PitchBook

EMERGING TECH RESEARCH

Mobility Tech

2Q 2019

Report preview

The report is available through the PitchBook Platform.

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Mobility market map

Recent news and insights

Event

Analyst view

July 11, 2019

Bird loses $100 million—with revenue dropping to $15 million—in 1Q and seeks new funding as cash reserves dwindle

Despite currently unfavorable unit economics, we believe micromobility could become a profitable, albeit low-margin business model if management teams can execute on manufacturing durable and cost-effective electric scooters. Newer scooter performance data is positive and suggests that Bird has made significant strides in reducing per-ride expenses such as charging, repair and insurance costs. In our view, investor focus will likely turn to scooter longevity as the company seeks a successful capital raise. We believe Bird's management team is at a critical junction as it seeks to convince skeptical investors that its scooters can operate long enough to justify their higher manufacturing cost, while investors become more selective in how they deploy capital. Whereas venture investing in micromobility exceeded $3.8 billion last year, investing through 1H 2019 totaled just $968.0 million. For a more in-depth analysis, see the shared mobility section of this report.

July 2, 2019

Ola Electric raises $250 million from SoftBank for electric vehicles

We expect fleet electrification to be a key trend driving adoption of electric vehicles over the next few years, as fleet-owning ridesharing companies such as **Ola** and Didi look to reduce their maintenance expense, carbon footprint and exposure to fuel prices. In the long term, we believe electrifying their fleets better positions these companies for autonomy as electric platforms have more compelling unit economics at high utilizations than traditional internal combustion engine powertrains. For a more in-depth analysis, see the new electric vehicles section of this report.

June 17, 2019

Self-driving startup Nuro partners with Domino's to launch driverless pizza delivery in Houston

Food delivery has seen wide adoption over the past few years. Despite this favorable trend, pizza companies such as Domino's have struggled to compete with the heavy discounts offered by third-party food delivery apps. We believe partnering with autonomous delivery providers such as **Nuro** could help level the playing field. We expect wider adoption of autonomous food delivery over the next few years as the technology matures, driven by higher cost efficiency and the secular trend toward ordering in.

Executive summary

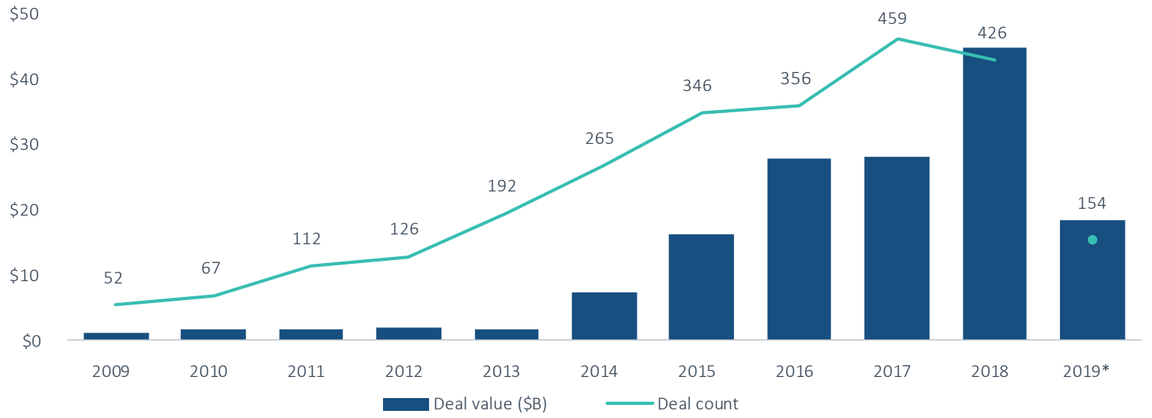
Consumer transportation is a massive global industry. In the US alone, households spent roughly $1.1 trillion annually for “on-road” transportation services, which includes the purchase, operation and maintenance of personal vehicles.[1] Despite the size and maturity of this market, however, it is rife with inefficiencies. Vehicles are often underutilized while large incumbent auto manufacturers and taxi service providers remain stagnant. This stagnation is reflected in the market capitalizations of the world’s largest auto companies which, for the past decade, have been relatively unchanged and have dramatically underperformed the broader stock market. While automakers have gone a long way in integrating automation technologies to extract more efficiencies from existing processes, these changes have not had a transformational impact on the industry. At the same time, the consistent rise in auto loans[2] underscores the increasing reliance consumers place on their cars even as the average automobile sits parked for 95% or more of its usable life.[3]

The development of the digital economy and mobile connectivity has altered this paradigm, giving rise to new technologies and business models that cater to what we see as strong underlying demand for low-cost, convenient and efficient mobility solutions. We believe this emerging industry of alternative mobility has helped bridge the divide between legacy methods of transportation and emerging methods of digital communication. This industry has given rise to several disruptive products and services including ridesharing and delivery platforms, micromobility scooter and bike services, commercial-scale fleet management tools and emerging autonomous vehicle technology. As the world becomes increasingly connected, we believe demand for mobility tech—or the intersection of transportation and technology—is higher than ever.

Venture funding has been key to fueling the growth of mobility tech. Since 2010, venture investors have invested $148.4 billion into mobility technology, with $44.7 billion invested across 426 deals in 2018. This sustained ability to finance capex-heavy private mobility startups helped fuel the rise Uber and Lyft, two companies revolutionizing and disrupting traditional methods of consumer—and increasingly commercial—transportation. We believe autonomous vehicles may represent the next phase of disruptive mobility technology, with startups including **Zoox** and **TuSimple** poised to usher in a new era. This report provides an overview of the mobility tech landscape and the products and services of the venture-backed startups in the space.

Figure 1.

Mobility tech VC deal activity



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

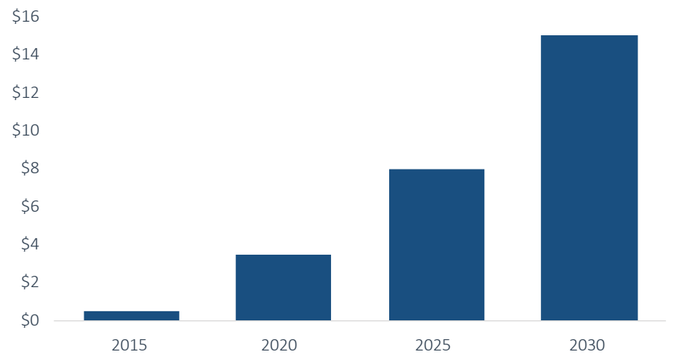
1: “TET 2018–Chapter 6–Household Spending on Transportation,” Bureau of Transportation Statistics, United States Department of Transportation, n.d.
2: “The Rise in US Auto Loan Debt Shows No Signs of Slowing Down,” Forbes, Niall McCarthy, January 3, 2019
3: “‘Cars Are Parked 95% of the Time’. Let’s Check!” Reinventing Parking, Paul Barter, February 22, 2013

SEGMENT DEEP DIVE

Autonomous vehicle software

AUTONOMOUS VEHICLE SOFTWARE

Figure 6. MARKET SIZE ($B)



Source: Roland Berger, internal PitchBook estimates | Geography: Global
This chart represents global autonomous vehicle software revenue (sales of internal autonomous vehicle software).

BUSINESS MODEL

Autonomous vehicle software companies provide software and solutions enabling vehicle autonomy. Some providers focus on specific aspects of autonomy such as localization, mapping, perception and simulation, while others focus on building full-stack autonomous solutions.

Companies in this space monetize by licensing software to automakers and automotive suppliers. In the future, full-stack providers could monetize by operating cost-effective ridesharing/delivery platforms or through direct vehicle sales.

KPIS

- Total miles driven
- Miles per safety critical event
- Simulated miles driven
- Ride quality
- Autonomous fleet size
- Total AV patents

KEY PROVIDERS

Waymo, Zoox, Cruise, Tesla, Apple, Baidu, Pony.ai, Intel, Uber, Argo AI, Aurora, TuSimple, Nuro

KEY INVESTORS

PlugAndPlay, Bosch, NEA, Trucks, Qualcomm Ventures, Intel Capital, SVAngel, Toyota AI Ventures, NVIDIA, Y Combinator, Andreessen Horowitz, Foundry Group

NOTABLE DEALS

Nuro

February 2019
$940M Series B

Led by:
SoftBank

Aurora

May 2019
$600M Series B

Led by:
Sequoia Capital

INDUSTRY DRIVERS

- Consumer and enterprise demand for more economic forms of transportation, logistics and delivery
- Large potential market opportunity ripe for monetization
- Regulation concerning accidents, congestion, pollution and other negative externalities associated with passenger vehicles
- Demand among large ridesharing platforms (Uber and Lyft) to reduce driver costs

SEGMENT DEEP DIVE

Autonomous vehicle hardware

industry valuation of the lidar market of approximately $7.9 billion. Based on our data of historical transactions, we believe a 4.0x EV/forward revenue multiple is roughly appropriate for the industry. Applying this multiple to our valuation assumption yields our estimate for global lidar sales of $1.7 billion in 2020, and we expect this market to grow to $19.7 billion by 2030, driven by increasing adoption of autonomous vehicle technology.

Lidar KPIs: We believe the key performance indicators differentiating lidar systems are range, rate and resolution (see Figure 11). Some of these KPIs have tradeoffs with one another. However, systems that have higher ranges, higher scan rates and higher resolution tend to have better performance at perceiving objects in an external environment. Though not mentioned as a KPI, a wider field of view can reduce the number of sensors required per vehicle but is not always desirable for specific applications. Most sophisticated lidar systems have software definable fields of view. Additional KPIs include unit cost, reliability, data rate, power consumption and operating temperature.

Solid-state lidar: We believe the lidar industry is shifting away from traditional spinning applications toward more emerging technologies such as solid-state. Examples of traditional spinning laser applications include those produced by Velodyne, Ouster and Waymo. These lidar units tend to be mounted on rotating gimbals and spin rapidly to create 360-degree views of driving environments. While these are well-tested units that have set the industry standard for performance, they are bulky and raise concerns about longevity as automobiles are constantly subject to fluctuations in temperature, vibration and weather conditions. The macro-mechanical movement inherent to spinning lidar generates significant wear and tear that necessitates frequent servicing, replacement and recalibration. In a future

Figure 11.

Lidar KPIs

Range	Longer range detection is favorable as it enables vehicles to see further distances. This is particularly important for high-speed uses. A range of 200 meters tends to be the standard for highway driving.
Scan rate	Low latency is a key advantage as it allows information processing and decision making to occur more quickly. Most competitive systems typically scan at 10Hz. Higher scan rates reduce latency and increase reactivity at the tradeoff of resolution.
Resolution	Higher resolution is favorable as it improves detection abilities but comes at the expense of latency.

Figure 13.

Lidar scanning approaches

	Beamsteering technology	Description	Advantages	Disadvantages	Key providers (>$20M in funding)	Cumulative VC and PE investment in key providers ($M)*	YTD investment in key providers ($M)*
Spinning lidar	**Macro-mechanical scanning**	Spins laser beams mounted on rotating gimbals	• Full 360-degree coverage means fewer per-vehicle sensor requirements • Maturity in software development makes it easy to integrate perception algorithms • High performance (long range, resolution)	• Highest priced systems on the market today • Higher ongoing maintenance, repair and replacement costs • Poor latency due to monostatic receiver design limiting scan rates • High power requirements for spinning systems	**Velodyne, Ouster,** Waymo, **RoboSense, SureStar, LeiShen,** Valeo (non-spinning), **Luminar** (non-spinning)	$625	$160
Solid-state	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Source: PitchBook, ArsTechnica, TechCrunch, LaserFocusWorld, IEEE Spectrum, AutoSens, various management teams | *As of July 15, 2019*

SEGMENT DEEP DIVE

Shared mobility

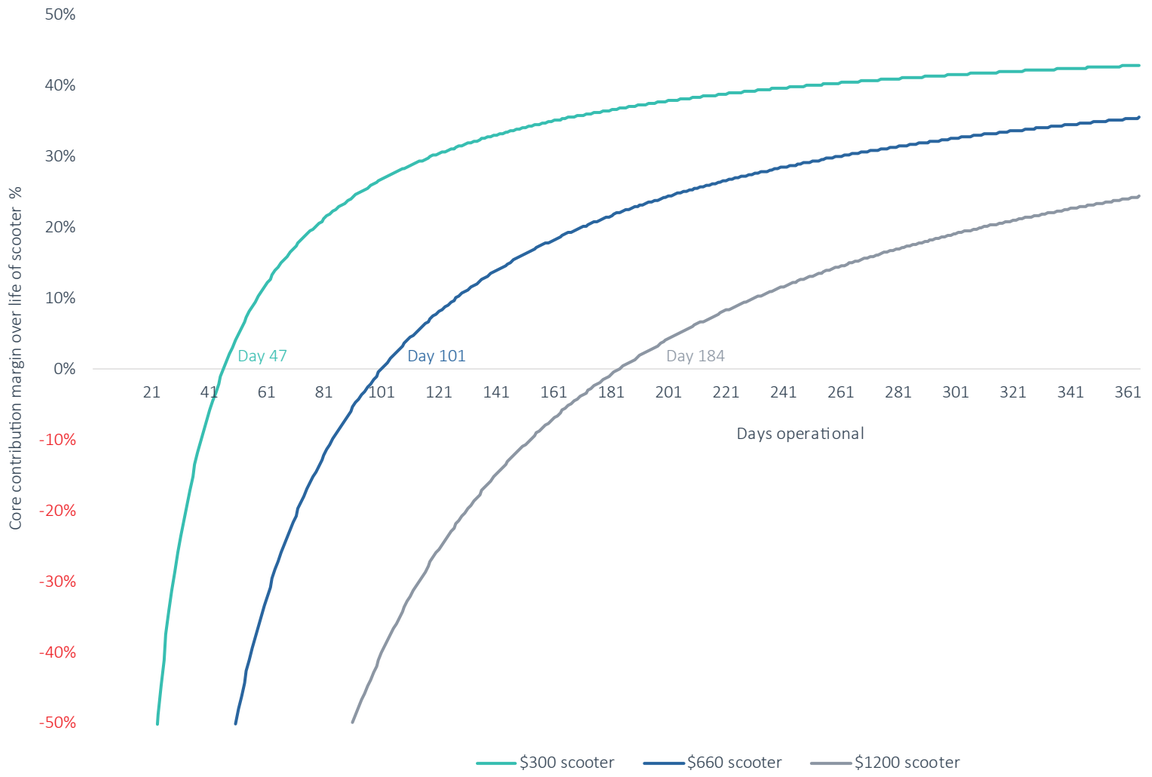
significant maintenance costs and municipal fees. However, an increase in operational lifespan to 12 months could dramatically improve margin potential, and Bird's management believes its new Bird One and Bird Two scooters could accomplish this. Figure 21 provides a scenario analysis for scooter profitability based on different lifespans and production costs. As shown, even a $1,200 scooter can drive 20% contribution margins if it can last a year. While lower-cost scooters can theoretically have higher margins, we believe it is unlikely they can last long enough for these margins to be realized. Reducing variable costs such as charging, replacement, repair, payment processing, support, insurance and additional municipal fees provides additional upside.

Pricing power unclear for micromobility: While micromobility startups have raised significant capital to expand their businesses, their ability to maintain pricing power and expand margins at scale remains a question mark. A key question for the micromobility industry is whether users will pay higher prices for added features or simply chose the lowest-cost provider; we believe this will be key to determining long-run profitability. A potential source of pricing power could be in the quality of service offering, such as delivering scooters to the homes of riders. Offering differentiated premium services such as on-demand delivery could promote brand loyalty among customers and help micromobility companies maintain some element of pricing power.

Disparate approaches to asset ownership and implications for valuations: Various shared mobility companies have taken different approaches to the problem of owning assets (i.e. the actual bikes and scooters). The largest and most established shared mobility providers—ridesharing companies—have largely taken an asset-light approach, choosing to serve as software intermediaries between passengers and asset holders. For example,

Figure 21.

E-scooter breakeven analysis



Source: PitchBook estimates

Holds rider utilization and per ride revenue, charging cost, and repair cost per ride constant. Excludes non-core costs such as research, development, general and administrative expenses

SEGMENT DEEP DIVE

Transportation logistics

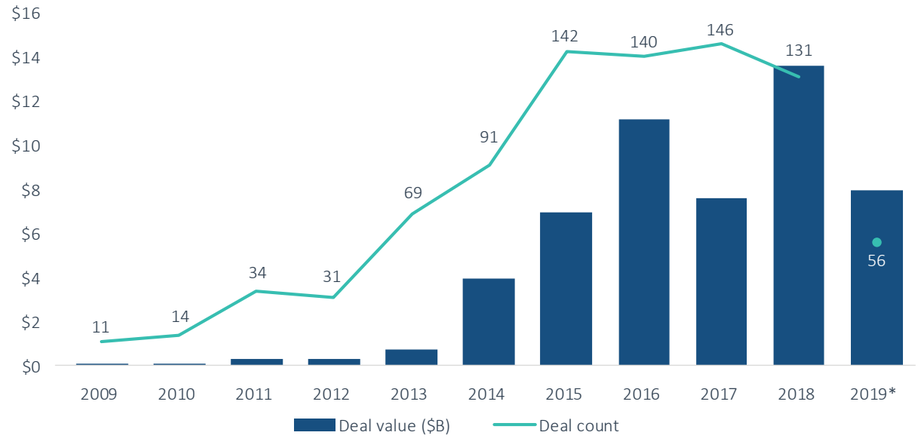
VC investment

Deal count down but value on the rise: VC deals in transportation logistics have trended upward since 2012, culminating in approximately $13.6 billion in deal value in 2018 despite a decline in deal count. This was largely driven by an increase in average deal sizes as more capital goes toward late-stage companies. 2019 is on pace to be another strong year for transportation logistics.

Dominance of late-stage deals: Most venture deals within the transportation logistics space are later-stage deals, reflecting the relatively established nature of this segment. So far in 2019, the majority of VC invested in the space has gone toward late-stage deals, such as **Flexport**'s $1.0 billion late-stage round in April.

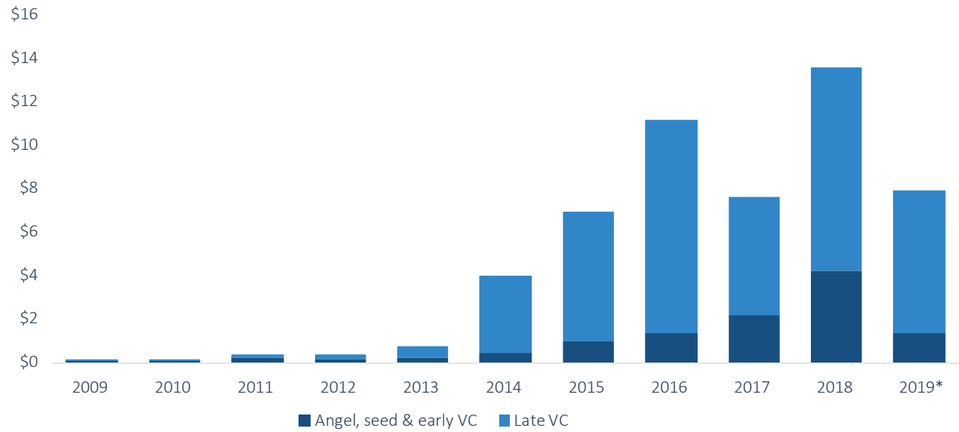
VC investors prefer delivery: A significant portion of investment in the space has gone toward startups focusing on delivery, such as Instacart and Ele.me. Other large deals in the space include startups matching cargo to trucks such as **Convoy** and **Trucker Path**. This likely reflects positive investor sentiment toward the on-demand gig economy as well as technologists' ability to disrupt incumbent processes in the world of transportation logistics.

Figure 27. TRANSPORTATION LOGISTICS VC DEAL ACTIVITY



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

Figure 28. TRANSPORTATION LOGISTICS VC DEALS ($B) BY STAGE



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

SEGMENT DEEP DIVE

Car connectivity

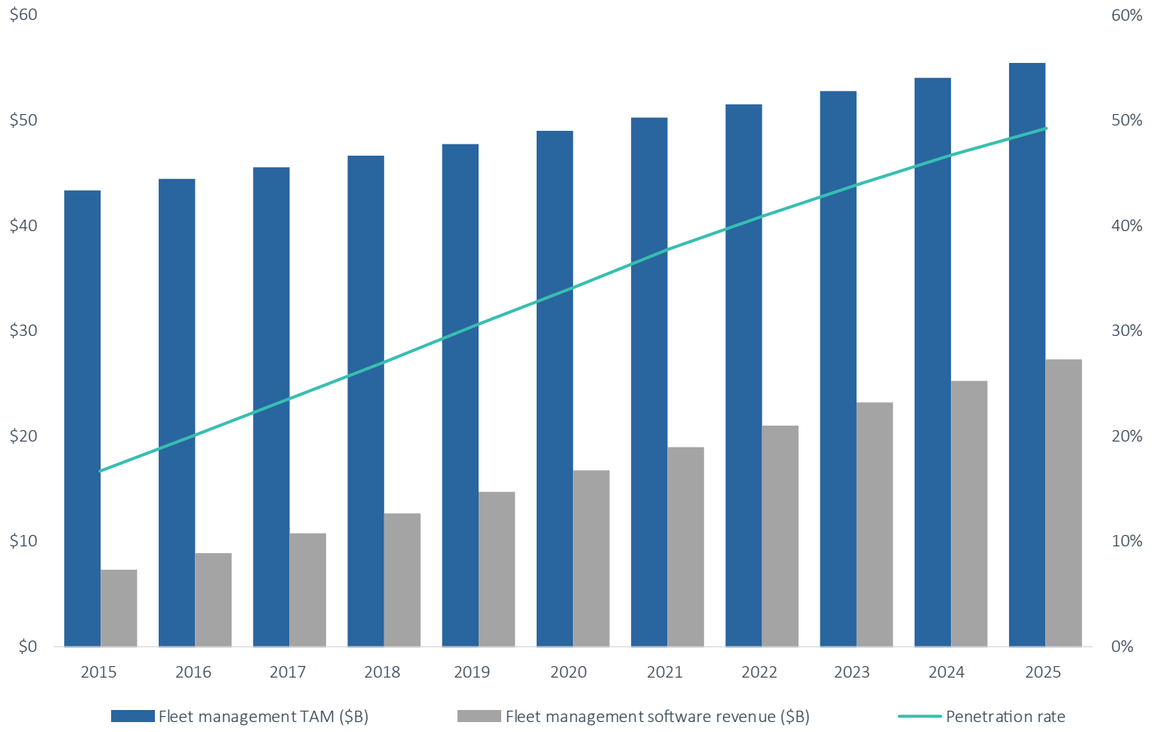
Smart cars: Today's automobiles have more computing power than ever, most of which is devoted to internal tasks such as engine management, fuel efficiency and diagnostics. We believe cars will increasingly require more computing power as they interface with the cloud to communicate with other vehicles and transportation infrastructure. Onboard-computers must also be able to synthesize information and present it to vehicle occupants in real time. Opportunities in this space include providing consistent access to cloud services, merging various information channels to create a unified experience and providing information to drivers, such as delays and safety hazards.

Monetization of data: Autonomous vehicles collect a large amount of data about their surroundings. According to a paper published by Dell EMC and Altran, the average data collection vehicle produces at least 30TB of data per year.[21] For this reason, we believe a significant growth opportunity exists in data management and the potential monetization of this data in unique ways. For example, a weather-tracking tool could benefit from having up-to-date temperature and atmospheric pressure data from thousands of data points across a city. Startups in this space include **Airbiquity**, which focuses on over-the-air software updates to vehicles, enabling cost savings for automakers and fleet operators; and mobility network platforms such as **Otomono**, which builds rich datasets from information gathered by autonomous vehicle sensors, such as mapping data, and sells it to third parties.

Automotive cybersecurity: We believe automobile connectivity poses new cybersecurity challenges. Distinct automotive systems that were once controlled manually (such as steering, acceleration and braking) can now be controlled electronically via a central hub. We see a large scope for auto-cybersecurity and note the NHTSA's definition to

Figure 30.

Global penetration of fleet management solutions among commercial vehicles



Source: FleetMatics, Berg Insights, internal PitchBook estimates

21: "Training AI for Self-Driving Vehicles: The Challenge of Scale," NVIDIA Developer Blog, Adam Grzywaczewski, October 9, 2017

SEGMENT DEEP DIVE

Electric vehicles

Outlook

Increasing adoption: Electric vehicle market penetration appears set to continue increasing over the long term, and we forecast electric vehicles will represent approximately 11% of all new car sales by 2025, up from 2% in 2018 (see Figure 35). We expect increased affordability to drive consumer adoption as providers scale, as lithium and battery pack costs decline and as regulatory subsidies persist.

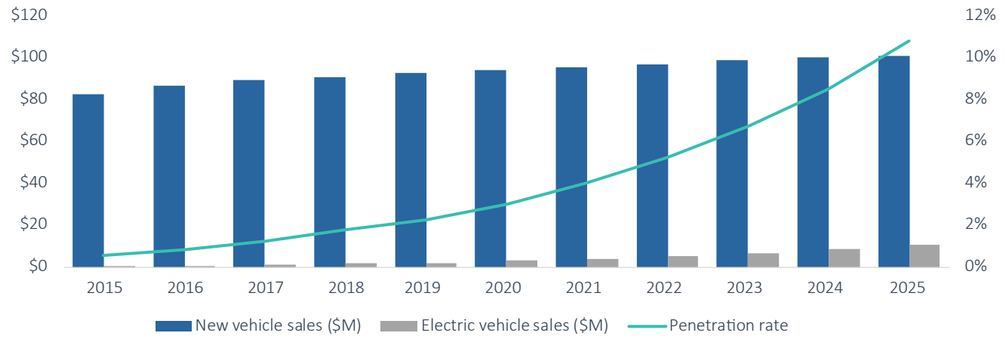
Acquisiton of electric vehicle platforms: We expect the electric vehicle industry to become more consolidated over the next few years as incumbent automakers seek to expand into the space. Attractive acquisition targets include companies such as **Rivian** and **AEV Robotics**, which provide electric vehicle platforms that could underpin several disparate use cases.

I**ncreased competition from automakers:** We anticipate barriers to entry in the electric vehicle space to increase as automakers saturate the market. In the US, leading automakers in the electric vehicle industry include Tesla, GM and Nissan (see Figure 36). We expect competitive pressure from these incumbents to increase as they make broader pushes into electric vehicle sales. Ford plans to sell 40 electric models by 2025 as part of an $11 billion investment into electrification; Toyota plans to invest $13 billion into electrification technology over the next 10 years; and VW plans to sell 50 models by 2025 as part of a $40 billion investment into batteries and electrification technology.[32]

Corporate venture funding to fuel electric vehicle startups: Developing, manufacturing and bringing electric vehicles to market is a capital-intensive process, and we believe large corporations are well suited to fund this investment. We expect corporate VC

32: "World's 10 Biggest Automakers & Their EV Plans," CleanTechnica, Zachary Shahan, October 29, 2018

Figure 35. ELECTRIC VEHICLE UNIT SALES ESTIMATE



Source: Bloomberg, internal PitchBook estimates

Figure 36. TOP US ELECTRIC VEHICLE MANUFACTURERS

Electric vehicle manufacturer	Unit sales (#) since 2010
Tesla	409,465
GM	203,994
Nissan	134,392
Ford	106,195
Toyota	100,759
BMW	70,491
Flat	26,858
Honda	25,018
VW	14,941

Source: Visual Capitalist | Data as of May 2019

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

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

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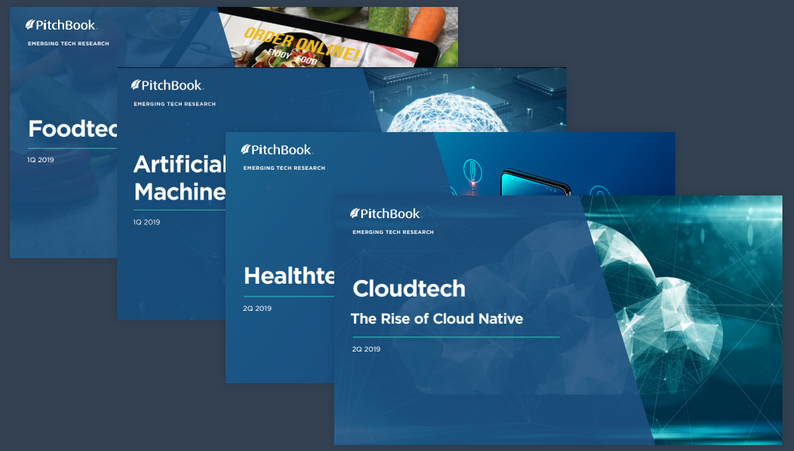

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