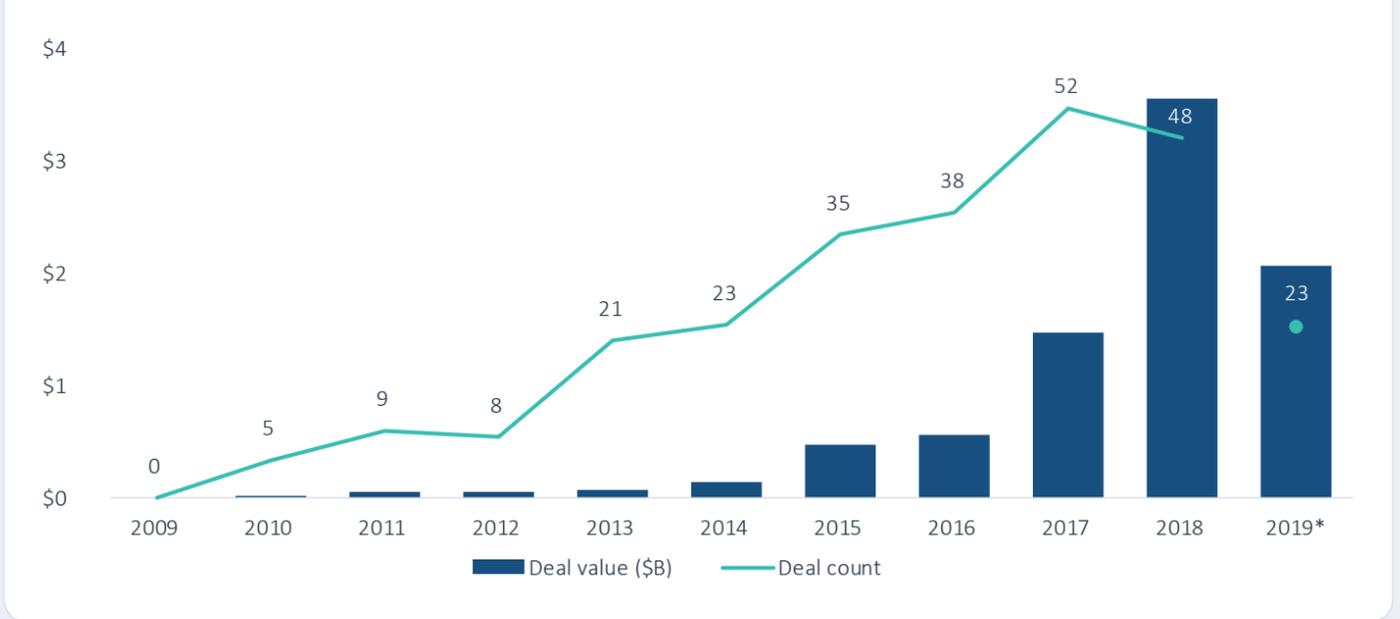
Opportunities

Digital freight brokerage: Digital brokerage platforms digitize and automate the process of connecting various players to one another, e.g. shippers to freight companies. These platforms are disrupting traditional relationship-based cargo-matching, which is often dependent on antiquated processes such as faxing documents to arrange shipments. Digital freight brokerage companies tend to offer significant value propositions, including increased price transparency, lower shipping costs and more efficient cargo handling. Automated pricing and matching has the potential to provide significant cost advantages for using digital freight brokerage relative to traditional freight brokerages. With cost of labor accounting for approximately 65% of the typical freight broker’s expenses, digital solutions that automate manual processes enable savings to be passed along to customers (shippers and carriers).⁶ 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.⁷ We believe digital freight brokerage margins could rise to mid-single digits over the next five years as the industry matures and consolidates and pricing becomes more rational. Along with increasing market penetration of digital freight brokerage services, we believe the market for digital freight brokerage could grow to \$17.5 billion by 2025.

Key digital freight brokerage providers include Uber Freight, **Convoy**, **uShip**, **Transfix** and **Trucker Path**. Chinese startup **Manbang**, which developed from a merger between Yunmanman and Huoc, has raised over \$1.9 billion and holds a dominant market position in China; most Chinese truck drivers are now on board the platform. These companies

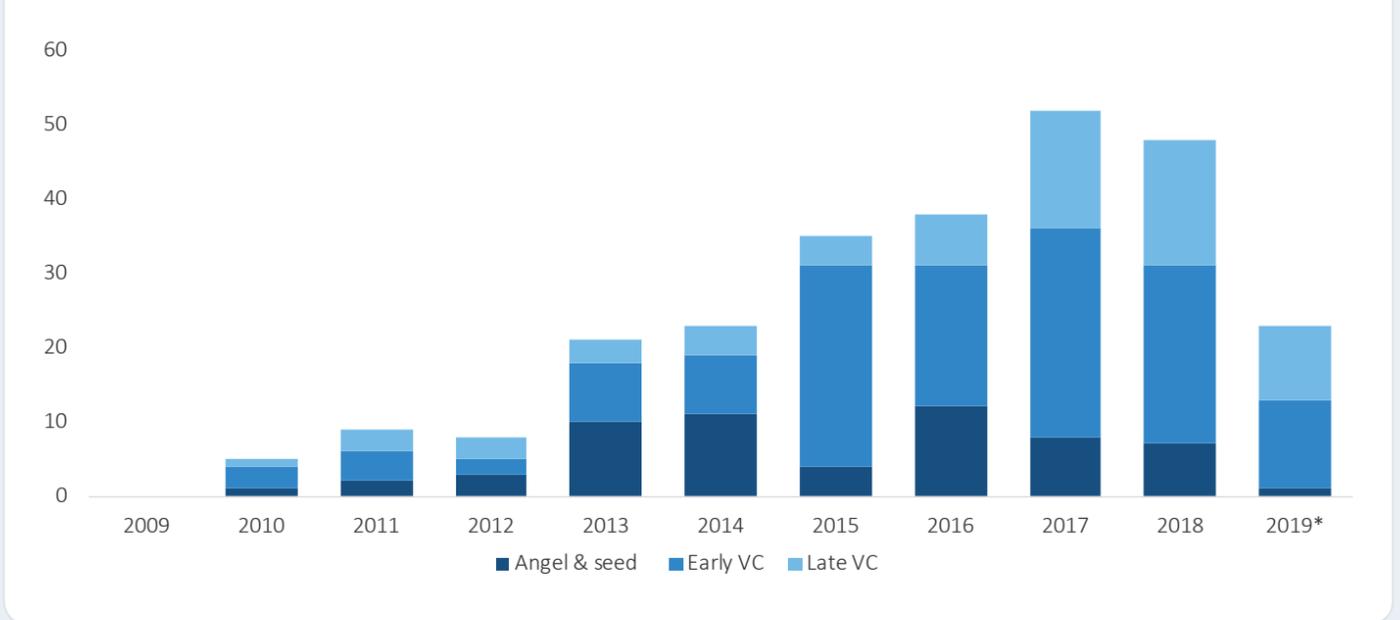
6: “Convoy Eliminates Human Intervention in Load-Matching,” FreightWaves, Brian Straight, February 5, 2019
 7: “Digital Freight Brokerage Growth to Accelerate Sharply Over Next Five Years,” FreightWaves, John Paul Hampstead, March 2, 2019

Figure 10. FREIGHT VC DEAL ACTIVITY



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 11. FREIGHT VC DEALS (#) BY STAGE



Source: PitchBook | Geography: Global | *As of June 30, 2019



FREIGHT

are putting pressure on incumbent freight brokers to invest their own capital into this technology to keep pace. J.B. Hunt launched its own digital freight marketplace named Carrier 360 that services more than \$500 million in freight. XPO Logistics has 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 tightness in trucking capacity slowing its growth rate.⁸ According to FreightWaves, differentiation from these incumbent providers comes from integration capabilities in drayage and final mile, as well as exception management to reduce errors in shipment statuses.

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 significant opportunity for more digitization and automation within the global freight forwarding industry, which is estimated at over \$140 billion.⁹ According to the Boston Consulting Group, automating manual processes could reduce industry back-office and operations costs by up to 40%.¹⁰ 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**, **FreightHub** 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-

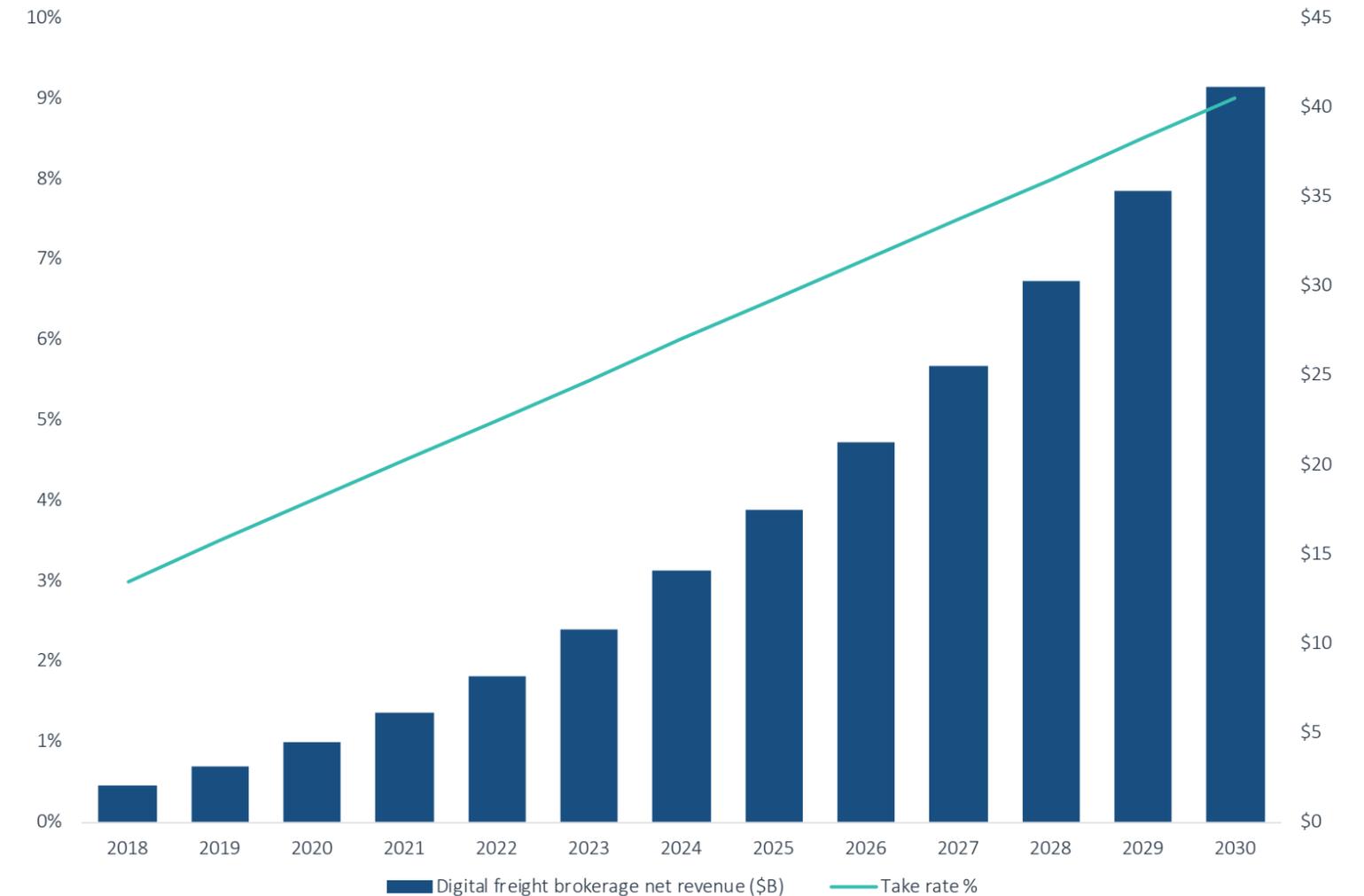
8: "Breaking: Amazon's Digital Freight Brokerage Platform Goes Live," FreightWaves, John Paul Hampstead, April 26, 2019

9: "Global Freight Forwarding 2017," Ti (Transport Intelligence), June 2017

10: "Banks Can Outsmart the Competition With Intelligent Operations," Boston Consulting Group, Derek Hayes, et. al, September 19, 2019

Figure 12.

Digital freight brokerage revenue forecast



Source: FreightWaves, internal PitchBook estimates | Geography: Global



FREIGHT

value goods. Prior to the rise of this technology, shippers would often have very little 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. Mobile app integration enables users to view additional delivery data and can capture signatures. Key providers in the visibility space include **project44**, **FourKites**, **MacroPoint** (acquired by Descartes) and **10-4 Systems** (owned by Trimble).¹¹ 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.

Electric trucking: We expect the number of electric medium and heavy trucks on the road to increase 15x by 2025. Electric fleets have several advantages relative to diesel fleets; they can help to eliminate fuel costs, reduce maintenance, lower repair costs and lengthen vehicle lifespans. Rising fuel costs and upward pressure on wages driven by a tight labor market continue to hurt profitability in the already low-margin trucking industry. Over the past decade, fuel costs have comprised 21%-39% of average marginal costs per mile (depending on fuel prices), making the reduction of a fleet's reliance on fuel compelling for trucking companies. Electric freight mileage is much greater than that of diesel trucks. Typical diesel trucks may have an average lifespan of roughly 10 years; however, electric vehicle battery warranties often cover 12 years, and the vehicles can last up to 20 years. In addition, electric powertrains have fewer moving parts than traditional internal combustion engines and generally have lower associated maintenance costs. Service and maintenance costs for electric fleets can be up to 20% less than diesel fleets, which require specialized equipment and service.¹² Key companies developing truck electrification technology include Tesla, **Nikola**, **Wrightspeed Powertrains**, **VIA** and **XOS** (formally Thor Trucks).

11: "Project44 Bags Amazon and Walmart," *Freight Waves*, John Paul Hampstead, August 2019

12: Ian Gardner, CEO at Royale EV. Panel at Sustain SoCal Driving Mobility Conference, June 25, 2019

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

Figure 13.

Electric vehicles in fleets worldwide

2019	2023
~520,000	2.5 million+

Source: Navigant Research

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 does not require a positive 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 limits complexity. 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, increasing the likelihood that the technology can be deployed and cost savings realized sooner. Walmart, which pioneered the retail hub-and-spoke distribution model, is now working to automate its logistics network through a partnership with startup **Gatik AI**.¹³



FREIGHT

Automating long-haul trucking: We view long-haul trucking as another potentially nearer-term use case for vehicle autonomy. It also represents an attractive opportunity for companies and investors given ongoing wage pressure and driver shortages in the trucking industry. In 2017, driver wages and benefits comprised 43% of per-mile average marginal costs, up from 35% in 2014. Automating drivers would help alleviate these cost pressures. We also believe the relative simplicity of automating highway driving as opposed to urban driving will accelerate deployment of this technology. We are already seeing the first signs of this; in June of this year, a commercial truck operated by **Starsky Robotics** traversed 9.4 miles on a Florida turnpike at highway speeds without a safety driver in the cabin (the vehicle was monitored by remote operator 150 miles away).¹⁴ Volvo is also targeting this market with its new cabless, fully autonomous Vera truck, for which it recently announced a partnership with Nvidia. Key VC-backed companies in the long-haul trucking space include **TuSimple**, **Embark**, **Kodiak Robotics** and **Starsky Robotics**. These startups compete with more established technology companies and automakers such as **Waymo**, Volvo and Daimler.

Financial market platforms: We see opportunity in the creation of financial market and digital media platforms serving the freight industry. **FreightWaves** has built a centralized dashboard to give market participants insights into freight markets, such as pricing data for trucking futures contracts and settlement. In collaboration with derivatives exchange **Nodal Exchange**, the company launched a financially settled futures market based on trucking spot rates. This instrument enables hedging in a historically volatile market, thereby giving shippers and trucking companies more control over shipping costs and price risk. The company has built a digital media presence around this platform providing news and analyst coverage on trends in

supply chain and logistics. As this industry becomes increasingly connected and digitized, we believe 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 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 reduce the cost of paperwork in the maritime supply chain.¹⁵ 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 Chinese-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 firm to grow significantly larger in both geographic scale and breadth of service offerings. Taking meaningful market share from incumbents is likely to require significantly more near-term investment.

¹⁴: "Starsky Robotics Remotely Drove an Unmanned Truck 9.4 Miles Down a Florida Highway," *Venture Beat*, Kyle Wiggers, June 26, 2019

¹⁵: "Shipping Blockchain Initiative Gathers Steam," *The Wall Street Journal*, Costas Paris, July 2, 2019



FREIGHT

Unsustainable growth strategies: Amazon's new digital freight brokerage platform has reportedly been undercutting market prices by 26%-33%.¹⁶ VC-backed startups in the space have adopted similar strategies to attract new shippers to their platforms. Although effective in near term, we believe this strategy may not be sustainable in the long-term, particularly during a period of economic contraction. If VC funding for early-stage logistics begins to dry up, these companies will be forced to become more rational with pricing. In that scenario, they risk losing market share to competitors and incumbent carriers that are able to sustain these types of discounts, such as Amazon, Uber Freight and some larger startups such as **Convoy** and **Transfix**.

Competition is large and established: 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. 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.¹⁷ 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.¹⁸

Unproven model in autonomy: Among all the segments within freight, we believe autonomy may represent the most difficult market for startups. This segment requires significant upfront investment to develop complicated and sophisticated technology that may yet 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 in Atlanta and has an announced partnership with Honda. VC-backed companies **TuSimple** and **Ike Robotics** were last valued at \$1.2 billion and \$250 million, 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 \$680 million acquisition of **Otto**, has dropped out of the race, potentially due to pressure to trim losses ahead of its IPO.

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 significantly reduce 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.

¹⁶: "Breaking: Amazon's Digital Freight Brokerage Platform Goes Live," *FreightWaves*, John Paul Hampstead, April 26, 2019

¹⁷: "XPO Logistics Joins Push to Digital Freight Booking," *Wall Street Journal*, Jennifer Smith, April 11, 2018

¹⁸: "Breaking: Amazon's Digital Freight Brokerage Platform Goes Live," *FreightWaves*, John Paul Hampstead, April 26, 2019



FREIGHT

Outlook

2019 could be record year for freight VC investing: So far, 2019 is on pace to be a record year for VC investment in freight with over \$2 billion invested in the first half of the year (see Figure 10). We believe this is reflective of strong investor interest in disruptive digital and autonomous technologies reducing costs associated with load matching and improving asset tracking visibility. Standout deals in the space include a \$1.9 billion early-stage VC round by Chinese digital freight brokerage **Manbang Group**, as well as a \$1.0 billion late-stage VC round by digital freight forwarding platform **Flexport**.

Early-stage deals dominate: VC deals in freight have seen an uptrend since 2012, largely driven by an increase in average deal sizes as the industry matures, with deal counts declining over the past few years as more capital goes toward fewer companies. Nevertheless, the segment is relatively nascent relative to more established segments in supply chain. Early-stage capital deployed in the space has largely concentrated on disruptive technology such as self-driving, which is being developed by VC-backed developers **TuSimple**, **Ike Robotics**, **Embark** and **Kodiak Robotics**.

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 demand cycles. Startups such as **Haven** serve as software-focused intermediaries that match shippers and cargo without holding inventory. This reduces liability and could limit downside risk during a potential economic contraction.

Growth opportunities in digit freight brokerage and autonomy: While we expect macroeconomic trends to have an impact on the transportation and logistics industry, we

believe higher growth opportunities exist for cost-reductive technologies penetrating this fragmented and relatively low-tech industry. We see the most revenue growth opportunity in the digital freight brokerage space given its large addressable market size. Longer term, we believe autonomous trucking solution providers have the potential to penetrate a large addressable market and expect strong growth rates once the technology is commercialized at scale.

Increased M&A activity: We also anticipate increased M&A activity and consolidation as firms look to scale and add capabilities. We believe startups focused on digital freight brokerage represent ideal acquisition targets for large enterprises looking to streamline their supply chains. In the long term, we expect the tail end of the digital freight brokerage space to consolidate as competition increases from large incumbent carriers such as J.B. Hunt and Echo Global Logistics as they gain traction with their in-house solutions. We expect offerings from larger technology companies such as Amazon, Uber Freight, **Convoy** and **Transfix** to succeed but face pressure in the long term to price more rationally. We also see freight visibility startups such as **project44** and **FourKites** as attractive acquisition targets for large retailers such as Walmart and Amazon seeking to vertically integrate to streamline operations.

Self-driving enablers are attractive acquisition targets: With autonomous trucking companies such as **TuSimple**, **Ike Robotics**, **Embark** and **Kodiak Robotics** having lower valuations relative to autonomous car companies, we view them as attractive acquisition targets for incumbent freight & logistics providers, OEMs 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.



FREIGHT

Figure 14.
Recent self-driving valuations

SELF-DRIVING CARS	
	N/A (\$30 billion-45 billion estimated)*
	\$19 billion
	\$15.3 billion
	\$7.5 billion
	\$7.3 billion
	\$3.2 billion

SELF-DRIVING TRUCKS	
	\$1.2 billion
	\$1 billion
	\$1 billion** (not yet closed)
	\$250 million
	\$210 million
	\$125 million

Source: *Internal estimates, **The Information, Bloomberg, TechCrunch, Bizjournals
Note: Waymo is also reportedly testing its technology on long-haul trucks.

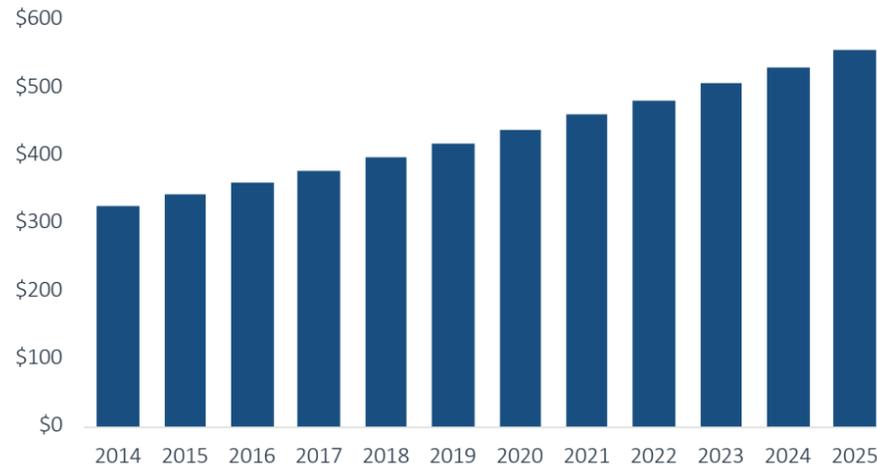
SEGMENT DEEP DIVE

Warehousing & fulfillment



WAREHOUSING & FULFILLMENT

Figure 15. MARKET SIZE (\$B)



Source: IMARC Group, internal PitchBook estimates
Note: This represents estimated revenue for global warehousing & storage.

BUSINESS MODEL

This segment includes companies that provide sorting, packaging, and shipping services. They also help enterprises with excess inventory find available warehouse space. Robotics and micro-fulfillment companies provide technologies powering small automated warehouses in urban locations to enable last-mile delivery.

KPIS

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

KEY PROVIDERS



NOTABLE DEALS



May 2019
\$43M Series B

Led by:
Activate Capital
Partners and Tiger
Global Management



July 2019
\$46M Series C

Led by:
Fort Ross Ventures

KEY INVESTORS



INDUSTRY DRIVERS

- Evolving approaches to inventory management to reflect real-time changes in demand
- Demand from smaller retailers for technologies and services enabling them to compete with large retailers such as Walmart and Amazon
- 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



WAREHOUSING & FULFILLMENT

Overview

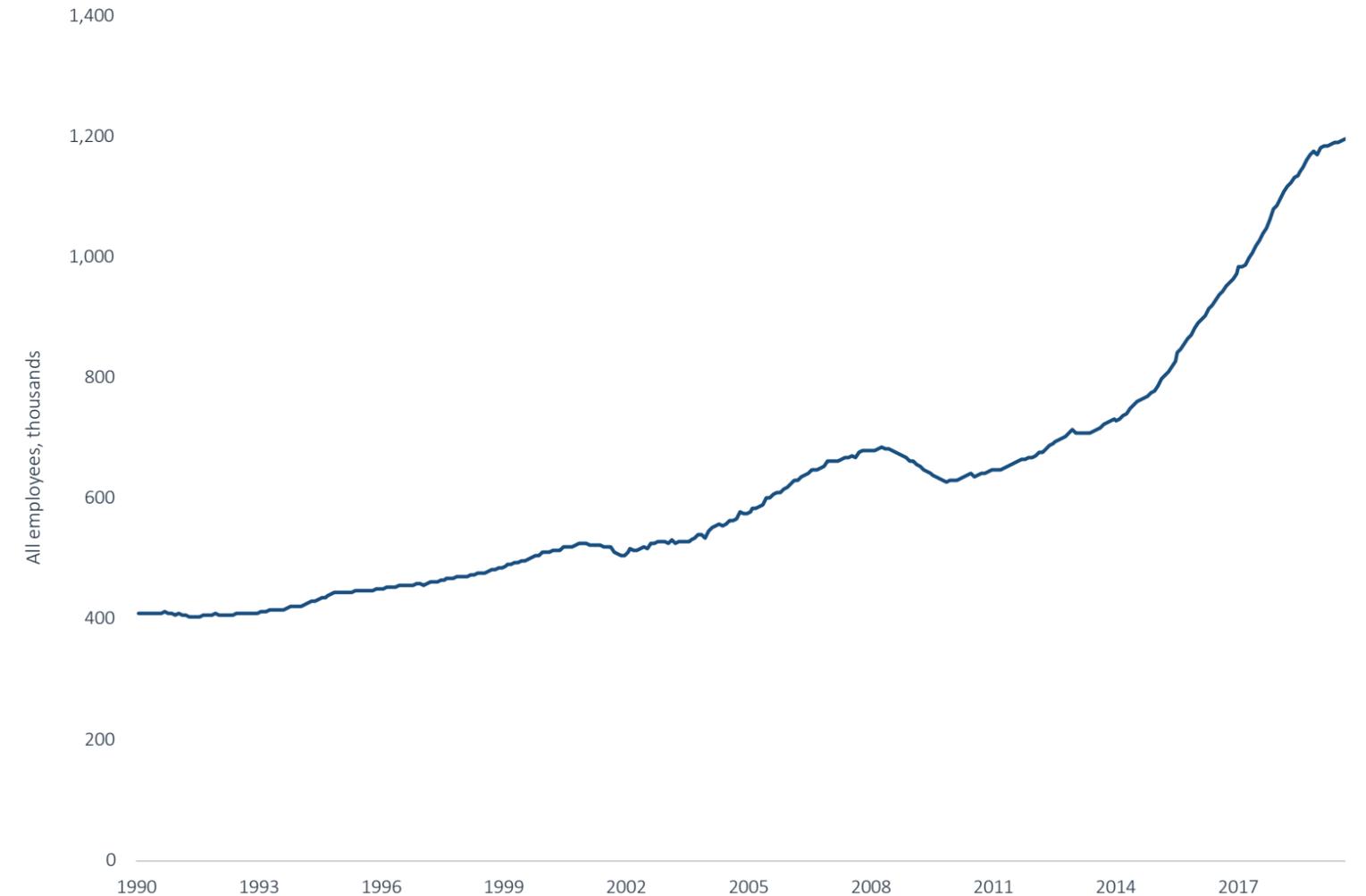
The warehousing industry has experienced strong growth in recent decades, as evidenced by the significant increase in employment and rising square footage of warehouse space. While this expansion has been fueled in part by economic growth, it also reflects important technological evolutions that continue to alter the supply chain ecosystem. Walmart's hub-and-spoke approach set the standard for big box retail in the 1990s and the early 2000s, 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 is driving the company's ongoing push for same-day delivery. More recently, 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.

Today's warehousing ecosystem reflects a blend of old and new supply chain models. While online retailers are leveraging fulfillment networks and drop-shipping models, traditional retailers are pursuing a hybrid approach intended to optimize fulfillment services with legacy hub and spoke infrastructure. Driven by the growth of these supply chain models, the warehousing industry has seen significant expansion in recent years. Warehouse employment has risen 187% since 1990 (see Figure 16), while total non-farm employment has risen only 40%. Demand for warehousing space is strong; 183 million square feet of new warehousing space was built in 2017, a significant increase compared to the 100 million annual average over the past decade, according to the CBRE.¹⁹

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

¹⁹: "Cold Storage Space: One Size Does Not Fit All," CBRE, n.d.

Figure 16.
Warehousing and storage employees (#)



Source: Bureau of Labor Statistics | Geography: US | *As of July 2, 2019



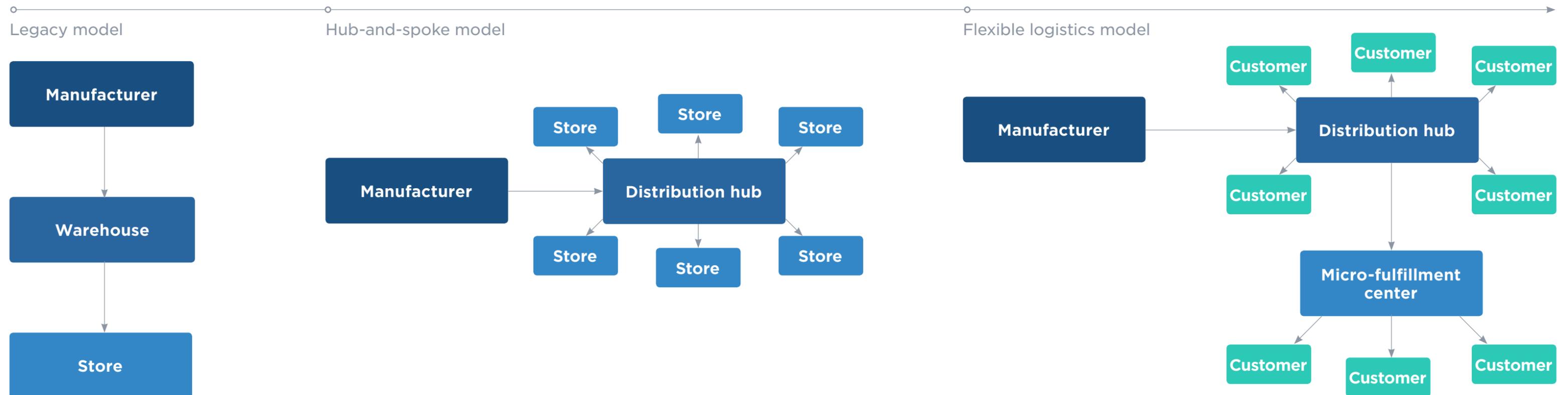
WAREHOUSING & FULFILLMENT

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,

Figure 17.
The evolution of warehousing





WAREHOUSING & FULFILLMENT

this has shifted the focus from the complicated logistics of product curation and stocking, to the adjacent—though equally as complicated—logistics of consumer delivery.

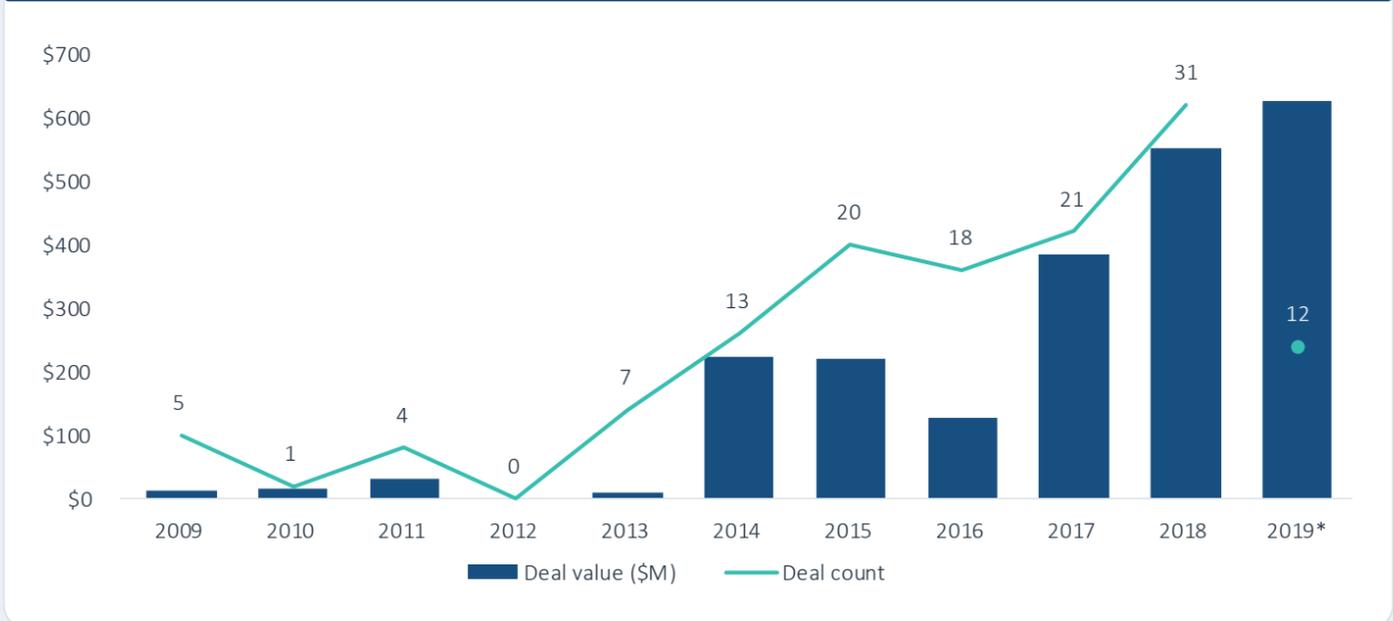
Amazon’s rise to the forefront of ecommerce has largely reflected the company’s ability to provide the best online shopping experience in terms of product search, quick delivery and easy returns. To accomplish the quick delivery part of this equation, the company turned Walmart’s hub-and-spoke model 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 **CommonSense Robotics** are creating automated micro-fulfillment centers of the future.

Opportunities

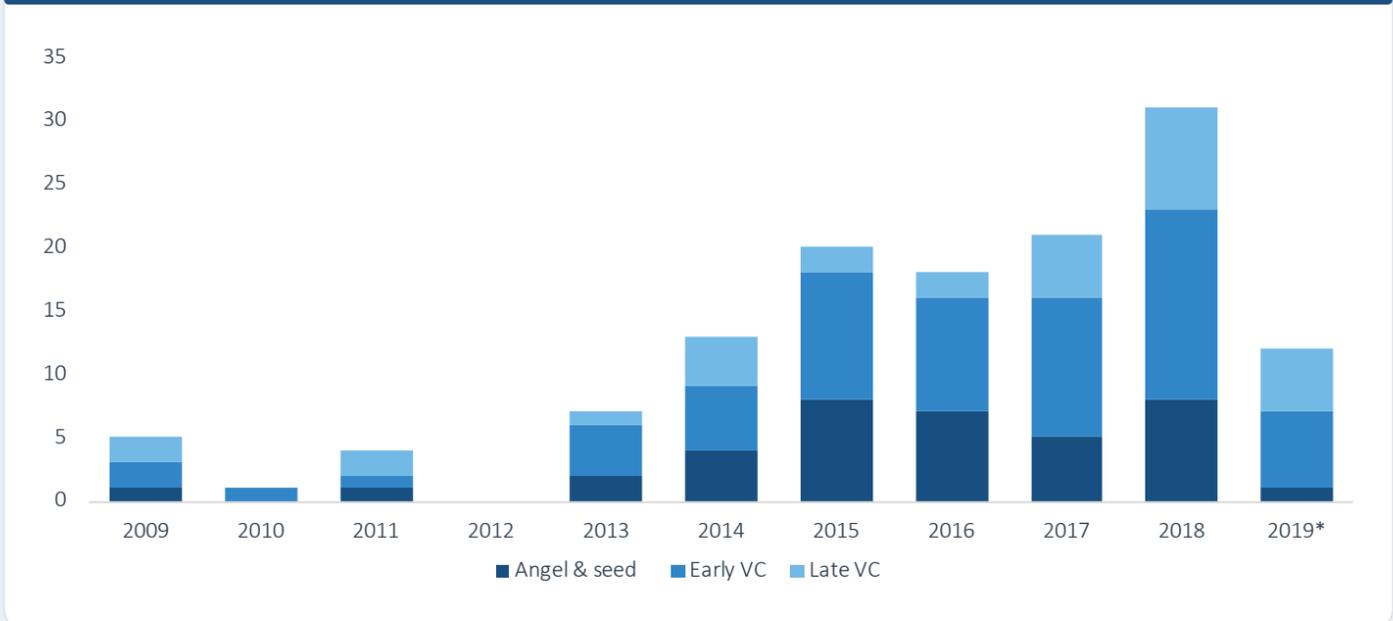
Fulfillment technologies: Much of Amazon’s ability to provide industry-leading delivery services can be attributed to its investments in warehousing, fulfillment, sorting and delivery stations. Emerging warehousing technology startups such as **ShipBob**, **Delhivery**

Figure 18. WAREHOUSING & FULFILLMENT VC DEAL ACTIVITY



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 19. WAREHOUSING & FULFILLMENT VC DEALS (#) BY STAGE



Source: PitchBook | Geography: Global | *As of June 30, 2019



WAREHOUSING & FULFILLMENT

and **ShipMonk** are emulating its model in their own offerings to provide smaller retailers with products and solutions to better help them compete with Amazon and Walmart. In addition to typical fulfillment 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, reduce 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 the 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 reduce 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 Key private companies in the space include **Geek+**, **Boston Dynamics**, **Fetch Robotics**, **GreyOrange**, **RightHand Robotics**, **CommonSense Robotics**, **Takeoff Technologies**, **6 River Systems**, **Magazino**, **IAM Robotics**, **Exotec Solutions**, **Invia Robotics**, **ATTAbotics**, **Kindred**, **Plus One Robotics** and **Alert Innovation**. For example, **RightHand Robotics** has developed a robotic arm to pick and place physical goods at warehouses. **GreyOrange** has developed scalable and modular robot systems that can be used to transport, store and pick goods in warehouses. We believe the adoption of autonomous warehousing technologies will see growth over the long term as enterprises seek to reduce labor costs.

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

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



WAREHOUSING & FULFILLMENT

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 consumer 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.

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 reduced productivity and unanticipated repair costs. In the medium term, we believe warehouse operators may prefer to invest in alternative technologies such as augmented reality. 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 significant 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 recently 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

VC investing on the rise: VC investing in warehousing & fulfillment companies has generally experienced an upward trend over the past few years. So far, 2019 has already eclipsed previous highs in the space and is on pace to be a breakout year for the segment. This outperformance has been driven by India-based warehousing and fulfillment company **Delhivery** receiving \$413 million in Series F funding. We are optimistic about the warehousing & fulfillment space and expect strength in funding trends to continue going forward.

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



WAREHOUSING & FULFILLMENT

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.

Attractive M&A candidates: We expect consolidation to increase over the next few years as warehousing and fulfillment companies with the largest scale are acquired by incumbent logistics providers. Companies in the space with the most intuitive and effective products could be attractive acquisition candidates for incumbent third-party logistics providers such as XPO Logistics, C.H. Robinson and J.B. Hunt. In the third-party warehousing space, we believe differentiation comes from scale. We expect the most successful companies to be the ones that can onboard a large selection of warehouses onto their network to attract new users.

Robotics-as-a-Service: We expect a business model shift toward Robotics-as-a-Service (RaaS) as warehouse automation providers offer subscription-based services rather than unit sales. 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. Moreover, this business model is favorable from a robotics investor perspective as it positions providers more toward a full-service, recurring revenue business model as opposed to dependency on cyclical changes in customer capex budgets. We believe companies such as **RightHand Robotics** that have adopted the RaaS business

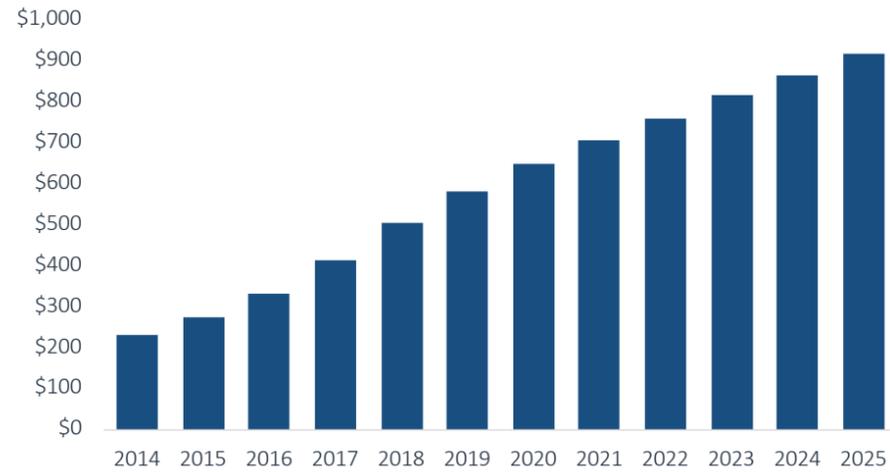
SEGMENT DEEP DIVE

Last-mile delivery



LAST-MILE DELIVERY

Figure 20. MARKET SIZE (\$B)



Source: Uber, CSI Market, internal PitchBook estimates
Note: This represents estimated revenue for global last-mile home delivery.

BUSINESS MODEL

Last-mile delivery providers focus on hyper-local delivery services that provide retailers with a unique way to get products to customers in very 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. It also includes autonomous delivery companies such as **Nuro** and **Starship Technologies**, which are developing solutions to deliver goods without the need for a courier.

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 %

KEY PROVIDERS



NOTABLE DEALS



April 2019
\$1B
late-stage VC

Investor:
SoftBank



April 2018
\$9.5B M&A
Acquired by:
Alibaba Group

INDUSTRY DRIVERS

- Growing consumer preference for on-demand, same-day delivery services
- Failure of traditional delivery infrastructure to provide seamless mobile experiences
- Retailer demand for Delivery-as-a-Service offerings to help reach new customers and provide new services
- Potential for automated and autonomous delivery services to drive significant cost savings

KEY INVESTORS





LAST-MILE DELIVERY

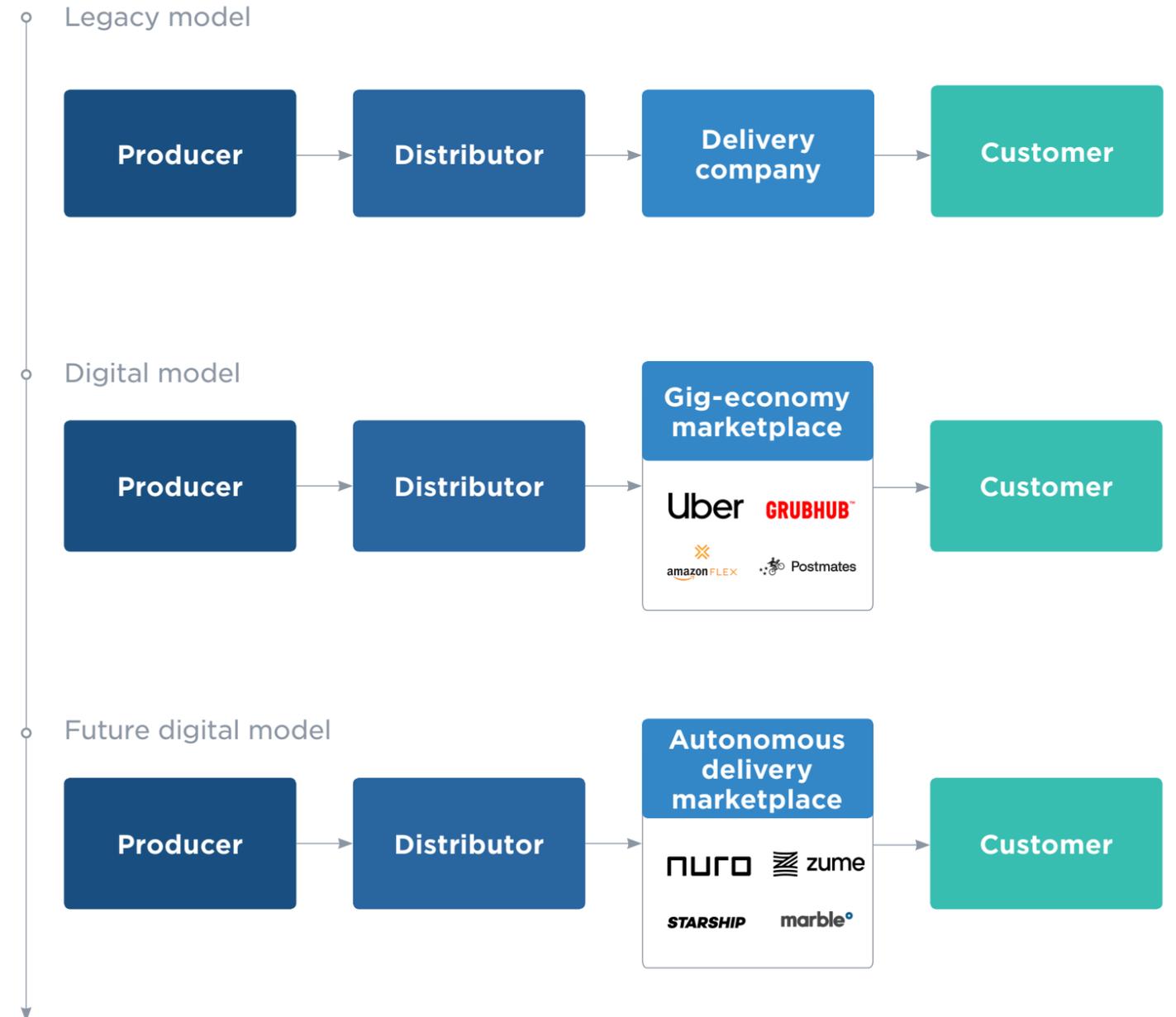
Overview

Technology is reshaping last-mile delivery. While traditional consumer delivery networks worked well in the pre-ecommerce world, new technologies are enabling quicker, more specialized consumer-direct delivery services which we believe are increasingly finding success among consumers. These services include courier networks and delivery platforms, as well as more emerging robots and drone services that promise to improve the way consumers receive goods.

Legacy last-mile retail delivery models are antiquated and ill-suited for the future of instant delivery. Under this model, finished goods are received by distributors from producers. The distributors then package and prepare the product for delivery, often at fulfillment centers. Finally, third-party delivery service providers such as FedEx or UPS handle the complex logistics of delivering goods to the consumer. While these services work well for consumer goods that are less time-dependent, they are insufficient to meet the rising demand for same-day or same-hour delivery. This is primarily because large-scale delivery services tend to operate on fixed routes carrying large numbers of packages from distribution hubs. Delivering in this way is cost effective but takes longer.

Mobile connectivity and platform technologies are altering the last-mile delivery landscape. In the food delivery space providers including Grubhub, Uber Eats and **DoorDash** are connecting couriers directly to restaurants and diners. In the consumer products space, Amazon has enabled same-day parcel delivery by connecting couriers directly to its fulfillment centers. These delivery platforms allow companies to access an extensive pool of individual drivers who use their own vehicles to provide local delivery services on a contract basis. This model can provide local delivery services with higher

Figure 21. Evolution of last-mile delivery





LAST-MILE DELIVERY

efficiency and at lower cost compared to traditional delivery fleets. While still several years away, we believe autonomous vehicle technology represents the next stage of this industry's evolution. This includes autonomous cars, robots, pods and drones that have the potential to replace human couriers in serving the need for low-cost, last-mile delivery.

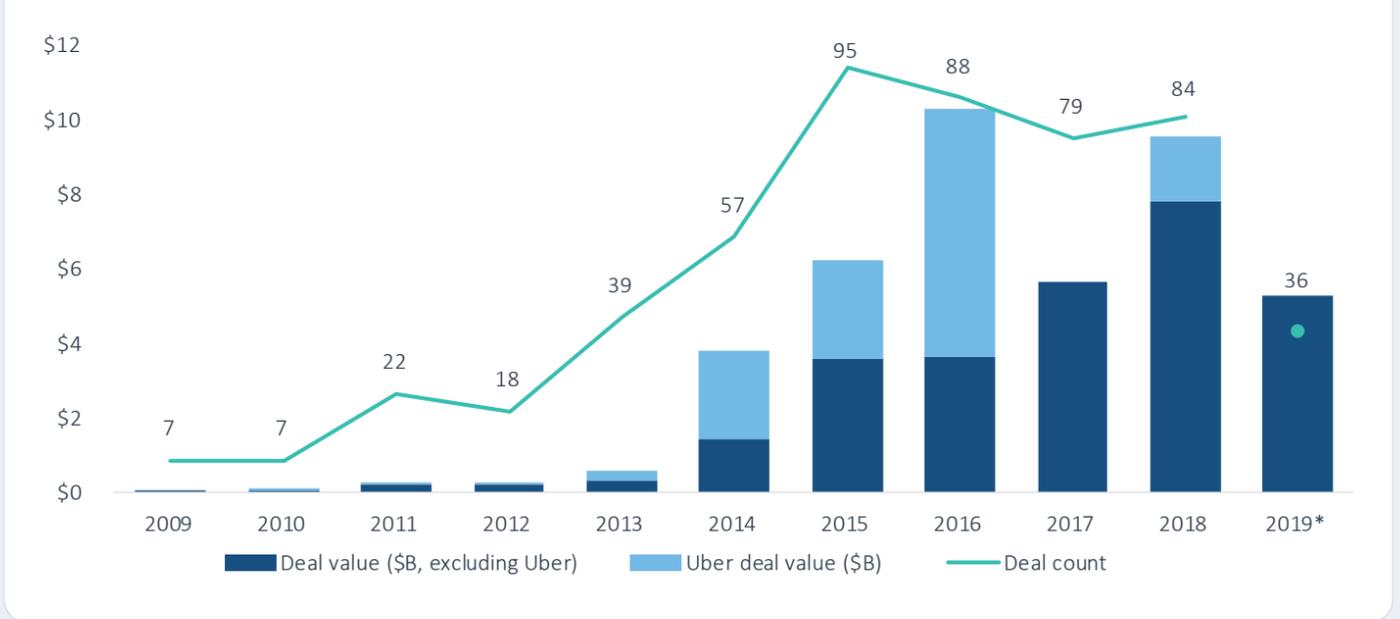
Opportunities

Food delivery: The rapid rise of food delivery platforms (i.e. 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. In its 1Q 2019 earnings call, Domino's called out the "increase in advertising spend and push around free and discounted deliveries" from third-party delivery services as a major force behind the decline in same-store sales, which declined more than 50% compared to the previous year. 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 According to UBS, millennials are three times more likely to order in than their parents.²³ 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. We see food delivery as an attractive mature market and are more positive on late-stage companies such as **DoorDash**, **Deliveroo** and **Instacart** relative to newer entrants, given their scale and capital advantages.

Ridesharing and food delivery platforms: Ridesharing companies are leveraging their platforms to provide food delivery services. While this includes Uber with its fast-growing

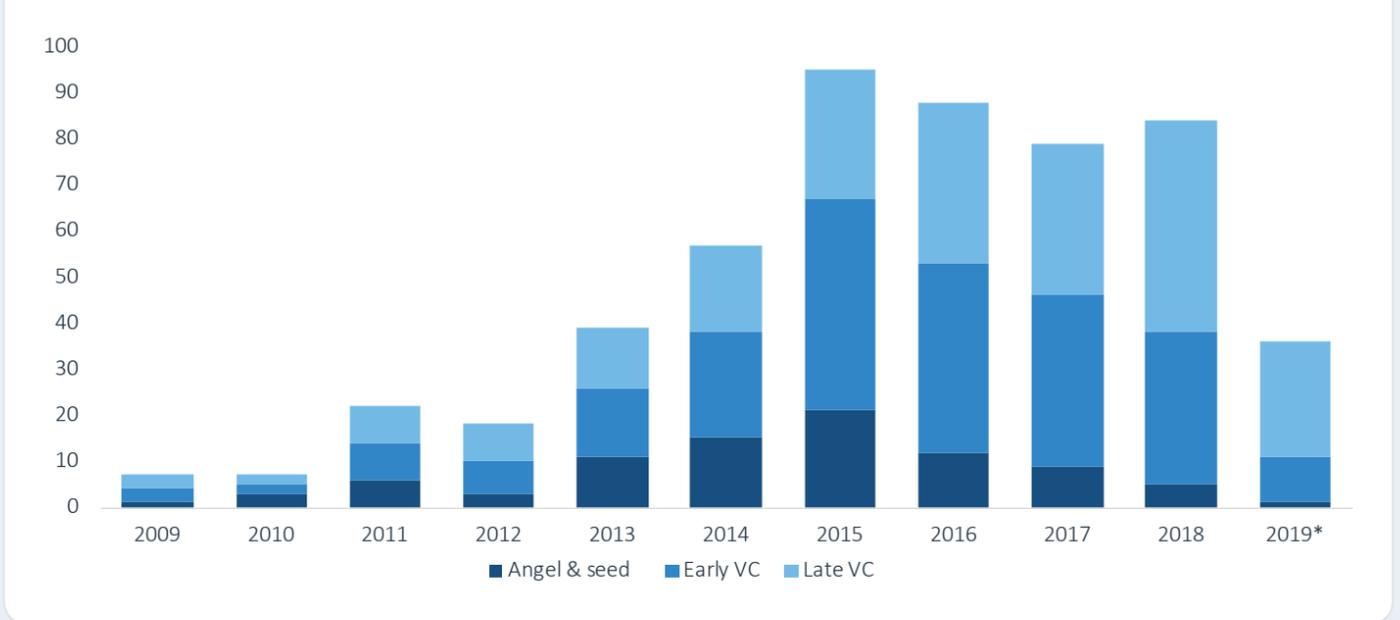
22: "Form S-1 Registration Statement: Uber Technologies, Inc.," SEC, April 11, 2019
23: "Is the Kitchen Dead?" UBS, Chris Grundberg, June 18, 2018

Figure 22. LAST-MILE DELIVERY VC DEAL ACTIVITY



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 23. LAST-MILE DELIVERY VC DEALS (#) BY STAGE



Source: PitchBook | Geography: Global | *As of June 30, 2019



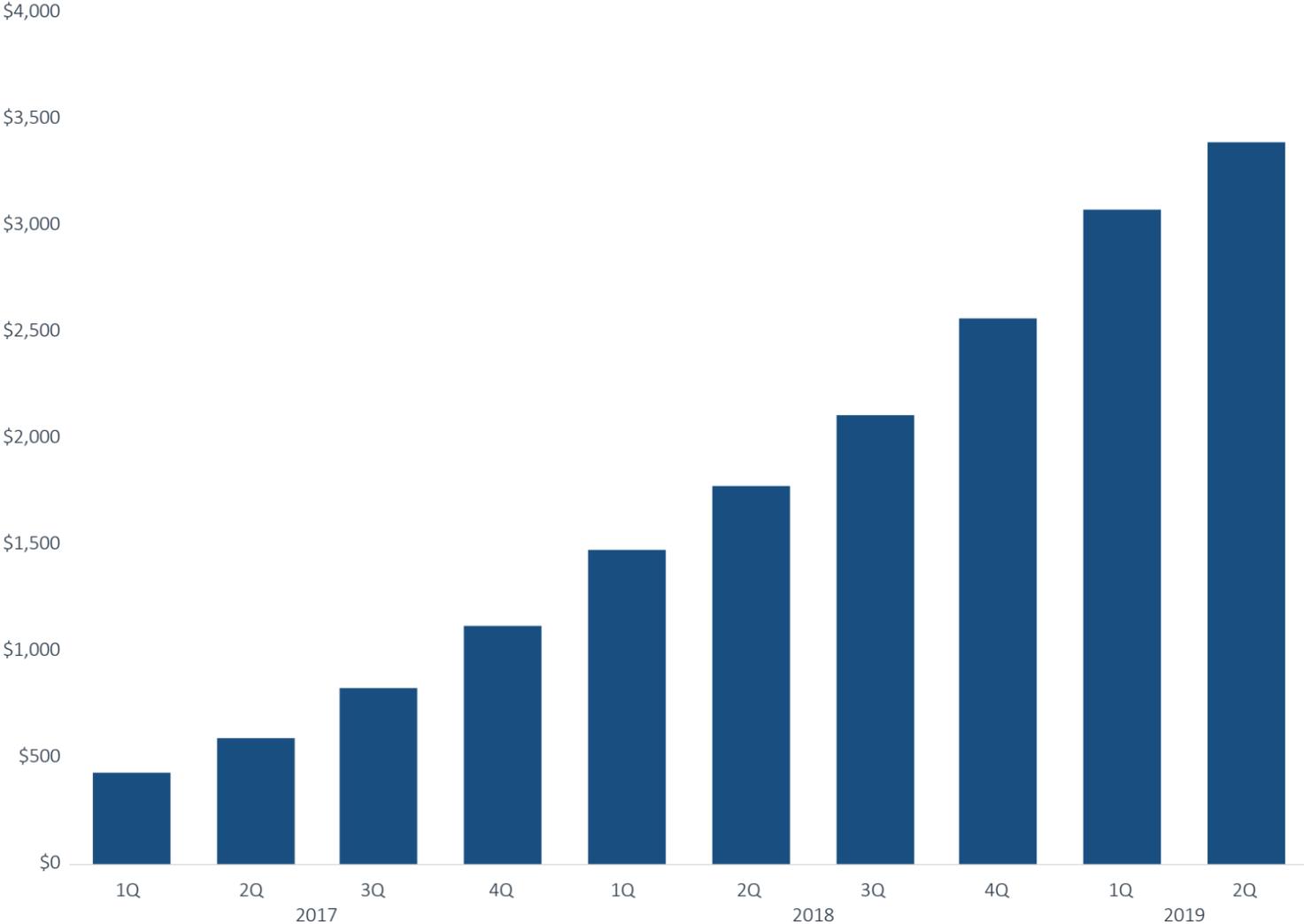
LAST-MILE DELIVERY

Uber Eats service, we see continued opportunity for global ridesharing platforms **Grab**, **Careem** and **Ola** to carve out market share and expect more late-stage investment in these businesses. We see long-term benefits to this type of platform Mobility-as-a-Service (MaaS) 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 has monetized its user-base across several services (i.e. 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: We believe last-mile food and goods delivery is a key use case for autonomy. Delivery robots have the potential to dramatically reduce costs across the supply chain, which largely consist of wages paid to drivers and couriers, while also improving automobile energy efficiency and traffic congestion levels. Backed by venture dollars, a number of startups are developing robots to capture this market, including: **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 Amazon, Alphabet, **Zipline International**, **Matternet**, **Flirtey** 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. **Zipline International** utilizes a fleet of drones to deliver blood, plasma and medicine to

Figure 24.
Uber Eats bookings (\$M)



Source: UBER



LAST-MILE DELIVERY

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.

Shared or open-source data in autonomous vehicles: While the enterprise software industry has thrived in recent years largely due to the role of open-source software development, we believe the closed-source approach to software development in the autonomous vehicle industry has been detrimental to progress. Despite a multitude of firms working on the same problem, autonomous vehicle development has largely been siloed with various companies keeping their data in-house. We believe a more open-source approach could help the industry to advance. For example, a shared pool of billions of on-road miles could speed up development processes while key performance metrics such as miles per intervention could be better defined and standardized. While some companies such as **Comma.ai** and **Apollo** are providing open-source autonomous software, this approach hasn't received much traction in the industry. We support continued movement toward open source and believe it represents the best path forward for the industry. We note that **Waymo** released a dataset to the public in August, which we see as a positive for the autonomous vehicle industry.

Delivery management software: Delivery management software helps inventory-heavy enterprises better manage local deliveries (done by employees) and integrate with third-party carriers. Features typically include real-time dispatching, managing and tracking of couriers and in-app proof of delivery and signature collection capabilities. These platforms typically have online integration for seamless online-order dispatch. Some providers also enable enterprises to more proactively select and integrate their

systems with third-party delivery services such as UPS and FedEx. We see opportunity for increased demand for delivery management software from small and medium-sized businesses seeking to reduce time and cost associated with delivery, increase capacity and ultimately improve the customer experience. Delivery management software providers include GetSwift, **MetaPack**, **Bringg**, **FarEye**, **WorkWave** and **LogiNext**.

Considerations

Significant barriers to entry for new entrants: We believe industry-wide low margins and incumbent scale and capital advantages are likely to be the largest obstacles faced by new challengers in the space, and this may limit the ability to attract VC funding.

Food delivery is fundamentally a low-margin business as providers must pay both the restaurant as well as the driver, with customer incentives often eating up additional margin. Uber's S-1 filing reveals its food delivery business has seen a generally decreasing margin trend throughout 2018 reflecting the heavy use of incentives. Similarly, Grubhub has seen a generally decreasing operating margin percentage over the past three years due to increased marketing spend and competitive pressure from companies such as Amazon and Uber Eats. While the market for food delivery is large, we believe consumer price sensitivity and the competitive landscape may permanently impede margin expansion, limiting returns for investors. While the restaurant industry is very fragmented, and these businesses typically don't have the market power to dictate delivery fees, larger chains such as McDonalds (partnered with Uber Eats) and Chipotle (partnered with **DoorDash**) could signal a low-margin future as these companies face their own margin pressures from rising wages and are increasingly pressured to cut costs.



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Food delivery startups need significant capital to grow and face increased competition from incumbent ridesharing companies that already have significant 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. Like 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**, **Careem** and **Ola**. As a sign of the difficulties posed by food delivery, ridesharing company **Didi** scaled back its venture presumably due to the low margins in the space.

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.

Lack of differentiation: We believe many delivery management software providers may find it difficult to stand out in a crowded field of competitors offering similar services. This highlights the risk of delivery management solutions where the underlying technology isn't particularly sophisticated.

Autonomous last-mile delivery stalled by setbacks: Although deep learning has enabled significant 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.

Outlook

2019 on pace to be record year for delivery: So far, 2019 is on pace to be a record year for venture investing in the last-mile delivery space, with over \$5.2 billion invested in the first half of the year. Excluding the impact of Uber, which we view primarily as a transportation business, deal value has seen an upward trend over the past few years as delivery services rapidly expand in an underpenetrated market full of consumers choosing to shop online and dine in.

VC investors prefer delivery: An outsized proportion of VC deployed in supply chain has gone toward last-mile delivery. We expect this trend to continue, driven by investor enthusiasm for the on-demand gig economy, as well as what may be viewed as a larger disruption opportunity. We expect venture investing in last-mile delivery to continue its upward trend over the next few years.

Later-stage VC dominates: Capital deployment in delivery is largely dominated by late-stage deals, reflecting the relatively mature age of venture-backed companies operating

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



LAST-MILE DELIVERY

in the space. Providers such as **DoorDash**, **Instacart**, **Ele.me** and Delivery Hero have achieved significant scale monetizing their product offerings.

Data will drive differentiation: Critics of ridesharing and food delivery frequently claim that consumers have little loyalty for any particular platform and will opt for the lowest priced option. We disagree with this view and believe delivery and other mobility-oriented platforms can successfully differentiate themselves by leveraging user data to create curated experiences. For example, a food delivery application could utilize delivery data trends to identify demand for specific foods in certain neighborhoods (i.e. the rise of “cloud kitchens”). Delivery platforms also allow users to store payment, address and contact information, along with order history to make the ordering process as quick and effortless as possible, improving stickiness among users. To the extent data collection improves the user experience, this can drive network effects on the platform.

Expect increased M&A activity among companies developing autonomy: We believe companies developing autonomous delivery technology such as **Nuro**, **Starsky Robotics**, **Boxbot** and **Gatik AI** could be well positioned as potential acquisition targets for potential buyers, such as Walmart and UPS, that don't have the expertise to develop such technology in-house.

Supplemental materials



Select company analysis: Early-stage VC



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. 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: \$63.6M 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



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: \$34.2M over seven deals
Most recent round; \$23.0M Series B (December 2018)
\$88.0M post-money valuation

Ownership

Menlo Ventures, Playground Global, GV, among others



Select company analysis: Early-stage VC

marble^o

Business overview

Developer of self-driving delivery robots designed to automate last-mile logistics. Unlike other providers that focus on sparser suburban areas, Marble robots traverse busy urban environments such as San Francisco where sidewalks are filled with obstacles and pedestrians. We believe this focus on challenging urban environments could give the company a competitive edge in the development of its technology. We are optimistic about autonomous technology enabling timely last-mile delivery and reducing costs across the supply chain.

Leadership

Co-founder & CEO: Matthew Delaney

Co-founder & hardware lead: Jason Calaiaro

Co-founder & software lead: Kevin Peterson

Competitors

Zume, Starship Technologies, Clearpath Robotics, Nuro, Waymo, GM Cruise, Ford (Argo AI), and others within the autonomous delivery space.

Financing history

Raised to date: \$14.0M over two deals

Most recent round: \$10M Series A (April 2018)

\$37.5M post-money valuation

Ownership

Gelt Venture Capital, Tencent Holdings, Lemnos, Maven, Promus, Tuesday Capital



Select company analysis: Late-stage VC

CONVOY

Business overview

Provider of an on-demand shipment platform connecting trucking companies with freight shippers. The company matches its large network of independent trucking companies to shippers that need to move freight, helping optimize supply chain performance. The company is generating run-rate annual revenues in the hundreds of millions of dollars, and we believe it is well positioned to see outsized growth over the next few years.

300+ employees

Leadership

Co-founder & CEO: Dan Lewis
Co-founder & CTO: Grant Goodale
CFO: Brian Kreiner

Competitors

Transfix, Uber Freight, Flexport, Haven, and others

Financing history

Raised to date: \$266.01M over four deals
Most recent round: \$185M Series C (September 2018)
\$1.08B post-money valuation
First institutional round: \$18.5M (December 2015)
Ownership
CapitalG, Greylock Partners, Y Combinator, Lone Pine Capital, T. Rowe Price, Bill Gates, Jeff Bezos, Cascade Investment

DOORDASH

Business overview

Developer of a food delivery application that provides on-demand food-ordering and delivery services from local restaurants. DoorDash allows users to schedule delivery and provides real-time order tracking. A formidable entrant to the third party delivery space, DoorDash most recently raised \$400 million in Series F financing at a \$7.1 billion valuation from investors including Softbank in February.

850+ employees

Leadership

Co-founder & CEO: Tony Xu
Co-founder & CTO: Andy Fang
CFO: Prabir Adarkar

Competitors

Postmates, Uber Eats, Grubhub, Deliveroo, Instacart, and others

Financing history

Raised-to-date: \$2.0B over nine deals
Most recent round:
\$600M Series G (May 2019)
\$12.6B post-money valuation
First institutional round: \$2.4M (September 2013)

Ownership

SoftBank Group, Sequoia Capital, Kleiner Perkins, GIC Private, DST Global, Coatue Management, Dragoneer Investment Group, Temasek Holdings



SUPPLEMENTAL MATERIALS

Select company analysis: Late-stage VC

project44

Business overview

Provider of real-time tracking and data analytics tools. The company provides shippers and carriers with improved visibility into load arrival times, with real-time updates and predictive analysis that gets product to market faster, limits product loss and reduces costs related to late delivery fines and fees. We believe a differentiator for project44 is real-time API connectivity, whereas much of the competition provides tools that provide intermittent updates not ideal for customer needs. Another key value add for the company is its end-to-end approach to visibility, which goes beyond just transit and provides visibility across workflows which include planning, documentation and invoicing. We see growth opportunities for this company to serve a relatively untapped carrier market. We see the next stage of growth in penetrating the intermodal market (drayage trucking, rail) which is in early stages of telematics adoption.

100+ employees

Leadership

Co-founder & CEO: Jett McCandless

President: Tommy Barnes

COO: Chris Helton

Competitors

FourKites, Descartes MacroPoint,

10-4 Systems, XPO Logistics

Financing history

Raised to date: \$110.5M over six deals

Most recent round; \$20M (estimated) Series C1 (June 2019)

\$280M post-money valuation

Ownership

OpenView Venture Partners, Sapphire

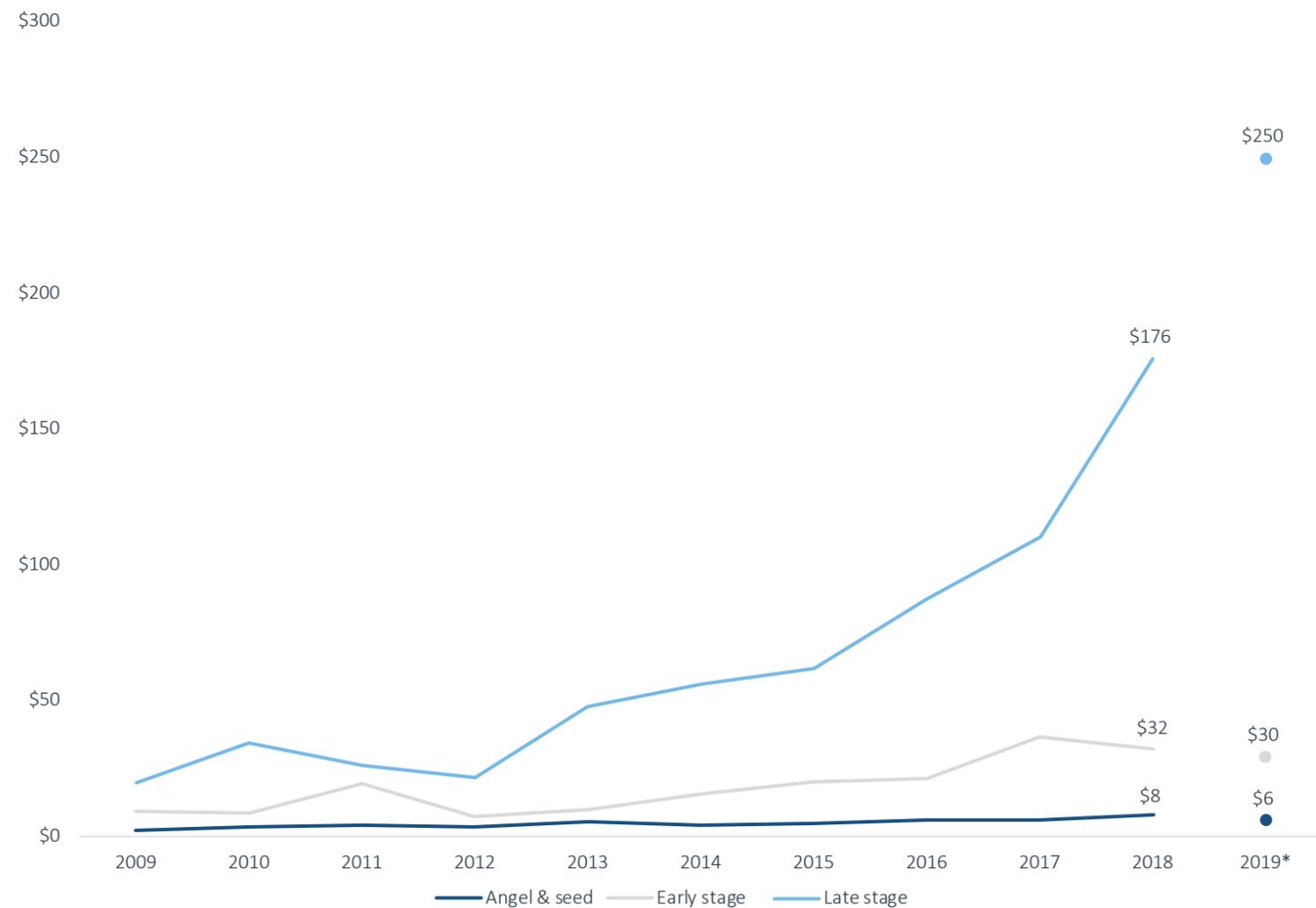
Ventures, Emergence Capital Partners



SUPPLEMENTAL MATERIALS

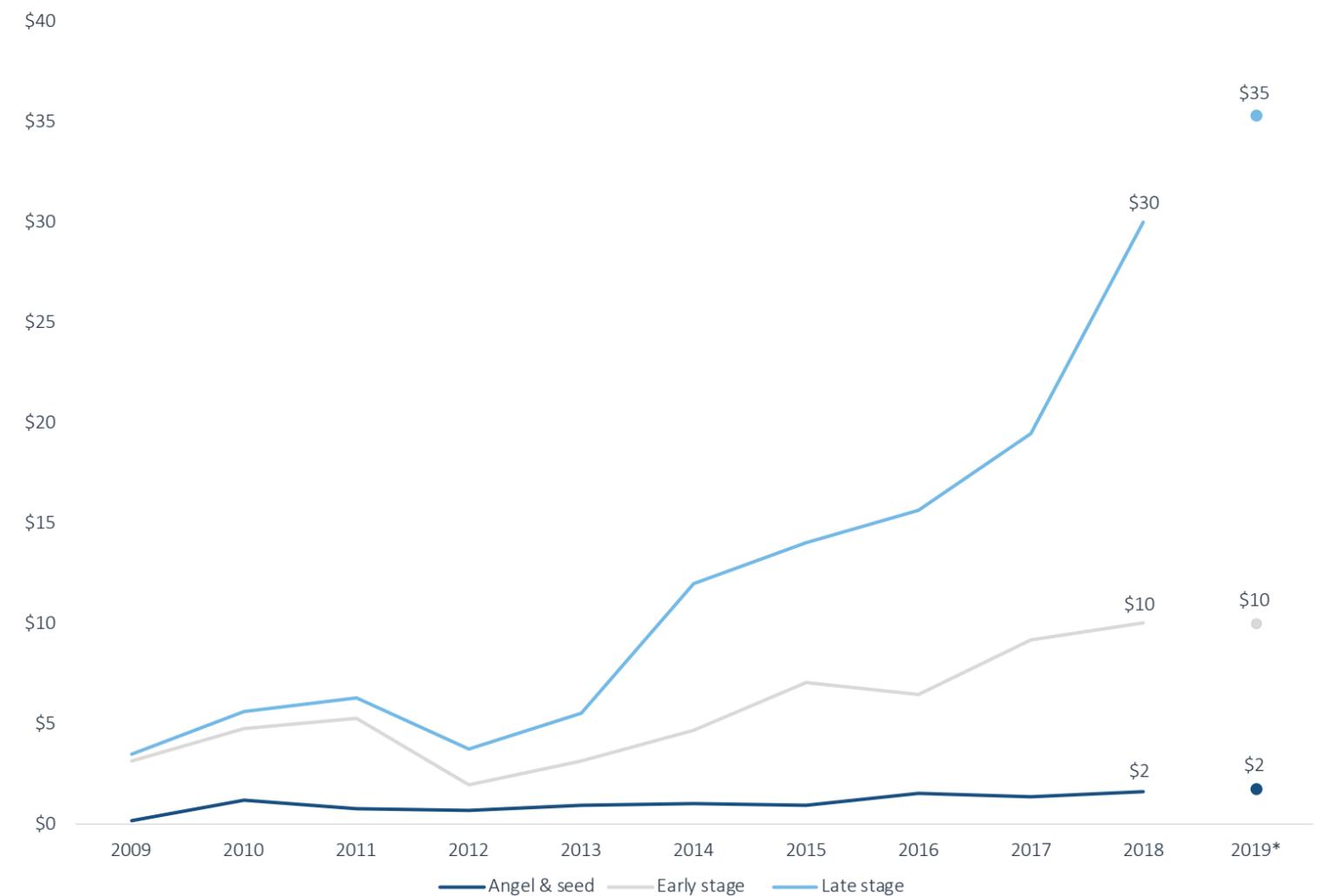
Additional VC data

Figure 25. Supply chain tech median VC pre-money valuation (\$M) by stage



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 26. Supply chain tech median deal size (\$M) by stage

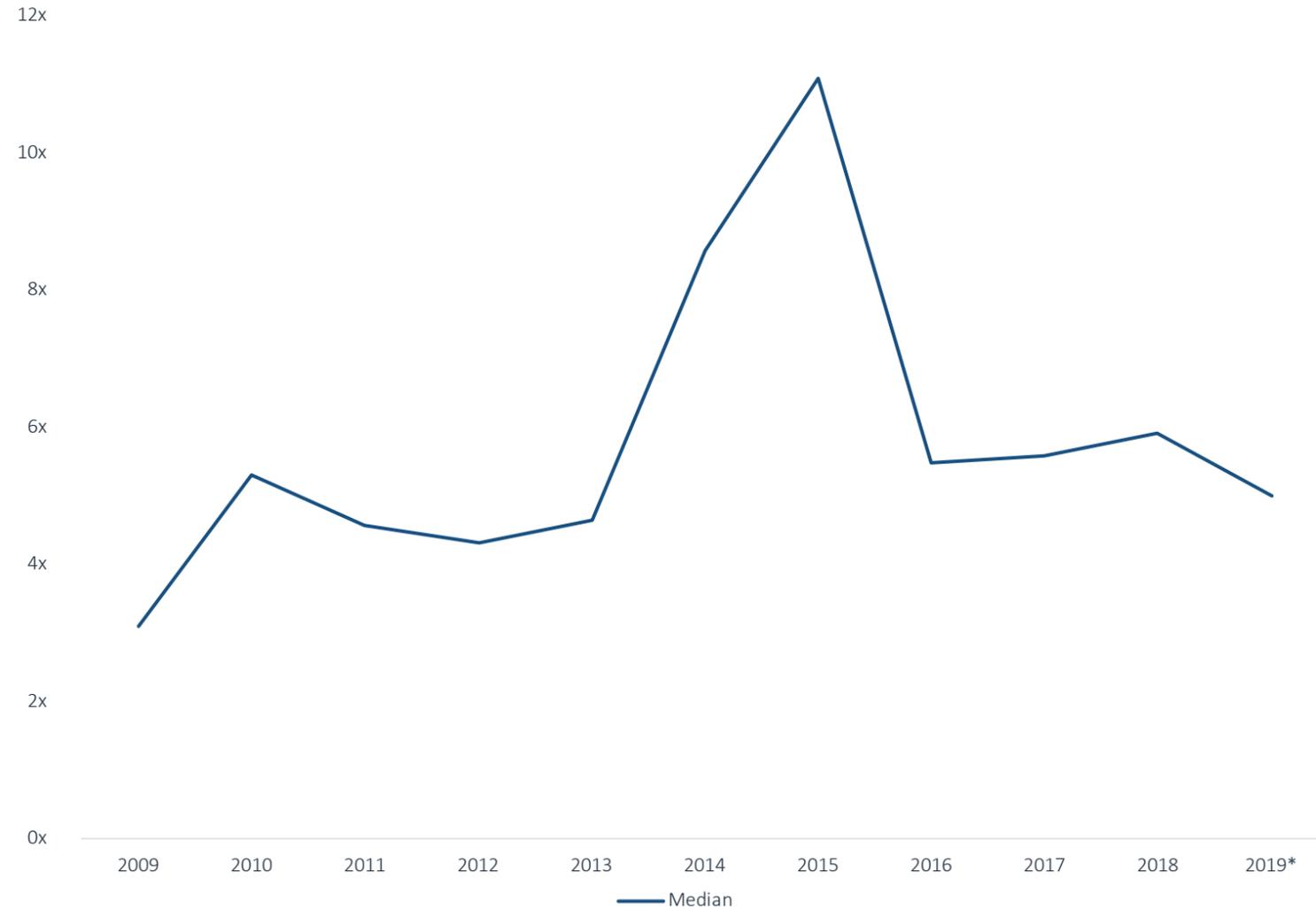


Source: PitchBook | Geography: Global | *As of June 30, 2019



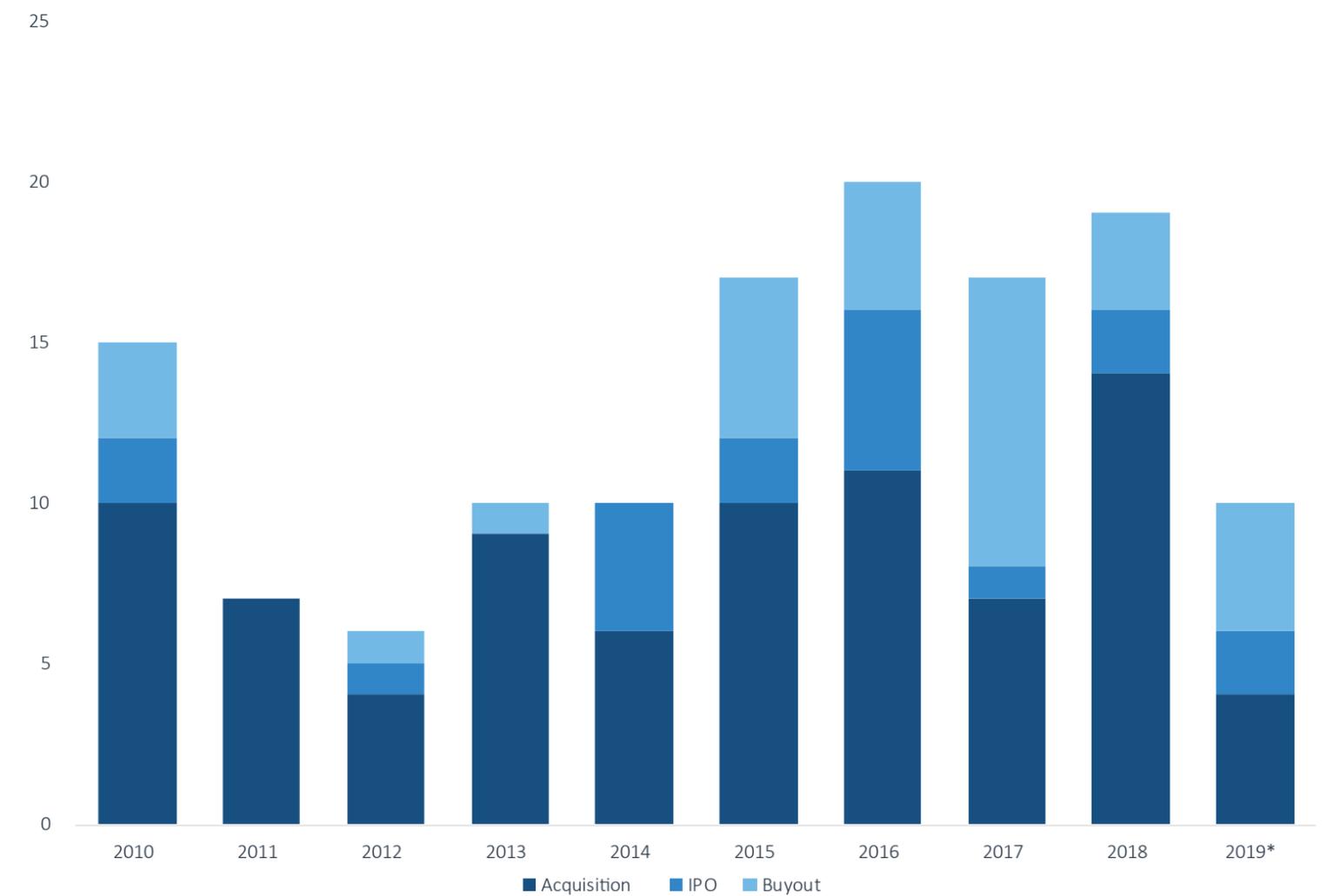
SUPPLEMENTAL MATERIALS

Figure 27.
Median supply chain tech forward EV/revenue multiple



Source: PitchBook | Geography: Global | *As of June 30, 2019
Note: Data counts are low for this chart.

Figure 28.
Supply chain tech VC exits (#) by type



Source: PitchBook | Geography: Global | *As of June 30, 2019



SUPPLEMENTAL MATERIALS

Figure 29.

Largest VC deals since 2008

COMPANY	CLOSE DATE	DEAL SIZE (\$M)	PRE-MONEY VALUATION (\$M)	POST-MONEY VALUATION (\$M)	DEAL TYPE	ROUND
Manbang Group	April 24, 2018	\$1,900	\$4,600	\$6,500	Early-stage VC	Series A
Ele.me	April 16, 2016	\$1,250	--	\$4,513	Corporate	Series F
Flexport	April 5, 2019	\$1,000	\$2,200	\$3,200	Late-stage VC	--
Ele.me	August 21, 2017	\$1,000	\$4,750	\$6,000	Corporate	Series H
Rappi	April 30, 2019	\$1,000	--	--	Late-stage VC	--
Katerra	September 20, 2018	\$999	--	--	Late-stage VC	Series D
Nuro	February 11, 2019	\$940	\$1,760	\$2,700	Early-stage VC	--
Instacart	December 13, 2018	\$871	\$7,000	\$7,871	Late-stage VC	Series F
Swiggy	December 20, 2018	\$800	\$2,500	\$3,300	Late-stage VC	Series H
Huitongda	April 20, 2018	\$720	--	--	Corporate	--
Ele.me	August 27, 2015	\$630	\$2,370	\$3,000	Late-stage VC	Series F
DoorDash	May 23, 2019	\$600	\$12,000	\$12,600	Late-stage VC	Series G
Deliveroo	May 20, 2019	\$575	\$3,425	\$4,000	Late-stage VC	Series G
Delivery Hero	February 6, 2015	\$563	\$1,314	\$1,877	Late-stage VC	--
DoorDash	March 1, 2018	\$535	\$865	\$1,400	Late-stage VC	Series D
Miss Fresh	December 25, 2017	\$500	--	--	Late-stage VC	Series D

Source: PitchBook | Geography: Global | *As of June 30, 2019



SUPPLEMENTAL MATERIALS

Figure 30.

Top investors by deal count

NAME	DEAL COUNT	NAME	DEAL COUNT
Accel	41	DST Global	22
Sequoia Capital	36	Shasta Ventures	21
Y Combinator	35	500 Startups	20
Tiger Global Management	31	Techstars	20
New Enterprise Associates	30	First Round Capital	20
Plug and Play Tech Center	28	FundersClub	20
GV	25	Khosla Ventures	20
Kleiner Perkins	24	Index Ventures (UK)	19
Lightspeed Venture Partners	23	Lerer Hippeau	18
Qualcomm Ventures	23	Point Nine Capital	18

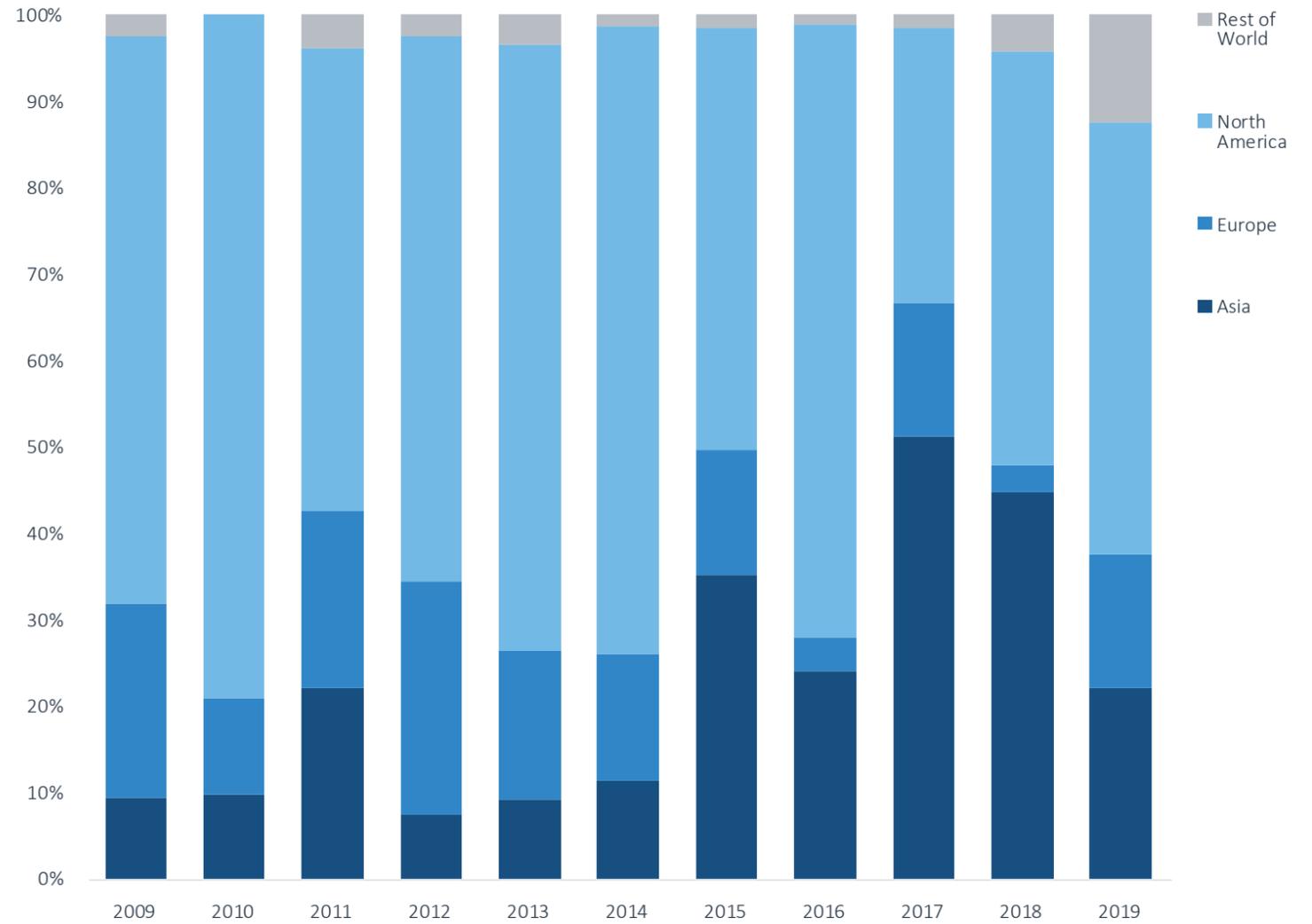
Source: PitchBook | Geography: Global | *As of June 30, 2019

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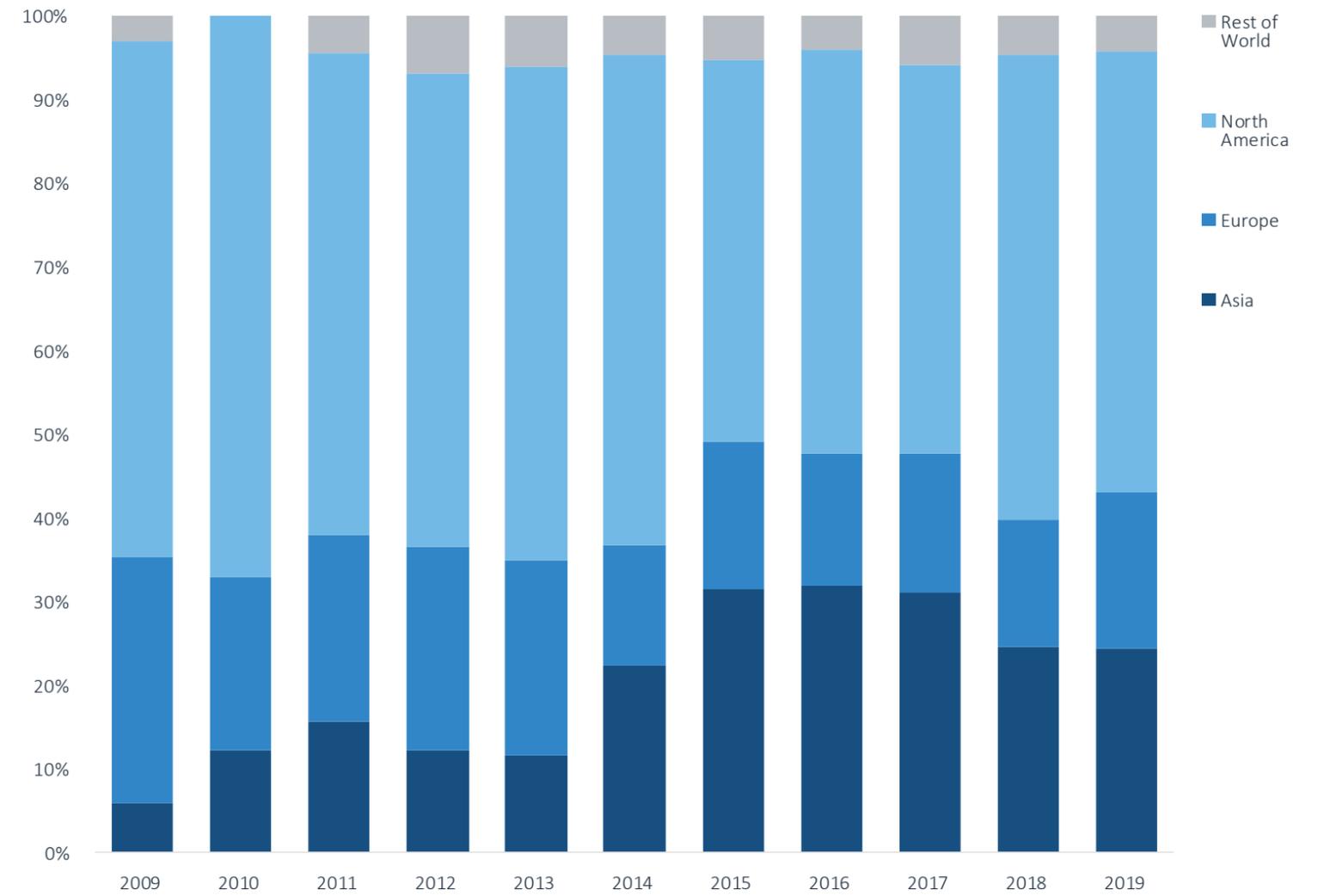
SUPPLEMENTAL MATERIALS

Figure 31.
Supply chain tech VC deals (\$M) by region



Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 32.
Supply chain tech VC deals (#) by region

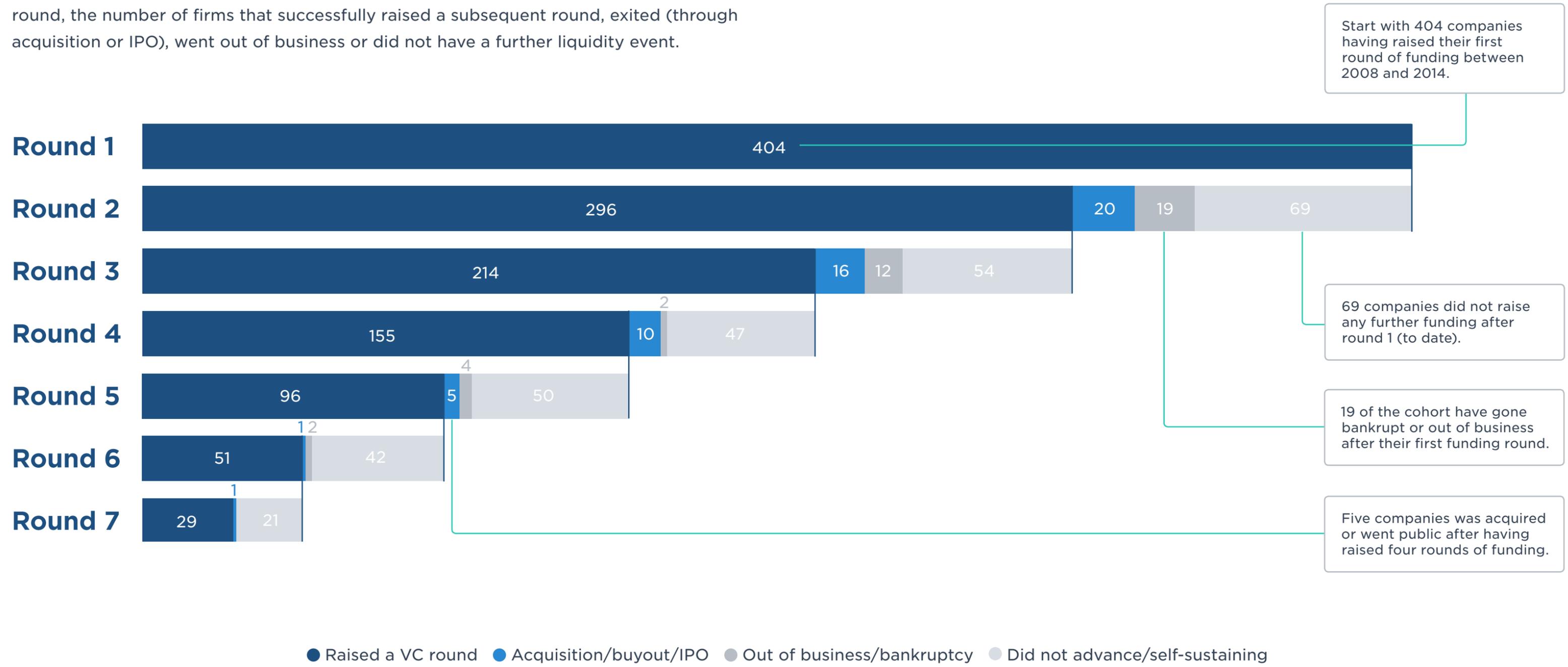


Source: PitchBook | Geography: Global | *As of June 30, 2019



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 33. **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 inhouse, they tend to partner or outright acquire key technologists in the space.

Amazon	Accenture
Walmart	Echo Global Logistics
UPS	Descartes Systems
SAP	WiseTech Global
Oracle	

Source: PitchBook | Geography: Global | *As of June 30, 2019

Figure 34. **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.

NAME	SECTOR INVESTMENTS (#)	NAME	SECTOR INVESTMENTS (#)
Golden Gate Capital	19	Parallax Capital Partners	13
Summit Partners	16	Infor Global Solutions	13
STG Partners	16	Audax Group	12
The Carlyle Group	16	Platinum Equity	11
Accel-KKR	14		

Source: PitchBook | Geography: Global | *As of June 30, 2019



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