Micromobility in the UK: Assessing the innovation opportunity

Report prepared for Innovate UK

Final version

April 2021

:vivideconomics
putting economics to good use

Executive Summary

The aim of the study was to undertake a comprehensive assessment of market characteristics and innovation potential of the micromobility sector in the UK. The assessment focused on areas of potential market failure with relation to innovation, barriers and opportunities faced by UK firms in the sector, market capture by UK firms in international and domestic markets and support necessary to support the innovation potential of UK firms. A series of structured interviews with stakeholders across the industry supported this assessment and identified areas for wider support to catalyse growth for UK firms.

The micromobility market was defined as pedal bikes, e-bikes and e-scooters, reflecting the more prominent role of these vehicles in the market. Ancillary markets, such as the role of micromobility to support freight movements, sales of parts, accessories and repairs and maintenance is considered out of scope. The market was segmented into two segments; retail firms (any firm engaged in selling vehicles to either customers or suppliers) and service providers (firms engaged in short or long-term rental of vehicles).

A five-stage methodological approach was used to support the technical analysis. First, a literature review was used to identify core market characteristics including defining the market, supply chain factors, modal sustainability and user trends, market drivers, regulation and policy, market considerations and innovation potential. Second, market research data was used to support the market sizing estimates over the period 2019 to 2025, with a regional revenue breakdown for both retail and service provider (SP) segments. Third, the potential opportunity for UK firms was estimated by deriving a typical value chain for a firm operating in either market segment. Fourth, an offer factor index was constructed, which can be expressed as an index of UK firm's competitiveness across all segments of the value chain. Future change in the value chain and UK firm's competitiveness was also estimated. Finally, sensitivity testing through adjusting the offer index provided a final envelope of market capture for UK firms.

The micromobility market is a private sector response to a number of market drivers, including congestion, poor transport connectivity, poor reliability of other modes and a net zero policy ambition to decarbonise the transport sector. In addition, other drivers such as COVID-19 have further accelerated a shift to more active modes although it is unclear how this will evolve in the long term. A key focus of the rental market to date has been around e-scooter deployment and this is seen as a key growth area going forward.

Our findings suggest there is some evidence of innovation market failure for UK firms across both market segments. Legislative and regulatory barriers have resulted in sub-optimal innovation by UK firms, largely due to subdued consumer demand in some areas (e-scooters) and constrained demand in others (rental markets). Ultimately, this has meant investment in parts of the UK micromobility sector is typically more risky than other regions and reflects limited capital inflows to UK firms and the distinct position of UK firms as second movers in the market with a lack of market power.

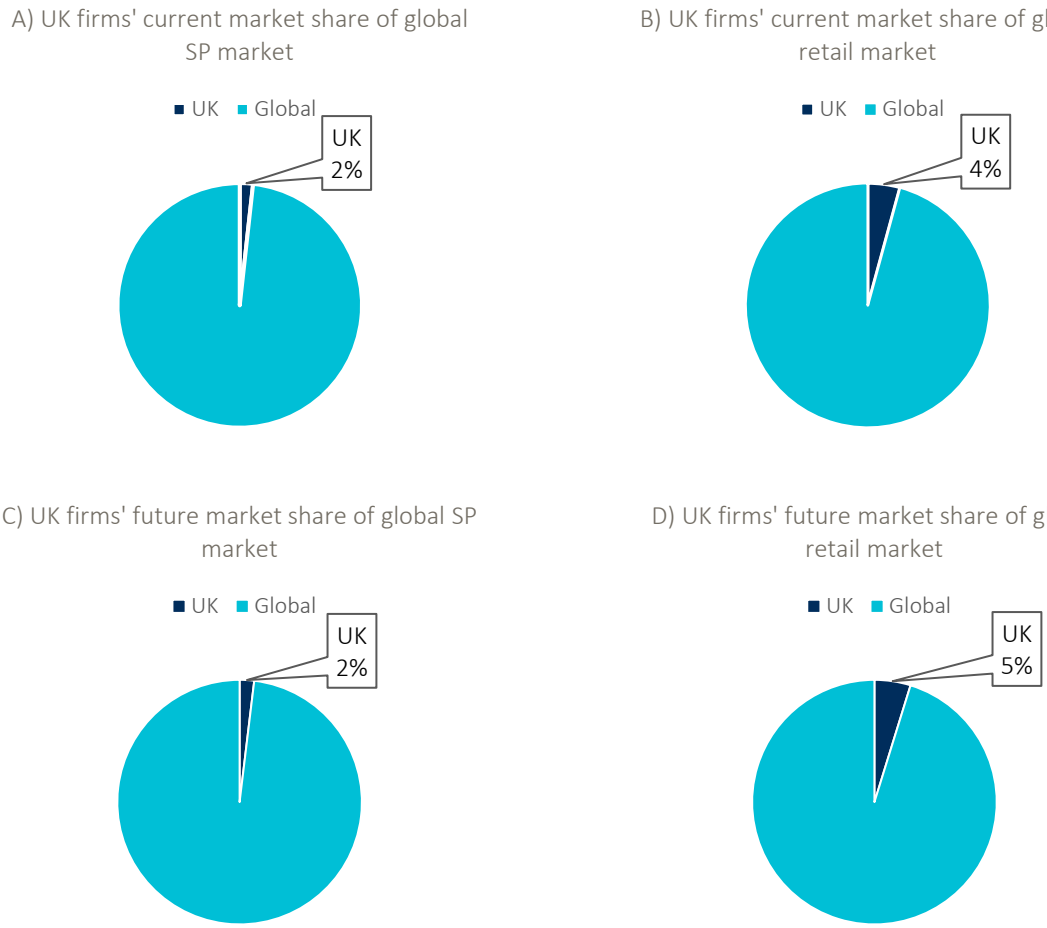
The global micromobility market is estimated to be worth $49 billion in 2020, rising to $60 billion in 2025. The global SP market is valued at $1.7 billion in 2020, rising to $3.4 billion in 2025, forecast to be growing at a CAGR of 14.5%. The retail market is much more mature (accounting for nearly 95% of the market) and is valued at $47.2 billion in 2020, rising to $56.8 billion in 2025 and forecast to be growing at a CAGR of 3.8%.

UK firms account for around 2% of the global SP market, while in the retail segment UK firms account for around 4% of the global market. We estimate UK firms account for around 17% to 27% of the UK SP market, whilst in the retail market UK firms account for between 22% to 37% of the market (in the B2C and B2B market). Based on our central case, we suggest the majority of UK firms' revenues are derived from the domestic market, with the European market the next most important contributor.

We suggest the domestic market share of UK SP firms is likely to decrease over time as better-capitalised international firms enter the market and win larger contracts. The domestic market share of UK retail firms is

likely to remain broadly flat over time, owing to the more prominent role e-commerce which may boost exports but reduce capture in the domestic market. See Figure 1 below for UK firms' global market share of the retail and SP markets.

Figure 1 UK firms' share of the global SP market (A,C) and retail market (B,D) for 2020 and 2025



Source: Vivid Economics analysis

The main barriers faced by UK firms in the domestic market relate to capital constraints, regulation, lack of political support, limited competitiveness with larger international firms and narrow provision of dedicated infrastructure to support the aggregate micromobility market. In the international market, UK firms face barriers around access to sufficient capital, divergent regulatory practices, consolidated supply chains, second mover status and logistical constraints that limit direct access to consumers in some markets.

There are opportunities for UK firms to innovate in the market, including around vehicle design, niche rental market models targeting smaller concessions and applying technology solutions in the wider value chain. Additional opportunities are possible for UK firms operating across the full value chain spectrum. This includes opportunities in ancillary sectors such as financial services, regulatory standards, consulting and advisory and novel insurance applications to name but a few. We suggest there are unlikely to be any sizeable opportunities in the manufacturing sector, where most production at scale is offshored to the Asia Pacific region which has a distinct competitive advantage arising from lower manufacturing costs (a function of lower wage bill, taxes and duties and more broadly the regulatory and business ecosystem).

While we suggest a broad range of support mechanisms could be used to catalyse growth for both start-ups and pre-existing firms, we believe such mechanisms (e.g. match funding and financial incentives) but are

unlikely to 'move the dial' to any great extent in terms of UK firms share of the market, simply due to first mover advantage that international firms exhibit. A relaxing of regulatory constraints in the domestic market for e-scooters is likely to open up the market and may promote more innovation among UK firms around vehicle design and rental models, which could be further encouraged through KTN, matchmaking and financial support (tax incentives and match funding). However, given the UK's late entry to the market, combined with the scale of activity in neighbouring competitor markets, means there is unlikely to be a sizeable shift in the extent to which greater market share could be attained by UK firms.

The six key recommendations for Innovate UK from our work are (and depicted in Figure 2) are:

1. **Innovate UK should focus on influencing policy and regulation, such that the UK develops 'best-in-class' regulation and standards for micromobility**. A key facet of this is that market information is needed ahead of regulatory decision points, so interim reports on the current micromobility trials taking place across the UK are highly relevant. Upholding higher regulatory standards that are evidence based is key and the BSI Smart City Standards are a good example of a best practice export opportunity. This may lead to further opportunities for UK firms, both around consulting on regulation and more broadly in design, reflecting higher standards for vehicle design.

2. **Innovate UK should target financial support towards specific areas of the market where innovation may be sub-optimal and the market alone may not be willing to address.** In particular, we suggest making vehicles more sustainable through reducing lifecycle emissions and improving sustainability should be a priority, through a greater emphasis on recycling and modular design. Innovate UK can use match funding as a lever to de-risk venture capital investments into this area which generates both public benefits and addresses a gap in the market for more sustainable vehicle design and operation. This has the added benefit of ensuring alignment between Innovate UK support and the UK Governments net zero policy ambition, including decarbonisation of the transport sector.

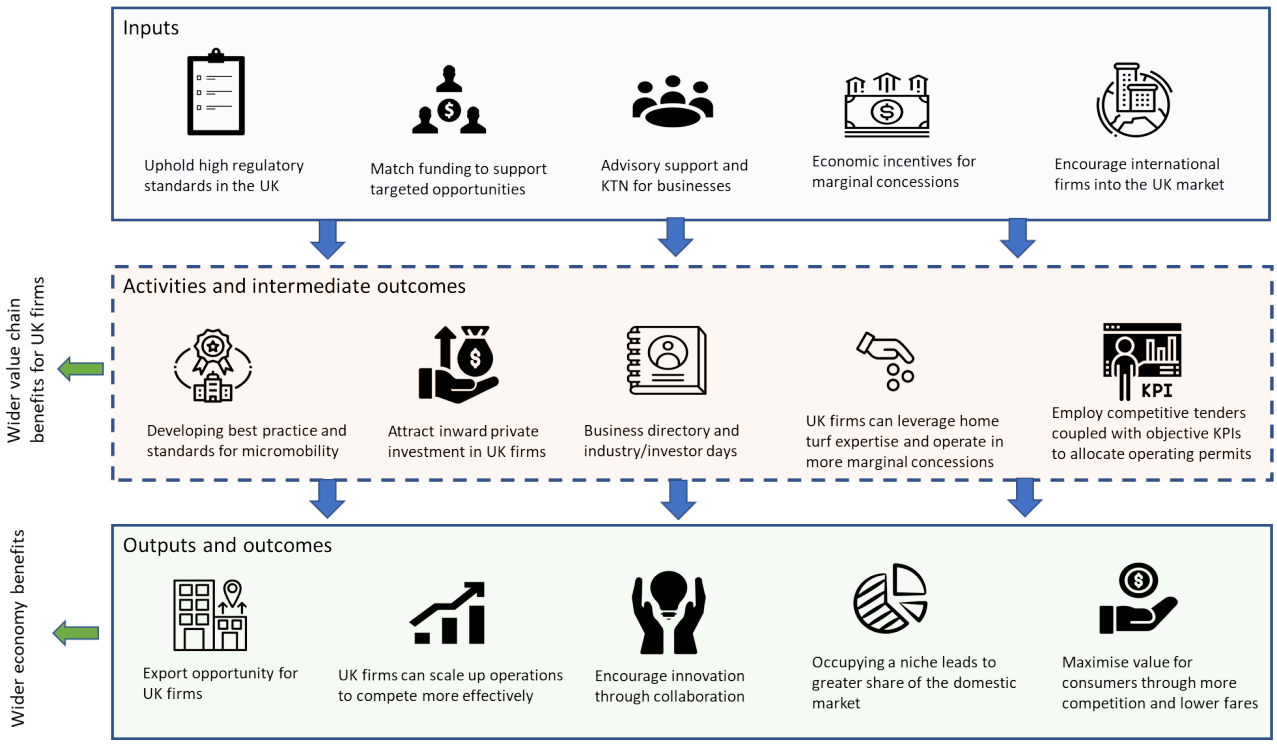
3. **Identify areas where incentives (such as lower charges to operators) can transact for demand in smaller towns and cities that may be less attractive to service providers.** Using tax incentives or lower charges to operators in smaller cities and towns would facilitate service provision in marginal areas, where the economics of operating are inherently different and potentially less attractive. This would ensure consumers can express demand for the positive externalities attributed micromobility (convenient transport, low carbon, active modes) in a variety of settings. As an added objective, this is an opportunity for Innovate UK to ensure alignment with broader levelling-up government policy to ensure poorer regions are equally represented in the market.

4. **Encourage international firms into the UK market, reflecting the wider economic benefits including employment, training and investment in the wider economy**. The UK has used FDI as a proven mechanism to promote growth in the wider economy very successfully. The opportunity area for UK plc should not be constrained to UK domiciled firms and there are many benefits to encouraging international firms into the UK market which may support sector employment and innovation. International firms may already have better, more efficient operating models and this could be advantageous for UK consumers through lower fares, more competition and better systems. Additionally, this may be the best route to international markets through partnering and knowledge sharing with international firms, recognising that we are second movers.

5. **Support wider opportunities for UK firms in the micromobility value chain through KTN, match making and industry/investor days to promote opportunities.** Some sectors in the UK economy may already have innovative responses to some barriers and opportunities already discussed here, but information asymmetries constrain market organisation and firm involvement. Raising awareness and brokering KTN may help firms enter the market with transferrable skills from other sectors. Examples of potential areas include battery production (the UK Government's commitment to a domestic Gigafactory), automotive drivetrains, data mining and software engineering.

6. **Develop a business directory for the micromobility sector linking different sectors to promote innovation in hardware design and technology.** Information failure regarding lack of awareness of other firms' activities in the market constrains the ability for firms to innovate, develop prototypes and advance technology. A business directory linking agents and suppliers would support co-creation across the sector and provide links to businesses outside trade associations.

Figure 2 Graphical abstract theory of change



Source: Vivid Economics

Acronyms

AI	Artificial Intelligence	mph	Miles per hour
API	Application programming interface	NABSA	North American Bikeshare Association
B2C	Business to consumer	NPIF	Northern Powerhouse Investment Fund
BBB	British Business Bank	RAG	Red-Amber-Green
CAGR	Compound annual growth rate	PLEV	Personal Light Electric Vehicle
DfT	Department for Transport	PM	Particulate Matter
EU	European Union	PRoW	Public Rights of Way
FDI	Foreign Direct Investment	ROW	Rest of World
FTZ	Future Transport Zone	SaaS	Software-as-a-service
GDPR	General Data Protection Regulation	SBRI	Small Business Research Initiative
GPS	Global Positioning System	SMEs	Small to Medium-sized Enterprises
GVA	Gross Value Added	SP	Service Provider
HQ	Headquarters	TfL	Transport for London
IoT	Internet of Things	UK	United Kingdom
IP	Intellectual Property	UKRI	UK Research and Innovation
KPI	Key Performance Indicator	US	United States of America
KTN	Knowledge Transfer Network	VC	Venture Capital
M&A	Mergers and Acquisition	VSO	Vehicle Service Order
MaaS	Mobility-as-a-Service		

Contents

List of tables

List of figures

1 Introduction

1.1 Project brief

Innovate UK has commissioned Vivid Economics to undertake a market assessment of the innovation opportunity for UK firms and other stakeholders in the micromobility market. The aim of the study is to undertake a comprehensive assessment of market characteristics and innovation potential of the micromobility sector in the UK. A literature review identifies key market characteristics, modal user trends, policy and regulation and barriers and opportunities within the sector. Technical analysis provides a market sizing for both the domestic and international market, with regional disaggregation. This is complemented by an approximation of the value chain opportunity and an estimated market share of UK firms in the domestic and international market. Finally, strategic investments/support to catalyse growth in the UK's micromobility sector are discussed. This is supported by a stakeholder engagement exercise that has run parallel to various tasks in the work brief and seeks to validate some inputs and assumptions used in the technical analysis, as well as identification of interventions to promote innovation and market growth for UK firms.

1.2 Scope of review

The review focuses on the innovation and market opportunity for UK firms in the micromobility sector. The market and impact sizing largely ignores the contribution of international firms, reflecting the focus of Innovate UK in supporting innovation for UK firms. Our working definition of the micromobility market exclusively considers the sale or rental of specific vehicles (e-bikes, e-scooters and pedal bikes) that support personal mobility. The report focuses on personal mobility and largely ignores the role of micromobility for moving freight and deliveries since this is both considered out of scope in the ToR and the market characteristics are largely distinct (e.g. adapted infrastructure requirements[1], market drivers and modal trends). While the broader report focuses on both the 'market' and 'innovation' opportunity, the market and impact sizing is constrained to the current and future market opportunity. Interventions to support growth are discussed not just in the context of innovation support, but also the wider market opportunity for UK firms since both factors can be considered symbiotic.

1.3 Report structure

The report is structured as follows. Section two provides an overview of the market characteristics, including supply chains, market drivers, growth barriers and opportunities, modal and user trends, regulation and policy and a gap analysis for market innovation where UK firms could play a role. Section three provides an overview of the stakeholder engagement exercise, including overall approach and key findings. Section four provides a technical analysis for market sizing, value chain elicitation and estimation of UK plc share in domestic and international markets. Interventions to improve the innovation and competitiveness of UK firms are also discussed. Section five provides conclusions and recommendations.

[1] For example e-cargo bike hubs to store goods and deliveries, or to transfer cargo from motor vehicles to e-cycles (these may be either static or dynamic). Other examples include wider cycle lanes with a broader turning angles and parking areas for unloading in urban centres.

2 Market Characteristics

Box 1 Market characteristics key takeaways

- On average, a typical trip via an e-scooter is likely to be slower, shorter distance and more expensive (both per unit and in absolute terms) for consumers than using e-bike rentals. Equally, the asset life of a typical rental e-scooter can be as short as six months which brings into question the sustainability credentials of using these devices.
- For e-bikes to be sustainable and lower emissions from transport, at least 34% of modal shift must come from car journeys. Lowering life-cycle emissions from e-scooters requires dramatically increased asset life, but there are signs of improvement.
- UK firms in the service provider market are considerably smaller and less well capitalised than counterparts in the US, EU and Asia Pacific markets. Retail firms are typically larger and more competitive across most markets.
- Hypothetically, micromobility could replace all trips under 8km, with greatest modal shift away from private passenger car journeys and walking.
- Legislation that constitutes e-scooters as Powered Light Electric Vehicles (PLEVs) has stalled growth in the UK e-scooter market, particularly in the service provider space. During this time, large overseas firms have emerged in more favourable markets.
- The key market gaps centre around adequate provision of designated infrastructure (important to improve ridership and user safety), better design of devices (to improve user experience), user compliance with regulation (important for user safety and credibility of operators) and asset life of fleets (to improve sustainability and emissions).

2.1 Defining a UK firm

The distinction between a UK firm and a firm that employs UK workers has important connotations for where innovation support may be better targeted. A firm's taxable income for corporate taxation purposes can be expressed through various metrics including:[2]

- The residence country in which the ultimate owners of the company are resident;
- The location of a company's head office or principal place of business; and,
- The source country, in which the company's assets are located and its production takes place.

Avoiding a long-winded discussion on the complexities of identifying domicile region of firms for taxation purposes, our assumption is that the location of a company's head office or principal place of business can be used to classify domicile.

A UK firm is likely to invest more in the domestic economy than international firms by citing its core operations and employment within the domicile. This could be HQ operations, or other ancillary functions like finance and professional services. At the same time, capital inflows will be directed to the UK, whether this be from taxation or investment in assets. Additional non-financial investments may include training for workers,

[2] The Mirrless Review (2011)

corporate social responsibility, etc. Capital outflows may include foreign investments in international markets and issue of dividends (depending on where the majority investors reside) although these outflows would likely be lower for a UK company. The focus of this analysis is largely on UK firms.

But the presence of international firms is still advantageous since they offer employment and investment opportunities and may have a competitive advantage that results in cost savings for consumers. International firms will have many capital inflows (such as economic rents, value added taxes, and non-financial investments such as training for workers). Capital outflows relate largely to the residency of institutional and retail investors and more broadly the nature of foreign direct investment (FDI).

2.2 Defining the micromobility market

Multiple criteria can be applied to define micromobility and definitions vary across the world. Typical criteria include weight (less than 500 kg), passenger or payload capacity, powertrain (human-powered or electric), maximum speeds (<30km/h) or ranges, or a combination of two or three criteria.

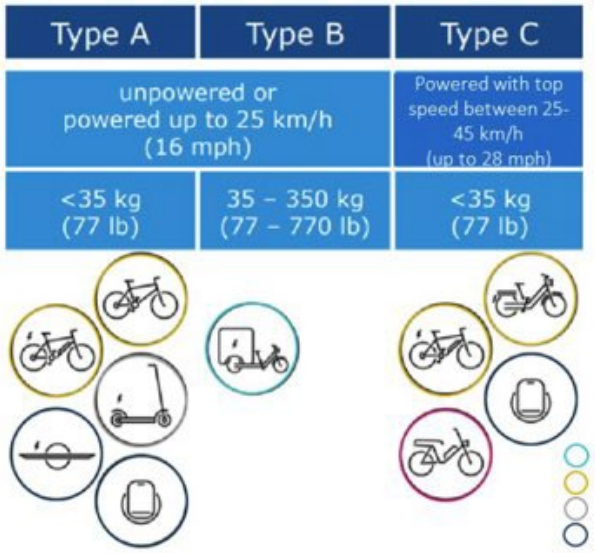
Innovate UK define micromobility as any device weighting less than 100 kg. As a widely accepted definition, the International Transport Federation defines micromobility, as "*…personal transportation using devices and vehicles weighing up to 350 kg and whose power supply, if any, is gradually reduced and cut off at a given speed limit which is no higher than 45 km/h. Micromobility includes the use of human-powered vehicles, such as bicycles, skates, skateboards and kick-scooters.*"[3]

Figure 3 classifies different types of micromobility. The most widely accepted definitions of micromobility typically focus on Type A vehicles (of which the mass market are e-scooters, push bikes and e-bikes). In particularly, e-scooters and e-bikes have seen surging demand from growing sales volumes and new methods of ridership, featuring large service providers (SP) that offer short-term and low-cost rental of devices, usually in urban environments.

Within the scope of this assessment, we define micromobility as a subset of Type A vehicles that includes pedal bikes, e-bikes and e-scooters. This definition reflects the more prominent role of these devices in the market and arguably the focus of innovation opportunity in the sector. Ancillary markets, such as sales of parts, accessories and repairs and maintenance, is considered out of scope and not captured here but may account for a further 25% to 50% of sector revenues.[4] We limit our focus to the personal mobility market, largely ignoring the role of micromobility in the freight market since this falls out of scope of the project ToR and the market characteristics are so different (e.g. different infrastructure requirements, market drivers and modal trends). However, we do acknowledge the potential opportunity for e-cargo bikes to occupy some share of the logistics market through last mile deliveries[5].

[3] International Transport Federation (2020)
[4] CONEBI (2016)
[5] Cairns and Sloman (2019)

Figure 3 Classifications of different types of micromobility



Source: International Transport Federation (2020)

2.3 Vehicle characteristics

Key travel metrics relating to e-bikes, e-scooters and bikes are reported in Table 1, including average trip length; trip duration; travel speed and cost per trip. The data is predominantly sourced from pilot micromobility trials across the US, where trial data is publicly available. Where multiple sources are available, we calculate the mean value, and the range (shown in brackets). The table is split under three headings: Data relating to the SP space, data relating to the retail market, and data which is relevant to both segments. Estimates can vary considerably by scheme and region.

This information shows:

- On average, e-scooters trip lengths and duration are shorter than for e-bikes and pedal bikes, which is generally confirmed in the literature. A higher trip distance on pedal bikes reflects that this survey data includes owner operated bikes.
- Average travel speeds are typically comparable for e-bikes and pedal bikes and lower for e-scooters.
- E-scooter journeys are typically more expensive, despite shorter trip distances and riding duration.
- Typically, manufacturing costs of e-scooters are also estimated to be lower per unit than for e-bikes, suggesting either higher margins for these devices or that trip costs reflect shorter asset life of e-scooters compared to e-bikes. Most manufacturing takes place in China and Taiwan[6], owing to lower unit costs of production as a function of lower wages, taxes and duties and more broadly the business ecosystem.
- In turn, the more frequent maintenance requirements of e-scooters also increases their life-cycle emissions (cradle to grave) relative to e-bikes, though estimates for life-cycle emissions can vary considerably by region. Swappable battery scooters have enabled a 51% reduction in emissions for Voi[7].
- Typically, e-scooters average a higher utilisation rate (trips per device per day) compared to e-bikes.

[6] https://www.brujulabike.com/where-main-brands-bicycles-manufacture/
[7] EY (2020)

Table 1 Device characteristics of different forms of micromobility

Factor	e-scooter	e-bike	Pedal bike
Device Hire			
Average trip length (miles)[1]	1.3 (1.1-1.6)	1.66 (1.6-1.7)	2.9 (2.5-3.3)
Average trip duration (mins)[2]	12.67 (12-14)	17.32	22 (13-31)
Average travel speed (mph)[3]	5.8 (4.2-8)	6.7 (5.9-7.4)	6.5
Average cost per mile (£)	£2.08	£1.54	£0.71
Average cost per minute (£)	£0.21	£0.14	£0.09
Average cost per trip (£)[4]	£2.71 (£1.95-£3.45)	£2.55 (£1.86-£3.23)	£2.06
Retail			
Average unit price (range)[5]	£350 (£200 - £500)	£750 (£500-£1,000)	
General			
Life-cycle emissions range [6,7,8] (g CO_2 per person km)	60.5 (35-126)	37.5 (25-50)	5
Number of trips per device per day[9]	3.2	2.6	

Sources:
[1] Various data from pilots in Austin, Santa Monica, Baltimore; NACTO; Cycling UK
[2] Various data from pilots in Austin, Santa Monica, Baltimore; NACTO; TfL (2016)
[3] Calculated using various data from pilots in Austin, Santa Monica, Baltimore and NACTO.
[4] McKinsey (2020); Santa Monica Pilot; NACTO.
[5] London Assembly: Micromobility and Active Travel in the UK (2020)
[6] Hollingsworth et al (2019)
[7] EY (2020)
[8] Clancy (2015)
[9] NABSA 2020 State of the Industry Report

2.4 Market characteristics

2.4.1 Supply chain characteristics

The micromobility market can be segmented into two core areas (retail and SPs) that help to understand the supply chain dynamics (see Figure 4) associated with both models.

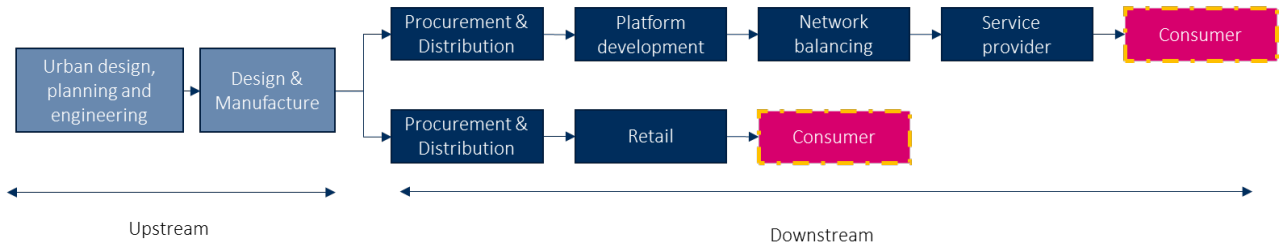
- **Retailers**: Broad definition encompassing vehicle sales, through either direct B2C or B2B channels; and,
- **SP**: Pay-as-you-go rentals and long-term leases.

In the upstream supply chain urban design, city planning and infrastructure are needed to ensure environments are suitable for micromobility application. Greater uptake of micromobility will require significant urban planning to meet the needs of a changing composition of road-users, implementing novel ideas such as low-speed zones and third lanes to protect and encourage micromobility users. Supporting infrastructure such as docking stations, geo-fenced parking zones and charging points around cities carves out a new opportunity for urban developers and private firms alike.

Design and manufacturing are needed to produce vehicles that meet consumer needs and regulatory requirements. Typically, a micromobility device is designed, the core body is manufactured and during assembly, the electric motor is attached, along with other on-board electronics.[8,9] Production of electrified micromobility therefore integrates both low-value and high-value manufacturing processes, offering more value-add production stages than traditional pedal-bike manufacturing.

Downstream, differences between the retail and SP segments are more pronounced. For retail, supply chains are much shorter and simply involve procurement and distribution of devices, retail at specific outlets/online and finally end consumers. The SP model is characterised by more value-add stages within the supply chain, including procurement and distribution, platform development and maintenance, network balancing, SP interaction and finally the end consumer.

Figure 4 Supply chain characteristics of micromobility market



Source: Vivid Economics analysis

Both market segments offer a different product to the end consumer. Retail channels sell device ownership and typically appeal to users with higher frequency ridership. SPs sell a convenience-based product through either docked, intermediate bays or 'dockless' systems and typically appeals to users undertaking first/last mile journeys that provide a link to transport interchanges – a niche not well served by any other modes. Trip type trends for SPs have been shown to evolve over time, moving from recreation focused trips initially to day to day use over time.[10] This has helped even-out daily fluctuations in demand and stabilise utilisation rates, although weather is still a major limitation with rain, snow, and cold tempering ridership and inducing strong seasonality in demand.[11]

2.4.2 Retailers in the UK

Operators in the retail industry sell new devices, parts, accessories and clothing, and offer repair and maintenance services. The bike retail sector in the UK is estimated to be comprised of over 2,500 businesses (many of which are small independent businesses). Independent firms have generally been declining over time owing to the more prominent role of e-commerce and consolidation in the sector that tends to favour firms that are most price competitive[12]. While we believe this trend is likely to continue in the long run, there may be more niche market opportunities for smaller firms that differentiate on quality, with leaders such as Brompton being an obvious example. Recently many firms, most notably Halfords, have reported increased

[8] IRJET (2020)
[9] Voro
[10] Deloitte (2020). Transportation trends 2020. What are the most transformational trends in mobility today?
[11] Deloitte (2020). Making micromobility work for citizens, cities, and service providers.
[12] IBIS World (2020). https://www.ibisworld.com/united-kingdom/market-research-reports/bicycle-retailing-industry/

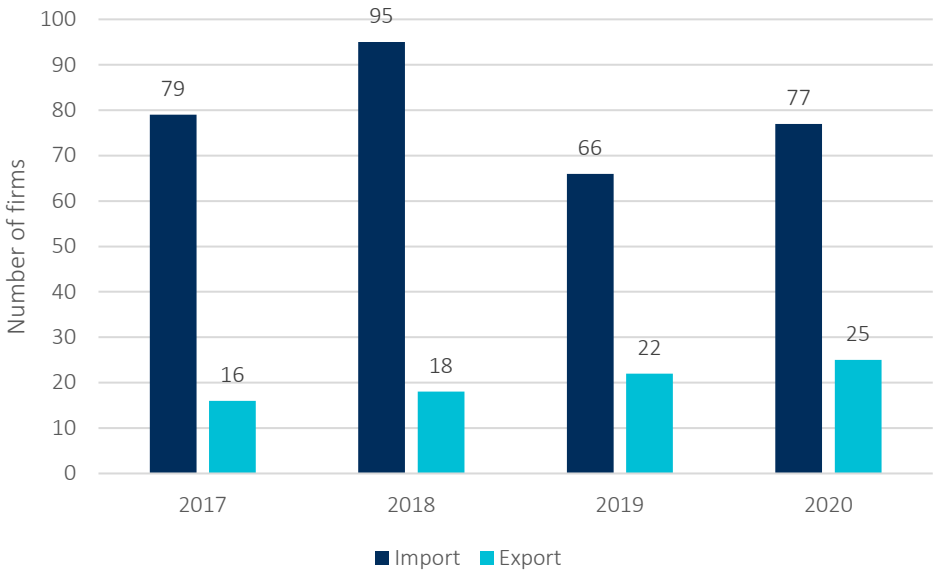
demand for bikes, e-bikes and e-scooters as people seek to avoid public transport due to COVID-19[13] and we suggest this trend is likely to continue, particularly for e-scooters when legislation around vehicle use changes.

In the UK there are some 77 firms actively importing e-bikes into the UK while only 25 were actively exporting in 2020 (Figure 5). The number of importers has been consistent over time and suggests the retail market is both fairly dispersed (since retailers range from SMEs to large caps) and that UK firms are more active in procurement and retail than manufacture and export. UK imports of e-bikes have been increasing over recent years and this is predominantly from devices manufactured in China where per unit costs of production are generally lower.[14] The same picture is likely to be observed for e-scooters, although no accurate commodity code currently exists to verify this.

UK firms that are leaders in the retail space include:

- **Halfords**: They are a UK market leader and sell high volumes, through both Evans Cycles and Halfords stores.
- **Pure Electric**: Pure specifically focus on sales of e-bikes and e-scooters and are a particular leader for e-scooter sales.
- **Brompton**: Manufacturing and retailing high-end foldable bikes, Brompton have promoted themselves as a high-end and iconic British brand.

Figure 5 Record of firms importing/exporting e-bikes in the UK[15]



Note: Since the commodity code for e-bikes was only recently introduced, there is no publicly available data on volumes.
Source: UK Trade Info (2020)

2.4.3 Service providers in the market

UK firms in the SP market are considerably smaller and less well capitalised than counterparts in the US, EU and Asia markets. International firms in the SP market account for the majority of inward investment flows and revenue generation in the market, while UK firms are very much marginal players (see Table 2)

[13] https://www.theguardian.com/business/2020/sep/08/electric-bike-and-scooter-sales-boom-pushes-halford-back-to-growth-covid-19
[14] WITS database (2020).
[15] Note, these estimates will include firms that re-export devices and does not include e-scooters. Based on commodity code 87116010.

Larger, international firms also typically have a more diversified operating coverage, while UK firms are largely only operational in the UK. The largest firms currently operating in the market are Lime, Bird, Voi and Spin. A more extensive list of firms operating in the SP market and wider value chain is supplied in Appendix A3.

Many international firms are already participating or are submitting tenders to participate in UK trials being held across various cities for e-bikes and e-scooters (see Box 2). The UK firms operating in this space are considerably smaller than their international rivals, the most established of the former are Ginger and Beryl with operations in several UK cities.[16] We are not aware of any examples where a UK firm is a leader in the SP space.

[16] See comouk for details on service providers.

Table 2 Service providers company due diligence and their presence in different regional markets.

Company	Country of Origin	North America	Asia-Pacific	U.K.	Europe	Rest of the World	Estimated Total Investment/funding (US$million)	Estimated Company valuation (US$million)	Estimated Annual Revenue (US$million)	Additional Information
Lime	US	↑	→	↑	↑	→	$ 935.0	$2,400.0	$ 290.0	VC funding from US
Bird Rides, Inc.	US	↑	→	→	→	→	$ 773.0	$2,800.0	$ 120.0	VC funding from US
Skip Scooter	US	→	↓	↓	↓	↓	$ 131.0	$ 100.0		
Mobike**	China	→	↑	↑	↑	→	$ 928.0	N/A	$ 223.0	VC funding from China
Spin	US	↑	→	→	→	→	$ 8.0	$ 100.0	$ 45.0	VC funding from US
Jump (Uber)	US	↑	↓	↓	↑	→	$ 11.6	$ 200.0	$ 15.0	Spin-off from uber bought by Lime
Yulu Bikes Pvt Ltd	India	↓	→	↓	↓	↓	$ 20.0	$ 77.0	$ 1.2	Investment from Indian VC
TIER Mobility	EU	↓	↓	↑	↑	↓	$ 381.0	$1,000.0	$ 14.3	VC funding from US
Ofo	China	↓	↑	↓	→	→	$ 2870.0**	180**		VC funding from China
Neuron Mobility	Singapore	↓	→	↑	↓	↓	$ 35.0	$ 55.0	$ 12.0	VC funding
Beam Mobility Holdings Pte. Ltd.	Singapore	↓	→	↓	↓	↓	$ 32.4	$ 120.0	$ 1.0	

Company	Country of Origin	North America	Asia-Pacific	U.K.	Europe	Rest of the World	Estimated Total Investment/funding (US$million)	Estimated Company valuation (US$million)	Estimated Annual Revenue (US$million)	Additional Information
VOI	EU	↓	↓	↑	↑	↓	$ 330.0	$ 500.0	$ 14.5	
Hello-bike	China	↓	→	↓	↓	↓	$1,800.0	$2,000.0	$ 1.0	VC funding from China
Beryl	UK	↓	↓	↑	↓	↓	$ 18.0	$ 30.0	$ 18.0	Small UK venture capital & BBB. Supplies lights to bike hire schemes in London and USY
Ginger	UK	↓	↓	↑	↓	↓	$ 0.5	$ 20.0	-	Debt financing from NPIF
Zwings	UK	↓	↓	↑	↓	↓		$ 10.0	-	Has no UK operations but has EU operations

Note: * Multiple operations including micromobility rental, ** Company filed for bankruptcy in 2020.
Note: See Appendix A4, Validation Exercise 3 (Figure 22) for a regional breakdown.
Source: Vivid Economics, BIS Research

Legend	
↑	Strong Presence
→	Weak Presence

Legend	
	Little or no Presence

2.4.4 Market growth

(1) UK Market

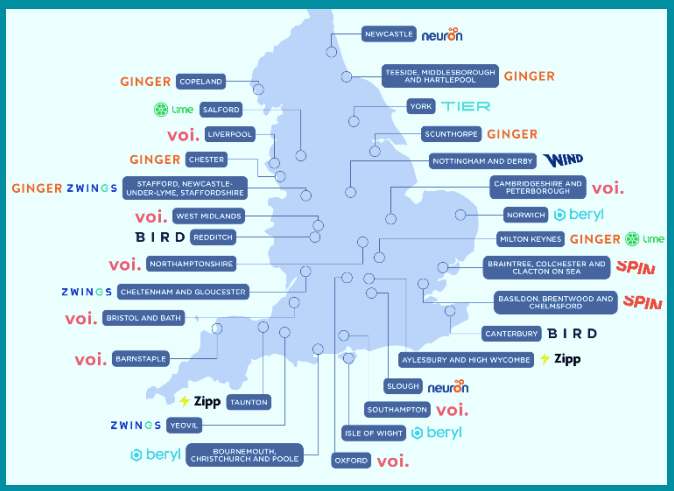
In 2018, it is estimated some 70,000 e-bikes were sold in the UK and this figure is increasing each year. Sales of electric scooters jumped 50% in 2019 at UK retailer Micro-Scooters, despite the vehicles being illegal to ride on UK roads and pavements and since April 2020, private sales have increased 134%.[17] This growth is set to continue and in 2019, Transport for London (TfL) found that up to 14% of vans could be replaced by cycle freight by 2025,[18] which currently account for 80% of road freight kilometres in London.[19] Variants of e-scooters may also be used for some deliveries (with seats, trailers, and other adaptations). UK firm Halfords reported that e-bike sales have been increasing by 30% annually since 2018 and predict 1.5 million e-bike sales by 2050.[20] This compares with current annual sales of around 3 million for pedal powered bikes.

Growth in the SP market is currently impeded by regulation, but local trials are now active across several UK cities and towns, such as Milton Keynes and Middlesbrough (see Box 2). Evidence from other cities suggests this is likely to be a key growth market going forward. In particular, shared e-scooters will exhibit faster market growth than shared e-bikes and drive overall market growth.[21]

Box 2 Case Study: UK e-scooter trials

On Saturday 4 July 2020, new regulations allowing the trials of rental e-scooters came into force in the UK. Originally planned for 2021, the decision was made to bring the regulation forward as a way to boost the green recovery from the pandemic and to help mitigate the impacts of the ongoing climate crisis.

The trials are spread across a wide array of towns and cities in England in areas outside of London, totalling nearly 50 unique trials (see inset map). The trials will be used to evaluate how shared and privately-owned e-scooters should be regulated in the UK, and also offer a glimpse into the prospects of UK-based startups such as Ginger, Zwings and Beryl.



UK firms have had unprecedented success, given their relative size versus European and US-based incumbents, winning 18 out of 48 trial locations. This said, these smaller UK firms have tended to win contracts in smaller towns, with the larger overseas firms taking bigger towns and cities due to their larger fleet sizes.

The trials are expected to continue until Autumn 2021, but in the meantime, a London trial will commence in April. The tenders are expected to be given to larger firms from overseas such as Lime, Bird or Voi. Beyond the trial phase, permits will be hotly contested by firms from the UK and abroad, and the current status quo of UK firms obtaining marginal concessions is likely to continue.

[17] Natwest https://natwestbusinesshub.com/articles/the-rise-of-the-e-scooter
[18] TfL (2019). Freight and servicing action plan.
[19] TfL (2019) Travel in London Plan
[20] London Cycling Campaign (2020)
[21] LSE (2020)

(2) Other Regional Markets

Globally e-scooter retail sales are predicted to peak in 2025 (pre-coronavirus analyses) with a value of around £20 billion. Sales are typically much slower in developing countries, which face unfavourable market conditions such as poor infrastructure and safety concerns.[22]

In the SP space, the market is expected to grow rapidly. In the US, the shared micromobility market is expected to be worth US$200 to $300 billion by 2030. In Europe, this figure is $100 to $150 billion and in China $30 to $50 billion. The market in Africa is in its infancy, where Morocco launched the first bike-sharing scheme on the continent in 2016.[23]

Hypothetically, micromobility could replace all trips under 8km, which account for as much as 50 to 60% of today's total passenger miles travelled in China, the EU, and the US. However, shared micromobility will convert only around 8 to 15% of this theoretical market due to various constraints such as customer adoption, weather conditions, age, presence and reliability of alternative modes and micromobility's lower presence in rural areas.[24] Table 3 reports a RAG rating for current growth in micromobility across regions, based on analysis of revenue growth in the regions. Red represents no or slow market growth, amber equates to moderate growth and green represents rapid market growth.

Table 3 RAG rating for recent growth in micromobility sector for retail and SP segments across regions

Growth of Micromobility	UK	Europe	North America	Asia Pacific	ROW
Retail Sales					
Service Providers					

Source: Vivid Economics analysis

2.5 Modal, sustainability and user trends

2.5.1 Modal shift to micromobility

Growth in micromobility is driven by a modal shift largely from private car and walking trips in the UK and in the US walking, taxi/rideshare and private car trips (see Table 4). Lower proportions of mode shift occur from public transport, which suggests micromobility is less competitive against this mode. Caution is needed when interpreting these estimates since they are likely to vary by city and region. Less mode shift occurs from public transport, which suggests micromobility is less competitive against this mode. From a city planning perspective, promoting modal shift from private car and taxi trips is likely to be a stated aim, while trying to minimise shifts from active modes and public transport.

Table 4 UK Mode shift to micromobility for different devices in the UK and US

Mode shift from	E-scooter	E-bike	Push bike
UK market[25]			
Private car	36%	34%	23%

[22] https://natwestbusinesshub.com/articles/the-rise-of-the-e-scooter
[23] CBInsights (2020)
[24] McKinsey (2020)
[25] London Cycling Campaign (2020), Steer (2018 - London), BikePlus Survey (2017).

Mode shift from	E-scooter	E-bike	Push bike
Walking	37%	14%	44%
Public transport	13%	40%	23%
Cycling	9%	-	16%[26]
Unknown	5%	12%	13%
US Market[27]			
Private car	41% (22-53%)	29%	
Walking	38% (30-43%)[28]	37%	
Public transport	8%	20%	
Cycling	4%	5%	
Unknown	4%	5%	

Source: Vivid Economics analysis
Note: 'Private Car' is inclusive of taxi and ridesharing services. Ranges are given where available.

2.5.2 Mode share

Table 4 presents mode share estimates for select European cities according to private car, public transport, walking and cycling use. No survey data currently report the modal share of micromobility, although shares of cycling are available which are a good approximation. Based on mode shift survey data in , the estimates show cities such as Paris (with high rates of walking) or Rome (where private vehicle usage is high) could see high shares of micromobility penetration. Cities like Amsterdam or Copenhagen (already with very high levels of cycling and lower levels of private car use) may see a much lower uplift.

[26] Includes shift from own bike.
[27] NABSA 2020 – did not differentiate between pedal and e-bikes.
[28] Micromobility in the UK - London Assembly

Figure 6 Estimated modal share per European city

EU Cities	Private car	Public Trans	Cycling	Walking
Amsterdam	38%	20%	22%	20%
Athens	53%	37%	2%	8%
Belgrade	26%	49%	1%	24%
Berlin	31%	26%	13%	30%
Bern	32%	31%	11%	26%
Brussels	44%	28%	3%	25%
Budapest	35%	45%	2%	18%
Copenhagen	33%	21%	30%	17%
Dublin	57%	21%	7%	15%
Helsinki	23%	34%	11%	32%
Lisbon	48%	35%	1%	16%
London	**40%**	**37%**	**3%**	**20%**
Madrid	29%	42%	0%	29%
Nicosia	85%	2%	1%	12%
Oslo	37%	26%	5%	32%
Paris	17%	33%	3%	47%
Riga	45%	34%	2%	19%
Rome	65%	28%	1%	6%
Sofia	51%	32%	3%	14%
Stockholm	47%	35%	1%	17%
Tallinn	26%	40%	5%	29%
Vienna	27%	39%	7%	27%
Vilnius	38%	25%	1%	36%
Warsaw	24%	54%	1%	21%
Zagreb	37%	37%	1%	25%

Source: EPOMM 2018

2.5.3 User demographics

Compared to the wider populations of the cities they operate in, the North American Bikeshare Association (NABSA) found that shared micromobility users in the US are disproportionately:

- Young (particularly age 25 to 44);
- White;
- Male;
- Likely to have higher incomes; and,
- Have higher levels of education.[29]

[29] NABSA 2019 Shared Micromobility State of the Industry Report.

Although demographics were skewed on average towards higher-incomes, pilot schemes also found higher adoption rates among the lowest-income residents[30]. On gender and age, a stronger consensus was found. We anticipate similar patterns of user behaviour in the UK. Such user demographics suggest a lack of social inclusion for some underrepresented groups, such as people with disabilities, older persons and people with lower educational attainment suggesting public sector support should aim to achieve greater social inclusion/equity, where creating more socially inclusive micromobility is a potential area for innovation.

2.5.4 Sustainability

Choosing an e-bike or scooter instead of a car translates to measurable emissions reductions. A 5% increase in trips made by bicycle and electric micromobility instead of cars globally could reduce CO_2 emissions by 7%, equivalent of taking more than 134 million cars off the road by 2030.[31] However, it is uncertain that the introduction of micromobility will consistently reduce car journeys and given high modal shift rates from walking, micromobility may have a net negative effect on emissions. The short but increasing asset-life of shared devices, currently estimated at 12-24 months, and the low recycling rates of battery packs are a joint threat to the sustainability of micromobility products and services.[32]

For micromobility to reduce emissions from transport, either significant reductions to life-cycle emissions must be made, or modal shift must predominantly come from car journeys. Even when electricity for charging is considered, e-bikes still emit around half the amount of particulate matter (PM) per passenger km as cars.[33] Life-cycle emissions are highly sensitive to asset life, which is improving year on year. Innovations such as swappable and recyclable batteries, and reduced collection distances reduce the life-cycle CO_2 emissions by 51% and 27% respectively.[34] [35]

Car displacement is the most important factor in reducing emissions, with Luo et. al., finding that at least 34% of bike trips must shift from car journeys in order to realize net impact reductions. Conversely, modal shift from walking or pedal-bike trips could have a net negative impact on the environment.[36]

Large delivery vehicles could be replaced with cargo e-bikes using last mile delivery and up to 25% of all goods could be delivered with bicycles in urban centres in Europe. Pilots implemented to shift from motor vehicles to cargo e-bikes consistently show increased environmental and health benefits, including reduced greenhouse emissions, energy use, and noise pollution, as well as improved safety and walkability.[37] One such trial has begun in the UK: the RIDES (Realising Innovative Deliveries in Southampton and Eastleigh) project has been launched by Southampton City Council who have distributed a fleet of electric cargo bikes capable of carrying a 100 kg payload.[38]

2.5.5 Incorporation within the wider mobility network

Evidence suggests the combination of public transport and micromobility can achieve synergy in reducing car dependency and the negative externalities of car transport. Integration of shared mobility and public transport is highly beneficial: a reliable public transport service can maximise the benefits of shared e-mobility by enabling longer car-free commutes. For example, a study in Nashville found that e-scooters, in conjunction with public transport doubled the citywide average number of jobs accessible in 45 minutes.[39,40]

[30] Note a possible selection bias if trials focused on Universities and Colleges.
[31] ITDP (2019)
[32] BCG (2020)
[33] ITDP (2019)
[34] Hollingsworth et. al. (2019)
[35] EY (2020)
[36] Luo et. Al. (2019)
[37] ITDP (2019)
[38] myjourneyhampshire.com
[39] Liao, 2020
[40] ITDP (2019)

There are few current examples of integration of micromobility services into the wider public transport network and this is a key constraint. Apart from vehicle storage and docking infrastructure at railway and metro stations, there is little evidence of systematic incorporation of micromobility into public transit operations. Thus, there remains large scope for wider integration of micromobility for shared scheme operators and private owners and this is a potential innovation area going forward.[41]

For service providers this includes:

- **Geofencing combined with price regulation can contribute to better integration with local public transport and to solving the first/last mile problem**. Using GPS technology, it is entirely possible to reduce fares for trips that start or end at a public transport station and use integrated payment systems. For example, Taiwan's EasyCard can be used to pay for any mass transit ride, from trains to buses to docked bicycles.

- **Two-way data sharing between micromobility firms and public transport operators presents another synergy available from incorporating micromobility into the wider transport network.** Transport for London (TfL) has revealed plans to run a pilot on management systems for micromobility to obtain real-time data on the movements of vehicles across the city, which will feed into optimising both parties' networks' performance and long-term planning decisions for London.[42]

For private owners:

- **Parking infrastructure can induce more first/last mile trips.** Offering secure docking stations at public transport nodes and final destinations such as offices, as well as accommodating on-board storage, is essential for encouraging multi-modal journeys for private owners. Where necessary, charging points can help to make public transport micromobility-friendly.

2.6 Market Drivers

Growth in micromobility is associated with several core drivers. These core market drivers help to explain why the micromobility market has grown strongly in the US, China and European markets and potential for future growth. We acknowledge that these are not the full list of market drivers, but a 'core' selection and other possible vectors perhaps less tangible to define include changing consumer preferences, demographic shifts and wider policy goals. The core drivers (documented in Figure 7) include:

- Low-mileage taxi and car journeys are the most suitable type of journey to be replaced with micromobility, for which micromobility is often faster and more convenient due to ease or lack of parking requirements and low-cost compared to taxis. In England, 15% of car journeys and 30% of taxi journeys are under 5 miles [43]

- Transit deserts (areas which lack public transport within 500m) are prime targets for micromobility where networks can be extended into new areas through first/last mile trips.

- Urban environments are conducive to shared micromobility schemes, where higher concentration of users enables more efficient resource use and journeys tend to be shorter and on smoother terrain.

- Congestion increases journey times, particularly in urban areas. High levels of congestion can be evaded by using micromobility instead of cars, leading to comparatively faster and cheaper journeys.

- Reliable public transport services can complement micromobility, particularly when viewed as an integrated mode. Replacing long car journeys with multi-modal trips requires reliable public transport

[41] Oeschger (2020)
[42] https://www.ukauthority.com/articles/tfl-aims-to-build-micromobility-data-system/
[43] National Travel Survey, Vivid Economics Analysis

and micromobility services. However, across shorter distances, micromobility may compete directly with public transport and unreliable services can create a gap in the market for micromobility.

- Improving safety is important to attracting new ridership, and adoption rates among cities are often reflected by the infrastructure investment in dedicated lanes and storage areas that improve both operating conditions and the perception of safety. Research suggests constructing bike lanes is extremely cost effective once the additional benefits of lower injury risk and more use of active modes are considered.[44]

- Net zero ambition is a key policy commitment from governments around the world. Micromobility is seen as a potential supply-side response to decarbonising the transport sector through encouraging modal shift into active modes of battery powered micro vehicles that are typically less polluting than cars.

- Behavioural change which has emerged most from the COVID-19 pandemic is a potential future market driver as people switch to more active modes to avoid public transport and socially distance. It is not clear whether this will be a temporary or longer-term market driver[45].

Figure 7 Micromobility core market drivers

Sources: Vivid Economics analysis, 1: portlandoregon.gov, 2: Deloitte, 2018, 3: Behrendt, 2018, 4: Sanders, 2020, 5: EY, 2020, 6:Liao, 2020; 7 Brooks et al (2020)

[44] Deloitte (2020). Making micromobility work for citizens, cities, and service providers.
[45] Brooks et al (2020)

2.7 Regulation and policy

The UK government has a pledge to achieve net zero emissions by 2050, but with different sector contributions. Emissions in the transport sector will need to see significant reductions to be consistent with the net zero policy ambition.[46] The UK is not alone in this ambition and governments globally are introducing similar stretch targets to reduce emissions and achieve net zero. The transport sector has traditionally been heavily polluting and micromobility is seen as a supply side response to lower emissions through encouraging modal shift for personal mobility away from cars, particularly in urban areas. It is also seen as an alternative and convenient response to reduce congestion in urban areas, which often involves capital intensive investments in infrastructure and public transport systems.[47]

Different forms of regulation across regions have resulted in a diverging regulatory framework for users and operators which may be impacting ridership and uptake. A range of aspects can and are already being regulated to improve safety though these regulatory standards vary across regions (see Table 5). A blend of both local and national regulation is evident across countries. Varying local and national regulations can create challenges for retailers (around vehicle regulations that may constrain exports) and SPs (around operating standards, such as parking and docking restrictions).

The focus of much regulation can be segmented according to vehicles, users and SPs themselves. For example, vehicle regulations include design standards and specifications, user regulation relates to operational safety while SP regulation focuses on city planning and balancing private and public benefits. These regulatory responses are seeking to achieve different outcomes, either around user and pedestrian safety or operations that maximise social good outcomes balanced with private needs. For example, the socially optimal allocation of permits for concessions within a geographic boundary[48]. The level to which these regulations are enforced is not clear, particularly those that require user compliance and therefore need significantly more policing. Some SPs are now using innovative measure to promote compliance with user-based regulation, for example in-app tests to discourage users who are intoxicated[49] or incentives for helmet use. In the retail sector, it is much more difficult to enforce user compliance at large.

With the regulatory environment evolving so quickly it is highly likely what is regulated could change considerably over time. The short-term need of reacting to the surge in micro vehicles in cities should be complimented by a longer-term objective of setting future-proof regulations. Flexible regulations would support innovation and not have to be revised each time a new form of vehicle hits the market. Authorities also need to find a balance between the regulations imposed on micromobility vehicles and other vehicles, since heavy regulation may negatively impact modal shift patterns.[50]

The most potential for innovation around regulation is likely to be for SPs, where novel forms of dynamic regulation may improve operating conditions and maximise public good outcomes. Flexible regulation should support innovation, which accepts market disruption and promotes new modes and business models with uncertain viability. Here, regulation around fleet capping, permit and entry requirements and charges and fees have the most potential to influence operations. For instance, for larger cities permit-based systems may allow for several operators to promote competition. But in smaller cities and towns, concessional agreements may allow just one operator since excessive number of operators may be undesirable. The latter are likely to be more 'marginal concessions', featuring higher entry costs and potentially lower levels of ridership. A combination of dynamic and adaptive regulation here may be best, through lower overall charges to attract operators and charging operators per scooter deployed per day to encourage dynamic fleet sizing that reflects actual demand and aligns the interests of city authorities and operators.

[46] DfT (2020)
[47] EY (2020)
[48] Fearnley (2020)
[49] Voi (2020)
[50] International Transport Forum (2020)

Table 5 Examples of micromobility regulation

Regulation	Type	Description
Minimum age	User	Minimum age requirements for operators are typically applied in many regions. In the US this ranges from 8 years to 18 years depending on state, while in Germany the minimum age is 14 yrs.
Helmet use	User	A requirement for users to use a helmet is imposed in some US states, although many regions regard this as optional for users. Some companies (e.g., Bird) offer users incentives for using helmets.
Maximum speed	Vehicle	All regions impose some form of maximum speed regulation, typically ranging from range from 20 km/h (12.5 mph) to 32 km/h (20 mph).
Vehicle class	Vehicle	European Union regulation N°168/2013 established L-category vehicles as a reference for member countries. L-category vehicles are powered two-, three- and four-wheel vehicles and uses power, power source, speed, length, width and height as classification criteria. Other regions have similar vehicle classification approaches but with subtle variations. The classification of e-scooters as PLEVs in the UK has meant their use on public rights of way is considered illegal.
Tyre types	Vehicle	Regulation in Amsterdam requires that standing electric scooters be equipped with pneumatic tyres.
Operating condition tests	Vehicle	In Germany, standing scooters must pass a series of tests which include braking tests and riding over vertical curbs before being allowed on public roads.
Turn indicators	Vehicle	The German Association of Vehicle Testing Services suggests revising regulations for standing e-scooters, requiring that they be equipped with turn indicators.
Restricted use in some areas	User and SP	Many regions restrict use of vehicles in certain areas. For example, in the UK e-scooters cannot be used on PROW due to their vehicle classification. For SPs, geofencing is a novel way to regulate go/no-go zones and speed restrictions in certain areas.
Insurance	User and SP	Some regions require that users of e-scooters hold valid liability insurance, for instance in Germany and France.
Drugs and alcohol	User	Most regions require that users respect the same alcohol limits as for motor vehicle drivers. The extent to which these regulations are enforced is unclear. Lime is reportedly working on the detection of impaired riding. Motion sensors found on e-scooters could be trained to detect excessive wobbling and slow the vehicle down.
Number plates	Vehicle	It is difficult to enforce pavement bans because of the lack of identifiable features on micro-vehicles and rider turnover. Some countries, such as Singapore and Japan, impose the use of an identification plate on micro-vehicles. Germany imposes a visible insurance sticker on e-scooters in a format that can help identify a vehicle at distance.
Permitting and entry requirements	SP	Various forms of market entry regulations can be used to control the number of competing e-scooter operators. This can take the form of permit-based allocations and concessional agreements. Permit-based approaches allow a number of operators into an area, while for smaller cities concessional agreements would likely focus on just one operator.

Regulation	Type	Description
		When evaluating bids for permits and concessions, there may be different decision criteria.
Charges and fees	SP	Price caps may be imposed on the changes operators can requested from riders. At the same time, local authorities will charge fees for operators. How these charges and fees are structured can have different outcomes. For instance, in Portland they are using a combination of static and dynamic fees, consisting of a one-off permit application fee of U$500, a per-scooter pilot permit fee of $80, a street use surcharge of $0.25 per trip and a right-of way use surcharge of between $0.05 and 0.20 per trip, depending on the area.
Fleet size capping	SP	A fleet cap limits the total number of vehicles or the number of vehicles each provider may offer. A cap may be conditional and include rules for when fleets can be expanded or must be reduced (e.g., expanding the fleet when usage per vehicle per day exceeds a predefined number, or to reduce the fleet if average usage falls below a certain threshold).
Penalties	User and SP	City authorities may apply penalties in numerous circumstances to either users or operators, including improper parking, failure to remove vehicles within a predefined reaction period, failure to educate users and missing safety equipment.
Data sharing	SP	To date, the evidence suggests that SPs do not share detailed operational data with cities voluntarily, although some operators such as Voi are now beginning to share some KPIs. Compulsory data sharing would provide local authorities with the means to dynamically regulate and respond to issues in real time and develop best practice.

Source: International Transport Forum (2020) and Fearnley (2020)

Various regulatory approaches are available to policy makers (Table 6) which are impacting both the pace of technology deployment and how easily regulation can evolve with changing market dynamics. For instance, regulatory sandboxes aim to pilot regulation before it is applied more widely to other cities and by extension is a trial-by-error approach (as applied in the UK). Adaptive regulation takes a more dynamic approach, accounting for varying local operating conditions and scheme objectives. A key tenant of most regulation is the flexibility to adapt and change to a rapidly evolving industry.

While limited examples of outcome/performance-based regulation were found for the selected regions, this is likely to be a key area to improve operational efficiency and equitability of ridership. Given this is an evolving area and KPIs are still being developed by cities, there are few examples of applied performance-based regulation although such approaches could even be used to incentivise better performance. In Denver, they are setting standards for minimum number of devices available in key areas – effectively a performance measure with regard to availability.[51] Conversely, Copenhagen is limiting the number of devices in play around key central locations to avoid visual pollution.[52] Other examples include around congestion, where a key indicator might be the percentage of trips that otherwise would have been made by car. If first/last mile challenges are paramount, assessing the percentage of micromobility trips beginning or ending at a transit hub could be a relevant performance measure.[53]

[51] Fearnley (2020)
[52] https://www.loc.gov/law/foreign-news/article/denmark-copenhagen-limits-number-of-electric-scooters-on-its-streets/
[53] Deloitte (2019). Small is beautiful: Making micromobility work for citizens, cities, and service providers.

In the UK the Department for Transport (DfT) is conducting a review into the 'Future of Mobility Regulation' that will consider options for appropriate testing regimes for micromobility, to ensure any such vehicles on the road are safe and fit for purpose[54]. The review will identify basic parameters for safe design and operation of new vehicles such as e-scooters as well as future trials of innovative ideas without the need to change legislation each time. The review may also consider measures to enable responsible and effective hire schemes for micromobility, such as a Code of Practice for operators. The trials will be used will to inform future government policy and possible legislative change. Around 50 local authorities were reported to be in negotiations with e-scooter operators over launching trials in their areas and need to be operational by 31st March 2021.[55] The evaluation of trials will be undertaken by Arup and NatCen.

[54] Dft (2019). Future of Mobility: Urban Strategy.
[55] Hirst (2020). Regulation electric scooters – briefing paper number 8958.

Table 6 Examples of diverging regulatory practices across selected regions

Regulation type	UK	Europe	North America
Adaptive regulation – *that can be quickly updated as the market evolves*	The UK DfT is conducting a review into the 'Future of Mobility Regulation' that will consider options for appropriate testing regimes for micromobility. As well as identifying basic parameters for safe design and operation of new vehicles such as electric scooters, the aim will be to enable future trials of innovative ideas without the need to change legislation each time.	The European Commission announced a review of legislation relating to various types of light electric vehicle in November 2020 to adapt to changing market conditions. The review will focus on vehicle classification to adjust the balance between safety and market uptake.	Dynamic regulation based on user patterns and utilization data provides flexibility and enables authorities to adapt fleet caps and network rebalancing to demand data. Some local authorities in North America have pre-agreed or retrospective arrangements (e.g., Portland and Los Angles) for data sharing requirements.
Regulatory sandboxes – *for testing the effects of micromobility solutions*	The UK is now using a range of test sites for pilots of e-scooters. The aim is to test the impacts of alternative forms of parking and user regulation.	-	Cities, such as Portland in the US, work with providers to test alternative adjusting fees and incentive structures. This can be compared against vehicle parking or on-street riding stats to see how behaviours and outcomes change.
Outcome-based regulation – *performance-based criteria for service providers*	-	In Copenhagen, only 200 e-scooters and 200 rental e-bikes may be placed in the most crowded areas of the city.	In Denver (US), they are setting standards for minimum number of devices available in key areas –a performance measure regarding availability of devices.
Risk-weighted regulation - *that acknowledges current infrastructure constraints and user needs.*	Riders will need a full or provisional car, motorcycle or moped licence to use the vehicles, and they must be aged 16 or over. Helmet use is recommended, and riders cannot use pavements due to risks to blind and disabled pedestrians.	Germany is among the countries that have developed regulations to frame the use of e-scooters based on infrastructure provision and safety. French regulations introduced in 2019 enforce helmet use as well as fitted lights, horns and brakes for e-scooters. Riders can only use cycle lanes and roads with speed limits of 50km/h or under.	In Denver (US), risk-weighted regulation is being used that allows scooters to use the pavement if no bike lane exists and the road speed limit exceeds 30 miles per hour.

Source: Vivid Economics analysis

2.8 Key market considerations

Micromobility firms face a broad set of considerations which vary in their potential impact across regions. These considerations are summarised according to five core themes; regulation, hardware and asset life, infrastructure, safety and technology. Market growth barriers and opportunities (where documented) represent areas for potential innovation, both in the micromobility sector explicitly or wider ancillary sectors, such as technology.

2.8.1 Regulation

Regulation presents the most significant barrier to firms operating in the UK, as e-scooters are currently prohibited from use on public roads and footpaths due to their classification as PLEVs. At the same time, legalisation and policy drivers presents a significant opportunity for UK firms to expand domestically. Micromobility is seen as a potential vehicle for reducing transport sector emissions and congestion in urban areas. Trials are currently taking place across various towns and cities in the UK as a result of Experimental Traffic Orders and Future Transport Zones (FTZs), in advance of likely changes to this law.

In overseas markets, regulatory barriers are generally lower. In Western Europe, countries like France and Germany have promoted adaptive regulation which has led to stronger market growth. Here, regulation is often devolved to the responsibility of local authorities. In the US, legislation is passed at the state level and an eagerness for operators to populate concessions with vehicles has resulted in some initial issues with residents.[56] Tightness of regulation differs, leading to diverging adoption rates across the country. In Asia Pacific, light regulation has fostered early adoption amongst users (e.g., e-bikes are classified as cycles in China, whilst in Korea they are classified as motor vehicles).[57]

Looking forward, a combination of dynamic and adaptive regulation will be key to promoting innovation both in vehicle design and how rental providers can operate. This is particularly true to encourage SPs to operate in a variety of urban settings and geographies for regional inclusion (i.e. not just large cities). Areas of regulation and their innovation potential are discussed further in Section 2.7.

2.8.2 Micromobility infrastructure

Poor micromobility infrastructure is a constraint to greater micromobility adoption in the UK. Construction of dedicated cycle lanes and parking infrastructure has lagged behind other European countries. For example, no UK cities feature in the Copenhagenize Index[58] of the top 20 bike-friendly cities globally. To get to a significant mode share for micromobility, there will need to be a proportionate reallocation of road space and investment in adapting infrastructure. This includes investment in creating strategic cycleways, car free streets, wider cycle lanes, parking bays located in strategic locations, such as transport interchanges and offices (this should include docked bays for charging, parking bays and bike hangers). There may be an opportunity to embed such requirements in design standards, such as the London Cycle Design Standards. There is evidence to suggest that investments of this kind in micromobility infrastructure would support increased modal shift[59].

Infrastructure for micromobility presents a lower barrier to growth in Europe and Asia Pacific, but a greater barrier in the US. In China, cycling has played a pivotal role in transport historically: between 50-60% of trips in most cities are made on foot or by bicycle. But bicycle use has been decreasing in recent years because

[56] San Francisco was one of the first American cities to allow e-scooters. A trio of companies deployed fleets in the city in spring 2018 and before long thousands of complaints were received from residents due to visual pollution from high numbers of devices. Shortly afterward the San Francisco Board of Supervisors put a temporary ban on all scooters. Tighter regulations were subsequently imposed via the permit system.
[57] International Transport Forum (2020). Safe Micromobility.
[58] The Copenhagenize Index is a comprehensive ranking of cycling infrastructure and other attributes in cities with a populous of over 600,000.
[59] Policy Forum of the London Cycling Campaign (2020)

conditions for both pedestrians and cyclists have deteriorated due to the rise in car ownership.[60] Cycling infrastructure in North America has traditionally lagged behind other regions, largely because urban planning has been very car-focussed and a widespread reallocation of road space for micromobility has not occurred despite calls from activities and users for such investments[61].

Planning policies need to be adjusted to provide space to securely park (and in some cases charge) significant numbers of micromobility devices. Dedicated lanes for micromobility users are also essential to ensure users feel safe when travelling and to promote seamless travel in urban areas which avoids integration with larger vehicles. Opportunities for growth are generally more prominent where infrastructure is most conducive to micromobility users.

2.8.3 Hardware & asset life

Damage and theft concerns may discourage market entrants, while short asset lives create costs to firms. Damage and theft of bikes and scooters is a strong disincentive to private owners and SPs of e-micromobility, particularly around investment in better vehicles. Vandalism and theft reduces hardware life, which harms profitability and sustainability of SP models – it is estimated that shared e-scooter schemes require device lifetimes of at least 4 months in order to operate profitably.[62] The use of innovative anti-theft and location-tracking technologies can alleviate some of these issues.

Improving the design of vehicles is a key area for future innovation, to respond to market trends and create new niche markets for hybrid vehicles. For example, scooters with seats bridge the gap between bikes and traditional scooters and may appeal to a new demographic of user. High-end vehicles with better designs, such as e-bikes built for comfort may appeal to longer distance journeys, thereby reducing pressures on existing modes[63]. Other market opportunities may include vehicles that can improve mobility for people with disabilities or the elderly.

Longevity of hardware is particularly important, and for rental firms this has been a key constraint to demonstrating long-term sustainability of operating models. For example, SPs Dott and Tier both say their scooters lifespan is currently six months, but with new hardware will reach one year.[64] Innovations to hardware that may improve asset life and reduce emissions include:

- Swappable batteries meaning that network re-balancing is now much simpler and utilisation rates can be improved. It has been estimated 43% of the lifecycle carbon impact comes from daily collection of vehicles for charging so this could also reduce emissions and creates opportunities for new operating models, such as battery rental models on a long-term contract.[65]
- Better vehicle recycling (including batteries) so component parts can be re-graded and used in future manufacturing. Employing modular vehicle designs is a key component in the circular economy.
- Built-in GPS tracking on devices and computerised locks/anti-theft.
- More powerful electric motors for climbing hills and innovative drivetrains for speed transmission that make riding smoother and more efficient.[66]
- Better docking stations that protect vehicles from adverse weather.

New design opportunities revolve around building core features that are too difficult for everyone to build. These types of innovations range from road-grade drive related components to updating mechanical hardware

[60] The World Bank (2012).Cycling and Walking trends in China.
[61] Policy Forum of the London Cycling Campaign (2020)
[62] BCG (2020)
[63] https://www.techradar.com/uk/news/bosch-unveils-futuristic-electric-bike-with-integrated-abs-and-on-board-computer
[64] EY (2020). Micromobility moving cities into a sustainable future.
[65] Hollingsworth et al (2019)
[66] https://electrek.co/2021/03/01/lime-unveils-slick-new-automatic-transmission-electric-bike-will-drop-50-million-into-them/

components (like brakes) with software innovation.[67] Regulation and standards can also create opportunities for batteries and powertrains, charging infrastructure and fleet management software.[68]

2.8.4 Safety

Actual and perceived safety of users will have implications for uptake. Adequate provision of dedicated micromobility infrastructure is paramount to making users feel safe and encouraging modal shift. Increased penetration of cycle lanes and other designated areas have been shows to lower the risk of cycling accidents and make users feel safer.[69] However, provision of infrastructure is largely a public good and so this challenge will require concerted policy action, such as scaling up of the DfT's £2 billion funding package to encourage cycling and walking in England.[70]

Emerging data suggests e-micromobility may result in more accidents that on traditional push powered devices. In 2019 rental firm Bird registered 37.2 injury reports per million miles travelled[71] while in Odense, Denmark, an estimate of 70 e-scooter accidents per million kilometres is estimated, about eight times higher than for bicycles.[72] A range of factors may be driving this change, including unfamiliarity with vehicles, compliance and other environmental factors. In short, if users do not feel safe, they are unlikely to ride and in recognition of this challenge, firms are adopting innovative designs to encourage greater uptake among safety-conscious users such as:

- Wider footplate on scooters allowing the rider to stand with their feet side-by-side for greater stability or scooters which feature a seat to provide more familiarity to users.
- E-bikes with more comprehensive designs, that feature larger tyres and better, lighter frame design to improve structural support and improve riding comfort.
- Scooters and e-bikes with lockable helmet storage on the device. Incentives are used by some providers to encourage users to wear a helmet, such as discounts on future rides.
- Number plates for tracking user compliance and adverse behaviour.
- Drink driving tests ingrained in user apps to encourage user compliance with regulation.

2.8.5 Technology

Smart phone penetration and digital connectivity are naturally a clear enabler for market capture and regions that lag behind with deployment of telecoms infrastructure may see lower adoption rates. Smartphone penetration is a key requisite to supporting customer acquisition for SPs and areas that lag being with advanced connectivity (4G and 5G) are likely to see lower market penetration. Digital economies support a series of other innovation areas, which are particularly centred around improving user experience, safety and realising alternative value generation opportunities. This includes a series of innovations such as:

- Improved accuracy of speed zoning through geofencing type mechanisms, to support remote device controls for better compliance with safety regulations.
- Better integration with other modes through MaaS applications.
- Novel dock designs, that are powered by renewable sources and support different vehicles.

[67] https://www.tomorrowstechnician.com/undercover-how-vehicle-software-is-changing-braking-hardware/
[68] Trucks VC (2021)
[69] International Transport Forum (2020)
[70] https://www.gov.uk/government/news/2-billion-package-to-create-new-era-for-cycling-and-walking
[71] Bird (2019)
[72] Rock (2019)

- Biometric applications that support device access through a seamless traveller journey concept.[73]
- More granularity around geofencing that is less constrained by urban landscaping, to support more refined controls around where devices can be used (e.g., distinguish between road and pavement).
- Realising the value of user data collected through data aggregator services, such as tracking user movements in urban areas.
- Development of software and programming to support rental companies, through software as a service (SaaS) applications.
- Sensors and other IoT devices that can be fitted to vehicles to improve user experience and safety.

2.8.6 Gap analysis

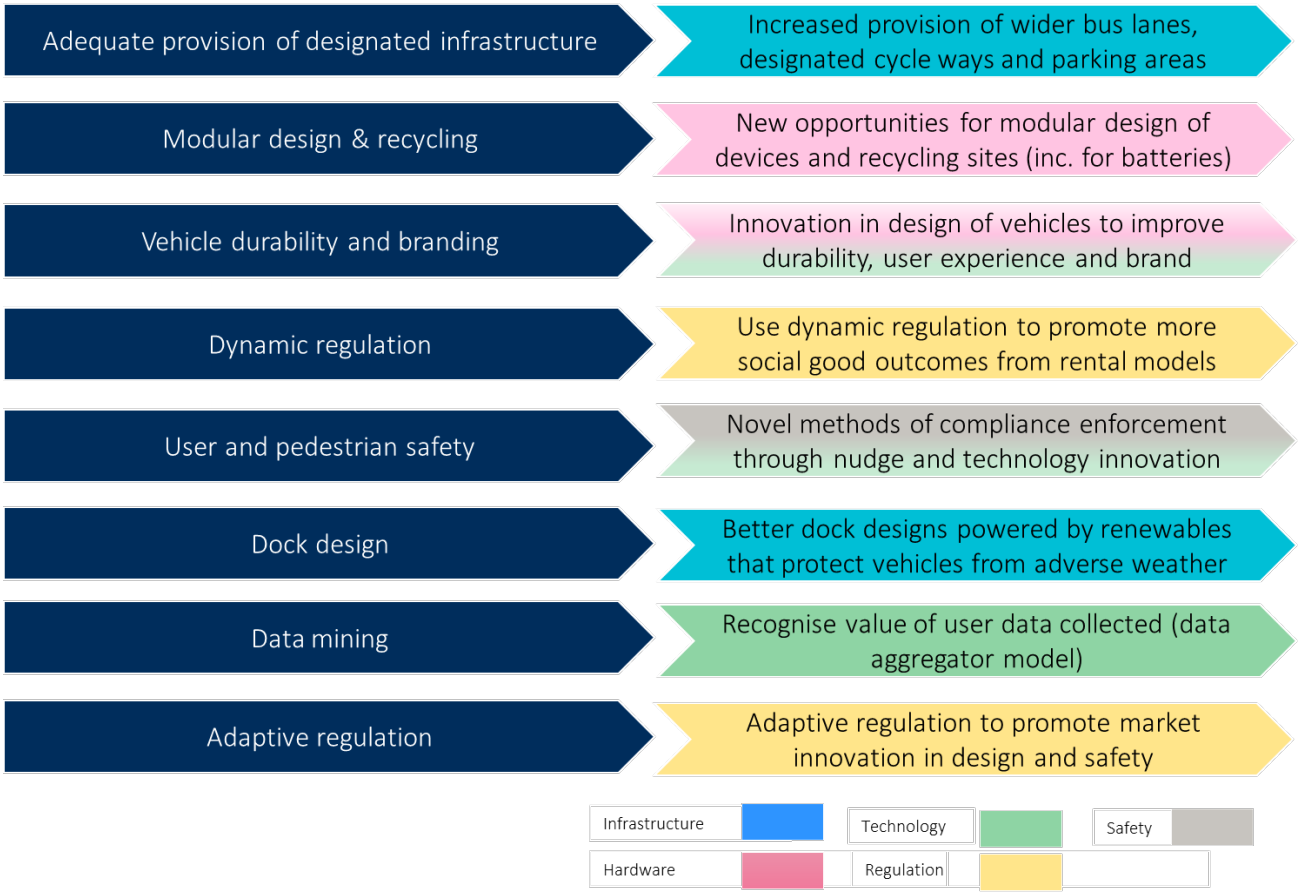
A gap analysis was used to identify key areas that may promote market and user growth, both in the UK and globally (Figure 8). The core opportunity areas associated with each gap are noted by the coloured arrows, linked to five thematic areas where the opportunity resides. The themes are based on those discussed in Section 2.8 (market barriers and opportunities) and consider regulatory, infrastructure, hardware, technology and safety aspects.

A fundamental gap that underpins the market is the provision of designated infrastructure to support both riding and parking, which serves an important role to improve safety and increase ridership. Better dock designs are a key infrastructure challenge, particularly around renewable power generation and improving storage options so docks are smaller but offer greater protection to devices from adverse weather.[74] Modular design of vehicles could improve durability and sustainability, particularly around maintenance and life-cycle emissions. This includes making hardware more recyclable and ensuing adequate provision of recycling facilities (e.g., more battery recycling facilities in the UK). Novel designs may also address improving vehicle durability, user experience (through greater comfort) and stylistic branding. User and pedestrian safety can be mediated through both nudge effects (helmet provision and infrastructure design) and technology options (in-app features, such as tests and incentives).

At the higher level, a different blend of regulatory options may improve market innovation and promote better social good outcomes. Dynamic regulation that tries to align operator and city authority interests is likely to be most successful, through a blend of incentives, KPIs and charges.[75] At the same time, adaptive regulation (particularly important for vehicles) can be updated, reflecting new innovation in design and manufacturing capabilities. For example, in the UK this may be around adaptive vehicle classification regulations that permit use of certain vehicles on PRoW. Lastly, the value of user data obtained by SPs can be recognised through data aggregator roles that commercialise aggregated journey and trip data, such as trip time of day, duration, distance travelled, approximate location and routing data.[76] The former is already highly regulated under General Data Protection Regulation (GDPR) and data sharing protocols.

[73] WTTC (2019)
[74] https://shared-micromobility.com/why-docks-are-part-of-the-future-of-micromobility/
[75] Hollingsworth et al (2019)
[76] For example, Beryl now provide a date aggregator role, with or without providing the vehicles demonstrating the value of data collected.

Figure 8 Global gap analysis for the micromobility sector



Source: Vivid Economics analysis
Note: Some colours are blended to reflect multiple themes

2.9 Innovation potential

2.9.1 Ongoing industry innovation

Ongoing innovations in the sector are typically focused on improving user and pedestrian safety and improving the design of vehicles and their characteristics. These innovations, spanning both retail and SP segments, are focused on improving safety, more efficient production manufacturing for vehicles and better infrastructure design to reduce cost and attracting new users that may not typically use bikes and scooters. Some key emerging innovations include:

- **Novel designs**: Bosch has recently unveiled a prototype design for an e-bike which will feature an on-board computer, ABS, integrated battery into the downtube and larger wheels for added user comfort. These design features will be increasingly important for integrating e-bikes in day-to-day use.[77] Other emerging design features include foldable e-scooters[78] and bike tyres that are made of novel materials to prevent punctures.[79]

[77] https://www.techradar.com/uk/news/bosch-unveils-futuristic-electric-bike-with-integrated-abs-and-on-board-computer
[78] https://techcrunch.com/2021/03/17/unagi-expands-e-scooter-subscriptions-with-10-5m-in-new-funding/
[79] https://techcrunch.com/2021/03/16/startup-founded-by-survivor-champ-debuts-airless-bike-tires-based-on-nasa-rover-tech/

- **Computer vision technology**: Voi is applying computer vision technology to its scooters which reduces speeds in busy areas, with the aim of improving safety for users and pedestrians.[80] Other firms are also seeking to apply this technology to bikes.[81]

- **Remote operated scooters**: Spin, Tourtouise and Go X are working on tele-operated scooters that can be controlled remotely through a customer service agent. Through the use of remote tele-operators, scooters can be repositioned back to a parking spot – or to respond to a request for an e-scooter to be delivered to a customer's door. Peachtree Corners (a US city) is trailing the early-stage technology[82] and Lime and Bird are also trialling similar technology.

- **3D printing**: Empire Cycles, working with UK metal manufacturer Renishaw, optimised the design of their mountain bike using additive manufacturing technologies and 3D printing. By using topology optimization software, Renishaw was able to determine the most efficient place for material, removing it from areas of low stress and reducing the bike frame's weight by 33%. The resulting mountain bike comprises a 3D printed titanium alloy frame and seat post bracket, reducing manufacturing time.[83]

- **Container-based charging**: Perch Mobility has developed a distributed network of retrofitted shipping containers equipped with charging equipment to provide safe and secure places to charge vehicles. The containers mitigate the need for long-distance transport to warehouse-based storage and charging facilities. The shipping containers operate as self-sustaining IoT devices and can be used by gig workers, third-party logistics providers or in-house workers on an hourly or subscription basis. The containers reduce vehicle downtime, enabling charging at any time of day and reduce transport distances between pick-up and charging locations.[84]

- **Docking**: Knot Scooters is a provider of docking, charging and locking infrastructure for electric scooters. The company's docks can host different mobility service providers, accommodating any solution with a proprietary backend application. They offer a flexible docking solution as a hybrid between docked and dockless rental. The multimodal charging hub utilizes vehicle adapters to allow scooters and bicycles to charge from the same plugs. Their model uses incentives (waving the unlock fee) to boost the usage rate of hubs since return on investment increases with rider usage.[85]

- **Crash detection**: Some firms are using accelerometers and gyroscopes (embedded in most smartphones) to detect rider accidents. Some bike helmet models can use this capability to call a predefined number on the rider's smartphone in the event of a collision.[86] Additionally, Hövding's wearable airbag, worn as a collar and charged via USB, measures the cyclist's movements 200 times a second to monitor for abnormalities. In the event of an accident—signalled by an abnormal movement—the airbag inflates to cover the neck and head with an air-filled cushion, dramatically reducing the risk of concussion and almost completely eliminating the risk of skull fracture.[87]

2.9.2 Barriers to UK market innovation

Many barriers to UK market innovation are not unique to micromobility and reflect ongoing tensions in the wider transport sector. These barriers (derived from a literature review) are centred around both creating an enabling environment to support innovation and the operation and delivery of innovation (see Table 7). The direct barriers to innovation centre around regulation, political support, public sector procurement processes and IP clauses. Additionally, a lack of technology road maps, whole system thinking, knowledge management and recycling facilities further constrain the ability of firms to innovate.

[80] https://www.smartcitiesworld.net/news/news/ai-computer-vision-used-on-e-scooters-to-detect-pedestrian-movement-5852
[81] https://www.siliconrepublic.com/start-ups/luxonis-computer-vision-bike-cycling-safer-technology
[82] https://www.intelligenttransport.com/transport-news/99132/city-launches-worlds-first-tele-operated-e-scooter-fleet/
[83] https://www.renishaw.com/en/first-metal-3d-printed-bicycle-frame-manufactured-by-renishaw-for-empire-cycles--24154
[84] https://www.perchmobility.com/distributed-charging-network
[85] https://www.knotcity.com/en/products/app/
[86] https://www.cyclingweekly.com/news/product-news/now-specialized-helmets-call-help-crash-401256
[87] https://hovding.com/

An indirect barrier is underinvestment in micromobility firms as a result of market forces that are responding to these barriers. A further indirect barrier is the lateness of the UK's response, which means international firms/markets have considerable first mover advantage (e.g., exhibit characteristics of competitive advantage, including size advantage and cost advantage). Tackling direct barriers to innovation may open up the market and in doing so promote capital inflows from the private sector to UK firms. Some of these barriers are further discussed in Section 3.3 arising from the stakeholder engagement exercise.

Table 7 Barriers to UK market innovation

Type	Barrier	Description
Enabling environment to support innovation	Regulation	The classification of e-scooters as a PLEV is a key regulatory barrier and means they cannot be driven on the road as they require insurance and registration but because they have a motor they cannot be driven on the pavement either.[88] This has constrained UK market innovation potential, particularly for SPs that have been unable to operate until recently in trials.
	Political support	Both in the UK and elsewhere rental models for e-scooters and e-bikes have come under serious political pressure owing to messy pavements and visual pollution.[89] Political support has been lacking, most notably at the local council level. Some residents and local councillors have been opposed to introduction of vehicles which creates a challenging environment for firms to operate in and may negatively impact public perceptions of the sector.
	Public sector procurement processes	A range of barriers exist to public sector procurement that could be used to support innovation in the micromobility sector. These barriers include a lack of collaboration and cooperation between public and private sector, a lack of adequate ring-fenced funding, risk aversion by the public sector, misalignment between procurement and technical teams, overly prescriptive procurement stifling innovation and limited use of pre-competitive procurement methods that share intellectual property (IP).[90]
	IP clauses	IP is an area of concern and confusion, in particular for small companies and their investors. It is known that some small companies in the wider transport space have not submitted bids to competitions due to the IP clauses, for example the Small Business Research Initiative (SBRI).[91] Removing complex IP agreements, between firms and universities and local authorities would create a more enabling environment for innovation across institutions and disciplines.
Operation and delivery for innovation	Technology roadmaps	Technology roadmaps are not used adequately by public authorities to communicate with the private sector and R&D partners to address transport challenges and bring new technology to market.[92] Information asymmetries therefore constrain the potential role of innovation in addressing key micromobility transport challenges faced by local authorities.

[88] https://www.18sjs.com/e-bikes-e-scooters-law-need-know/
[89] https://www.bbc.com/future/article/20200608-how-sustainable-are-electric-scooters
[90] Transport Technology Forum (2018)
[91] Ainsworth et al (2020)
[92] Ainsworth et al (2020)

Type	Barrier	Description
	Whole system thinking	The complex structure of the transport sector means understanding how a new innovation may need to integrate into the wider transport system is difficult due to silo thinking. This has been observed across the transport sector[93] and is particularly pertinent to micromobility, where integration with other modes and services is lagging.
	Recycling facilities	A key innovation barrier is around sustainability and recycling, both for vehicles and particularly batteries where there is a lack of appropriate facilities in the UK. This is not only a problem for micromobility but also the automotive sector and the UK now lags behinds Asia and Europe with commercial scale recycling facilities.[94] Improvements in this area could encourage new innovations regarding the sustainability of vehicles and fleet operators.
	Knowledge management	Limited knowledge sharing between UK firms, suppliers and academics may constrain innovation through more silo-based thinking. This barrier includes information failures regarding other firms in adjacent industries and R&D activities by universities that may have cross-cutting themes with the micromobility sector. This includes both domestic and international organisations.[95]

Source: Vivid Economics analysis

2.9.3 Support mechanisms for innovation and R&D in the UK

Addressing barriers to UK market innovation through support mechanisms will be key in not only fostering more innovation but innovation that improves social good outcomes. For UKRI, a key aim is to support British businesses in domestic and international markets. Additional objectives around public good provision may include improving rider and pedestrian safety, improving sustainability of vehicles, bettering urban environments through reduced congestion and more choice for consumers to express demand throughout alternative modes. Some of the key levers to promote innovation and R&D across these areas include:

- **Financial incentives**: Capital subsides, grants and tax credits could be used to support the early phases of technology development and penetration that are deemed desirable by national/local government. An example of this is the UK Government's e-Cargo Bike Grant Fund, which has provided £2 million for the acquisition of e-cargo bikes to support green last mile deliveries in England.[96] Extending such incentives and capital support to other innovation areas, such as remote operated vehicles or better docking station design could achieve more positive impact.

- **Transport policy**: Micromobility needs to be discussed as part of a wider transport policy agenda. Investment for improving cycle networks, parking areas and docking stations is a necessary pre-requisite to encourage more modal shift and reduce congestion and emissions in urban areas. The UK Government's Transport Decarbonisation plan should give equal weight to e-bikes and e-scooters as it does to other electric motor vehicles to support a reduction in car and van use. Additionally, the £2 billion announced for cycling and walking investments in England could also be extended.[97] In 2016

[93] ibid
[94] https://www.theengineer.co.uk/automotive-battery-recycling-wmg-report/
[95] Ainsworth et al (2020)
[96] Sustrans (2020)
[97] Department for Transport (2020)

Sustrans modelled that by 2025 £8 billion is required to double cycling in England and in a way that helps make cycling more inclusive and prioritises disadvantaged and marginalised communities.[98]

- Technology roadmaps: Developing technology roadmaps through partnerships between local authorities, universities and the private sector would help the micromobility sector better understand the need for future innovation and articulate a clear end-state vision. For example, the role of micromobility in MaaS applications could be further clarified through better road mapping.[99]

- Developing standards: The development of standards can help an emerging technology ecosystem rally round the issues to promote successful commercialisation of new products.[100] Currently, the micromobility market lacks a common standard around vehicles, which has created a patchy framework with subtle variations in design. Standards could help establishing the essential characteristics of vehicles and SP models and identify the best practice to encourage further innovations that improve on the status quo.

- Innovation networks: Levels of knowledge sharing need to be increased across local authorities and the private sector, to promote better collaboration between institutions and stronger business cases[101]. Better innovation networks, that use Innovate UK and the Catapults, could generate new understanding in supplying novel transport services to local authorities in emerging areas, such as for the disabled or socially disadvantaged. Such networks may also tackle other challenges by linking adjacent industries and universities together to tackle common barriers, such as battery recycling for the automotive and micromobility sector.

- Simpler public sector procurement: A potential barrier relates to the complexities around public sector procurement and IP clauses in contracts that may deter the private sector from entering markets. Reducing some of these complexities may encourage more innovation across SPs, particularly around technology trials and new operating models.

- Market stimulation policies: Market development policies can help to create or stimulate markets for low-carbon technologies and recycling initiatives. For example, niche markets for electric vehicles in cities have been created through public demonstration projects and competitions.[102] Support could be offered in the form of prizes or secure niches for innovations that reach specified sustainability standards, such as vehicles that are 100% recyclable with zero lifecycle emissions.

[98] Sustrans (2016)
[99] https://www.maas-market.com/sites/default/files/SOREN%20SORENSEN.pdf
[100] BSI (2020)
[101] Transport Technology Forum (2018)
[102] Foxon (2002)

3 Stakeholder engagement

Box 3 Stakeholder engagement key takeaways

- We engaged with 11 firms operating within the micromobility sector, across both retail and SP segments to explore a range of issues, including the market landscape, value chain, barriers to growth, opportunities for UK firms and support options to catalyse growth.
- Vertically integrated supply chains mean there are limited opportunities for UK firms in the wider value chain, especially in overseas markets.
- UK firms do not currently hold any significant market share in overseas markets, although their future prospects are viewed more positively.
- Regulation remains the greatest barrier to growth for e-scooters, but overall stricter regulation could create a growth opportunity for UK firms to export best practice in design and operations.
- There is a lack of access to capital to support sufficient scaling up of operations for UK firms. Stakeholders often called for access to low-cost financial products such as lease-finance.

3.1 Approach

Structured interviews were used with stakeholders to validate inputs and assumptions used in the technical analysis, as well as identify barriers and opportunities facing UK firms and the potential support options necessary to catalyse growth. Our structured interviews were organised over two rounds. For round one we contacted seven individuals representing a range of British SP and retail companies and research organisations. In round two, we contacted four individuals from domestic and international retailers and SPs. The interviews aimed to capture the broad spectrum of firms operating in the micromobility market.[103]

In round one we gathered impressions on the makeup of the micromobility value chain and estimates of UK firms' market share within segments of the value chain to inform our technical analysis. We also discussed barriers and opportunities faced by market participants, both now and in the future. In round two, we focused on validating outputs from the technical analysis and identifying intervention options to encourage innovation across UK firms were also discussed.[104] The key findings from the interviews are structured around:

- The micromobility value chain;
- Barriers and opportunities facing UK firms; and,
- Support options and interventions available to improve innovation and growth prospects of UK firms.

We have leveraged evidence from our market analysis to report and affirm observations from our interviews with stakeholders, in order to uncover novel insights and identify targeted intervention options. Insights have been sense-checked against our market research and results have been validated where possible. When an observation cannot be validated, we clarify its anecdotal nature. The below section synthesises stakeholder insights with our own assessment of the micromobility market.

[103] See Appendix A1 for list of stakeholders interviewed.
[104] See Appendix A2 for a full list of questions used with stakeholder discussions.

3.2 UK micromobility value chain

Here, we asked stakeholders to define their perceived value chain (as a function of cost incurred in production/operations). The graphical output from this exercise is reported in Section 4.2.2.

3.2.1 UK firms' current market capture

- **Limited international presence:** UK firms do not report holding any significant market share abroad in any stage of the value chain. Supply chains are often vertically integrated, so larger overseas players may not require support from UK firms in downstream components when operating in the UK. For example, Lime track, rebalance and charge their devices using their own software platform, allowing them to provide and maintain their service without external support.
- **Centralised operations:** SP operations and management are usually centralised, so back-office support is usually managed from a global headquarters. For example, Lime scooters manage their Paris network operations from their San Francisco office.
- **Need for a domestic market:** UK firms believe that to be an exporter that can compete internationally, the UK needs to first have an established home market in which domestic firms can grow.
- **Manufacturing is shipped overseas:** UK retail firms often design e-scooter/e-bike products but manufacture them abroad. According to stakeholders, assembly is sometimes re-shored to the UK, and at small scale, some high-value manufacturing occurs in electric motor and battery production in the UK. E-micromobility manufacturing is likely to follow trends exhibited in the pedal-bike market, where manufacturing is restricted to high-spec products such as Brompton's folding bikes: 83,000 bikes were manufactured in the UK in 2016 (of which 50,000 are by Brompton), a small fraction of the 3 million units sold that year.[105,106]
- **Design and manufacturing make up a significant share of costs:** UK firms report that the global market is heavily invested in design and manufacturing of devices. As devices become more durable, costs are expected to shift towards technology development and marketing and sales where firms will aggressively compete for user acquisitions.
- **Technology development capabilities are currently weak but are likely to improve.** Due to the immaturity of the micromobility market, UK firms have not been afforded the time to test and develop micromobility technologies, and as a result, lag behind overseas competitors. UK service providers operating abroad, such as Pure Electric,[107] outsource technology development to more experienced overseas firms. This trend is unlikely to hold, however. As the domestic market develops, the UK's strong overall technology competency will help UK firms to quickly catch up.

3.2.2 UK firms' future opportunities

- **Market penetration overseas:** UK firms perceive Europe and North America as markets they are most likely to succeed in. Asia Pacific represents the largest growth opportunity but is perceived as the hardest to enter, with stakeholders referring to a highly saturated market and inherent geographic barriers to participation.
- **Brand power:** UK firms can leverage greater market share in design and manufacturing through competing on quality, rather than price. UK brands have a global reputation for high-quality design, evidenced by Brompton's strong sales in Asia and recent store opening in Tokyo.

[105] Statista
[106] Statista
[107] Pure Electric operate a long-term e-scooter hire service

- **Existing specialisations:** The UK's existing specialisation in advisory and professional services, marketing and sales can help UK firms gain greater market share in the wider value chain (see for example).

- **Supporting role domestically:** Operations and network management requires a local presence, so UK firms can gain significant domestic market share and add greater value as the UK market grows. For example, UK charging startup Bumblebee Power's wireless charging solution claims to offer a 50% cost saving for e-bike hire schemes and are supporting Voi's UK operations amongst others.

3.3 Barriers and opportunities for UK market growth and innovation

Here, we asked stakeholders to discuss barriers and opportunities for UK firms to innovate in the market. However, many of the points discussed were from the perspective of the firm and so inherent in these discussions are market barriers/opportunities and innovation barriers/opportunities.

Barriers:

- **Regulation:** Legislation banning the use of e-scooters on PROW is the most significant barrier to growth for UK firms engaged in e-scooters, since this impacts consumer demand. The lateness of the UK's response to trials and regulation has given foreign firms significant first mover advantage even for bike sharing where the UK has lagged behind.

- **Finance:** Many cited a lack of funding and investment from private sector capital to grow medium-sized firms into larger firms which will be necessary to scale up operations. For example, UK based SPs account for an estimated 0.3% of total private sector investment flows into the rental market.[108]

- **Lease finance:** A lack of available finance for leasing assets to overcome high capital cost barriers of rental models hampers UK firms' competitiveness and ability to innovate - European firms are reportedly eligible to receive asset-backed finance for micromobility devices.

- **Infrastructure and safety concerns:** UK firms reported concerns around an underinvestment in cycling infrastructure that could help promote greater modal shift to micromobility. Additionally, poor compliance, vandalism and theft are often cited as issues which deter shared scheme operators and hamper profitability.

- **City-centric business models:** Some UK firms believe suggested the economics of SP models are unlikely to work in suburbs, meaning that micromobility will become city-centre-focused, raising questions around social good aspects of rental models and the need for incentives.

- **Battery shipping restrictions:** UK firms exporting suggested couriers are no longer accepting exports of batteries, which block small e-scooter exporters who are using direct B2C models (not via a distributor). If these restrictions persist, innovations in domestic battery production should be strongly supported.

- **Battery recycling:** Stakeholders suggested a lack of battery recycling capacity in the UK will hold back innovation around battery recycling, without an increase in the number of battery recycling centres across the UK. Improvements in this area could encourage new innovations regarding the sustainability of vehicles and fleet operators through knowledge transfer.[109]

Opportunities:

- **Second-mover advantage:** The UK holds a second-mover advantage which it can use to create a 'best in class' regulatory environment. Regulation can be used to protect UK firms through use of high

[108] Vivid Economics analysis
[109] Warwick WMG, 2020

thresholds for product sellers and SPs. If UK regulation is adopted abroad through standards and best practice, this may create opportunities for UK advisory and consultancy services. A pre-existing example of this is the British Standards Institute (BSI) who design global regulatory standards for sectors such as Smart cities.

- **Brand power:** Stakeholders suggested UK assemblers and retailers have strong brand power and can compete abroad in the retail sector on quality and product differentiation, particularly in Europe and Asia Pacific region although the domestic market was seen as key.

- **E-scooters are typically more popular than e-bikes:** Stakeholders suggested that e-scooters are more popular among consumers than e-bikes and that the main growth market for rental models is likely to be around e-scooters. For example, trials launched in England in 2020 have reported higher utilisation rates for e-scooters over e-bikes (expressed through more frequent demand), demonstrating higher popularity among users.[110]

- **Scalable technology innovations:** Innovations in technology to improve shared ownership model efficiency should be supported as they can be rapidly scaled to the global market. Citymapper, for example, is a UK firm whose route-planning technology has been rapidly scaled to 41 cities in 8 years and now supports dockless e-bikes and e-scooters. Additional opportunities may include SaaS applications which support the micromobility industry.

- **Support services:** Advisory and professional services are not yet prevalent in the micromobility sector, but as the market matures, UK firms will form significant part of this sub-market due to existing UK specialisation and reputation in this area. Stakeholders suggested there may be innovation opportunities around micromobility-centric insurance and finance products, alongside software-as-a-service initiatives.

3.4 Support and interventions to improve innovation

Here, we asked stakeholders to consider intervention options that could be used to support UK firm's innovation potential in the domestic and global market. Again, many of the discussion points are from the perspective of the firm and as such consider both support to increase market capture and foster innovation in the market.

- **Directing greater finance to firms:** The main concern raised by firms was a lack of financial support and access to sufficient capital for firms to grow and innovate. All forms of finance were suggested to be helpful and firms encouraged the use of a diverse portfolio of financial support.

- **Equity investment raises concerns:** Equity investment was viewed by some firms as encouraging, although concerns were raised around conflict of interest and shareholder unrest, particularly around voting rights and setting corporate strategy.

- **Grants should go to productive ends:** Grants are viewed as helpful, but often too small relative to the reporting costs. However, some firms are may also 'surviving' on grants, meaning that grants may be going to unproductive ends which fail to generate novel innovations.

- **Research can improve public perceptions:** Research into micromobility safety would aid UK firms to abate consumer fears and improve public perceptions of micromobility, giving firms greater freedom to test new products. Resident and political unease around vehicle parking and storage in urban areas could equally be addressed through research aiming to reduce visual pollution.

[110] https://www.scotsman.com/news/transport/popularity-electric-scooters-threatens-eat-bike-shares-lunch-2990195

- **Prototype development:** Assistance in developing prototypes would alleviate a significant early-stage market barrier for UK manufacturers and designers, such as access to specialist equipment or skillsets.
- **Matchmaking:** Matchmaking of firms with academics and other ancillary sectors was suggested as a key mechanism to reduce information barriers and help manufacturers, designers and technology firms to collaborate where interdisciplinary thinking is needed. In particular, a business directory (or similar) was suggested as a method to remove blockers around identifying UK suppliers to support small-scale manufacturing efforts in the UK.
- **Lease finance and investment incentives:** One stakeholder suggested extending the Enterprise Investment Scheme for leasing firms[111] to help SPs, whilst others called for wider tax and investment incentives.
- **Lowering compliance costs:** SPs we spoke to suggested authorising Vehicle Special Orders (VSO) for an entire region rather than by city/council would reduce the fixed compliance cost of service provision, particularly for smaller towns and cities where tendering and market entry costs are typically higher for firms.

Box 4 Case Study: Pure Electric

Pure Electric is a specialist electric mobility retailer, stocking market-leading electric scooters, electric bikes and accessories. Their aim is to make a meaningful impact on the way we all travel every day.

Pure Electric started online as an e-commerce business but it soon became clear that physical stores would open up their reach and meet the growing needs of customers. The company has experienced rapid growth and now has stores throughout the UK.

They invest heavily in innovation and concentrate on affordability and reliability. Pure have prioritised recruitment of talented individuals, such as designers from Dyson, to engage in innovative design that meets changing consumer needs.

They experimented with a 'pop-up' store in Belgravia (London) for 12 months. This was a great success – not only could potential customers experience the scooters and bikes for themselves, but it gave Pure Electric colleagues the chance to answer any customer queries face-to face. This led to further Pure Electric physical stores being opened in February 2020. Naturally, these are in urban spaces on commuter links, where there is a real need for this innovative kind of transport.

Pure Electric are able to meet strong demands, thanks to the strong relationships with several key brands and has a significant relationship with Cyclescheme, the UK's no.1 cycle to work provider. They have recently partnered with Barclays to offer their customers new financing options for larger ticket items, demonstrating added value from wider value chain collaboration.

[111] Micromobility service providers are considered leasing firms and therefore do not qualify for the EIS

4 Market and impact sizing

Box 5 Market and impact sizing key takeaways

- The market sizing results suggest the global micromobility market is worth $49 billion in 2020, rising to $60 billion in 2025.
- The global SP market is valued at $1.7 billion in 2020, rising to $3.4 billion in 2025, forecast to be growing at a CAGR of 14.5%. The retail market is much more mature and is valued at $47.2 billion in 2020, rising to $56.8 billion in 2025, forecast to be growing at a CAGR of 3.8%.
- We estimate UK firms account for around 17% to 27% of the domestic SP market, whilst in the retail market UK firms have a share of between 22% to 37%.
- Globally this translates to 2% of the SP market and 4% of the retail market, reflecting the infancy of the UK's SP market. Much of this reflects capture rates in the domestic market.
- UK firms are likely to command a very low capture rate in overseas markets, owing to first mover advantage (not held by UK firms) and structural differences in market organisation. Looking beyond the trial phase, it is unlikely UK firms will have the ability to scale-up operations and win permits/concessions for the key cities in the UK.
- The future outlook suggests declining market capture for UK SP firms and broadly unchanged market capture for UK retail firms. Merges and acquisitions are likely as the industry consolidates.

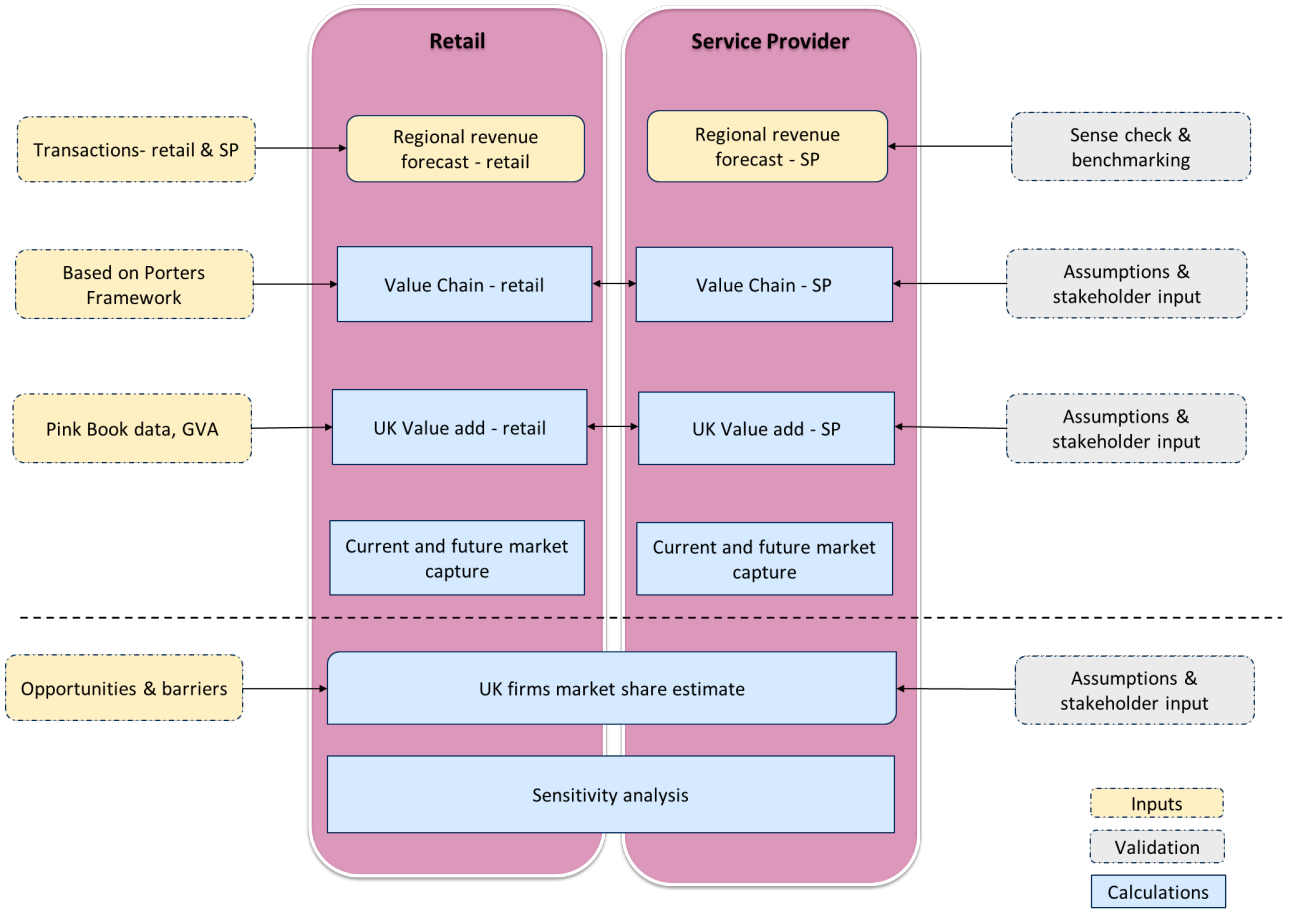
4.1 Approach

4.1.1 Methodology

The aim of the market and impact sizing was to identify market capture of UK firms in the global micromobility market and assess the competitiveness of UK firms in both the domestic and international market. The methodological approach to market and impact sizing is outlined in Figure 9. The analysis was disaggregated between retail and SP's and is reported at the regional level (UK, Europe, North America, Asia Pacific, ROW). Throughout, the analysis was supported by stakeholder discussions, wider data validation and varying assumptions. The analysis was broken down into the following components:

- Estimate the size of the overall micromobility market, disaggregated by region;
- Construct a typical value chain for firms operating in each market segment;
- Identify the current and future 'offer factor' for UK firms operating in each segment, based on value-add from different economy sectors; and,
- Estimate market capture for UK firms in each regional market and how this may evolve over time.

Figure 9 Method framework for market analysis



Source: Vivid Economics

The following steps were used to support the technical analysis:

- **Step 1**: Procured market research data to estimate regional market sizing for both market segments.[112] Various validation tests were conducted on data including bottom-up revenue calculations for UK firms and analysis of global firms' revenues to affirm our sizing estimates.
- **Step 2**: Estimate value chain for both segments based on Porters Value Chain Framework. Wider literature and stakeholder discussions were used to support value chain estimates which reflect wider economy interactions with the micromobility sector. Both current and future changes in the value chain were estimated.
- **Step 3**: Estimate value-add of UK firms in the value chain based on a RAG rating system discussed with stakeholders and informed by macro-economic data triangulation, including balance of payments, import and export flows and GVA.
- **Step 4**: Approximate current and future market capture of UK firms in regional markets as a function of a RAG rating index. Capture rates were informed by market capture in other adjacent industries and investment flows in the global micromobility sector.

[112] Market research data was procured from BIS Research detailing the estimated market revenues for specific regions according to both market segments over the period 2019 to 2025.

- Step 5: Derive market share estimate for UK firms in regional markets, over the period 2019 to 2025, broken down by segment and value chain component.
- Step 6: Conduct high-level sensitivity analysis, including varying the market capture rate and future changes to market capture. This forms the wider envelope of our estimate.

4.1.2 Assumptions

The following assumptions underpin the technical analysis:

- The market sizing is based on estimated sector revenues using top-down calculations (e.g., company revenues) with validation from other sources using data triangulation.
- The market sizing considers e-bikes, pedal bikes and e-scooters based on either sales of these devices (retail) or rental of these devices (SPs). Ancillary markets, such as sales of parts, accessories and repairs and maintenance is considered out of scope and not captured here, but may account for a further 25% to 50% of sector revenues[113].
- The analysis of 'UK firms' only considers the revenue generation opportunities for UK domiciled firms and does not reflect wider benefits such as employment from international firms operating in the UK. These would be additional to what is covered in this analysis.
- The market sizing is based on estimated sector revenues using top-down calculations (e.g., company revenues) with validation from other sources using data triangulation.
- Market segmentation based on retail (any firm that is selling a micromobility device to a customer or supplier) and SP firms (providing rental services for micromobility devices) in the market.
- COVID-19 impact is incorporated into market sizing estimates, with most markets predicted to recover by 2022/23. This does produce an added level of uncertainty in the underlying market sizing estimates and there may even be a reverse COVID effect (increasing demand for active modes).
- Market capture for UK firms is estimated based on 'internal' and 'external' value chains, where internal includes companies specifically operating as retailers or SPs, while external include firms operating in ancillary sectors but that form the wider value chain (e.g., financial services).
- A central, lower and upper bound estimate encompasses the envelope of market capture and reflects uncertainty in our estimates. These should not be considered as scenarios but are plausible future changes to the possible market capture of UK firms in domestic and international markets across the value chain.
- Anchoring of market capture associated with RAG rating indices is based on Vivid Economics' professional judgement supported by stakeholder discussions, alongside analysis of wider data sources including HM Treasury Pink Book trade balances, investment flows into micromobility firms and SP trials in the UK. The wider analysis evidence base is reported in Appendix A4.
- Changes in market capture rates resulting from potential interventions by Innovate UK are not estimated in our market sizing exercise, as quantifying the uplift from such interventions would involve an excessive degree of uncertainty, rendering such estimates ineffective.

[113] CONEBI (2016)

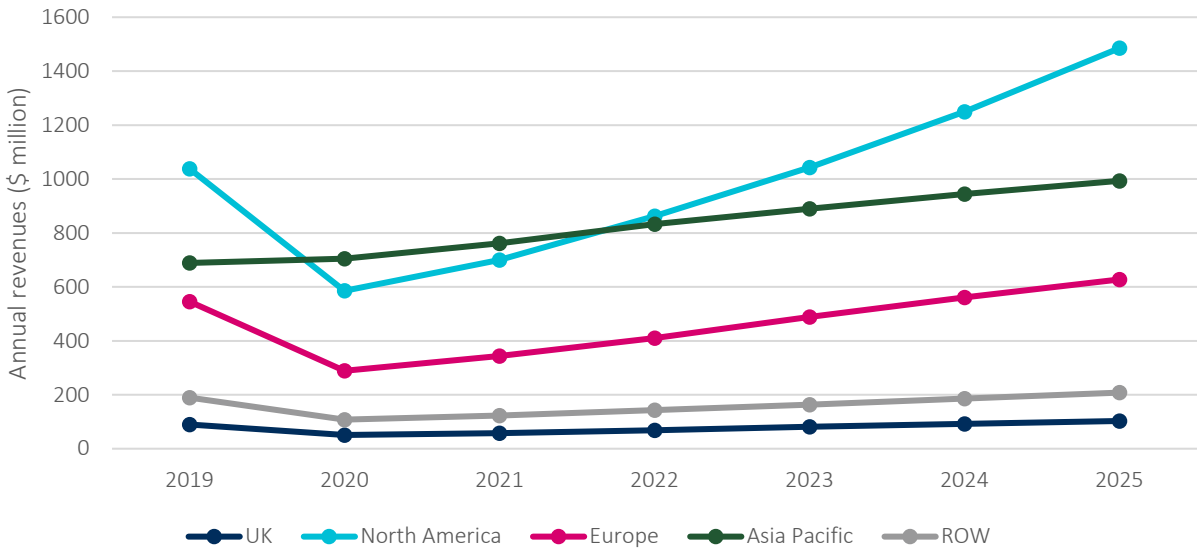
4.2 Analysis of UK firms

4.2.1 Market sizing

The market sizing results suggest the global micromobility market is worth $49 billion in 2020, rising to $60 billion in 2025. The market is forecast to be growing at a nominal rate of 4.2% (CAGR 2020-25) - in real terms this likely represents annual growth of 1-2%[114]. While this estimate is lower than some other market sizing work[115] we would argue this reflects inherent uncertainty in forecasting such a rapidly evolving sector. Additionally, our estimate is not based on top-down aggregation of market capitalisation of companies but aggregate sector revenues – a subtle difference in approach but one that results in a more conservative estimate, since growth/technology companies typically have bloated valuations. Of course, a limitation here is that our approach does not capture book value (valuation of all market assets).

The global SP market is valued at $1.7 billion in 2020, rising to $3.4 billion in 2025 (Figure 10), forecast to be growing at a CAGR of 14.5%. Much of this is assumed to be organic growth although it is inevitable some expansion may be fuelled from the retail market. North America is the fastest growing market (20.5% CAGR) while Asia Pacific is the slowest (7.1% CAGR). This reflects a more mature market for rental services in the Asia Pacific region (particularly China). The UK market is still in its infancy and there represented just 3% of the overall global market in 2020. A COVID-19 recovery is estimated in 2022/23[116].

Figure 10 SP market regional revenue forecast (2019-2025)

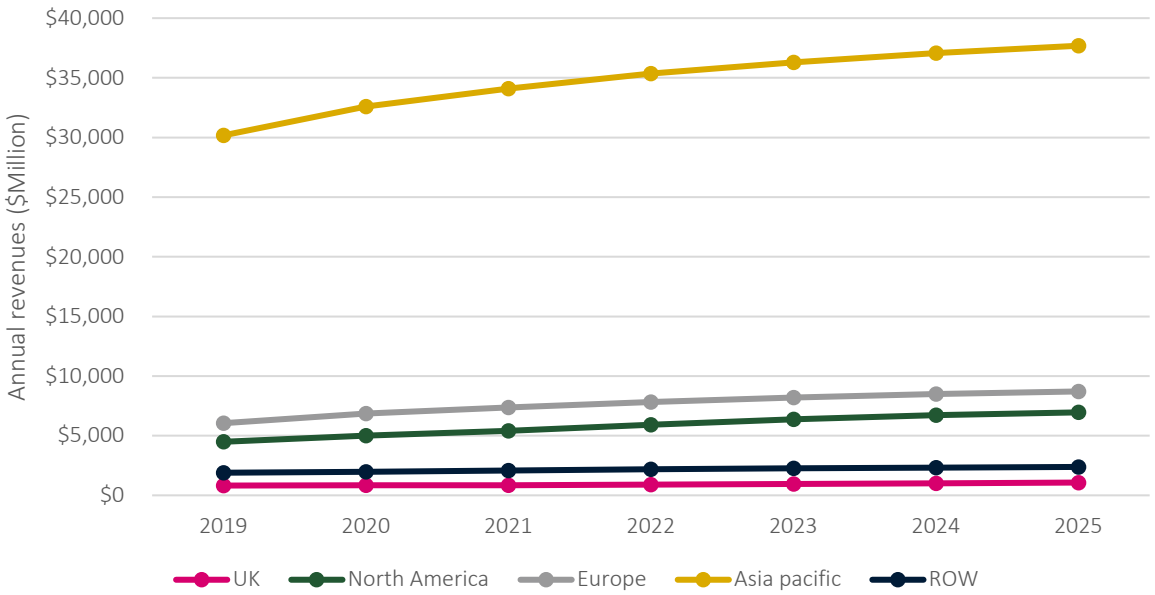


Source: BIS Research

The retail market is much more mature than the SP market (accounting for nearly 95% of the overall market) and is valued at $47.2 billion in 2020 (Figure 11), rising to $56.8 billion in 2025, forecast to be growing at a CAGR of 3.8%. The fastest growing region is North America (6.8% CAGR) while Asia Pacific is growing at just 2.9% CAGR, although the region accounts for nearly 70% of the market. Higher growth rates in North America reflect an increasing propensity to cycle in the US.[117] The UK accounted for just 2% of the overall market in 2020.

[114] BIS Research (2020)
[115] McKinsey (2019)
[116] BIS Research (2020)
[117] UCI (2020)

Figure 11 Retail market regional revenue forecast (2019-2025)



Source: Vivid Economics

4.2.2 Value chain

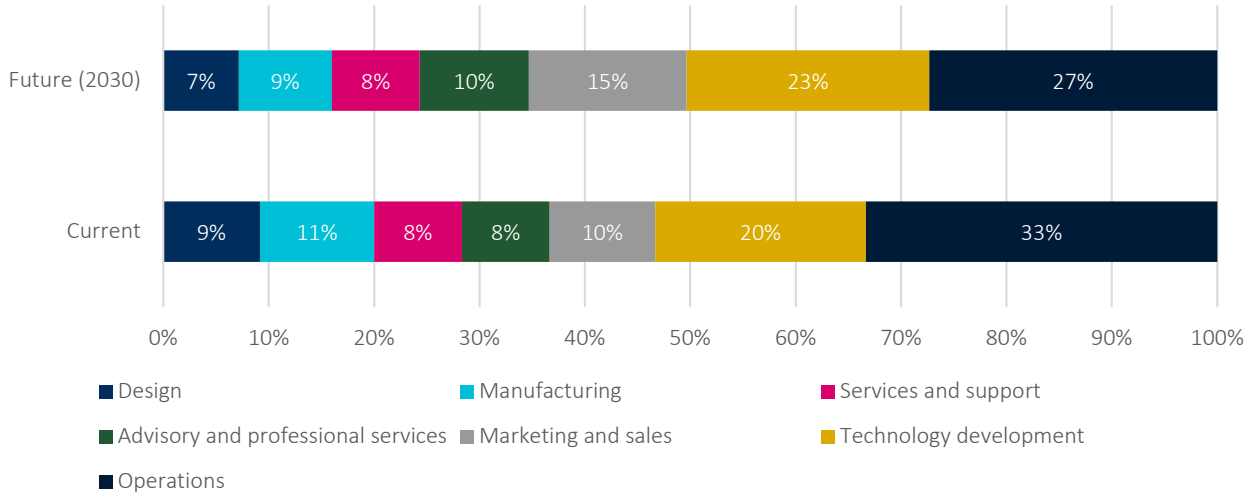
The value chain is best considered as value creation (apportionment of cost) throughout the supply chain and includes factors internal and external to companies operating in this space.[118] The value chain therefore accounts for wider supply chain interactions and was estimated through stakeholder discussions using the Porters Framework.[119]

For SPs (Figure 12), operations and technology development are estimated to account for over 45% of the SP value chain, followed by manufacturing and services and support (another 30%). The high cost attributed to operations reflects network rebalancing, maintenance and fleet operation requirements, while for technology this includes software engineering and modification of devices/programmes through R&D.

By 2030 a small redistribution of cost across the value chain is likely, with a reduction in spending on operations reflecting efficiency gains and better operating models. Design and manufacturing costs are also likely to fall as hardware is made more durable with longer asset lives. Cost increases are likely to be incurred around marketing and sales as more aggressive strategies are used to support customer acquisitions for growth. At the same time, a small growth in technology development will be necessary to support development of new APIs and IoT devices.

[118] Internal factors represent value creation through firms operating directly as either retail or SP firms, while external factors includes value creation indirectly through the wider value chain (broader sector linkages).
[119] Porter (1985)

Figure 12 SP value chain (both current and in future)

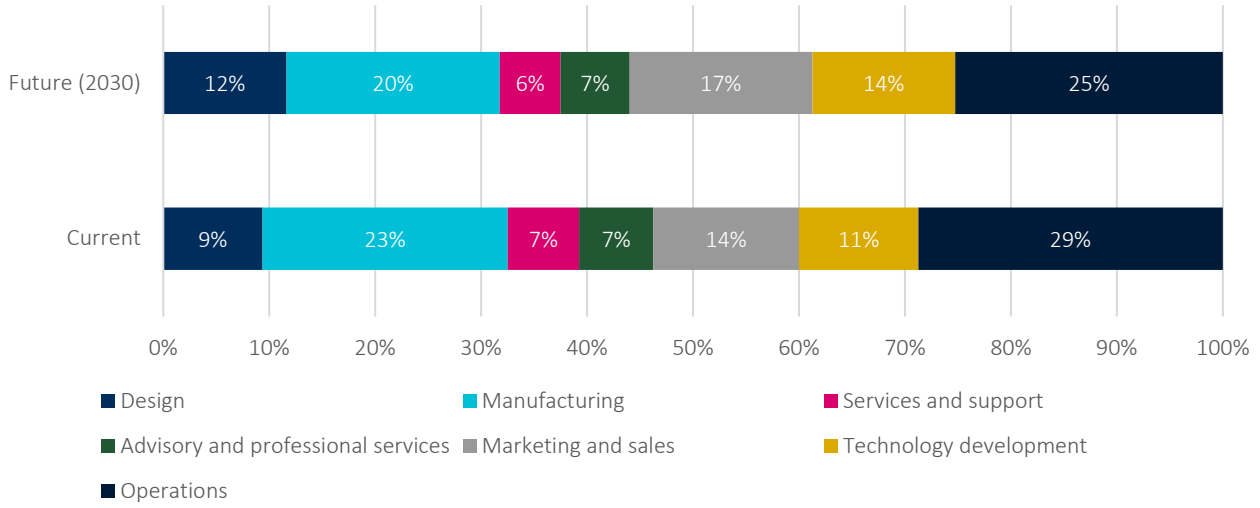


Source: Vivid Economics analysis

For retail, (Figure 13), design and manufacturing account for around 32% of the overall value chain, reflecting the costs associated with designing devices and buying manufactured stock against the backdrop of shorter supply chains that aim to rive cost from production. Marketing and sales and technology development account for a further 26% of cost, much of this likely to be driven by advertising, discounting, e-commerce platforms and device modifications. Operations reflects costs principally incurred around real estate management, logistics and warehousing and is a further third.

By 2030, manufacturing costs are likely to fall as the market matures and the manufacturing sector benefits from economies of scale. Other cost reductions are likely in operations, reflecting turnover of higher volumes as the sector matures and streamlined operating models with e-commerce at the core. The reallocation of cost is likely to be around design, reflecting a drive to differentiate devices and offer new innovative product lines that appeal to different segments of the market (e.g. high-end). Increasing costs apportioned to marketing and sales reflect a likely transition to better branding and higher cost of sales as a result of more aggressive customer acquisition strategies.

Figure 13 Retail value chain (both current and in future)



Source: Vivid Economics analysis

4.2.3 UK offer factor

The market capture rate of UK firms was estimated by deriving an 'offer factor' index for UK firms operating in each segment, based on value-add from different economy sectors. The offer factor is an index of UK firms' competitiveness across all segments of the value chain and was informed through professional judgement based on stakeholder discussions and macroeconomic analysis of UK sectors.[120] The offer factor captures factors internal to each sector and the wider economy linkages that comprise the value chain (see Figure 14).

Figure 14 Market capture rates for UK firms in various regional markets (current)

Segment	Cost factor	Mapped sector(s)	UK	Europe	North America	Asia Pacific	Rest of world
Service Provider	Design	Professional, scientific and technical activities	18%	3.0%	2.4%	2.4%	0.6%
	Manufacturing	Manufacturing	3%	3.0%	0.6%	0.6%	0.6%
	Services and support	Administrative and support service	25%	3.0%	0.6%	0.6%	0.6%
	Advisory and professional services	Professional, scientific and technical activities	25%	3.0%	3.0%	0.6%	0.6%
		Financial and insurance activities	25%	3.0%	3.0%	0.6%	0.6%
	Marketing and sales	Professional, scientific and technical activities	25%	3.0%	0.6%	0.6%	0.6%
	Technology development	Information and communication	25%	3.0%	0.6%	0.6%	0.6%
		Professional, scientific and technical activities	25%	3.0%	0.6%	0.6%	0.6%
	Operations	Wholesale and retail trade; repair of motor vehicles	25%	3.0%	0.6%	0.6%	0.6%
Retail	Design	Professional, scientific and technical activities	21%	7.5%	7.5%	6.4%	0.6%
	Manufacturing	Manufacturing	3%	3.0%	3.0%	3.0%	0.6%
	Services and support	Administrative and support service	40%	7.5%	7.5%	3.0%	0.6%
	Advisory and professional services	Professional, scientific and technical activities	40%	15.0%	7.5%	3.0%	0.6%
		Financial and insurance activities	40%	15.0%	7.5%	3.0%	0.6%
	Marketing and sales	Professional, scientific and technical activities	40%	5.3%	5.3%	3.0%	0.6%
	Technology development	Information and communication	40%	11.3%	7.5%	3.0%	0.6%
		Professional, scientific and technical activities	40%	11.3%	7.5%	3.0%	0.6%
	Operations	Wholesale and retail trade; repair of motor vehicles	40%	6.4%	6.4%	3.0%	0.6%

Source: Vivid Economics analysis

[120] Vivid Economics validated our market capture by comparing results from our stakeholder engagement to macro-scale patterns of trade and areas of strength in the UK economy which supported a widely-held consensus among stakeholders. The validation checks are reported in more detail in Appendix A4.

(1) Service providers

For SPs, the offer factor index shows UK firms are likely to command a very low capture rate in overseas markets, predominantly a function of first mover advantage (which UK firms do not possess) and lack of competitiveness in this space. In the domestic market, UK firms will capture more of the market though this will be shared with large international operators that are better capitalised. The sector is currently in its infancy in the UK and lags behind many regions, principally due to regulatory barriers. The trial phase currently taking place across UK towns and cities suggests UK firms will occupy in the region of 20% to 30% of the market.[121]

However, beyond the trial phase and at wider roll-out it is unlikely UK firms will have the ability to scale-up operations and win permits/concessions for the key cities (London, Birmingham, Manchester). This would put them at odds with larger, international firms that are better capitalised with proven operating models, meaning UK firms would be subject to operating at the margin through less profitable concessions such as towns and small cities. A further consolidation of firms will likely exaggerate this effect through M&A activity. We therefore assume a reduction in the market share for UK firms in the SP segment.

(2) Retailers

For retailers, evidence suggests UK firms are unlikely to command a high capture rate in overseas markets, due to structural differences in market organisation.[122] In the domestic market, UK firms can capture more of the market simply due to characteristics of the retail sector (mainly through either e-commerce or physical stores). In particular, physical outlets create an opportunity for UK retailers to generate recurring revenues through after sales services, such as maintenance and repair. We estimate some 67% of sales occur through retail stores/outlets (e.g., Halfords, Pure Electric, Evans Cycles and independent stores) that are predominantly UK businesses, with a further third generated through e-commerce – much of which is characterised by international firms.[123] We assume that device-only sales account for around 50% of total retail revenues (captured here) while a further 50% is derived from sales of parts, accessories and repairs and maintenance (not captured here).[124] Bricks and mortar retailing present a clear opportunity for UK firms in this space, where competition from larger international firms is less intense and pre/after-sales care and personalisation is something consumers are willing to pay a premium for.[125]

Looking ahead, we assume a minor reduction in domestic market share of UK firms due to the ever-growing presence of online only retailers. However, this may be partially offset by a small but growing presence in the European market through e-commerce.

(3) Wider value chain

UK firms in the wider value chain are likely to occupy a high share (30% to 50%) of the domestic market, driven largely by service sector expertise. The standout areas are advisory and professional services, marketing and sales, and technology development - reflecting UK sector expertise in these areas as a net exporter.[126] We assume there are more opportunities for UK firms in the retail space simply because the nature of bricks and mortar retailing tends to rely more heavily on domestic firms. Conversely, the SP operating style is more adapted to 'drag and drop' type models that are replicated at scale across multiple locations, with most non-operational work commissioned in the HQ country. Across both sectors, we assume limited activity of UK firms in the international market, mostly centred around the service sector where the UK holds a competitive advantage.[127]

[121] See appendix A4, Validation Exercise 1
[122] Usually a focus or blend of either e-commerce or bricks and mortar outlets, with varying distribution channels.
[123] See appendix A4, Validation Exercise 2
[124] CONEBI (2016)
[125] Deloitte (2019)
[126] See appendix A4, Validation Exercise 4
[127] PwC (2016)

(4) Future outlook

We suggest the future outlook is likely to result in declining market capture for UK SP firms but broadly unchanged UK retail firms. The future outlook was estimated according to stakeholder discussions, supporting trade data and professional judgement (see Appendix). While a loosening of regulatory restrictions in the UK may improve the domestic market outlook, it is unlikely this will give UK firms a competitive edge unless high regulatory standards cause problems for operating models of international entrants. On the international front, until the UK has a more prominent foothold in the domestic market we see limited opportunities for UK firms overseas (see Figure 15).

Looking across the wider value chain, the key findings are:

- **The UK manufactures** only a small quantity of bicycles and scooters, with the key players being Brompton and Pashley. The UK market is principally supplied by vehicles imported from the Asia Pacific region, such as China, Vietnam and Taiwan because they can produce at scale and with lower per unit cost. These lower costs are a function of lower wage costs, strong business ecosystem, lack of regulatory compliance and enforcement and low taxes and duties in China and Taiwan.[128] In the future, this position will likely remain unchanged and imports will still dominate the sector. There may be specific opportunities around domestic battery production, drivetrains and assembly of vehicles to support the wider market.

- **The UK designs** a small number of bicycles and scooters, mainly for foreign manufacturers under licence or for UK assemblers. This participation reflets strengths of the UK design sector underpinned by firms such as Mas Design, Beryl and Pure Electric. Looking forward, the UKs strength in design under the GREAT Britain brand may result in marginal gains to market capture across some export markets.

- **Services and support** functions are largely back-office and relate to business administration. Traditionally, larger UK firms have exported some of these functions offshore in a bid to lower costs but more recently there has been a drive to bring some of these customer focused functions back into the UK.[129] Most of these services are carried out internally by companies, and we anticipate this would be the case for both retailers and SPs in the sector, meaning a marginal reduction in market share here is likely.

- **Marketing and sales** occupy a small but growing portion of the value chain. The market is currently caught between two strands; i) a race to the bottom (low cost, high volume) and ii) high quality brand differentiation. Within the latter, firms like Taur are innovating to develop unique products with strong brand identity that differentiate themselves from the wider competition. UK firms in the marketing sector are well positioned to support brand management and wider advertising requirements for increasing market capture. As the sector matures and customer acquisition strategies become increasingly competitive, we anticipate a growing role for UK firms in the domestic market but with limited international penetration.

- **Advisory and professional services** are traditionally an area where UK firms have excelled. UK firms operating in this part of the value chain are likely to capture a reasonable portion of this market, through consultancy and advisory services and insurance and banking (both area where the UK is a net exporter). By their nature, these opportunities are largely external to retailers and operators and are often high-value but low volume transactions. In the future, advisory and professional services are likely to become increasingly important to develop more efficient business models to maximise margin and new ways of financing growth, particularly though not exclusively in the domestic market.

[128] https://www.investopedia.com/articles/investing/102214/why-china-worlds-factory.asp

[129] While this was the trend, Brexit has created renewed moves to sight some business operations overseas in Europe due to restrictions around trade tariffs and administration burden.

- **Technology development** is a sector strength in the UK, and some firms are already innovating in this space around data aggregation (Travel AI), app development (Beryl) and mounted devices (SeeSense). The UK's strength here is the wider technology architecture already prevalent in the UK economy that can support firms in software engineering, programming and IoT devices. Due to the nature of the sector, we anticipate a reasonable proportion of technology innovation to come from outside the micromobility sector. As the market matures, supporting technology is likely to become more refined and this ongoing refinement creates an opportunity for UK firms to support UK and international markets, although the competitive nature of this sector may constrain market capture.

- **For operations,** many functions will need to be delivered in country. Depending on business function, this may include logistics, storage and distribution, property and asset management and networks. Such functions could be delivered by UK or international firms, depending on the proportion of operations farmed out versus delivered internally. It is likely a minor reduction in market capture will be evident here, reflecting the more prominent role of international firms in both market segments.

Figure 15 Annual estimated changes to market capture rates for UK firms (2022-2025)

Segment	Cost factor	Mapped sector(s)	UK	Europe	North America	Asia Pacific	Rest of world
Service Provider	Design	Professional, scientific and technical activities	0.1%	0.6%	0.6%	0.6%	0.0%
	Manufacturing	Manufacturing	0.0%	0.0%	0.0%	0.0%	0.0%
	Services and support	Administrative and support service	-2.0%	0.0%	0.0%	0.0%	0.0%
	Advisory and professional services	Professional, scientific and technical activities	0.8%	0.0%	0.0%	0.0%	0.0%
		Financial and insurance activities	0.8%	0.0%	0.0%	0.0%	0.0%
	Marketing and sales	Professional, scientific and technical activities	-0.6%	0.0%	0.0%	0.0%	0.0%
	Technology development	Information and communication	-0.6%	0.0%	0.0%	0.0%	0.0%
		Professional, scientific and technical activities	-0.6%	0.0%	0.0%	0.0%	0.0%
	Operations	Wholesale and retail trade; repair of motor vehicles	-1.5%	0.0%	0.0%	0.0%	0.0%
Retail	Design	Professional, scientific and technical activities	0.4%	0.8%	0.6%	0.6%	0.0%
	Manufacturing	Manufacturing	0.0%	0.0%	0.0%	0.0%	0.0%
	Services and support	Administrative and support service	-0.8%	0.8%	0.0%	0.0%	0.0%
	Advisory and professional services	Professional, scientific and technical activities	0.8%	0.0%	0.0%	0.0%	0.0%
		Financial and insurance activities	0.8%	0.0%	0.0%	0.0%	0.0%
	Marketing and sales	Professional, scientific and technical activities	0.0%	0.4%	0.0%	0.0%	0.0%
	Technology development	Information and communication	0.0%	0.4%	0.0%	0.0%	0.0%
		Professional, scientific and technical activities	0.0%	0.4%	0.0%	0.0%	0.0%
	Operations	Wholesale and retail trade; repair of motor vehicles	-0.6%	0.6%	0.0%	0.0%	0.0%

Source: Vivid Economics analysis

4.2.4 UK plc market share

Based on the full value chain, we estimate UK firms account for around 17% to 27% of the UK SP market, whilst in the retail market UK firms account for between 22% to 37% of the market (see Figure 16). The error bars show uncertainty in our estimates and represent the market capture envelope for UK firms, which we suggest is a plausible outcome.

- **The domestic market capture of UK SP firms** is likely to decrease over time although revenues will grow owing to background market growth. As better-capitalised international firms enter the market and win larger contracts, UK firms may be forced into more marginal concessions. UK firms occupy a small proportion of the international market (0.6% to 3%), reflecting an immature domestic market that constrains the ability of UK firms to compete effectively overseas.

- **The domestic market capture of UK retail firms** is likely to remain broadly flat over time, even as their overall market revenues grow due to background market growth. UK firms in the retail value chain command a larger share of international markets (ranging between 0.6% to 7%) mainly because of online retailing that has driven exports. In particular, UK firms have a small but growing presence in Europe and North America, largely driven by higher-value products with novel brands. There is some uncertainty around market capture of UK firms in the Asia Pacific region.

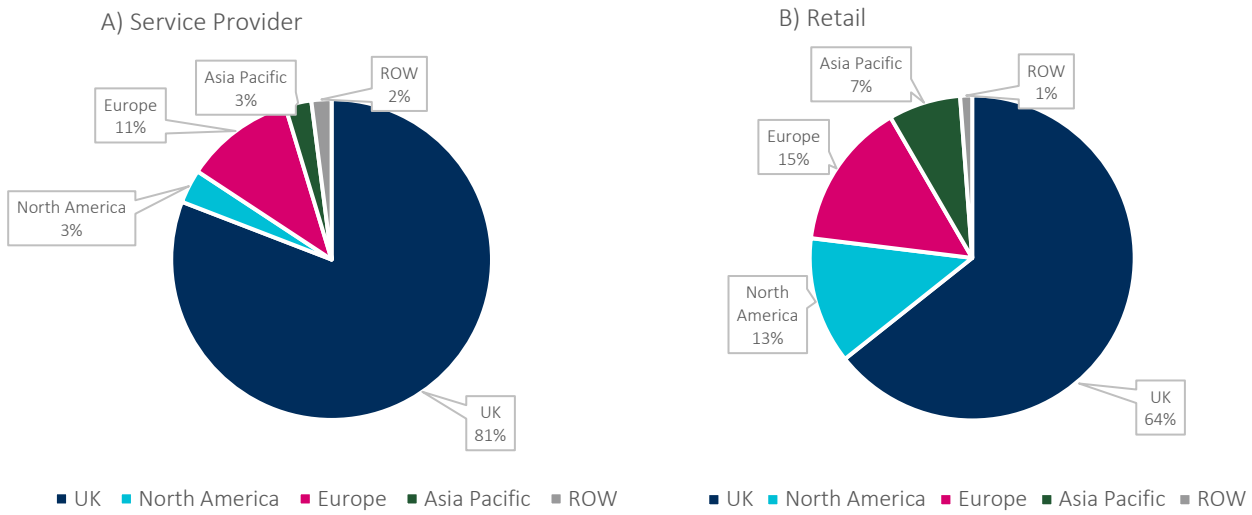
Figure 16 Market share of UK firms in regional markets for both SP (A) and retail (B)

Source: Vivid Economics analysis

Based on our central estimate, the majority of UK firms' revenues are derived from the domestic market, with the European market also being particularly important (Figure 17). UK firms operating in the SP segment derive the overwhelming majority of revenues from the UK market, while the international market is a relatively minor income stream where any revenue generation is largely driven by capture rates across the wider value chain. Similarly, for UK retail firms most revenues are derived from the domestic market. Exports, largely driven through e-commerce, overseas distributors and wider value chain capture, account for around a third of revenues with highest market capture rates in Europe and North America. In absolute terms, the Asia Pacific

market is still the largest source of revenue generation simply due to the size of this market, despite much lower market capture.

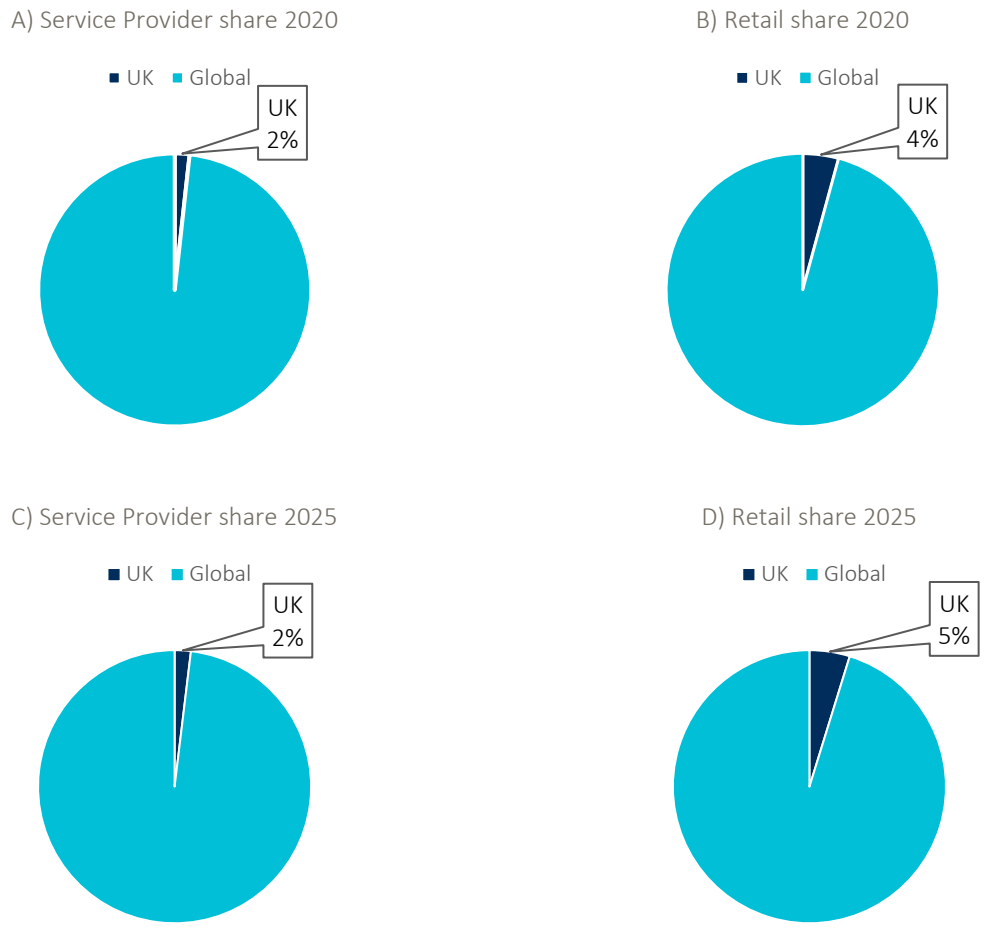
Figure 17 Revenue streams for UK firms by region in 2020 for SPs (a) and retail (b)



Source: Vivid Economics analysis

UK firms account for around 2% of the global SP market, while in the retail segment UK firms account for around 4% of the global market (Figure 18). Estimates of market share should be considered with an envelope of +/- 1% for SPs and +/- 2% for the retail sector, reflecting uncertainty in our estimates. The low levels of market capture at the global scale reflect a consistently domestic focus across both segments, with limited capture of international markets which are typically much larger than the UK's.

Figure 18 UK firms' share of the global SP market (a, c) and retail market (b, d) for 2020 and 2025

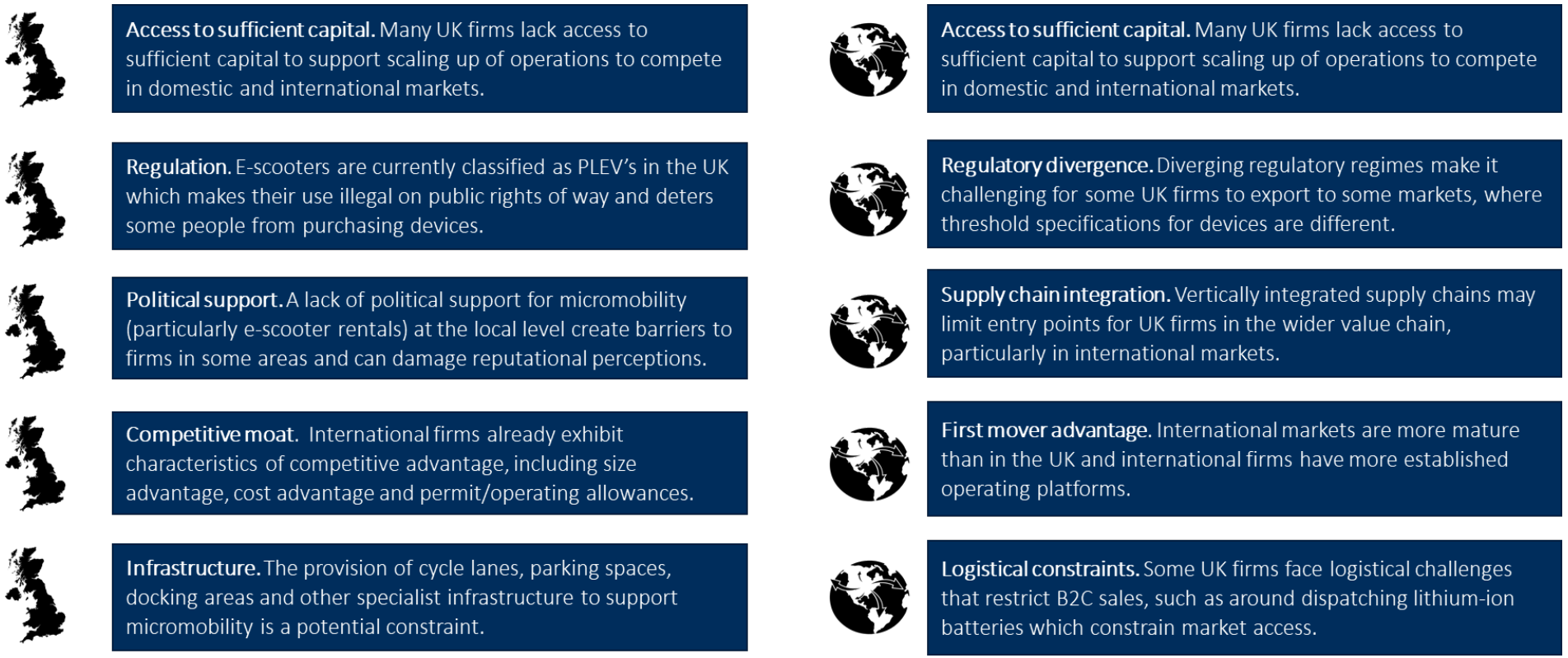


Source: Vivid Economics analysis

4.2.5 Market barriers and opportunities

The core barriers facing UK firms in the domestic and international market are denoted in Figure 19. The main barriers faced by UK firms in the domestic market relate to capital constraints, regulation, identification of suppliers to support supply chains, lack of competitiveness with larger international firms and limited provision of dedicated infrastructure to support the aggregate micromobility market. In the international market, UK firms face barriers around access to sufficient capital, divergent regulatory practices, consolidated supply chains, first mover advantage for large international firms and logistical constraints that limit direct access to consumers in some markets.

Figure 19 Core barriers faced by UK firms in domestic and international markets



Source: Vivid Economics analysis

The micromobility sector does offer a number of targeted opportunities for UK firms. For SP and retail firms directly, these opportunities are:

- UK SP firms could target marginal concessions, where the economics of operation are fundamentally different from permit-based allocations in larger cities which rely on at-scale models with significant capital investment (currently a key barrier facing UK firms). While unlikely to be as profitable, marginal concessions would require operating models that are better adapted for smaller-scale sites where a clear understanding of local transport issues and demand flows is core to profitability, potentially giving UK firms the edge. There may also be opportunities to extend such operating models into Europe to occupy other niche concessions.
- UK retail firms may target new growth areas, such as in bespoke adjustments of devices and personalisation, servicing and maintenance and additional lines such as clothing and IoT devices. Additionally, retail firms may increase capture rates in international markets through e-commerce lines that focus on high-quality products and brands, reflecting the GREAT Britain brand.

In addition to these specific opportunities, further opportunities are situated across the full value chain spectrum and span several sectors, from design to sales and marketing (Table 8).

Table 8 Opportunities for UK firms according to sector and region

Segment	Sector	Region	Opportunity
All	Insurance	Domestic	Novel insurance instruments, such as 'pay as you go' type services and low-cost premiums for devices.
All	Finance	International	A strong UK financial services sector can play a supporting role in corporate and investment banking, including supporting M&As, underwriting equity raises and debt financing, venture capital flows and asset backed lending that is currently not offered at the micro scale on rental devices. Also extends to other areas such as auditing & accounting.
SP	Consulting & advisory	International	Consultancy services, including Transaction Advisory and transport modelling to support firms in developing new pricing structures and targeted revenue generation opportunities. Other specialist areas may include management consulting to streamline emerging business models.
SP	Technology	International	Software engineering, app development and SaaS models for SPs or ancillary rental companies. Programming to support IoT devices that link to the cloud, supporting functions like geo-fencing, locking and other related services.
SP	Data aggregation	International	Data aggregation services and data mining could be used to add-value to SPs by selling user-derived transport data. Such models are already proving popular for satellite navigation service providers.
Retail	Brand management	Domestic	Developing powerful and differentiated brands aligned to customer wants/needs that project the GREAT Britain brand. Other ancillary opportunities may be around developing brand extensions and brand ambassadors for firms.
SP	Sales and marketing	Domestic	Designing innovative sales and marketing strategies, such as subscription-based models, incentives and promotions and aggressive marketing campaigns to support customer

Segment	Sector	Region	Opportunity
			acquisitions in the domestic market. Marketing activities may also target encouraging behavioural change and modal shift.
All	Manufacturing	Domestic	Limitations around logistics and distribution of lithium-ion batters due to unstable compounds and size[130] means more localised battery production may be increasingly advantageous as part of wider assembly lines. Britishvolt has already cited it will start construction of the UK's first Gigafactory this year in Blyth, largely for the automotive sector and may offer ancillary opportunities for the micromobility industry.
All	Design	International	Demand for new concept designs that support branding strategies and technology innovation (e.g., docks with renewable charging capabilities or vehicles with more efficient drivetrain). These designs may be used to support international manufacturing efforts as well-as UK assemblers. The opportunity is likely to be limited to higher-value design challenges.
All	Operations	UK	As the number of devices (either sold or used in rental fleets) increases so the market for service and maintenance operations is likely to grow. This is a key opportunity for UK firms to service the domestic fleet and may also create opportunities for secondary markets.
All	Regulatory standards	International	Imposing higher standards and tighter regulations would allow the UK to develop a 'best in class' micromobility sector with potential to export best practice through firms like the British Standards Institute (BSI) – see Box 6 - and other related institutions.

Source: Vivid Economics analysis

Box 6 Case study: British Standards Institute (BSI)

The BSI is the government-appointed standards body of the United Kingdom operating as a non-profit public body. The BSI regularly exports best-in-class standards and regulations to 84,000 clients in 193 countries to facilitate market development, increase trade and accelerate innovation.

The Smart-city standards is a good example how BSI are collaborating with other institutions (Future Cities Catapult) and industry stakeholders to identify key challenges facing urban environments and solutions to common problems cities face.

[130] Huo et al., (2017)

Smart cities standards are helping to drive the future cities market through:

- Helping to shape the market to enable the right conditions for innovation
- Shape the best direction for providing solutions
- Enable uptake of smart city standards regionally and internationally
- Jointly prioritize urban problems so city leaders can identify their priority areas of improvement that industry needs to address

Many of the current smart city standards published by the Cities Standards Institute are already being considered for adoption in international standards organisations such as ISO and are being implemented by cities around the world.

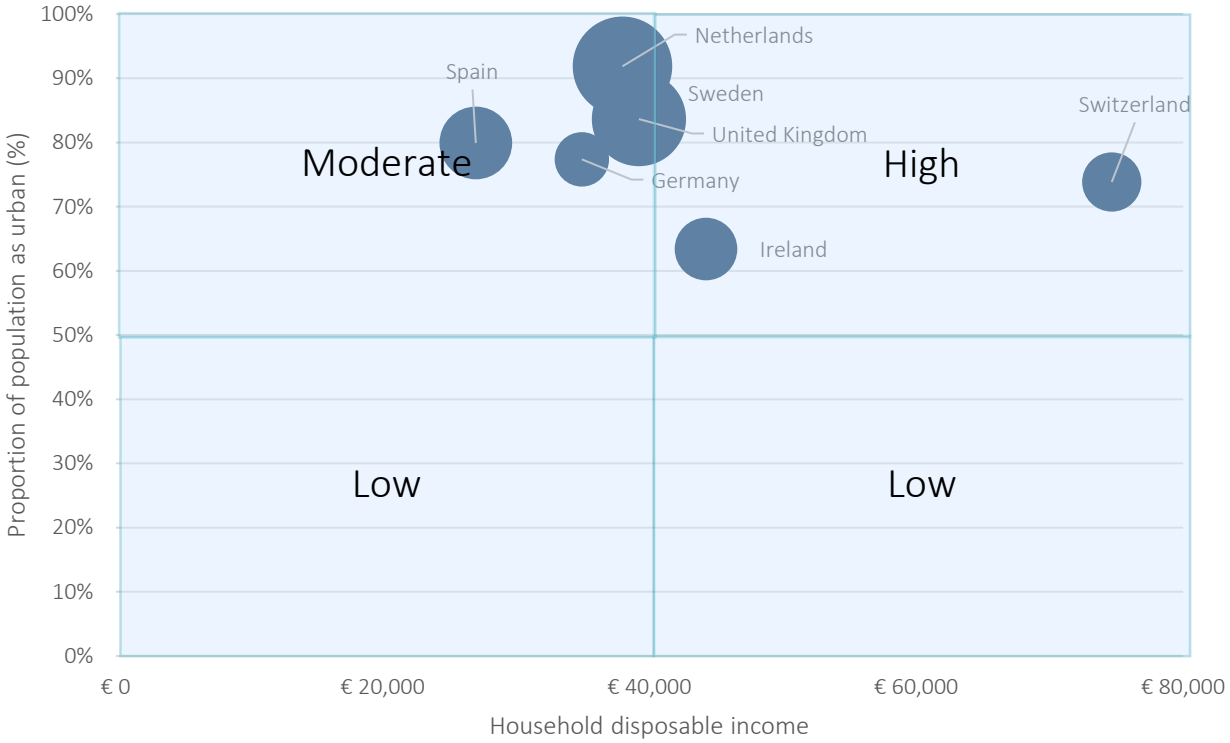
These activities could be extended to the micromobility sector through adjoining standards that build on the robust set of standards already developed by BSI and approaches that can be taken to improve city performance.

4.3 Scale of potential market

The potential market for micromobility is a function of the market drivers noted in Figure 7. Here, we consider the potential addressable market for select countries in Europe, where VC investment data is available, to explore how the addressable market in the UK compares against European counterparts and UK VC investment performance relative to other countries. This also acts as proxy for the potential scale of the UK market, as compared to European competitors.

In Figure 20 we plot three market drivers; the proportion of population classified as urban and disposable household income. The size of the bubbles represents the proportion of the population aged 15-24 years and living in cities. Since younger people with higher incomes living in urban areas/cities are the most popular rider demographic, this is a reasonable proxy of the addressable market. Based on these metrics alone, most countries analysed are likely to have a high to moderate addressable market based on the four graph quadrants. The UK falls somewhere in the middle and compares well with European counterparts. Of course, it is worth caveating that a myriad of other market drivers not included here will also impact ridership. Unfortunately, data for other drivers is not readily available to support further analysis.

Figure 20 Addressable micromobility market based on urbanisation

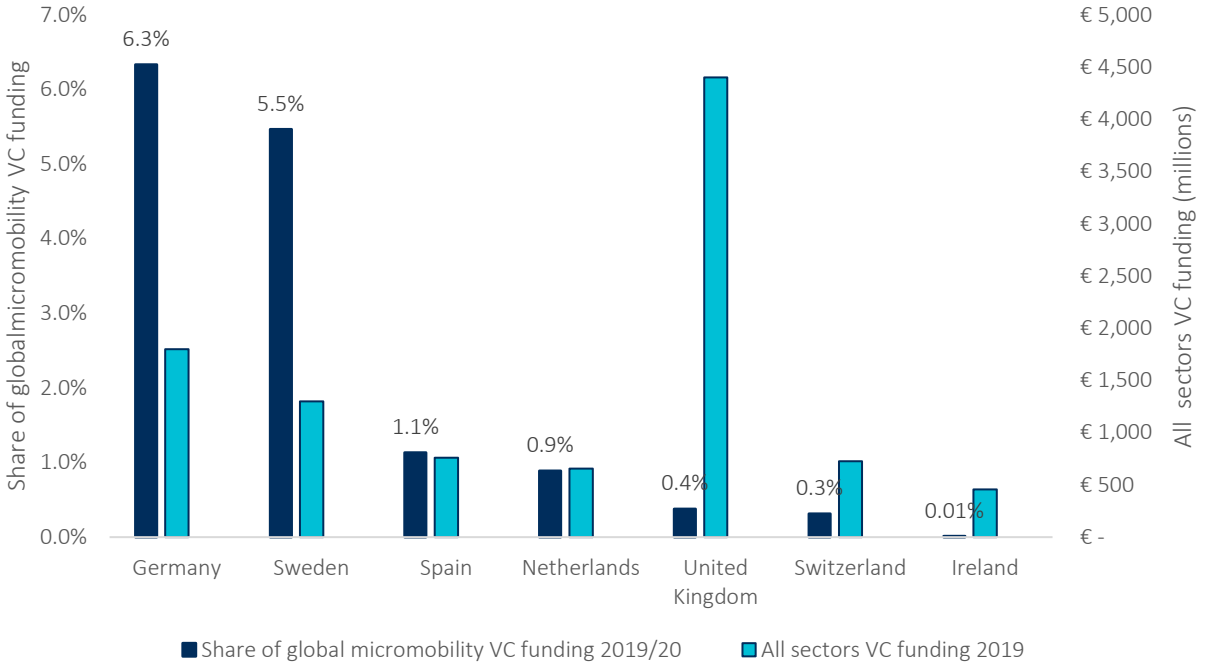


Note: The size of bubbles shows percentage of the 15-24 years population living in cities
Source: Eurostat, World Bank and Vivid Economics analysis

In Figure 21 we report the proportion of global VC investment flows for SP firms directed to the select countries analysed. This is based on attribution of VC investment to companies and aggregation according to company domicile. Germany and Sweden account for the majority of VC investment, owing to the success of companies like Tier and Voi in particular. The UK accounts for a much lower share of investment, largely a result of regulatory uncertainty around e-scooters. It is worth noting a bias in the data towards larger companies since smaller companies and start-ups are often underrepresented in market reporting and analysis. There is no immediately obvious overlap between our analysis of the potential addressable market and VC investment flows.

Typically, we would expect there to be a correlation between potential addressable market and VC capital flows if the UK were on a similar footing to neighbouring countries in terms of the enabling environment (e.g. infrastructure, regulation, market characteristics, etc.). This is especially true when benchmarking typical VC performance for the UK against neighbouring countries, where the UK and Germany have some of the strongest VC inflows in Europe (see below). In fact, the UK is a laggard with a comparable addressable market to that of Germany, yet less than one fifth of the VC activity. On the surface this suggests that should market barriers be removed there is scope for growth in the UK (as measured by VC activity). However, it is also likely that the UK's late entry to the market, combined with the scale of activity in neighbouring competitor markets, means there is unlikely to be a sizeable shift in VC flows to support UK firm's growth ambitions in what is now a highly competitive market.

Figure 21 Global VC investment flows for micromobility and overall by select European country



Note: Note there is a bias in valuation and investment flow estimates towards larger companies
Source: BIS Research, Statista and Vivid Economics analysis

4.4 Interventions to support UK firms

Increased ability to access capital investment, targeted financial support to better fund growth and a loosening of regulatory barriers are needed to improve the competitiveness of UK firms and catalyse growth. While we suggest a broad range of support mechanisms could be used to catalyse growth for both start-ups and pre-existing firms (see Table 9), we believe such mechanisms (e.g. match funding and financial incentives) are unlikely to 'move the dial' to any great extent in terms of UK firms share of the market, simply due to first mover advantage that international firms exhibit. A relaxing of regulatory constraints in the domestic market for e-scooters is likely to open up the market and may promote more innovation among UK firms around vehicle design and rental models. However, given the openness of the UK economy to international entrants and more prominent role of e-commerce in buying trends we suggest the extent to which greater market share could be attained is still likely to be limited.

Some of these support measures include creating British standards that reflect principal quality in vehicles, using partnerships and tax incentives to help firms exploit niche gaps in the market and wielding government policy and competitions to both fund new micromobility infrastructure and target innovation around more sustainable vehicle designs (e.g., modular designs and recycling). The full series of instruments and support mechanisms are documented in Table 9. This includes the core levers available to Innovate UK to offer targeted support but also broader policy and regulatory responses to support UK firms in the market.

Table 9 Interventions to support UK firms in the micromobility market

Barrier (B) / opportunity (O)	Instrument/ support mechanism	Targeted area	Description
B: Access to sufficient capital	Match funding	All	Attracting private investment (e.g., venture capital) is key for firms to scale-up operations. Using match funding schemes can improve the business case for

Barrier (B) / opportunity (O)	Instrument/ support mechanism	Targeted area	Description
			investors and de-risk private sector investment. However, this should be targeted at certain areas where there are synergies with social good outcomes, such as safety, social inclusion and efficiency.
B: Regulation	Revised regulation; adaptive & dynamic regulation	All	Revised vehicle classification for e-scooters in the UK and application of dynamic and adaptive regulation to uphold high standards in the UK that deliver desirable social good outcomes but do not crowd-out private sector innovation.
O: British Standards	Support creation of a British Standard	Vehicle design	Supporting the BSI to develop a British Standard for vehicle design will promote best in class safety and user comfort for vehicles. There may be further opportunities to expand standard creation into other areas (e.g., rental operations).
B: Knowledge transfer	Innovation networks and matchmaking	All	Employing a range of instruments to support knowledge transfer across the full value chain may help create new relationships between firms, universities and local authorities. This is particularly valuable to identify non-sector specific expertise, such as in technology, finance and design.
B: Competitive moat/first mover advantage	Match funding and tax incentives	Service providers	Using match funding may attract private sector investment to firms through de-risking the opportunity. Other support options include offering financial incentives to firms operating in niche areas of the market that are more focused on service provision, such as those offering rental firms operating in marginal concessions (smaller cities) tax or other financial incentives. This also serves a social good angle to ensure equal access to provision of services across towns and cities.
B: Micromobility infrastructure	Government policy and competitions	Infrastructure and docking	Government policy could strengthen commitments to the micromobility sector, both in terms of investment in infrastructure and creating cross-cutting policy agendas that centralise the role of low carbon and active modes. Award-based competitions could also be used to support innovation in specific infrastructure, such as novel dock designs.
B: Diverging regulation	Educational resources	All	Educational resources could be used to inform stakeholders of diverging regulatory practices in different countries to promote awareness regarding potential barriers to export to foster adaptive designs.
B: Supply chain integration	Advisory support	All	Advisory support may help firms identify opportunities to leverage and market their expertise domestically and overseas in specific value-add sections of the value chain. For example, SaaS applications or novel hardware designs.
B/O: Technology roadmaps and whole system thinking	Stakeholder engagement	All	Developing technology roadmaps that use whole system thinking is a clear opportunity to focus private sector innovation in key areas. This should be public sector led and is used to articulate a clear end-state

Barrier (B) / opportunity (O)	Instrument/ support mechanism	Targeted area	Description
			vision regarding micromobility. Engaging with stakeholders across the sector will be key, particularly when considering whole system thinking for complex transport networks.
B/O: Modular designs and recycling facilities	Grants and competitions	Vehicle design	Improving the sustainability and emissions intensity of vehicles will be key going forward. Using grants and competitions to promote innovation in development of more modular designs on vehicles will create a more circular manufacturing sector. Additionally, bolstering the presence of recycling facilities in the UK (particularly for batteries) through grants that are synergistic with parallel sectors (such as automotive industry) may further improve sustainability and crate cross-cutting pathways for collaborating with other industries.
B: Public sector procurement and partnerships	Policy	Service providers	Reducing complexities around IP and public sector procurement frameworks may encourage more innovation across SPs, particularly around technology trials and new operating models.
B: Logistical constraints	Stakeholder engagement; Educational resources	Retailers	Stakeholder engagement and educational resources could be used to increase awareness among retailers regarding dispatch constraints around lithium batteries and to identify alternative routes to export markets.
O: Vehicle durability and branding	Grants and loans	All	Use grants and loans to support UK businesses to design and assemble more durable vehicles and powerful brands that appeal to consumers.
O: Technology and user safety	Equipment access and test sites	All	Providing access to specialist equipment, particularly to develop early-stage prototypes is essential to help firms design and innovate for user safety cost effectively. Testing sites can support prototypes development in laboratory type settings that mimic real world conditions.
O: Novel technology applications	Advisory services and matchmaking	Technology	Supplying advisory services is essential for businesses to build better links and identify relevant expertise for creating novel technology applications (e.g., SaaS type models) that have an end market. Matchmaking may also help link firms with specific technical skills to exploit gaps, for example realising the value of user data through data aggregator services.

Source: Vivid Economics

5 Conclusions and Recommendations

Box 7 Conclusions and Recommendations key takeaways

- There is some evidence of innovation market failure for UK firms. The main barriers faced by UK firms in the domestic market relate to lack of private sector investment, restrictive regulation and market power (a lack of competitiveness with larger international firms).
- There are opportunities for UK firms to innovate in the market, including around vehicle design, niche rental market models targeting smaller concessions and applying technology solutions in the wider value chain.
- UKRI should focus on influencing policy and regulation, such that the UK develops 'best-in-class' micromobility regulation which can create an export opportunity across the value chain.
- The UK should encourage international firms into the UK market, reflecting the wider economic benefits including employment, training and investment flows in the wider economy.
- Innovate UK should ensure targeted financial support is available but towards specific areas of the market that the market alone may not be willing to solve, such as social inclusion, sustainability and safety. This will act to de-risk private sector investment and support firms to scale up operations in these areas.

5.1 Conclusions

The headline conclusions are:

- **There is some evidence of innovation market failure for UK firms across both market segments**. Legislative and regulatory barriers have resulted in sub-optimal innovation by UK firms, largely due to subdued consumer demand in some areas (e-scooters) and constrained demand in others (rental markets). Ultimately, this has meant investment in parts of the UK micromobility sector is typically more risky than other international markets and reflects limited capital inflows to UK firms and the distinct position of UK firms as second movers in the market (lack of market power).
- **The UK needs to identify suitable regulatory and policy models that embed micromobility within the wider transport services architecture and balance private and public sector interest**. Interim reporting on current UK micromobility trials are vitally important so market information around successes and failures of trials can be employed at key regulatory decision points. To maximise social good outcomes a number of factors should be considered in policy and regulation, including allocation criteria for issuing permits and concessions supported through competitive tendering, the potential for price cap regulation to limit fees, minimum standards regarding the design of vehicles and safety regulations and the use of incentive instruments to support operators in marginal concessions to balance the provision of services.
- **The provision of infrastructure to support micromobility is inadequate and further investment is needed to support user group segregation in urban areas**. Investments in cycle ways, roadway separation and bigger bus lanes are necessary to make riders feel safer and reduce mixing with other modes. Identification of areas to support parking and storage for docked and dockless based systems is necessary and should also include integration with public transport (i.e. citing parking areas at key

transport interchanges). This compliments wider transport policy agenda around emissions reductions and reducing congestion in urban areas.

- **The UK micromobility market is a private sector response to a number of market drivers, including congestion, poor transport connectivity, poor reliability of other modes and net zero policy ambition**. In addition, other drivers such as COVID-19 have further accelerated a shift to more active modes although it is unclear how this trend may continue going forward.

- **A key focus of the rental market to date has been around e-scooter deployment and this is seen as a key growth area**. While both e-bikes and e-scooters are used in rental models, a major focus of rental companies is around e-scooter applications since they have proved overly popular with consumers. We suggest this trend is likely to continue, particularly with novel vehicle designs such as seated scooters serving to increase user familiarity and comfort.

- **The global micromobility market is estimated to be worth $49 billion in 2020, rising to $60 billion in 2025.** The global SP market is valued at $1.7 billion in 2020, rising to $3.4 billion in 2025, forecast to be growing at a CAGR of 14.5%. The retail market is much more mature (accounting for nearly 95% of the market) and is valued at $47.2 billion in 2020, rising to $56.8 billion in 2025 and forecast to be growing at a CAGR of 3.8%.

- **The micromobility value chain is largely concentrated around operations, manufacturing and technology development**. Value chains for both SPs and retail firms are distinct reflecting varying operation models and longer supply chains associated with SP firms. These compositions are unlikely to change dramatically in the future.

- **UK firms account for around 2% of the global SP market, while in the retail segment UK firms account for around 4% of the global market**. We estimate UK firms account for around 17% to 27% of the UK SP market, whilst in the retail market UK firms account for between 22% to 37% of the market. Based on our central case, we estimate the majority of UK firms' revenues are derived from the domestic market, with the European market the next most important contributor.

- **We believe the domestic market share of UK SP firms is likely to decrease over time as better-capitalised international firms enter the market and win larger contracts which small UK firms cannot fulfil, forcing UK firms into smaller marginal concessions**. In other markets their share is likely to remain low owing to a lack of maturity in the sector.

- **The domestic market share of UK retail firms is likely to remain broadly flat over time, even as their overall market revenues grow**. UK firms in the retail value chain command a larger share of international markets (ranging between 0.6% to 7%) mainly because of online retailing that has driven exports. UK firms have a small but growing presence in Europe and North America, largely driven by higher-value products.

- **The main barriers faced by UK firms in the domestic market relate to capital constraints, regulation, lack of political support, competitiveness with larger international firms and limited provision of dedicated infrastructure to support the aggregate micromobility market**. In the international market, UK firms face barriers around access to sufficient capital, divergent regulatory practices, consolidated supply chains, first mover advantage for large international firms and logistical constraints that limit direct access to consumers in some markets.

- **There are opportunities for UK firms to innovate in the market, including around vehicle design, niche rental market models targeting smaller concessions and applying technology solutions in the wider value chain**. UK SP firms could target marginal concessions, where the economics of operation are fundamentally different from larger, permit based allocations in big cities which rely on at-scale models with significant capital investment – currently a key barrier facing UK firms. UK retail firms may target new growth areas, such as novel vehicle designs focused on comfort and new user segments (such as

appealing to older users), personalisation of vehicles, developing powerful brands that make vehicles more appealing and technology applications such as data mining, SaaS models and IoT devices.

- **Additional opportunities are possible for UK firms operating across the full value chain spectrum**. This includes opportunities in ancillary sectors such as financial services, regulatory standards, consulting and advisory and novel insurance applications to name but a few. There are unlikely to be any real opportunities in the manufacturing sector, which is largely offshored to the Asia Pacific region which has a distinct competitive advantage owing to lower unit costs for production. These lower costs are are a function of lower wage costs, strong business ecosystem, lack of regulatory compliance and compliance and low taxes and duties in China and Taiwan[131].

- **While we suggest a broad range of support mechanisms could be used to catalyse growth for both start-ups and pre-existing firms, we believe such mechanisms (e.g. match funding and financial incentives) but are unlikely to 'move the dial' to any great extent in terms of UK firms share of the market**, simply due to first mover advantage that international firms exhibit. A relaxing of regulatory constraints in the domestic market for e-scooters is likely to open up the market and may promote more innovation among UK firms around vehicle design and rental models, which could be further encouraged through KTN, matchmaking and financial support (tax incentives and match funding). However, given the scale of activity in neighbouring competitor markets coupled with first mover advantage exhibited by many international firms, means there is unlikely to be a sizeable shift in the extent to which greater market share could be attained by UK firms.

5.2 Recommendations

The headline recommendations for Innovate UK are:

1. **Innovate UK should focus on influencing policy and regulation, such that the UK develops 'best-in-class' regulation and standards for micromobility**. A key facet of this is that market information is needed ahead of regulatory decision points, so interim reports on the current micromobility trials taking place across the UK are highly relevant. Upholding higher regulatory standards that are evidence based is key and the BSI Smart City Standards are a good example of a best practice export opportunity. This may lead to further opportunities for UK firms, both around consulting on regulation and more broadly in design, reflecting higher standards for vehicle design.

2. **Innovate UK should target financial support towards specific areas of the market where innovation may be sub-optimal and the market alone may not be willing to address.** In particular, we suggest making vehicles more sustainable through reducing lifecycle emissions and improving sustainability should be a priority, through a greater emphasis on recycling and modular design. Innovate UK can use match funding as a lever to de-risk venture capital investments into this area which generates both public benefits and addresses a gap in the market for more sustainable vehicle design and operation. This has the added benefit of ensuring alignment between Innovate UK support and the UK Governments net zero policy ambition, including decarbonisation of the transport sector.

3. **Identify areas where incentives (such as lower charges to operators) can transact for demand in smaller towns and cities that may be less attractive to service providers.** Using tax incentives or lower charges to operators in smaller cities and towns would facilitate service provision in marginal areas, where the economics of operating are inherently different and potentially less attractive. This would ensure consumers can express demand for the positive externalities attributed micromobility (convenient transport, low carbon, active modes) in a variety of settings. As an added objective, this is an opportunity for Innovate UK to ensure alignment with broader levelling-up government policy to ensure poorer regions are equally represented in the market.

[131] https://www.investopedia.com/articles/investing/102214/why-china-worlds-factory.asp

4. **Encourage international firms into the UK market, reflecting the wider economic benefits including employment, training and investment in the wider economy**. The UK has used FDI as a proven mechanism to promote growth in the wider economy very successfully. The opportunity area for UK plc should not be constrained to UK domiciled firms and there are many benefits to encouraging international firms into the UK market which may support sector employment and innovation. International firms may already have better, more efficient operating models and this could be advantageous for UK consumers through lower fares, more competition and better systems. Additionally, this may be the best route to international markets through partnering and knowledge sharing with international firms, recognising that we are second movers.

5. **Support wider opportunities for UK firms in the micromobility value chain through KTN, match making and industry/investor days to promote opportunities.** Some sectors in the UK economy may already have innovative responses to some barriers and opportunities already discussed here, but information asymmetries constrain market organisation and firm involvement. Raising awareness and brokering KTN may help firms enter the market with transferrable skills from other sectors. Examples of potential areas include battery production (the UK Government's commitment to a domestic Gigafactory), automotive drivetrains, data mining and software engineering.

6. **Develop a business directory for the micromobility sector linking different sectors to promote innovation in hardware design and technology.** Information failure regarding lack of awareness of other firms' activities in the market constrains the ability for firms to innovate, develop prototypes and advance technology. A business directory linking agents and suppliers would support co-creation across the sector and provide links to businesses outside trade associations.

Appendix

A1: List of stakeholders interviewed

Table 10 List of stakeholders interviewed and company information

Firm name	Interview date	Sector	Number of employees	Regions operating in
Universidad Polytecnica de Madrid	02/02/2021	Academic institute researching mobility	-	-
Beryl	02/02/2021	Service Provider	51-250	UK, NA
Taur	03/02/2021	Escooter retailer	12	UK sells worldwide
PureElectric	03/02/2021	Retailer	200	UK sells worldwide
Ginger	04/02/2021	Escooter Service Provider	20	UK
TravelAI	05/02/2021	Auxiliary Software	6	UK, EU
MicroScooters	05/02/2021	Retailer	>250	UK sells worldwide
CP Catapult	05/02/2021	Public sector org	-	-
Swifty Scooters	25/02/2021	Retailer	10	UK sells worldwide
Mas Design	25/02/2021	Designer	6	UK sells worldwide
SeeSense	26/02/2021	Auxiliary Hardware Retailer	14	UK sells worldwide
Voi	12/02/2021	Service Provider	400	EU, UK

Source: Stakeholder Engagement Interviews

A2: Questions from stakeholder engagement

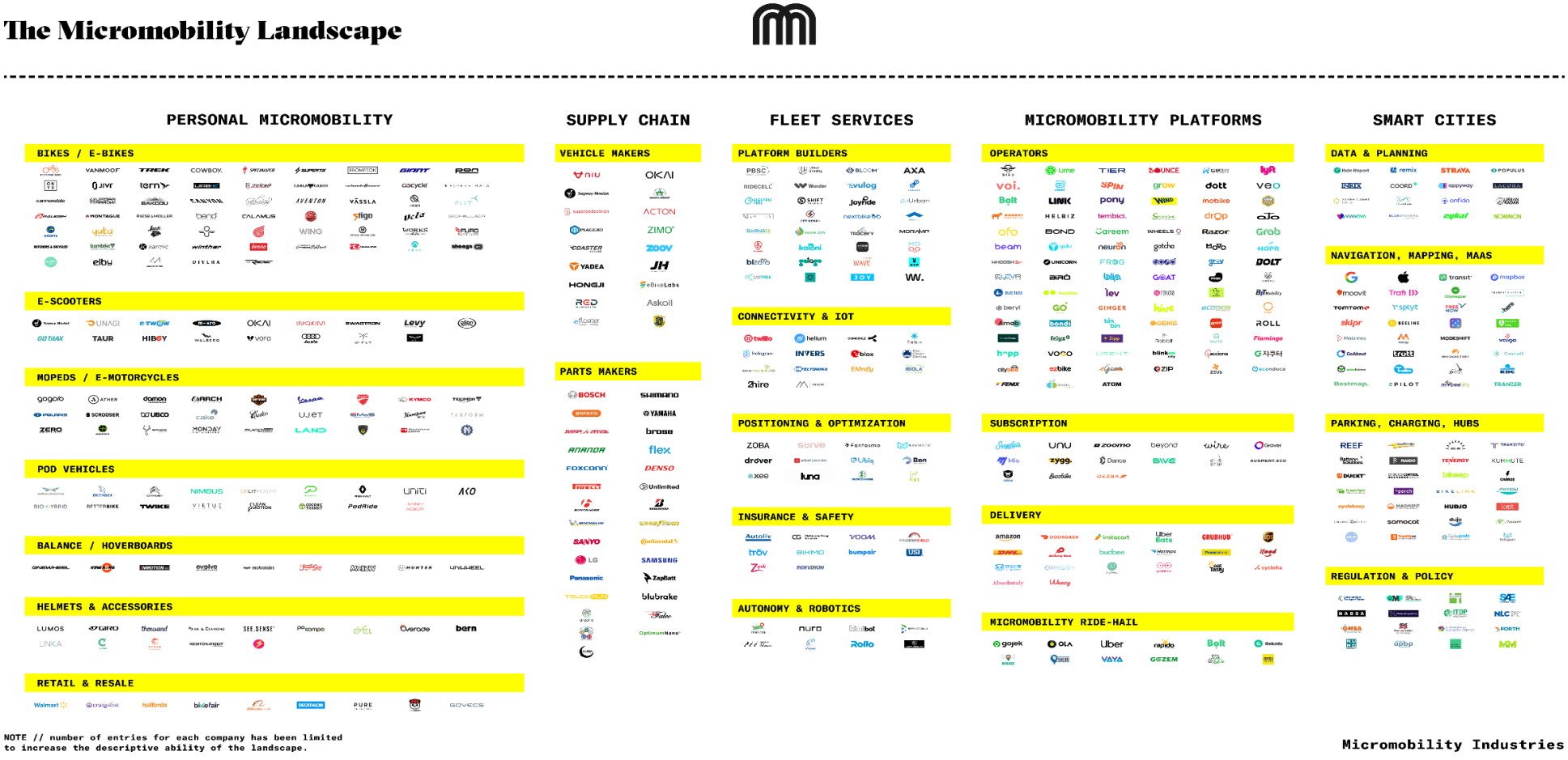
Table 11 Question list from structured interviews with stakeholders

#Q	Question
1)	How would you describe your main business activity/micromobility sub-activity?
2)	Are you operating in the service provider or retailer space or both?
3)	Within this, where would you best describe your position in the value chain?
4)	Which of the following best describes how many people are employed by this business?
5)	In which regions do you operate?

#Q	Question
6)	Is our approximation of the micromobility value chain accurate?
7)	Where in the value chain are UK firms/employers most competitive in the domestic and overseas markets?
8)	Where in the value chain can UK firms expect to grow their market share in domestic and overseas markets?
9)	What are the key barriers to growth faced by UK firms in the micromobility market?
10)	Where are the gaps/opportunities in the market for UK firms?
11)	Can UK firms/employers fill some of these gaps in the market?
12)	What type of business support will be the most beneficial to support innovation in the micromobility market by UK firms?
13)	Overall, how do you rate UK firms' ability to obtain greater market share across different stages of the value chain?
14)	How large do you estimate the global and regional micromobility markets are?
15)	In which regions do UK firms have strong presence in the micromobility market?

A3: List of micromobility firms in the market

Figure 22 Firms in the global micromobility market



Source: Micromobility Industries

A4: Benchmarking and validation exercise

Given the great deal of uncertainty in our analysis, we ensured our estimates for UK firms' share of the domestic and global markets were accurate by validating our results using a bottom-up approach, as well as cross-validating our stakeholder engagement findings with country-level import and export flows. These checks helped guide our modelling assumptions and ultimately estimation of market capture by UK firms across all regional markets. The validation checks employed were:

- Bottom-up estimates of market capture by UK SP firms using company-level trial data and revenue estimates where applicable.
- Bottom-up estimates of UK market size using company revenue data for UK-based retail and SP firms to validate estimates of market capture by UK firms in domestic market.
- Bottom-up estimates of global service-provider market composition using company-level investment
- Top-down assessment of wider value chain opportunities by transposing the UK's relative sectoral strengths and weaknesses based on macroeconomic analysis.
- Top-down analysis of export opportunities in the sector by exploring import/export metrics to understand direction of trade flows between UK and other regions to validate stakeholder consensus on UK firms' export opportunities.
- Validation Exercise 1: UK trials for SPs
- To estimate the size and composition of the UK service provider market, we analysed information available on each existing e-scooter rental scheme in the UK to estimate the shares of the market captured by firms from the UK and other regions. We computed market shares based on three criteria: the number of firms partaking in the trials from each region, the coverage by population of each firm across all its trials and the coverage by GDP. A further breakdown of the number of locations operated by each firm is available in Table 13.
- This information suggests UK firms command somewhere in the region of 27% to 11% of the UK SP market as a function of the trial schemes only (Table 12). The rest of the trial market is occupied by US, EU and Asia-Pacific firms. These estimates do not suggest how the market is likely to evolve over time post trial phase.

Table 12 Estimated market share of firms in UK e-scooter trials in 2020

Origin	Count	Proportion by count	Population	Proportion by population	GDP (£Million)	Proportion by GDP
UK	18	35%	3,054,333	20%	£ 99,605	29%
EU	20	39%	10,375,682	68%	£ 175,716	51%
US	11	22%	1,325,011	9%	£ 53,618	16%
Asia Pacific	2	4%	445,671	3%	£ 15,449	4%

Source: Como.org, Nomis.web, ONS.gov, ONS.gov

Table 13 List of firms participating in UK e-scooter trials

Company	Origin	Number of trial locations	Trial population covered	Trial GDP covered
Voi	EU	14	9,309,391	£140,499
Ginger	UK	7	913,914	£32,588
Spin	US	7	789,020	£28,931
Zwings	UK	6	1,406,105	£47,016
Beryl	UK	5	734,314	£20,001
Zipp	EU	3	321,281	£8,792
Wind	EU	2	580,641	£19,352
Lime	US	2	287,587	£17,897
Bird	US	2	248,404	£6,791
Neuron	Asia Pacific	2	445,671	£15,449
Tier	EU	1	164,369	£7,074

Source: Como.org, Nomis.web, ONS.gov, ONS.gov

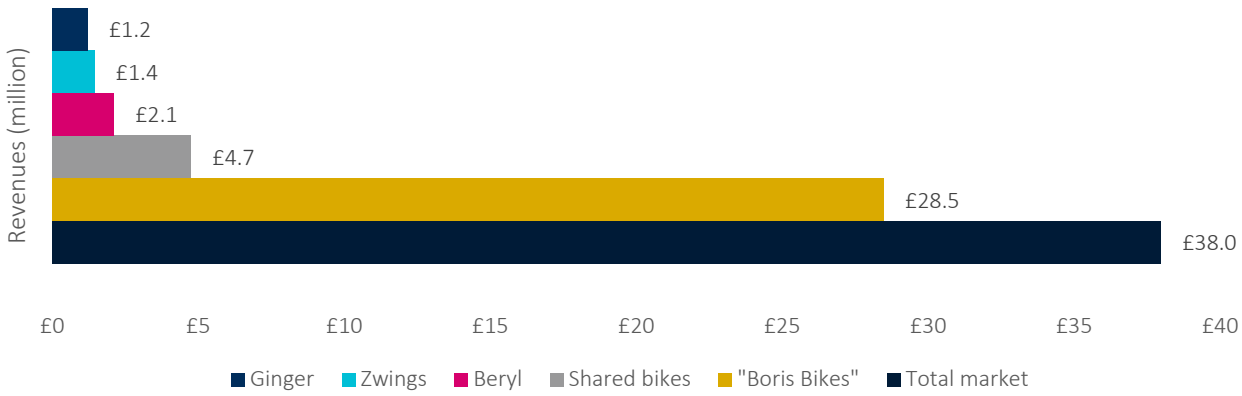
Validation Exercise 2: UK firms' revenue estimates (retailers and SPs)

In order to validate our market sizing estimates of the UK retail and service provider segments, we estimated the revenues of leading UK micromobility retailers and service providers, using a bottom-up approach. For retailers we used company revenues to gain a lower bound estimate, while for service providers we used trial information such as number of scooters and assumptions on revenue per device. We used this exercise to validate our modelling results for UK firms' revenues in the UK, across both the retail and service provider market segments.

The core barriers facing UK firms in the domestic and international market are denoted in Figure 19. The main barriers faced by UK firms in the domestic market relate to capital constraints, regulation, identification of suppliers to support supply chains, lack of competitiveness with larger international firms and limited provision of dedicated infrastructure to support the aggregate micromobility market. In the international market, UK firms face barriers around access to sufficient capital, divergent regulatory practices, consolidated supply chains, first mover advantage for large international firms and logistical constraints that limit direct access to consumers in some markets.

- The results in Figure 23 show annual revenues for UK SP firms are likely to be in the region of £38 million, including consideration for bike share and Boris bikes scheme.
- The results in Table 14 show sales of devices may account for around £480 million in annual revenues. Of this, around £360 million is estimated to be retained revenues by UK firms.
- These estimates should be interpreted as approximate, since they rely on generalised assumptions around trips per device and revenue per trip which our revenue calculations are sensitive too.

Figure 23 Annual revenue estimates (2020) of key firms engaged in the UK SP market



Note: Each bar represents the annual revenue of UK-based micromobility service providers, with the total market a cumulative sum of all the above operators. 'Shared bikes' represents all British, private bike share service providers, is assumed to have equal revenue to combined revenues of shared scooters providers, given that total shared scooter counts are close to those for shared bikes. 'Boris Bikes' is formally the TfL Santander Cycles schemes, is assumed to have triple the revenue of combined private shared bike and scooter providers, proportional to the ratio of Santander Cycles to scooters.

Source: 1,2,3,4,5,6,7,8,9,10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Table 14 Estimate of retail firms' revenues (2020) in micromobility market

Company	Revenues from micromobility (£million)	Assumption
Halfords	£ 481	50% of Financial Year 2020 retail revenues of £961 are attributable to micromobility products and services.
Evans Cycles	£ 77	All reported revenues are attributable to micromobility products and services.
Brompton bicycles	£ 57	All reported revenues are attributable to micromobility products and services.
Pure Electric	£ 20	All reported revenues are attributable to micromobility products and services.
Subtotal	*£ 634*	*Subtotal of the market leaders' revenues from micromobility devices and services.*
E-commerce	£ 159	E-commerce sales are estimated to account for an additional 25% of cumulative retail sales of the market leaders[132].
Independent	£ 159	Independent sales are estimated to add an additional 25% of cumulative retail sales of the market leaders
Total market	*£ 951*	*Total market revenues from micromobility devices and services.*
Devices only	£ 476	Devices alone account for 50% of total micromobility related revenues (i.e. excluding clothing and accessories)

[132] CONEBI (2016)

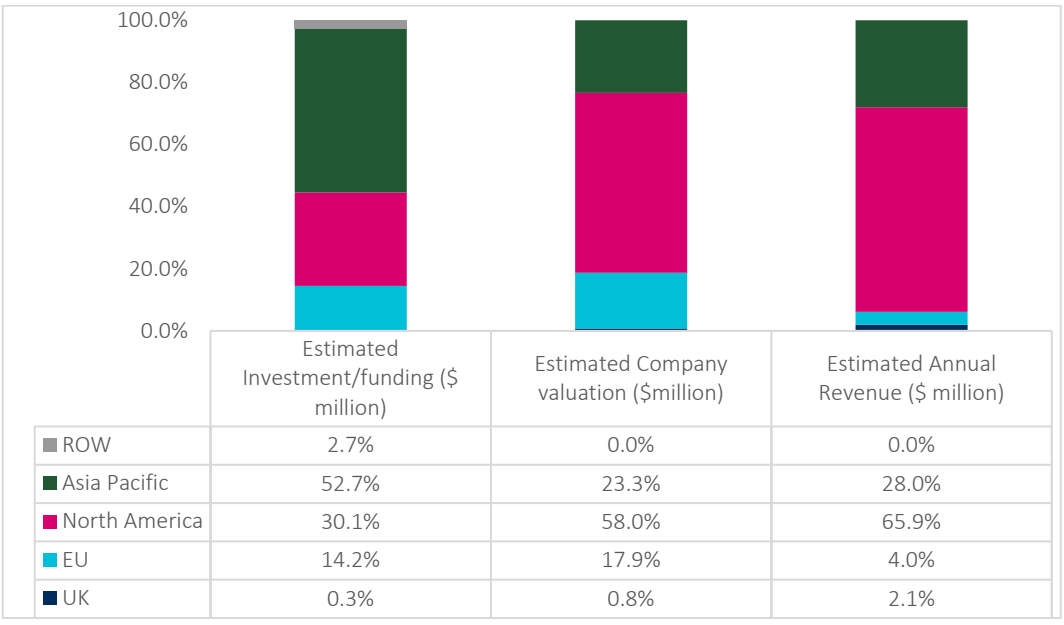
Company	Revenues from micromobility (£million)	Assumption
UK devices only	*£ 357*	*This adjusts for imports, exports, ancillary sectors or lost revenues overseas.*

Source: Halfords, Evans Cycles, Times, Times, Vivid Economics

Validation Exercise 3: Investment flows into SPs

- To validate our market sizing estimates for the five global regions, we used a bottom-up company level market sizing approach to estimate global service provider market sizes by company revenues, total capitalisation and company valuation.
- Not only was this to validate our estimates of the regional disaggregation of the global service provider market, but this exercise also corroborated a common stakeholder complaint regarding the lack of available capital to micromobility firms in the UK.
- The results in Figure 24 suggest UK SP firms account for in the region of 0.1% to 0.8% of the global SP market directly. This, of course, ignores indirect participation in the wider value chain. Results also show that North American and Asia Pacific firms typically dominate the market across all metrics.
- Note there is a bias in these estimates towards larger firms due to lack of information and also accuracy of records. The estimates should therefore be treated as approximate.

Figure 24 Micromobility service provider firms' investment funding, valuations and revenues by region



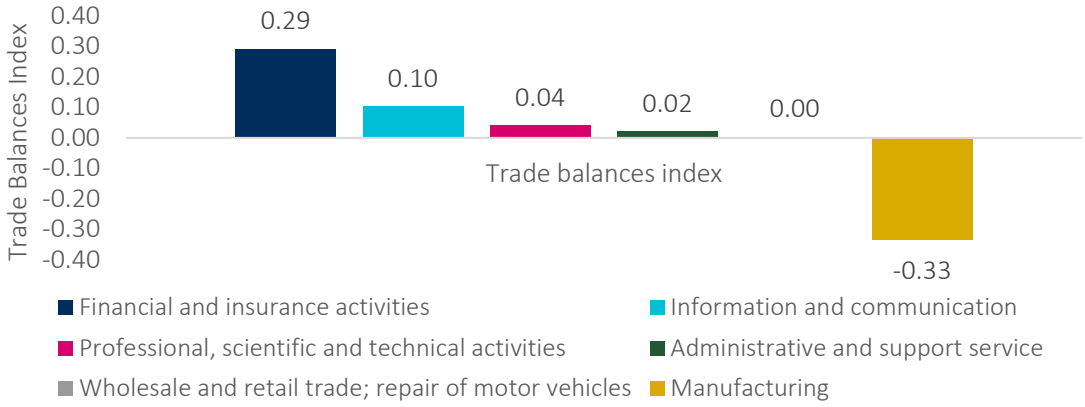
	Estimated Investment/funding ($ million)	Estimated Company valuation ($million)	Estimated Annual Revenue ($ million)
ROW	2.7%	0.0%	0.0%
Asia Pacific	52.7%	23.3%	28.0%
North America	30.1%	58.0%	65.9%
EU	14.2%	17.9%	4.0%
UK	0.3%	0.8%	2.1%

Source: BIS Research, Owler.com, Crunchbase.com

Validation Exercise 4: Balance of payments

- We used the UK Balance of Payments Pink Book data to explore trade flows around imports/exports across sectors to understand the potential contribution of UK firms across the value chain by linking the UKs comparative strengths in certain sectors. We created a 'trade balances index' by assessing the balance of payments across sectors and ordering into an overall index.
- The results in Figure 25 show a trade surplus in the financial, technology, professional services sector but with a trade deficit in manufacturing. Other areas are negligible.
- However, the micromobility value chain is not perfectly represented by the UK economy, with vertical integration and centralised operations a key distinction. For this reason, we engage with stakeholders to understand crucial details which fill our modelling assumptions.

Figure 25 UK trade balance index across different industrial sectors:



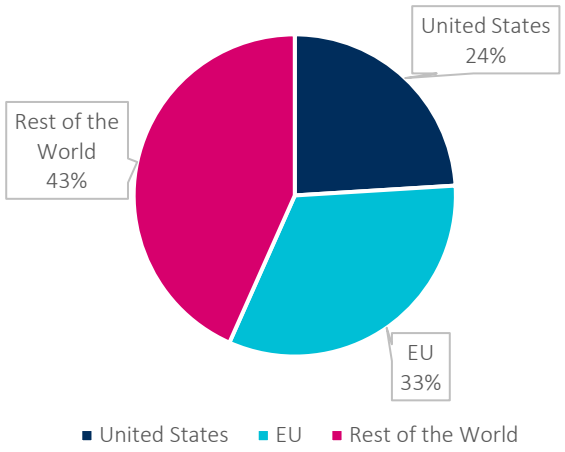
Note: Trade balance index are calculated as trade balance/total net trade balance, where values are on a relative scale of -1 to +1.

Source: Pink Book

Validation Exercise 5: Import and export flows

- Finally, we used import/export flow data to understand the regions with which we have the greatest and fewest trade flows to estimate export potential with regions.
- This helped to validate our stakeholder engagement results regarding UK firms' existing and future market shares in the different regional markets and to benchmark exactly what market share constitutes a significant overseas presence.
- The results in Figure 26 show the UKs main export partners are North America and Europe, with ROW accounting for a further 43% of trade flows (most of which is dominated by Asia Pacific exports). There is no reason to suggest these export flows would be dramatically different for UK firms operating in the micromobility market.

Figure 26 Percentage shares of UK exports by end destination – Q2 2019



Source: Vivid Economics, ONS.gov

Company profile

Vivid Economics is a leading strategic economics consultancy with global reach. We strive to create lasting value for our clients, both in government and the private sector, and for society at large.

We are a premier consultant in the policy-commerce interface and resource- and environment-intensive sectors, where we advise on the most critical and complex policy and commercial questions facing clients around the world. The success we bring to our clients reflects a strong partnership culture, solid foundation of skills and analytical assets, and close cooperation with a large network of contacts across key organisations.

Contact us

Vivid Economics Limited
163 Eversholt Street
London NW1 1BU
United Kingdom

T: +44 (0)844 8000 254
enquiries@vivideconomics.com