Freeing the Robots:

The Economic Benefits to the UK of Personal Delivery Devices

PRYSM GLOBAL

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The economic analysis in this report was undertaken by Robert Johnson, with the insight and support of Bridget Rosewell. Rebecca Marston contributed to and edited the report.

Robert Johnson is a professional economist, with analytical and public policy expertise from over five years' experience in the think tank and consulting sectors.

Bridget Rosewell CBE is one of the UK's top transport economists, chair of the M6 Toll Road and a director of the National Wealth Fund.

Rebecca Marston is a former BBC Business Correspondent.

Thanks to staff members at Starship Technologies who contributed their data, expertise and insight to the report.

Prysm Global is a strategic regulatory affairs consultancy, helping companies navigate regulation, policy and politics. It was founded by Anthony Browne and Jonathan Davidson.

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Executive Summary

Personal Delivery Devices (PDDs), an embodied AI delivery solution operated by Starship Technologies, have seen successful operations in a number of places up and down the country, including Milton Keynes, Cambourne, and Leeds. Over the past few years, these PDDs have expanded grocery sales, improved access to essentials and provided a sustainable delivery alternative for those who need "top-up" shopping, particularly in areas that do not have extensive existing delivery services. However, the availability of this service has so far been limited by the lack of clear regulation in the sector.

Starship Technologies is committed to the UK market. Though an Estonian company, the first commercial Starship deliveries were in Milton Keynes, and historically their largest and most sophisticated operations hubs have been in the UK. This is no longer the case. Starship is committed to the UK market and wants to significantly expand delivery operations and further commit by creating a new robot manufacturing programme in the UK. However, for companies in this sector to invest, a clearer regulatory landscape is needed. This report, an economic analysis of the impact of PDDs, finds that the current regulatory uncertainty is stymieing growth.

'Unleash £1.3bn in extra economic activity'

UK highways law is outdated. Laws as old as the Highways Act 1835 could potentially govern the deployment of embodied AI - like Starship's robots - in the UK. A small change in the law around pavement use would break that barrier, unleashing £1.3 billion in additional economic activity to the UK over the next decade. As well as creating 555 quality jobs across the country, PDDs could bring life to "delivery desert" areas turning them into thriving consumer zones, helping local businesses by increasing the customer catchment area. They can help people less able to physically reach the shops - the disabled, those with young children or other caring responsibilities or simply the time poor - to access both essential and discretionary items much more easily. They potentially can deliver not just groceries and food, but medicines and prescriptions.

The opportunities and challenges for the "final" or "last-mile" delivery are well known. The market for global last-mile grocery delivery is both substantial and rapidly growing. Revenue is forecast to grow by 9.74% a year from $938bn (£705bn) this year to $1.49 trillion by 2030, with user numbers forecast to reach 2.3 billion, or more than one in five people [1].

Since 2020, last-mile deliveries have surged. Alongside this market growth, assuming no interventions, last-mile emissions are expected to grow by 60% by 2030 in major cities[2]. Globally, these can already contribute up to 50% of logistics-related emissions in these areas. Powered by electricity, PDDs could help curb the growth of last-mile emissions.

1 https://www.statista.com/outlook/emo/online-food-delivery/grocery-delivery/worldwide
2 https://reports.weforum.org/docs/WEF_Transforming_Urban_Logistics_2024.pdf

‘Generate £125m new grocery spending’

People in areas where the Starship PDDs operate report a sense of pride in being on the future’s frontline, while also noting the ease with which the technology has integrated into their communities. This helps to inspire the next generation of engineers, meanwhile bringing in existing workers, willing to start at base level and skill up with the help of responsible employers such as Starship Technologies. This improves the UK’s skills base, raises wage levels, and further encourages interest in the tech sector.

Specific parts of the country would clearly benefit more from greater regulatory certainty. This would equate to almost half a billion pounds of benefits in combined authority areas. Greater London accounts for almost a quarter with £116 million, followed by the West Midlands (£54m) and Greater Manchester (£48m).

Anthony Molloy

The Co-op is Starship Technologies’ leading UK retail customer. The benefits to the Co-op range from environmental improvements to increased demand, while their speedy, local delivery helps keep products fresher from store to door. **Anthony Molloy**, Senior Manager for Co-op Delivery and Technology, said: ***“Autonomous robot deliveries are a popular part of Co-op’s quick commerce mix. Co-op’s approach to quick commerce sees orders picked fresh in the local store and then delivered quickly and conveniently in the community, so the High Street store benefits from online demand. The robots also support the environmental agenda of local authorities and councils – in particular efforts to reduce short car journeys. They are known to benefit those in the community who have mobility challenges, and cannot easily pop to their local Co-op for groceries. The robots are very popular with customers, with communities taking them to heart and feeling very protective towards them – they welcome the ability to receive delivery of Co-op products in as little as 20 minutes and are aware of the environmental benefits associated with reducing the number of short car journeys being taken. Residents have even been seen to help the robots, over curbs and crossings, and are delighted and amazed when the robot ‘thanks’ them!”***

In these last two areas, a sizeable proportion of the population live in delivery deserts, which would be opened up to new customers suddenly able to access a delivery service. This would have a real high street impact, inducing £125 million extra grocery spending across the country. Benefits would be disproportionately focused in the local authorities (LAs) of Knowsley, Rochdale, Kirklees, and other areas across the North and Midlands.

The local authority areas that would benefit most include Birmingham (£19m of additional economic activity), Bristol (£19m), Bournemouth, Christchurch and Poole, (£16m) and Cardiff (£15m). PDD licensing in Cheltenham, Exeter, Portsmouth and Reading LAs would see the largest gains relative to their size. Other areas that would punch above their weight are Leicester's suburbs, Gloucester and Exeter, as well as towns and cities along the South Coast.

Even more locally, PDDs would have a large impact in certain parliamentary constituencies. Cambridge, Reading Central, and Gloucester would all see £5 million of additional economic activity. York Central (£4.7m) and Coventry South (£4.3m) are also top performers.

PDDs also help areas to become more productive. This report suggests the local authority areas of Slough, Rushmore, Reigate and Banstead, South Ribble, Tamworth, Halton and Knowsley could all see the largest productivity benefits from working hours saved for local employees.

The greatest local impacts would be in those where PDDs would be made and serviced. Milton Keynes serves as a case study for a potential manufacturing and maintenance hub. Along with more than £10 million in GVA impact, the City Council area would enjoy up to £138 million in direct investment, and 166 new high-skilled positions in manufacturing and servicing, putting an additional £2.4 million in local workers' pockets by 2035. PDDs have the potential to grow the Advanced Manufacturing sector and the business service support sector in the area by 5% and 3% respectively over the same period.

Summary in Figures

The quantitative analysis in this report shows that providing regulatory certainty for PDDs in the UK would lead to a range of economic benefits around the country, including more growth, jobs, investment, consumer spending and productivity.

Economic Growth

- In aggregate, PDDs would have £1.3 billion gross value added (GVA) impact on the UK economy by 2035.
- More than a third of this is in mayoral areas, with Greater London alone accounting for £116 million. However, in terms of impact relative to population, £36 million additional economic impact in the West of England provides the most for each local resident.
- PDDs have 60% more impact in larger urban areas where online grocery delivery accessibility is low. As many of these areas are on the fringes of cities, this helps disperse economic activity. This is notable in West Yorkshire and Greater Manchester, where just over a third of residents live in delivery deserts. These city regions will see almost half of the GVA impact in these underserved areas, many of which will have felt the sharp end of de-industrialisation.

Investment

- Legislation would help the UK achieve its Industrial Strategy goals of raising business investment for Advanced Manufacturing over the next decade by enabling on-shoring of PDD manufacturing into the UK. In the Milton Keynes City Council area alone, this would bring in up to £138 million direct investment to the local economy.

Jobs

- Manufacturing jobs would increase, helping the UK towards its sector-specific goals for Advanced Manufacturing. Our analysis suggests 555 additional high-skilled jobs by 2035, leading to almost £11 million more in local workers' pockets over the next decade. The Milton Keynes City Council area alone would see a 5% increase in its Advanced Manufacturing sector.

- These jobs will be focused on where PDDs will be made and serviced. All robot operations require maintenance, servicing and technical support. A maintenance hub in Wigan could have real impact, seeing 65 new servicing roles and £1.4 million in extra wages paid out in the local authority area by 2035, increasing the size of its business support sector by 2% in ten years' time. Similar hubs in Havering and Swindon borough councils would boost this sector locally by 10% and 5% respectively.

Additional spending

- PDDs would enable additional spending on UK high streets. Effective licensing would bring £125 million of grocery shopping over the next decade that would not happen without this.

- The benefits would be most enjoyed across Northern local authorities because of the PDD's outsized impact in delivery deserts – for every £1 additionally spent elsewhere in large cities, almost £6 will be spent in delivery deserts, as PDDs extend the grocery delivery market to underserved areas.

Productivity

- PDDs save time. Our analysis shows they could save 300,000 working hours, with almost £140 million of additional impacts through productivity increases over the next ten years.

Emilia Ala-Kurikka

Finland's S- Group is the biggest retailer in Finland. It has been using Starship's PDDs for three years and has expanded their use to most of the major cities in the country. **Emilia Ala-Kurikka**, product lead at S-kaupat, S-Group's food e-commerce business, says they were astonished by the positive strength of their reception, which bounced them in to an abrupt change of strategy: ***"I'm responsible for our e-commerce grocery business. We did a pilot with the Starship robots, just for a short period. We were keen to develop our own delivery systems but when we stopped using Starship's our customers gave us tons and tons of feedback: 'Where are the robots? We're very happy to still shop with you, but can't you send it in a robot?' Those robots are really something for the customers."***

Introduction

Personal Delivery Devices: The case for a legal framework

Personal Delivery Devices (PDDs) are effectively compact insulated containers on wheels, the size of a mini fridge. They operate 99% autonomously using a combination of sensors, radar, cameras and AI. They use machine learning and neural networks to continually learn more about the world around them to deliver goods, such as top-up shopping from stores like the Co-op, and hot food. They do not replace the weekly big shop but supplement it. There is no limit to what can be delivered in this manner, with Starship reporting the main request being secure prescription delivery. Orders are placed via an app and, once loaded at the stores, a sophisticated combination of hardware and AI guides the robots to the customer's door. Once there, they send an alert and wait to be offloaded.

The robots are low weight and low speed, with a software-limited maximum of four miles per hour - walking pace. They operate as a cautious pedestrian would, in many ways mimicking human behaviour. They travel on pavements, only using roads to make crossings, with Starship stating that their robots make an average of 125,000 crossings per day globally.

Starship Technologies' PDDs have so far made more than eight million deliveries to customers worldwide. They currently serve the US, Germany, Finland, Estonia and Sweden and, in the UK, seven local authorities (LAs): Milton Keynes City Council, Central Bedfordshire Council, West Northamptonshire Council, Leeds City Council, Wakefield Metropolitan District Council, Trafford Council and South Cambridgeshire District Council. The feedback in these local authorities from users and officials has been overwhelmingly positive. Independent resident surveys put approval ratings at between 75-93%.

They are not traditional "vehicles" and are not currently defined in UK law. Though pavements - especially in areas with delivery deserts - are often under-utilised spaces, there is ambiguity about the operation of pedestrian-like robots in this space. This is where regulation is required.

While other countries have legislated, in the UK the PDDs operate with a lack of clarity. Both the US and Finland now host larger fleets than the UK, even though Starship launched here. Though the risk profile is low, the safety record impeccable and value clear, the UK risks missing out. Legal uncertainty creates a barrier to the potentially considerable growth of these services.

Starship Technologies has called on successive Governments to set out clear and consistent regulations that will ensure the safety of pedestrians and other road users, formalise procedures around liability in case of accidents or incidents and set minimum safety standards, either through a national framework or by local licensing. Despite the lack of legal clarity, PDDs have been included in the Government's new Industrial Strategy.

The English Devolution and Community Empowerment Bill presents an opportunity to provide legal certainty. It is set to allow all local transport authorities to regulate on-street micromobility operations, including small, lightweight vehicles like bicycles and e-bikes, but with the flexibility to add other micromobility operations in future, which should allow PDDs freedom to operate across the country.

However, rather than the licensing of PDDs being a possible “next step” in the Bill, if it is adopted now within the Bill, it would allow the growth of a service that will clearly benefit the country in both jobs and services.

The Economic Impact of PDDs

This report sets out the potential economic impact of bringing forward clear and supportive regulation for the use of PDDs in the UK, assuming the route would be granting local authorities the power to licence PDDs. It models the economic impact of the expansion of deliveries through:

- The estimated total Gross Value Added (GVA) impact of extra deliveries by local authority, aggregated up to the national level.
- The impact on jobs and wages from creating high-skilled positions across the country from on-site servicing of PDDs.
- The likely additional direct investment, in monetary and job terms, from onshoring manufacturing of PDDs to the UK.
- The additional spending this would facilitate on high streets in different areas of the UK.
- The potential productivity implications through saved working hours from avoiding trips to the shops.

Results are also given at the combined and local authority levels. Also set out is how the impact varies in smaller UK geographies: by parliamentary constituency, and the specific impact on neighbourhoods classed as delivery deserts.

In the rest of this report, we set out our approach to modelling the future economic impacts of the legislative change and present the results.

Economic approach

This section sets out the modelling approach to estimating the economic impact of PDD regulation across the UK, in terms of GVA, additional spending, jobs, investment, and productivity. Annex 1 presents the detailed methodology.

Overall framework

To assess the potential economic impact of PDDs, the modelling compares the outcome of UK local authorities having devolved powers to allow PDDs in their areas, versus a counterfactual scenario where this does not happen.[3]

This ensures all stated benefits are "additional" – they would not have happened if the legislation had not passed. For example, spending by PDD operators on inputs to production (e.g. parts) is not additional as in the counterfactual these would be used in other industries. Similarly, this applies to deliveries by PDDs where customers would otherwise use a competitor service (e.g. a standard supermarket delivery). In this way the modelling only considers the "added value" that PDD operators would bring to a local authority.

The analysis assesses benefits over the ten-year period 2026-35 (equivalent to two full parliaments). All benefits are stated in 'present value' terms (denoted Net Present Value (NPV)), and monetary values in 2025 prices unless otherwise stated.[4] Due to data limitations, this report does not consider Northern Ireland.

The scope of the analysis is conservative in that it only considers the impact of PDDs facilitating grocery deliveries. It does not factor in their potential impact in other sectors, including pharmaceuticals or restaurant delivery. It additionally does not consider their impact on the output and productivity of supermarkets themselves (beyond additional spending).

Ian Achurch

North Northamptonshire Council has found Starship Technologies' PDDs of benefit to its economy, encouraging local shopping, helping both big and small retailers reach customers. **Ian Achurch**, economic head at the council says: ***"The robots have gone down really well here, like a breath of fresh air. They're positive in so many ways. If you take retail, your Co-op and the larger shops can use them but also small retailers, local businesses can get onto that platform. They just encourage people to shop locally. They could safeguard local businesses, they're able to provide an alternative means of connecting with their customers."***

3 This is the standard approach taken according to the Green Book used by the UK Government.

4 This uses the standard Green Book discount factor of 3.5% and accounts for future OBR inflation projections to state the path of future benefits in today's terms in real prices.

Gross Value Added

This component assesses the additional economic activity resulting from the activity of PDD operators in the UK which would not occur without legislation change.

Estimating additional economic value to the operators themselves involved the following steps:

1) Data at the neighbourhood level was provided by Starship Technologies from areas where they have run PDD services in eight local authorities since 2018, including Milton Keynes, West Northamptonshire, and South Cambridgeshire.[5]

2) Pilot areas were used to assess the determinants of delivery numbers by location. These were broadly how urban an area was, and the accessibility of grocery deliveries for residents.[6] It was assumed PDDs would not operate in rural areas. Regression analysis (additionally accounting for maturity of the pilot area, and regional factors) found:

a) Neighbourhoods in smaller urban areas saw slightly more deliveries per resident than similar ones in big cities; and

b) Less grocery delivery accessibility saw fewer deliveries in smaller urban areas, but more deliveries in big cities.[7]

3) These results were used to predict what deliveries would look like across the country, matching the characteristics of non-pilot neighbourhoods to similar pilot areas.

4) Deliveries were assumed to grow over time, based on observed rollout rates in pilot areas, and forecast growth of grocery delivery and "quick commerce" markets.[8]

5) Delivery numbers were multiplied by net margin per delivery, using financial data from Starship Technologies.[9]

To translate this to additional economic value to the UK (i.e. Gross Value Added, or GVA) required assessment of which deliveries were truly "additional" and would not have otherwise happened with a competing delivery service (e.g. Deliveroo, Tesco, etc.). The counterfactual scenarios modelled were:

1) The customer would use another delivery service to make the purchase (delivery is not additional economic activity);

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5 Neighbourhood-level areas of operation, or 'Geo Areas', roughly match UK Lower Super Output Areas (LSOAs), which were the basis of the initial analysis. See Annex 1 for details.

6 This used DEFRA's Rural Urban classification data: https://www.gov.uk/government/collections/rural-urban-classification, and the Consumer Data Research Centre (CDRC) 'e-foods desert index' (https://hasp.ac.uk/research/place/). See Annex 1 for further details.

7 In smaller urban areas, this likely reflects fewer grocery options available and lower demand overall. In big cities meanwhile, it likely reflects the fact that PDDs are less commercially viable in buy areas of large cities, reflecting less of a competitive advantage against other traditional grocery delivery or quick commerce options (e.g., Deliveroo). Where PDDs can have added value in big cities is more fringe areas with lower grocery access and fewer delivery options.

8 The scale-up rate in Milton Keynes was used to predict rollout from zero PDDs for each place, as the most established pilot area. Deliveries were then assumed to grow year-on-year at the rate of the fast-growing 'quick-commerce' market until 2032, at which point growth slowed to the rate of the supermarket grocery delivery market until 2035. See Annex 1 for details.

9 This used combinations of UK and Finnish costs and revenues, with Finland representing a more mature market. See Annex 1 for details.

2) The customer would make the purchase by travelling to the shop instead (delivery is additional economic activity); or

3) The customer would not make the purchase at all (delivery is additional economic activity and induces additional spending).

Starship provided an internal customer survey which allowed the prediction of incidence of each counterfactual depending on the food delivery accessibility rating of each neighbourhood.[10]

Results were aggregated up to the local authority level to determine the direct GVA impact of PDDs in each place. The following second-order GVA impacts were calculated using standard Input-Output tables:[11]

- The indirect GVA impact (i.e. the additional economic activity in the sectors of intermediate suppliers to PDD operators);
- The induced GVA impact (i.e. the additional economic activity from extra spending of workers employed in by PDD operators); and
- Further GVA impact of additional spending in supermarkets.

Taken together, these give the total GVA impact of PDD activity in each area relative to no legislation change. This was then added up to estimate the national level.

Jobs, wages and direct investment

Operating PDDs across local authorities would create skilled positions needed for operating and servicing the PDDs, focused on "maintenance hubs" located across the country. Using Starship estimates of required servicing staff needed for given volumes of PDDs and associated wages, predicted deliveries were used to estimate PDD numbers in each area of operation and therefore total number of servicing staff needed.

It is unrealistic to assume that new positions are "created" – discussion of new roles is always framed as changing the wage distribution of existing jobs. In this sense, PDDs will raise overall wage levels by providing high-skilled, higher-wage jobs (i.e. the technical roles associated with PDDs).

This analysis assumes that Starship Technologies would onshore the manufacturing of their PDDs to the UK in response to legislation change. This would bring in significant inward investment, in terms of setting up manufacturing and assembly facilities and infrastructure, all additional to the status quo scenario, as well as manufacturing jobs.

Starship provided estimates for inward investment and manufacturing jobs needed to support production of given volumes of PDDs. This was scaled in the same manner as servicing jobs.

10 This was a survey contained 400 responses over six of the pilot areas, and asked the question: 'If Starship delivery was not available, how would you get your shopping?'. Responses to this question were used to model the incidence of counterfactual scenarios.

11 See Annex 1 for additional detail.

Andrei Bud

STARSHIP

People who work with the robots say they can see fast growth for their services and a knock-on boost to jobs - if only they had a better licensing framework. **Andrei Bud**, Starship technician, says: ***"They need to be licensed to create more jobs. I use them. They're safe, they just need the final documentation. And, yeah, after that we will definitely have 1000s of robots. You know, we're going to need a bigger team. And, you know, it's a nice thing for the community, it's green, it doesn't disturb anyone."***

Additional spending

PDDs would generate additional in-store spending on groceries across the country. The value of this additional spending is important when considering the impact of legalisation on the high street.

This was calculated using survey responses from customers who would "go without" if PDDs did not operate in their area, combined with predicted deliveries and purchase values.[12]

Productivity

Finally, PDDs can save time – customers do not have to travel to the shops. This will have an additional impact on customer time saved where other time-saving delivery services are not available, or distances to groceries are large.

Survey responses from customers who would otherwise travel to the shops and the proportion of users working were combined with Starship data on deliveries during working hours and delivery distances to estimate the number of working hours saved in each local authority.[13] It was assumed that saved working hours would be used to generate additional output at current and forecast rates of productivity.

12 This analysis assumes customers would have 'gone without' in absence of PDDs would truly forgo these purchases (as indicated in the customer survey), and not compensate by increasing spending in other areas (e.g., clothes or leisure activities). See discussion in Annex 1.

13 This was further adjusted to account for customers shifting purchases outside working hours, and bundling purchases in other non-working hour shopping trips. See Annex 1 for details.

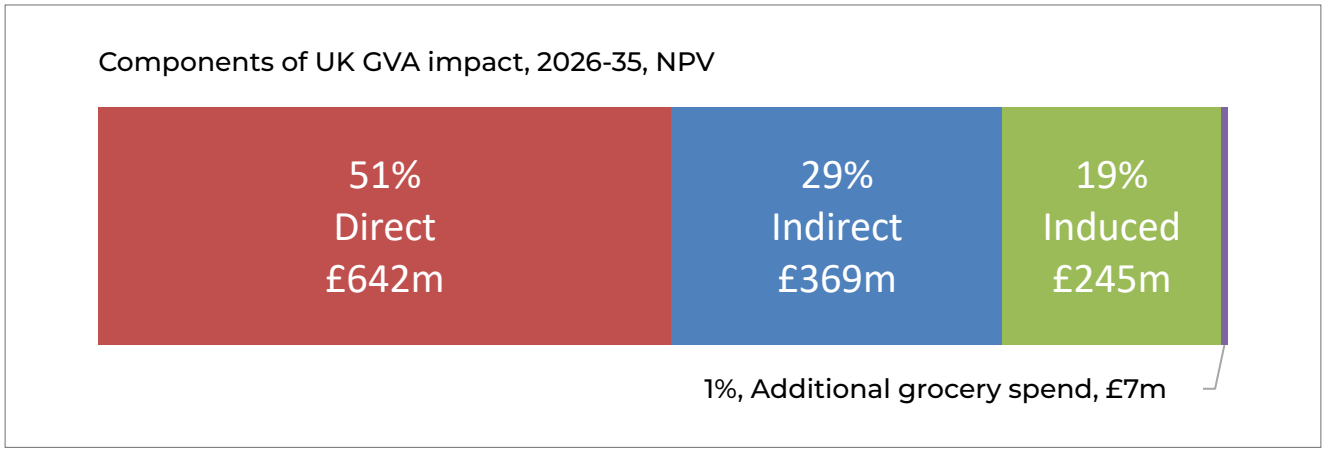
Results of the Analysis

Aggregate economic impact to the UK

PDD regulation is worth £1.3 billion to the UK economy over the next decade

The grand total present value GVA economic impact on the UK economy over the next ten years of PDD operation across the country (at the local authority level) is £1.3 billion in 2025 prices. This is equivalent to £126 million per year. This comprises direct GVA of £642 million, indirect GVA of £369 million, induced GVA of £245 million, and £7 million GVA from additional spending in supermarkets (Figure 1).

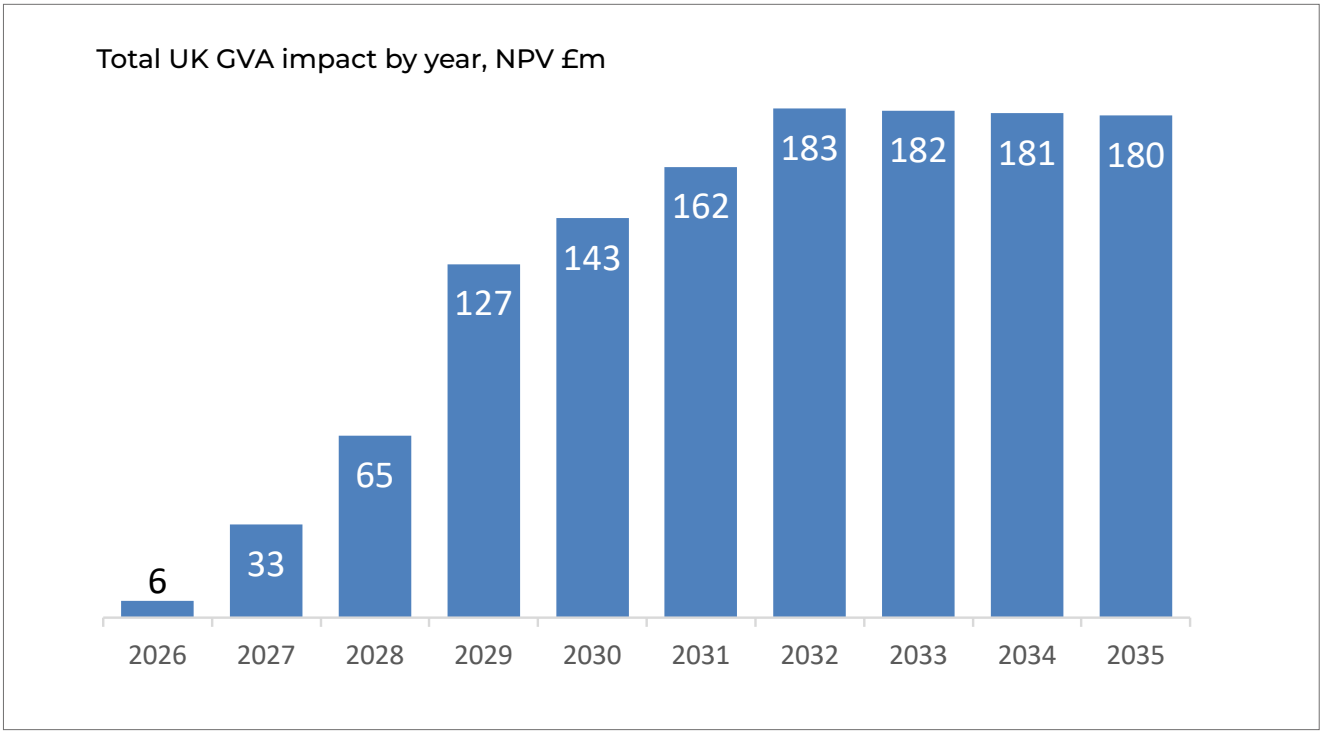
Figure 1: PDDs would add £1.3 billion to the UK economy over the next decade, half of which is direct impact



Source: Prysm Global calculations

Figure 2 presents this total present value GVA impact by year, showing that the benefits ramp up and accrue mainly towards the end of the period, reflecting the ramp up of PDD rollout across the country and the initial fast-forecast growth of the "quick commerce" market in the UK. 70% of the benefits occur in the last five years of the period.

Figure 2: GVA benefits increase rapidly over the first five years



Source: Prysm Global calculations

PDDs would net the UK £138 million in direct investment and 555 high-skilled jobs

Manufacturing PDDs to meet the estimated deliveries requires direct private investment of £138 million in present terms over the period. This impact will be focused where PDDs will be manufactured. We explore this further in the local authority economic impact section.

Manufacturing PDDs in the UK could onshore manufacturing operations such as batteries, metal chassis and custom electronics. Therefore, putting in place a supportive regulatory framework for PDDs would align with the Government's recent Industrial Strategy goals on boosting advanced manufacturing over the next decade, a sector in which it hopes to double annual business investment by 2035.[12]. With supportive regulation, direct investment in UK PDD manufacturing alone would contribute toward 0.2% of that national growth goal, and up to 0.8% in the first three years.[13] This is an outsized impact in a sector containing industries such as aerospace, space and advanced materials.

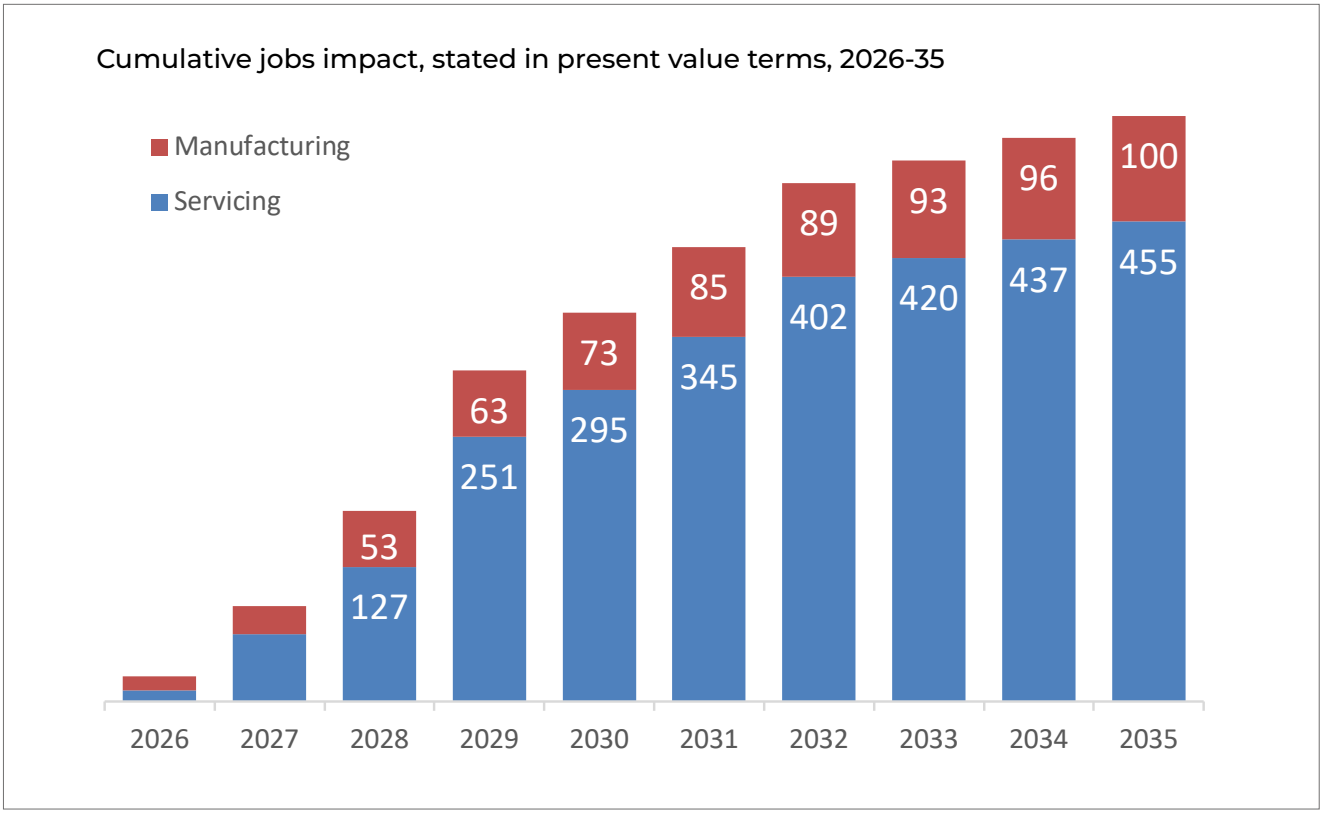
Kyle Mear

STARSHIP

Starship's PDDs attract demand not just from customers, but from potential workers. And as well as keeping shopping local, they could help boost employment - and keep it more local, says **Kyle Mear**, Starship technician: ***"I was working in insurance for five years, claims processing. I'd always been interested in tech but in Leeds if you want a good tech job you have to move out of the area. So when I saw an ad from Starship about robots coming to Leeds I was really happy. I would have worked for them for free. Growing up we were told to get into tech but there weren't the opportunities here. If we could have more of these opportunities outside of London, you're going to see more people like me getting into tech. You would see such an explosion of people coming into the role and not having to run away down south or run away to another country."***

The rollout of PDDs across the country and their manufacturing in the UK is estimated to support the equivalent of 555 Full Time Equivalent (FTE) jobs by 2035, representing new positions in high-skill occupations in PDD servicing, operations and manufacturing. This comprises 455 servicing jobs and 100 manufacturing jobs. Figure 3 shows how these positions accumulate over the decade.

Figure 3: The majority of jobs impact would be through servicing and operational roles



Source: Prysm Global calculations

This will have a cumulative present value impact of £9.8 million of increased earnings over the period, or £21,500 per additional position. These jobs and increased wages will be focused in specific places where maintenance hubs are set up (see local authority impact section).

Manufacturing jobs are assumed to be entry-level, or replace existing Advanced Manufacturing roles[14], and would have a cumulative present value impact of £1 million of increased earnings over the period, or £10,000 per additional position. This effect will be localised where manufacturing takes place (see local authority impact section).

PDDs would facilitate £125 million extra spending on UK high streets

Across the UK, an estimated 3% of all deliveries by PDDs would be for goods that customers would not have bought otherwise (either using an alternative delivery service or buying in-store). This translates to £125 million additional spending on groceries between 2026 and 2035 in present value terms.

By saving trips to the shops, PDDs would net the UK £139 million in productivity gains

PDDs are estimated to save the equivalent of almost 300,000 working hours per year over the next decade, as customers save time spent in travelling to the shops. At a national level, this translates to £139 million additional GVA output over the next ten years.

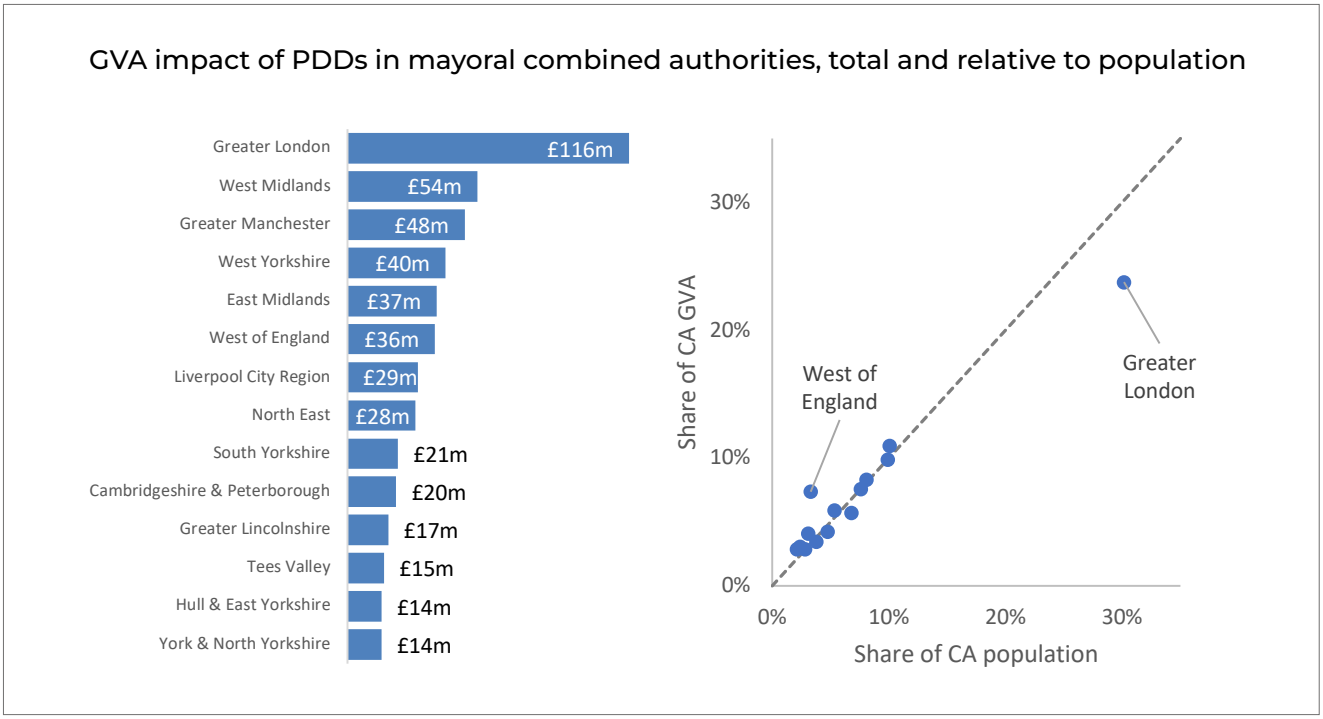
14 https://www.gov.uk/government/publications/industrial-strategy/industrial-strategy-sector-definitions-list

Economic impact by combined authority

As part of the reorganisation of local government as set out in the Devolution Bill, local transport authorities could be allowed to regulate micromobility schemes - which PDDs could potentially fall under if there is political will - in their area.[15] This will happen at the level of the Mayor in the seven Established Mayoral Strategic Authorities gaining these powers next year, with the idea to grant other existing combined authorities (CAs) these powers in due course.[16] This section therefore presents results at this level of local government to reflect the likely level at which PDD operation will be authorised.

Combined authority areas would net almost half a billion pounds of GVA impact of the £1.3 billion UK total. Of this, Greater London accounts for almost a quarter with £116 million (Figure 4). This is followed by the West Midlands (£54m) and Greater Manchester (£48m).

Figure 4: While PDDs have the largest impact in London, the West of England sees the largest relative to its size



Source: Prysm Global calculations

15 https://www.gov.uk/government/publications/english-devolution-and-community-empowerment-bill-guidance/english-devolution-and-community-empowerment-bill-guidance

16 These are: Greater London, Greater Manchester, West Midlands, Liverpool City Region, South Yorkshire, West Yorkshire, and North East.

This is not the whole story. London's share of impact is lower than its size might suggest – it has 30% of the total CA population, but just 24% of the GVA impact. The West of England is the opposite – despite having only 3% of the total population, it overperforms with 7% of GVA output.[17] In other words, West of England would be the city region area to get most "bang for buck" in terms of economic impact for its residents. The other CAs have impacts roughly in line with their size.

Economic impact by local authority

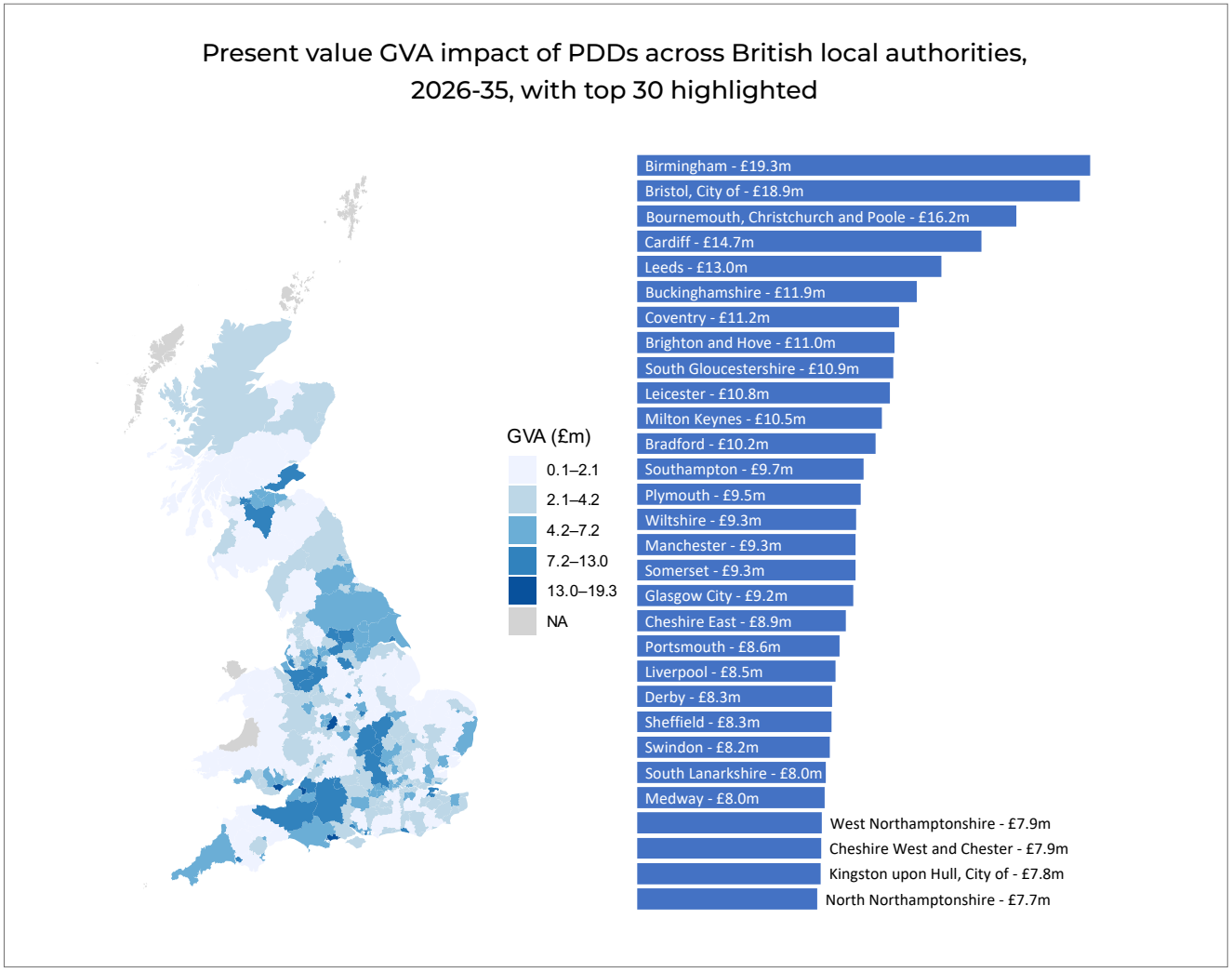
The largest GVA economic impacts are in Birmingham, Bristol, and Bournemouth, Christchurch and Poole.

Figure 5 shows how the £1.3 billion GVA impact is distributed across local authorities in England, Wales, and Scotland.

The top local authorities by GVA impact for their residents are Birmingham (£19.3m), Bristol (18.9m), Bournemouth, Christchurch and Poole (£16.2m), and Cardiff (£14.7m). Overall, the biggest impacts are focused in large city LAs, smaller cities across the South and Midlands, and larger more rural LAs in the South West which contain urban areas.

17 This is because Greater London is a large urban area with lots of food options, and so PDDs have more competition with established delivery services. Meanwhile the West of England also has good grocery accessibility, but contains many more smaller towns and urban areas, meaning more orders via PDDs.

Figure 5: GVA impact is concentrated in the South West, East Midlands, Cheshire and Yorkshire, and the Central Belt of Scotland

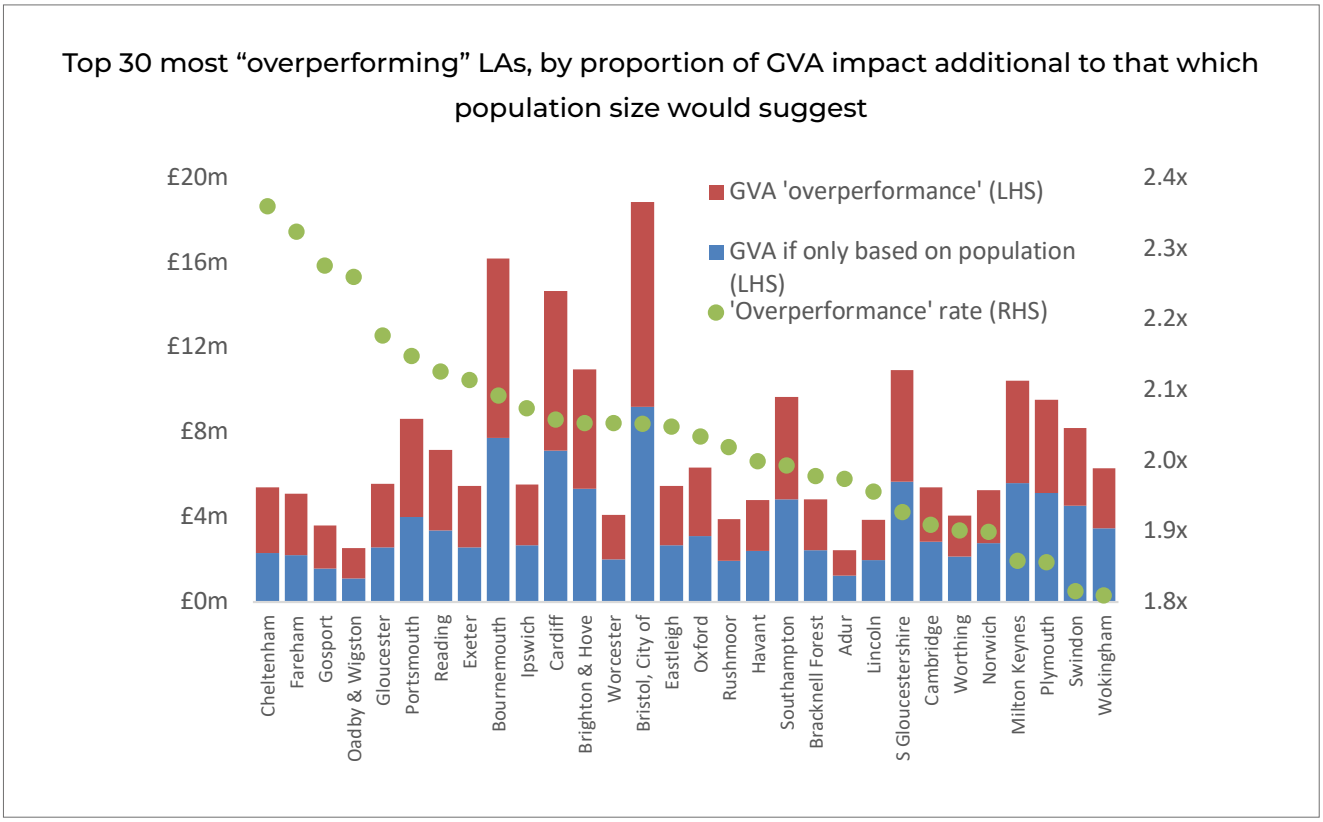


Source: Prysm Global calculations

When we look at which local authorities overperform relative to their population those local authorities which would get the largest GVA impacts of PDDs relative to their size stand out (Figure 6).

Top of the list is Cheltenham Borough Council, where the GVA impact for local residents is almost 2.4 times what would be expected if it was just driven by population. This additional impact accounts for £3.1 million of the £5.4 million total impact in this small LA. Leicester's suburbs, Gloucester, Exeter, Reading, and other towns and cities along the South Coast all effectively double their economic impact relative to their population size. This is worth an additional £9.7 million for Bristol, £8.5 million for Bournemouth, and £7.5 million for Cardiff LA residents beyond that which their population size would otherwise suggest.

Figure 6: Some local authorities see more than twice the GVA impact than their sizes would suggest – this is worth an additional £10 million to Bristol



Source: Prysm Global calculations. Notes: Bournemouth, Christchurch and Poole abbreviated to Bournemouth; South Gloucestershire, S Gloucestershire

Most overperforming local authorities are in the South East and South West, with some in the Midlands. These LAs tend to cover smaller cities and towns with high predicted demand for deliveries using PDDs. This reflects their multitude of grocery delivery options, higher likelihood of using online deliveries, and consumer demand from disposable income while avoiding the competitive environment for grocery deliveries found in larger urban areas.

The top-ranking local authorities in other regions with the greatest overperformance are:

- York (32nd overall, 1.8x overperformance) and South Ribble (33rd, 1.8x) in the North;
- Falkirk (59th) and West Lothian (61st) in Scotland (both 1.5x); and
- Newport (60th, 1,5x) and Torfaen (68th, 1.4x) in Wales (outside of 11th place Cardiff).

For full GVA impacts by local authority see here.

Operating and servicing PDDs would have large localised effects on jobs

While PDDs would operate all over urban parts of the country, servicing and operations will in practice occur in hubs focused in specific locations. Starship Technologies has existing hubs in Milton Keynes and Leeds City Councils for its UK operations. In practice the number of hubs would increase with the significant expansion of PDDs across the country.

Andrei Bud

STARSHIP

Starship Technologies helps workers build on their interests and increase their skills to enable them to move up within the company. **Andrei Bud**, techician, started working for the company firstly as an on-the-ground technician, inspired simply by the sight of the robots. He says: ***"I was intrigued by them, I was living above the Co-op which was the first store to use them. They're really cute and really interesting. I was very interested and researched the company, applied and got in and quit my retail job. I started as a basic technician - collecting the devices and doing basic programming. But Starship supported me fully to learn more and develop. Basically, every day it's a school day. We learn about the robots, and it's such a supportive family, let's say it's brilliant!"***

For the purposes of this analysis, we estimate the impact of servicing jobs, assuming the two existing hubs continue and additional hubs are set up in the following LAs: Sunderland City Council, Wigan Council, Cardiff Council, Swindon Borough Council, and Havering Borough Council (on the outskirts of Greater London).[18] These locations are based on information provided by Starship Technologies. However, these do not necessarily mark the precise locations of these hubs if legislation were to be passed. All analysis in this section should be taken as indicative of the local impacts on jobs these hubs could have.[19]

Figure 7 shows how the 455 additional servicing roles and £9.8 million cumulative wage impact would be distributed across each hub area.[20] Havering would account for almost 25% of additional servicing jobs by 2035, benefiting workers in the LA with cumulative increase in wages of £2.5 million over the period. Next is Swindon LA, accounting for 68 (15%) of the additional jobs with a wage benefit of £1.5 million. Despite its size as the smallest geographical area, it contains many of the LAs which see the

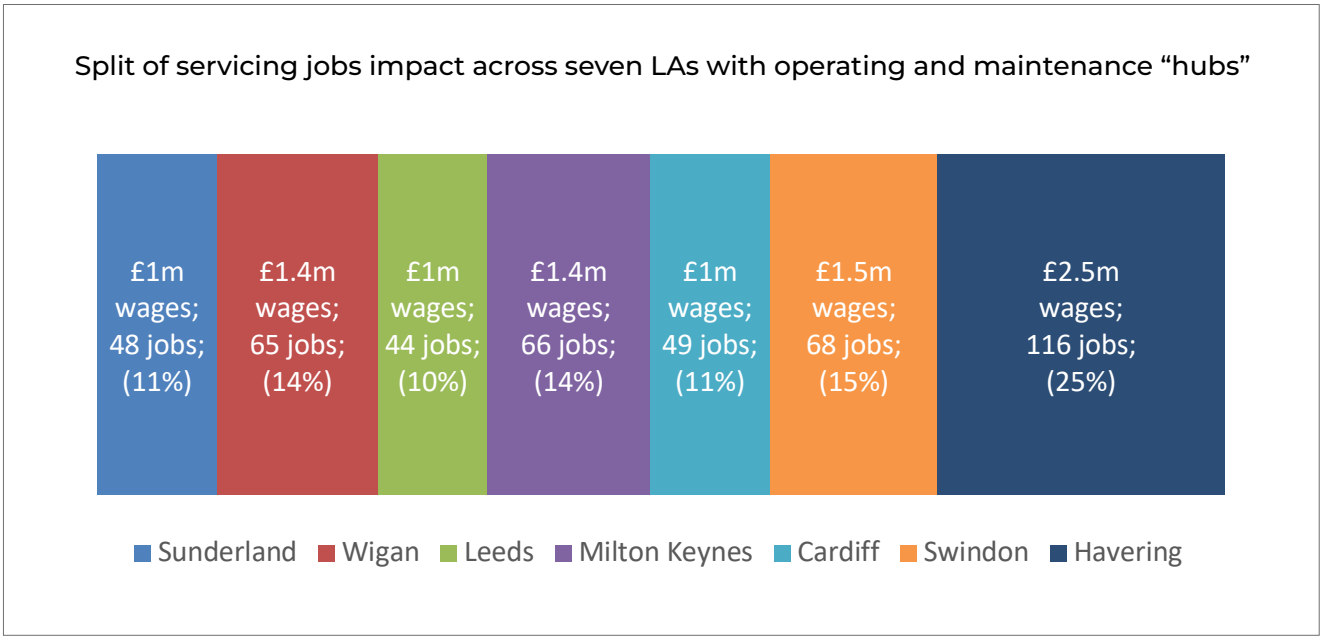
18 We apportion predicted PDDs to each hub based on distance of operation from the hub. Assuming a hub is set up at the centroid of the local authority, PDDs are apportioned to that hub if the majority of the local authority they operate in is closer to that hub than any other in the country.

19 These locations moreover represent a relatively even geographical spread and are focused in or near where PDD operations are estimated to be concentrated. Therefore it is informative to base the analysis on these places, even if local impact is not guaranteed there.

20 The wage impacts are assumed attributed entirely to hub LAs as the wage impact from freeing up delivery driver occupations across the country would be negligible in each LA.

largest per capita impact from PDD deliveries, including all of the top three. Finally, £1 million and £1.4 million wage impacts for Sunderland and Wigan workers respectively would have significant impacts in areas with some of the lowest wages of any urban areas in the country.[21]

Figure 7: Havering could see a quarter of the jobs impact, while Sunderland, Wigan, and Leeds could see over £1 million each in local workers' pockets over the decade



Source: Prysm Global calculations

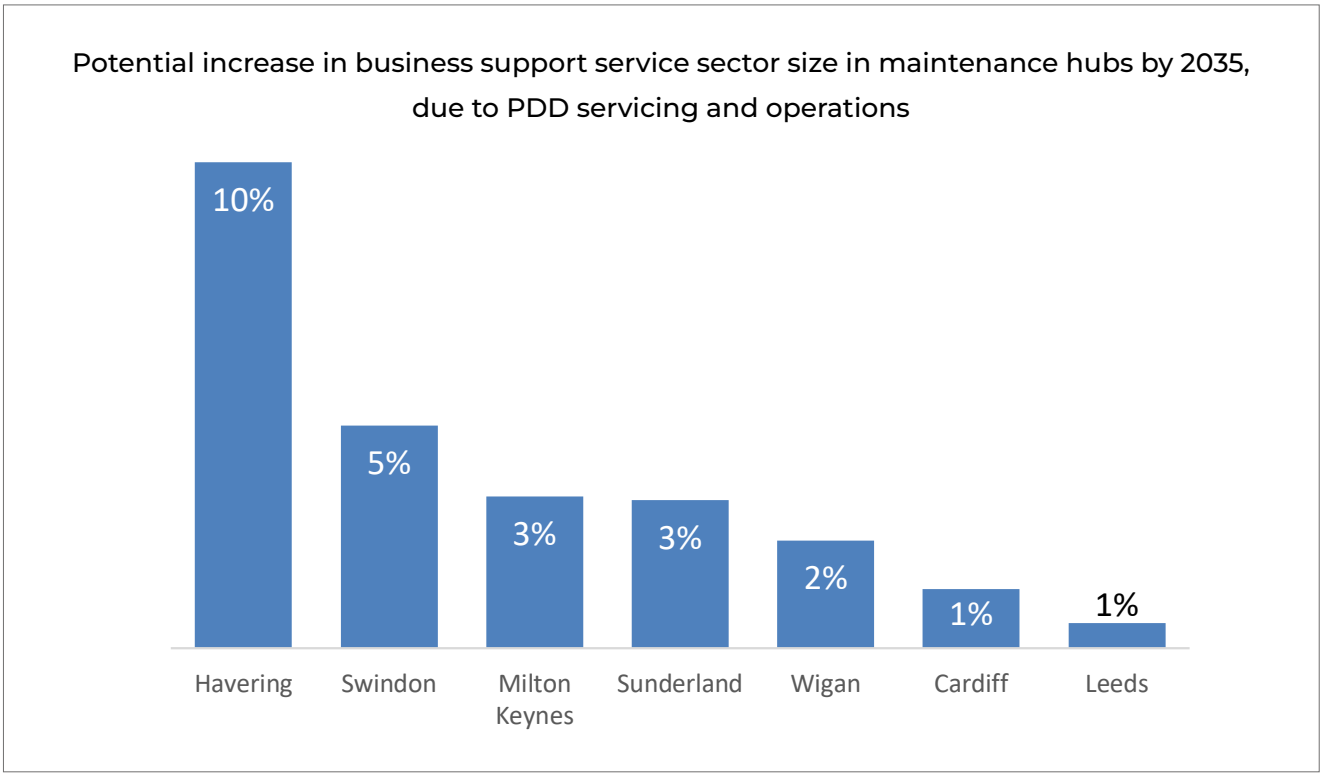
Although impacts on jobs are modest in aggregate, they could have significant local industry effects in each hub LA. Assuming workers are hired broadly from across the country (reflecting the actual operational spread of PDDs), having a PDD hub in Havering could increase the size of its business support service industry up to 10% by 2035.[22] This is a skilled, high-wage, service-led sector and that sell goods and services to other parts of the national and global market bringing money into the local economy.[23] The equivalent increase in Swindon is 5%, and 3% and 2% in Sunderland and Wigan respectively, boosting a growth industry in places with wages and employment below the national average. There would be smaller effects in Leeds and Cardiff which have more established sectors.

21 This is based on weekly workplace wages from the Annual Survey of Hours and Earnings: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/placeofresidencebylocalauthorityashetable8

22 Operations and servicing roles for PDDs are assumed part of SIC code 82: 'Office administrative, office support and other business support activities', as this is Starship Technologies registered 2-digit SIC group from Companies House. This is set against forecasts for the wider industry in each hub LA using BRES data and population projections.

23 https://whatworksgrowth.org/insights/understanding-tradable-non-tradable-sectors/

Figure 8: Havering's business support service sector could increase by 10% (and Swindon by 5%) due to PDD servicing



Source: Prysm Global calculations, BRES. Note: based on SIC code 82: "Office administrative, office support and other business support activities"

Legislation change would lead to manufacturing of PDDs in the UK, having large local effects and helping achieve the UK's industrial strategy goals

With legislation change, Starship Technologies would onshore manufacturing of some of its PDDs to the UK, to meet national demand for deliveries. This analysis assumes this takes place within the jurisdiction of Milton Keynes City Council – the most established UK operations area. However, this does not necessarily mark the precise locations of UK manufacturing if legislation were to be passed, and so all analysis in this section should be taken as indicative - there are possibilities for a manufacturing presence across the UK.

Based on projected delivery numbers, the rollout of PDDs would benefit the UK through £138 million of direct investment in present value terms. Given the localised nature of manufacturing, it is assumed that most of this impact would be concentrated in the Milton Keynes City Council area. To give a sense of scale, this is equivalent to over 20% of the local authority's capital investment in 2024-25 (at a minimum).[24]

24 This is comparing the level of direct investment to figures from MHCLG's tables on local government finance: https://www.gov.uk/government/statistical-data-sets/live-tables-on-local-government-finance. The figure used is 'other investment' (i.e., excluding deposits, gilt purchases, and investment in other money markets and funds, which totaled £680 million for Milton Keynes in 2024/25. Note that **this 20 % figure is a lower bound estimate**, as some of this 'other investment' will not be comparable capital spending, and some will be invested outside the local authority.

This investment would help establish Milton Keynes as one of the drivers of the UK's Advanced Manufacturing sector, a key component of the recent Industrial Strategy.[25] Given their reliance on specialised skills, these sectors tend to cluster in certain places, both within and across different industries.[26] Therefore a large and concentrated investment in an advanced industry such as PDD manufacturing is likely to crowd in investment in related industries and make the local authority more attractive to high-skilled workers.

Ian Achurch

North Northamptonshire Council

As well as enticing the existing workforce to move into tech jobs - and improve once there - **Ian Achurch**, economic head at North Northamptonshire Council, believes Starship Technologies' PDDs will attract the next generation to skill up and join the tech future: ***"People here are really inspired by them [the PDDs]. We've worked with students to show them how they work, hands on, controlling the robots. They encourage people's interest in tech and skills. They start thinking about, if there are more robots around, what makes them do that, what makes them work? What opportunities might that provide? But at the moment, you could say it's quite risky to innovate further with something where there's no legislation. We want to make the UK good place to innovate and to trial new technologies."***

Manufacturing PDDs in Milton Keynes would generate 100 additional high-skilled manufacturing roles within the City Council area by 2035, which would benefit from most of the cumulative increase in wages of £1 million over the decade.[27] With PDDs manufactured in the local authority, Milton Keynes' Advanced Manufacturing sector would be 5% larger by 2035.[28]

Figure 9 summarises the local impacts that legalising PDDs could have in Milton Keynes City Council alone.

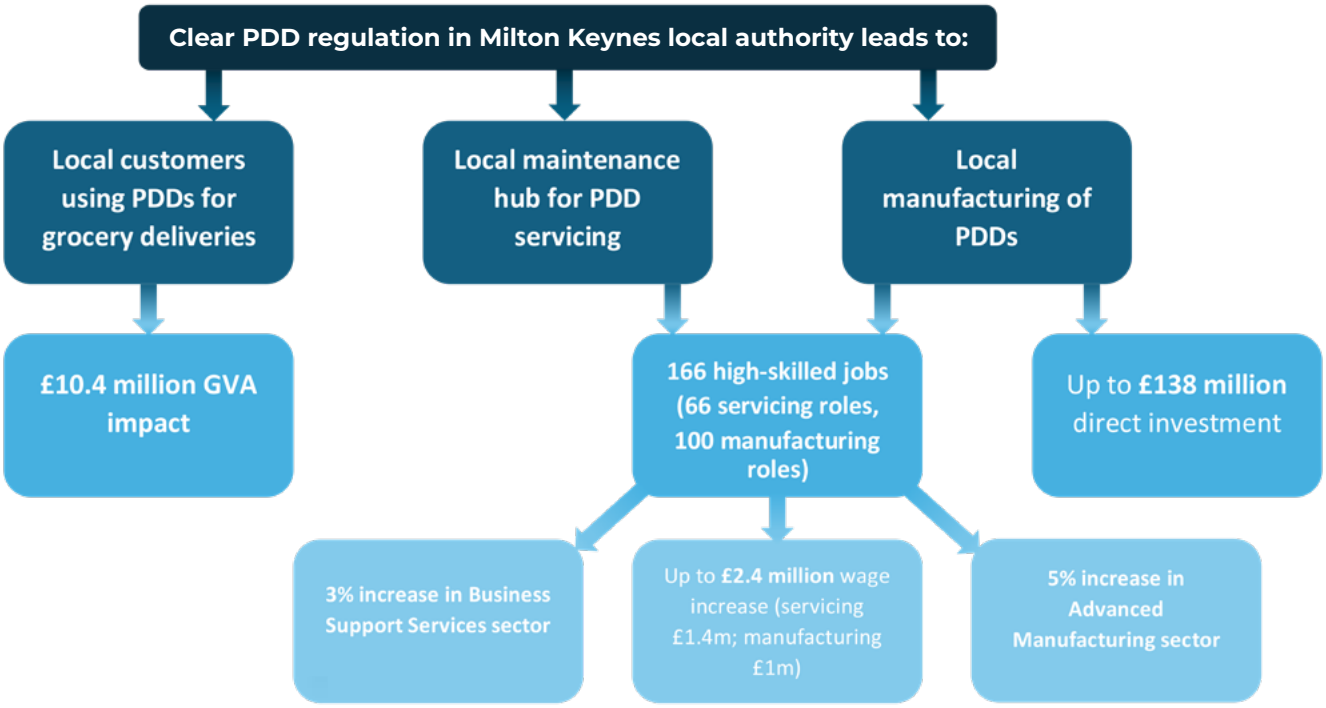
25 https://www.gov.uk/government/collections/the-uks-modern-industrial-strategy-2025

26 https://www.innovationclusters.dsit.gov.uk/

27 The wage impacts are attributed mainly to Milton Keynes LA as the wage impact bringing in workers in the Advanced Manufacturing industry across the South East (as assumed in the modelling) would be negligible in other South East LAs.

28 Advanced Manufacturing is defined as SIC codes 26 (Manufacture of computer, electronic and optical products), 27 (Manufacture of electrical equipment), 28(Manufacture of machinery and equipment n.e.c.), and 30 (Manufacture of other transport equipment), drawing from UK's classification for its Industrial Strategy. The 5% figure is calculated by comparing projections of the Advanced Manufacturing sector (using BRES 2023 data and population projections) and the estimated additional roles attributable to PDDs by 2035. Roles are assumed to be filled by recruiting from the South East region, so this difference is adjusted for the fact the Milton Keynes accounts for 3% of the Advanced Manufacturing sector in this region.

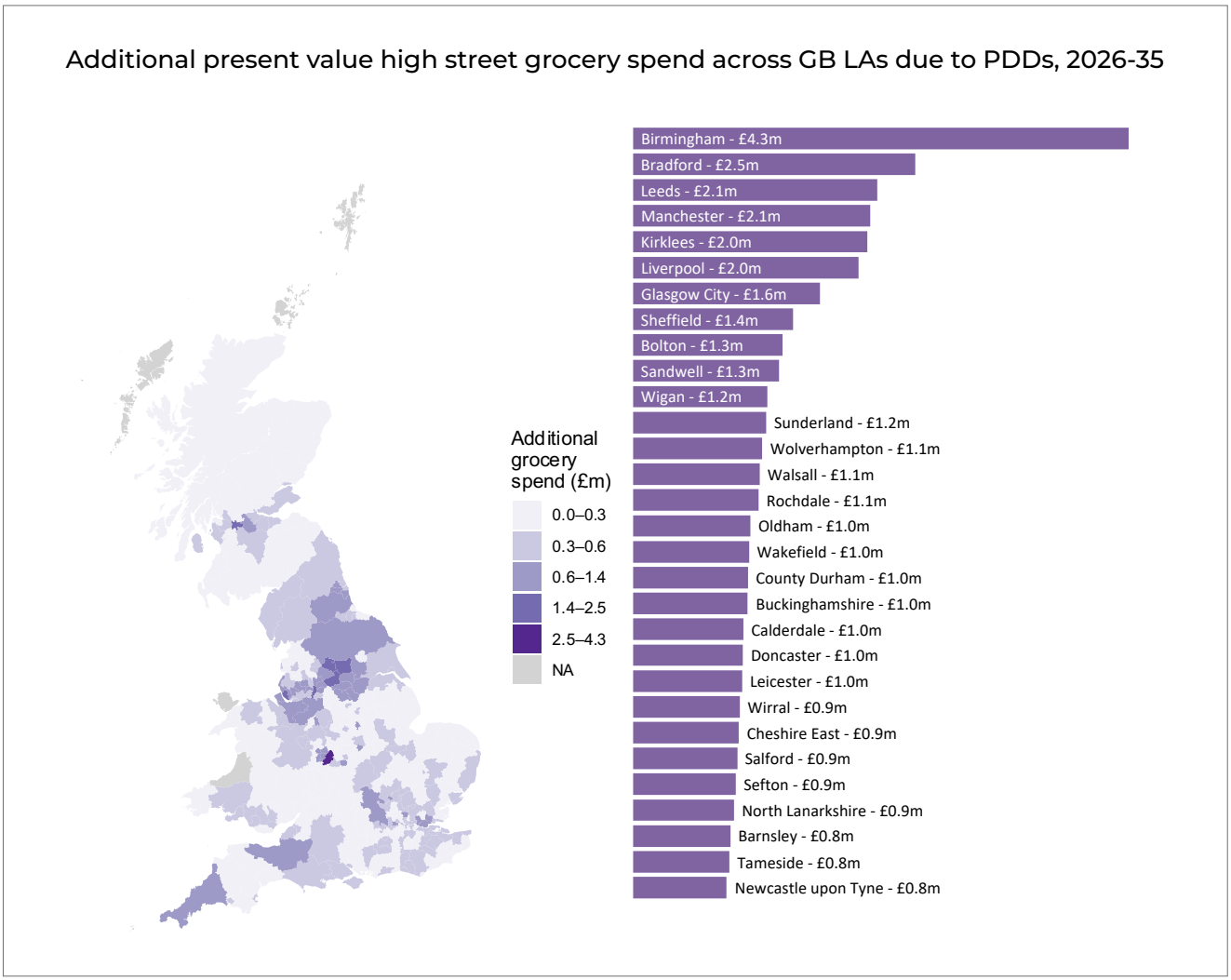
Figure 9: Economic impact of PDDs in Milton Keynes



PDDs would boost high street spending across the North of England

Figure 8 shows the benefits to high street spending are more concentrated across the North of England. Birmingham also tops the list for additional grocery spending among all LAs (£4.3m), followed by Bradford (£2.5m), and Leeds and Manchester (£2.1m each).

Figure 10: PDDs could generate over a million pounds worth of additional grocery spending in many Northern local authorities



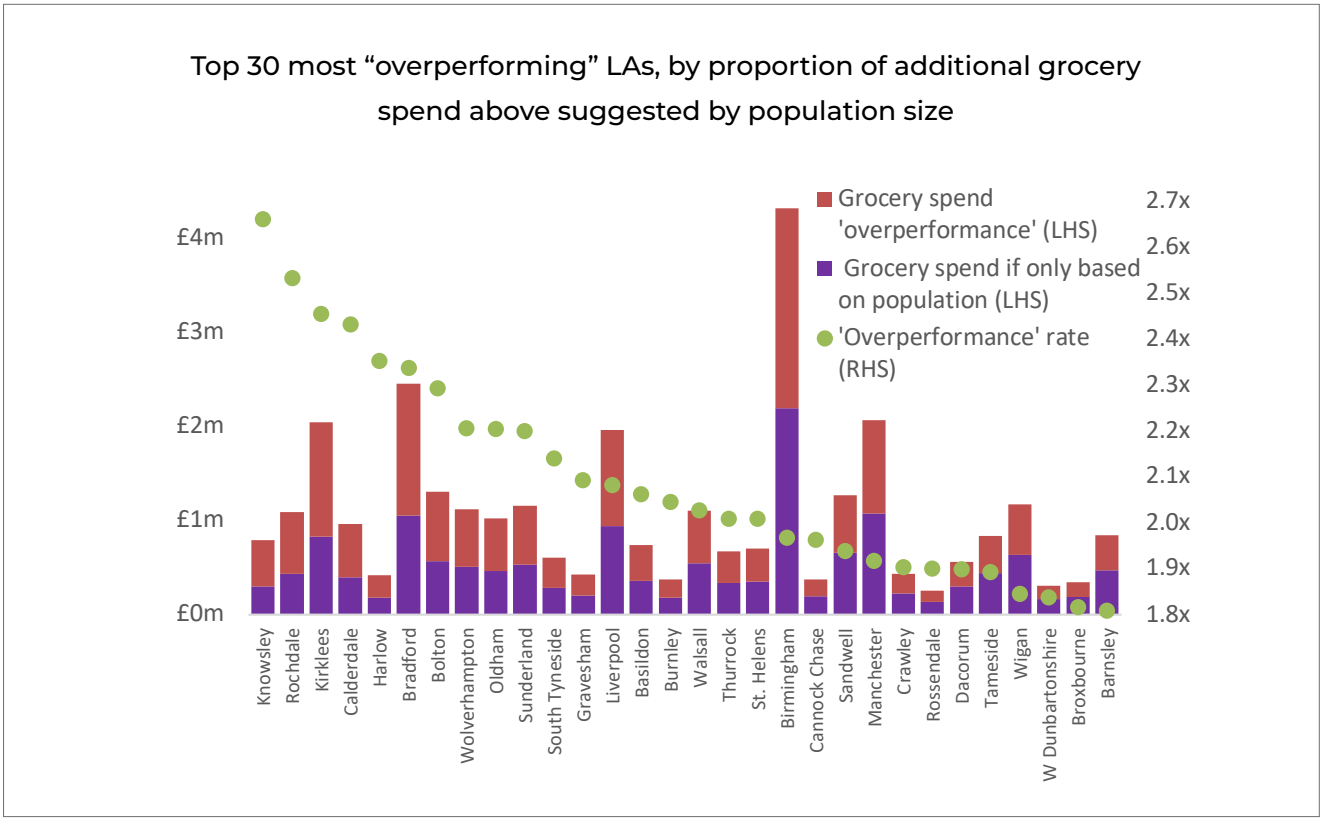
Source: Prysm Global calculations

This differs from the distribution of additional economic impact. The reasons are two-fold: Southern local authorities have smaller urban areas with greater online grocery accessibility, meaning more deliveries and additional economic activity, but not additional grocery spending as customers would travel to the shops instead. In contrast, Northern local authorities have more grocery delivery deserts, meaning more grocery purchases using PDDs that would not have happened otherwise. However, the volume of deliveries themselves are smaller due to lower demand for deliveries and fewer grocery options.

This can be seen by looking at the top local authorities that overperform in terms of additional high street spending (Figure 11). Most are in the North of England, reflecting greater levels of poor grocery delivery accessibility in these places.

Birmingham local authority district sees an additional £2.1 million high street spend than if it had an "average" impact. There are also large additional impacts for the local authorities of Bradford (£1.4m), Kirklees (£1.2m), Liverpool and Manchester (£1m each).

Figure 11: Mainly Northern local authorities see disproportionately high increases in high street grocery spend due to PDDs, with large impacts in Birmingham, Bradford, Kirklees, Liverpool, and Manchester

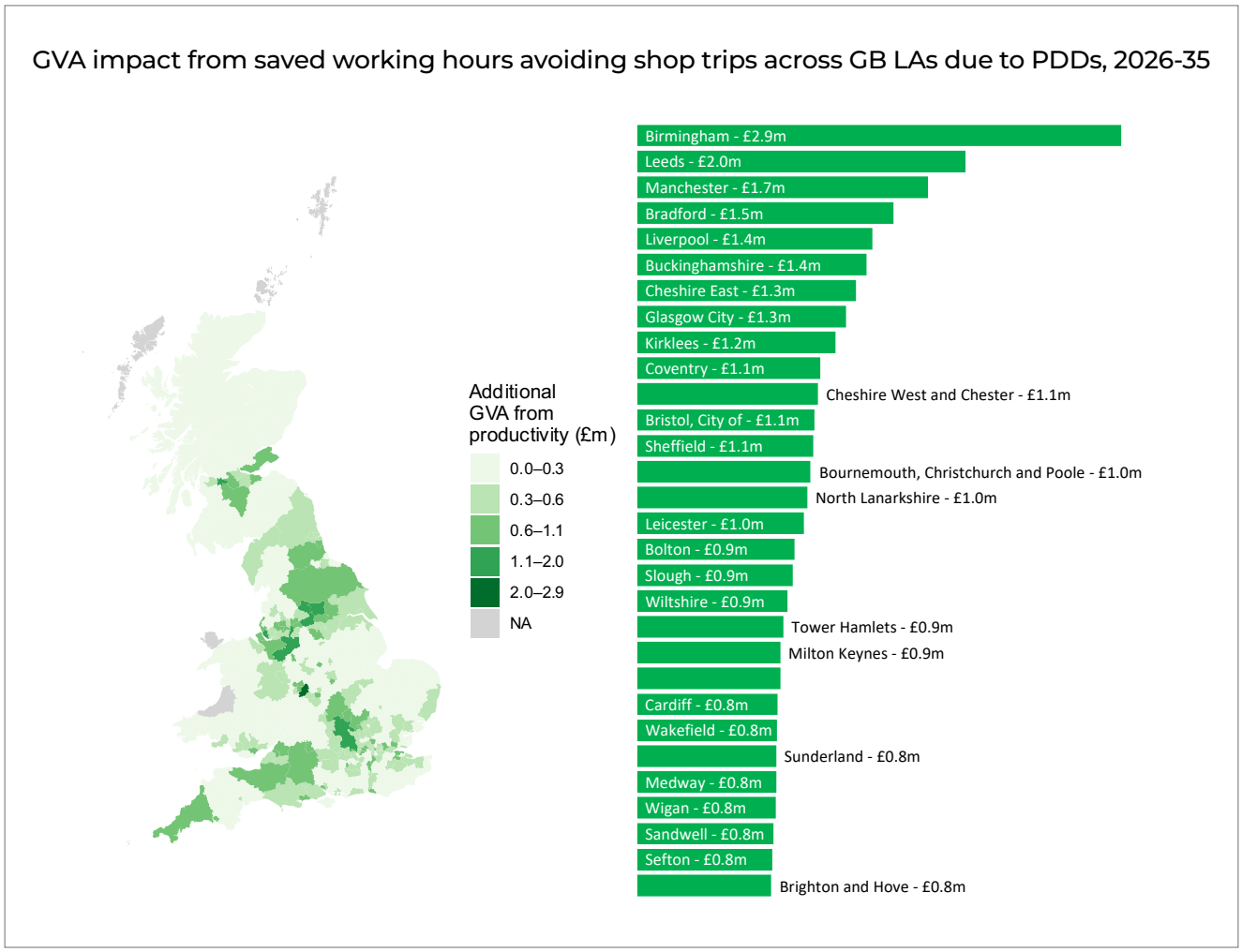


Source: Prysm Global calculations. Notes: West Dunbartonshire abbreviated to W Dunbartonshire.

PDDs would boost productivity in both the UK's productive hotspots and in less accessible urban areas

Figure 12 shows how the GVA impacts from increased productivity are spread across the country, with hotspots in the South and North. The largest aggregate impacts are in large urban local authorities once again: Birmingham (£2.9m), Leeds (£2m), Manchester (£1.7m) and Bradford (£1.5m).

Figure 12: Productivity impacts of PDDs are concentrated in high delivery volume areas in the South, and less accessible areas in the North

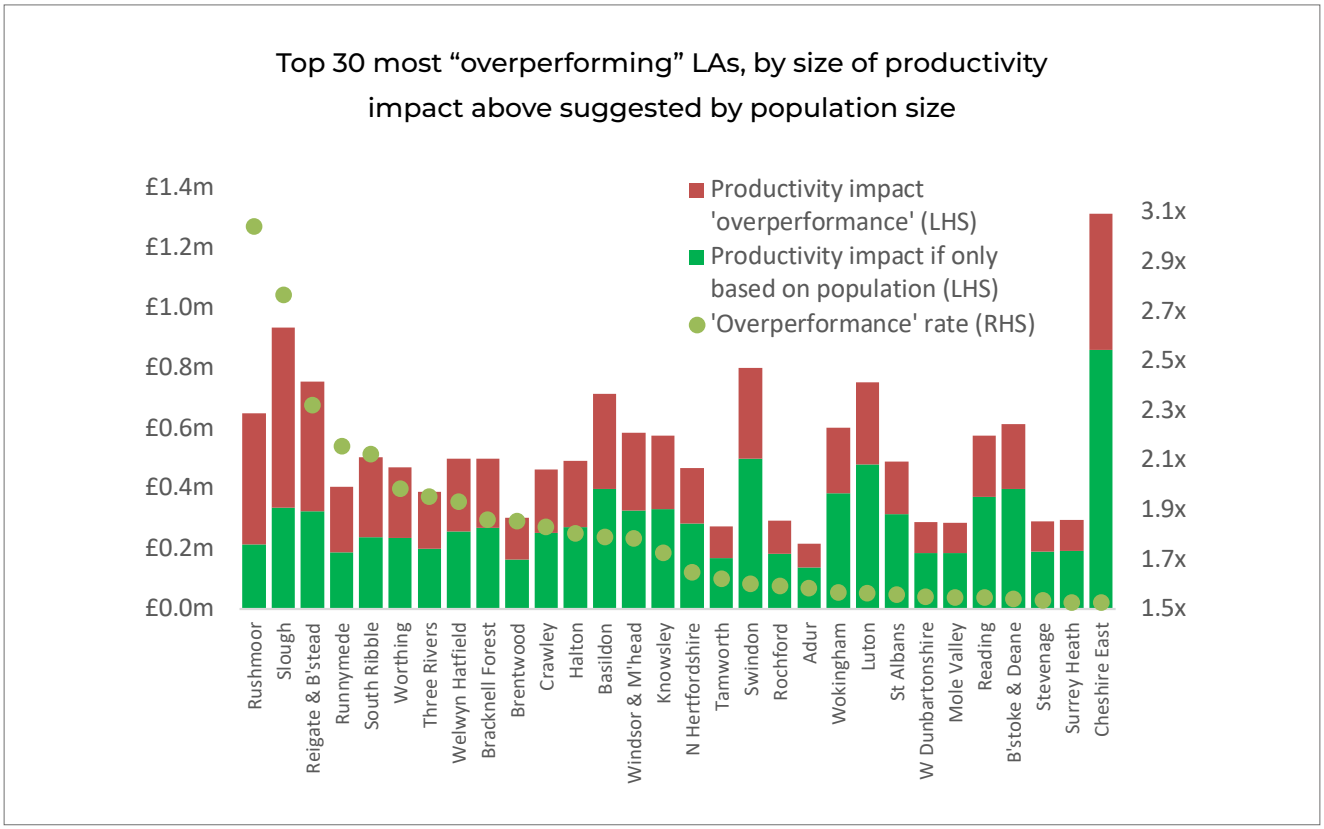


Source: Prysm Global calculations

Accounting for residents, the most overperforming areas are those that are a) already the most productive parts of the country, and b) places with low grocery accessibility where saved time from PDDs is greatest. This can be seen from Figure 13. Top overperformers are some of the most productive areas in the country outside of London, where PDD deliveries are relatively high – additional productivity impact within the Slough Borough Council area "overperforms" by £0.6 million relative to its population size; the LA areas of Rushmoor and Reigate & Banstead by £0.4 million.[29] Other council areas in the top 30, such as South Ribble, Tamworth, Halton, and Knowsley, have more average levels of productivity but see greater impacts due to more saved working hours, given grocery accessibility is low.

29 Although many London boroughs are as or more productive, delivery numbers are relatively low and so they do not feature in the Top 30.

Figure 13: Productive areas and those with lower grocery accessibility see the most disproportionate productivity impacts of PDDs



Source: Prysm Global calculations. Notes: B'stead = Banstead; M'head = Maidenhead; B'stoke = Basingstoke. North and West abbreviated to N and W.

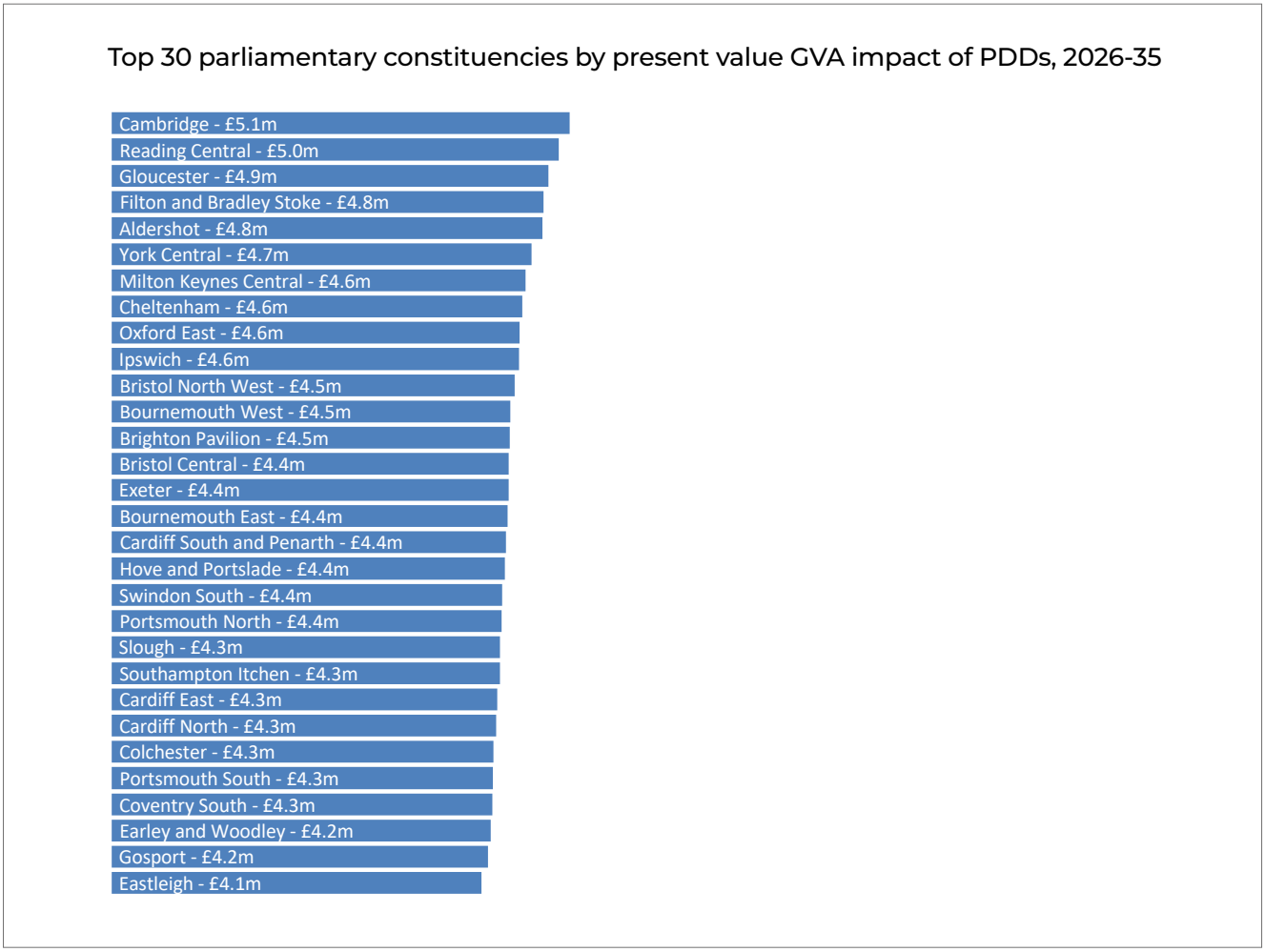
Economic impact by constituency

As the analysis takes place at the neighbourhood level, it can be restated at even finer geographies than local authorities. Figure 14 shows the estimated GVA impact at the level of parliamentary constituency.

Cambridge and Reading Central see more than £5 million of additional economic benefits each. Cardiff, Bristol, and Bournemouth constituencies also rank highly. York Central (£4.7m) and Coventry South (£4.3m) are the top representatives from the North and the Midlands respectively.

This ranking closely matches the local authority "overperformers" in Figure 14. These are mainly constituencies representing affluent smaller towns and cities with lots of grocery options, and a high propensity to place orders online.

Figure 14: PDDs are worth over £4 million to more than 30 constituencies



Source: Prysm Global calculations

Economic impact in delivery deserts

PDDs could have particular impacts on urban areas considered delivery deserts – areas underserved by established services providing grocery deliveries. This is because:

- PDDs can extend the grocery delivery market in these areas. It may not be viable for services relying on drivers to operate in areas with low-density urban form, or sparse grocery options. The lower operating costs of PDDs set them apart in these areas.
- PDDs can operate with smaller transaction sizes. Many supermarket delivery services have £15 minimum spend limits, or charge an additional fee for smaller baskets. Meanwhile, Starship Technologies data shows that two thirds of PDD orders are valued below £15. These small purchases have more value to the customer (in terms of convenience) in delivery deserts, where usual accessibility to groceries is low.

The parts of the UK with the lowest accessibility to groceries tend to be the most deprived, so extending grocery deliveries to these areas could have implications for local inequality- and health-related outcomes.[30]

We define delivery deserts as the 30% of neighbourhoods in Great Britain that have the lowest accessibility to online grocery delivery, as set out by data from the e-food deserts index.[31] The focus of this section is delivery deserts in large cities, as pilot data established that grocery accessibility was a complement to PDD deliveries in smaller cities, towns, and urban areas.[32]

Daniel Bingley

Starship's robots increase demand for when customers can't get out of the house. This is plainly of huge benefit to those with mobility challenges, small children or other constraints on ease of movement. **Daniel Bingley**, a former UK military service member and leg amputee, used PDDs weekly in Milton Keynes but can't access them in his new location: ***"The robots were a tool that I used for extra deliveries when I couldn't get out of the house quickly. When I wake up on a Sunday morning, my bread's gone mouldy - because it's the heat and everything - and I want a bacon and egg, I can go on to a robot and in half an hour, 20 minutes, a robot comes outside my house. My kids love it because it makes little tunes and, for different times of the year, says nice little messages. I can get the bread out, even being disabled it is so easy to use. And then I can have a have my bacon and egg. That's about it, really. It's an aid for anybody, including disabled, old people, which could help your life."***

Our analysis estimates that PDDs would have a 60% higher GVA impact per person in delivery deserts compared with other big city neighbourhoods. The effect on additional high street spending is even greater: for every additional £1 spent per person due to PDDs in normal big city neighbourhoods, an extra £6 would be spent per person in delivery deserts.

Looking at GVA impacts in England's largest cities (i.e., the ones covered by "Established Mayoral Strategic Authorities") shows these results more concretely.

Only 36-37% of all residents in West Yorkshire and Greater Manchester live in delivery deserts. Yet these delivery-desert areas account for almost half the city region's GVA impact from PDDs (Figure

30 https://www.sciencedirect.com/science/article/abs/pii/S0143622823003156

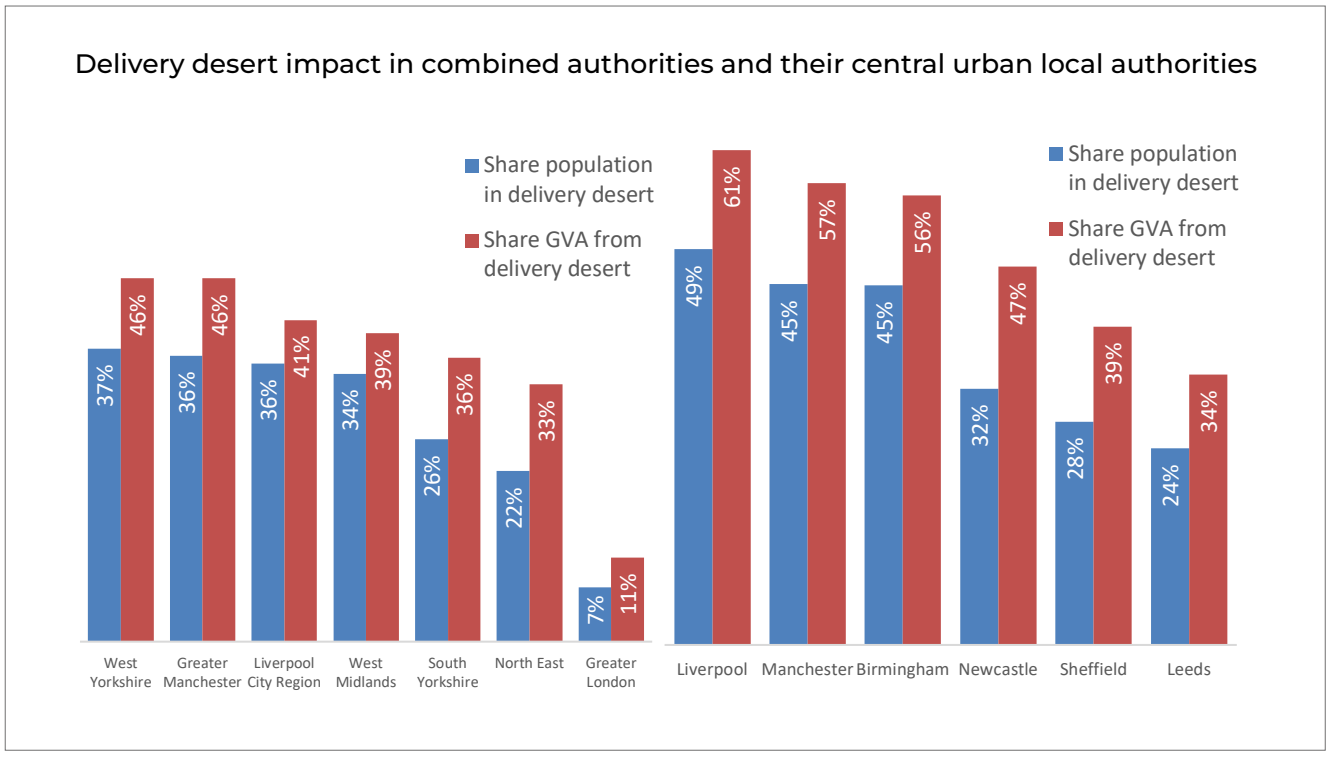
31 https://www.cdrc.ac.uk/research/retail/assessing-the-presence-of-e-food-deserts-in-the-uk/

32 See Annex 1. This is likely due to inherent lower competition from other grocery delivery and q-commerce services in these areas.

15). That's £19 million and £22 million respectively in mainly fringe areas with poor connectivity in these cities. Even in the North East, where only 22% of the population live in these areas, a third of the total economic impact (£9m) is generated in them. London stands out from the rest, having far fewer delivery-desert neighbourhoods, and so has less localised impact.

The wider city regions cover wider urban and rural areas around these big cities. If we just consider the "central" local authority in each city region which contains the urban core (e.g., Liverpool LA in Liverpool City Region), economic impacts are even more concentrated in delivery deserts. Half of Liverpool local authority's neighbourhoods are delivery deserts which account for £5 million of its £8 million GVA impact. Newcastle again sees a disproportionate fraction of its economic impact in these areas – delivery deserts cover a third of residents but half of the potential economic impact of PDDs.

Figure 15: Big cities get a disproportionate share of their GVA impact from delivery deserts (LHS) – this is particularly true for their most central, urban authorities (RHS)



Source: Prysm Global calculations. Note: London has been excluded from the right-hand chart as it does not have a central authority in the same way as the other EMSAs

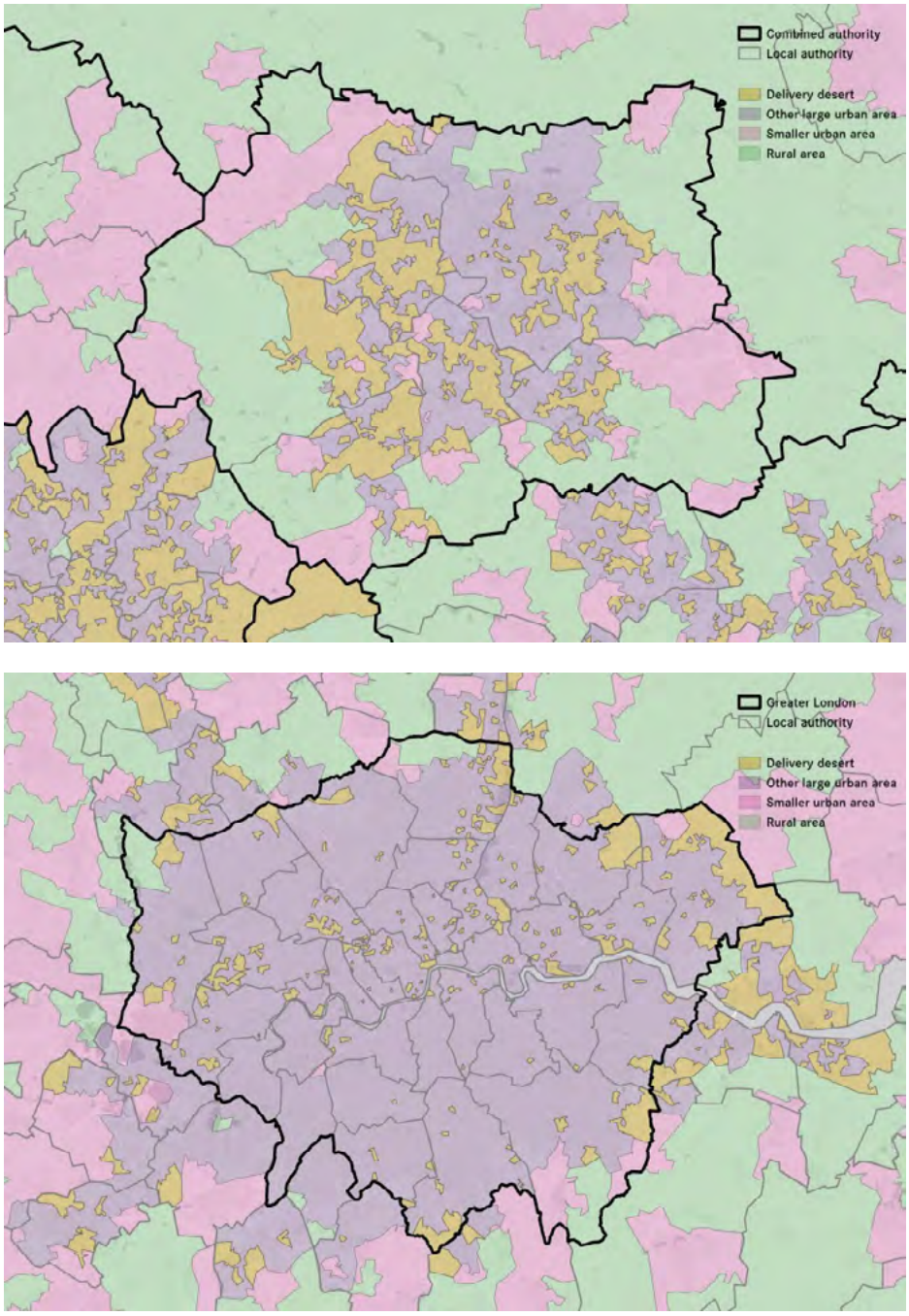
The geography of delivery deserts determines the impact PDDs could have within large cities. Figure 15 shows this for the examples of West Yorkshire and Greater London.

West Yorkshire's pattern of delivery deserts is typical for other large city regions outside of London. Leeds city centre and some suburbs have high delivery accessibility, but delivery deserts are concentrated in certain patches in inner areas around the centre and at the fringe of the urban footprint. This can be seen concentrated in Kirklees, Calderdale, and Bradford (where parts of the city centre are deserts). It overall shows that the £19 million GVA benefits (half of the CA's total) are concentrated away from typical centres of economic activity. These areas would also get even more disproportionate benefits from high street spending. In other words, PDDs can help disperse economic activity in large city regions.

Greater London paints a slightly different picture. With very few central delivery-desert neighbourhoods, most occur right on its periphery, with the largest patch in Havering, the potential location for a PDD maintenance hub. This is on the periphery of its urban footprint too, which spreads beyond its boundaries, meaning PDDs would have outsize impact on poor accessibility local authorities such as Thurrock, Dartford, and Gravesham. Within its boundary, PDDs would have £19 million economic impact in these fringe areas of the capital.

Figure 16: PDDs having outsized impacts in urban delivery deserts benefits inner patches of Leeds and fringe local authorities in West Yorkshire; and the edges of Greater London and surrounding local authorities in the capital

Map of delivery deserts in West Yorkshire Combined Authority and the Greater London Authority



Source: CDRC, ONS, DEFRA, Prysm Global calculations. Notes: PDDs are assumed not to operate in rural areas. Delivery deserts shown are only those in large urban areas (i.e. where PDDs will have an outsized impact).

Annex 1: Detailed methodology

This section sets out more detail for the modelling approach and assumptions for each component of economic impact estimates.

Gross Value Added

The basis of this analysis is a projection of deliveries based on financial and delivery data provided by Starship Technologies. The company has run pilot PDD services in eight different local authorities since 2018.[33] Data within each pilot area was broken down by deliveries at the neighbourhood level ("Geo Areas"), with information including number of deliveries, timing, value of goods ordered, and delivery distance. These neighbourhoods were matched to UK Lower Super Output Areas (LSOAs) to ascertain characteristics about each area.[34]

Regression analysis was used to assess how neighbourhood characteristics could determine PDD delivery volume in pilots (specifically, an outcome of annual deliveries per resident). Two main factors were considered:

- **Degree of urbanisation**. This likely impacts the size of demand, availability of other options, shop accessibility, as well as other lifestyle choices of residents. DEFRA's Rural Urban classification data was used to set apart neighbourhoods in large cities versus those in smaller cities and towns, suburbs, and fringe areas.[35]

- **Grocery delivery accessibility.** This used e-foods desert index data (EFDI) published by the Consumer Data Research Centre (CDRC) in 2020.[36] This includes web-scraped data on prevalence of online delivery from supermarket retailers, internet usage statistics, and availability of groceries in the local area to construct an index of accessibility to online grocery delivery at a neighbourhood level.[37]

33 Pilots were in Milton Keynes, Northampton (West Northamptonshire), Bedford, Cambourne (South Cambridgeshire), Leeds, Rushden (North Northamptonshire), Wellingborough (North Northamptonshire), Wakefield, and Oldham. Bedford and the two North Northamptonshire pilots ended in 2024.

34 These are statistical geographies, typically containing 1,000-3,000 residents, and number around 40,000 across England, Wales, and Scotland.

35 https://www.gov.uk/government/collections/rural-urban-classification. Scottish Rural Urban Classification data was matched in separately: https://www.gov.scot/publications/scottish-government-urban-rural-classification-2020/

36 This was developed in collaboration in partnership with Dr Andy Newing at the University of Leeds (see working paper: https://www.tandfonline.com/doi/epdf/10.1080/09593969.2021.2017321?needAccess=true). CDRC was an ESRC grant funded collaboration, with funding ended in April 2025. The 'e-food desert index' has since been transferred to the Healthy and Sustainable Places Data Service: https://hasp.ac.uk/research/place/

37 Where multiple LSOAs matched to one Geo Area, the minimum accessibility index score was assigned.

These factors were assumed to interact.[38] The analysis additionally controlled for regional differences in delivery behaviour, and the maturity of the pilot in each area to make results comparable.[39]

Table 1 displays estimated coefficients from the model, showing statistical significance for each.

Table 1: Regression results

Outcome: Annual PDD deliveries per resident	
Large urban area (binary)	0.38*
	(0.10)
Grocery Accessibility Index (continuous)	0.10**
	(0.01)
Large urban area * Grocery Accessibility Index	-0.12**
	(0.03)
Intercept	YES
Regional fixed effects	YES
Pilot maturity controls	YES
Geo Areas	**121**
R-squared	**0.10**
Model F-statistic	**3.1*** **

*Notes: Clustered standard errors reported in parentheses. Statistical significance levels *** p<0.01, ** p<0.05, * p<0.1*

These estimated model results were used to predict "steady-state" delivery numbers in other LSOAs in Great Britain, based on these characteristics.[40] They excluded rural areas – it was assumed that PDDs are not viable last-mile delivery options in rural areas, due to the impractical distances and lack of concentrated demand. None of the pilots took place in rural areas.[41]

38 I.e., accessibility may increase demand for PDDs in smaller urban areas, but decrease demand in large urban areas. The example is Central London versus Cheltenham – both may have high grocery accessibility, but larger urban areas face greater competition, have less carriageway space, and are more workplace focused, all potentially affecting PDD viability.

39 All these factors, including the interaction term, were used to estimate annual PDD deliveries per resident in an Ordinary Least Squares (OLS). Standard errors were clustered at the level of pilot area to account for correlation between model errors at the higher geographic level.

40 Meaning what annual deliveries would look like today, assuming PDDs had fully rolled out in that area.

41 Assuming PDDs are rolled out to all areas they are viable, this would cover around 80% of Britain's population.

Predictions were converted to dynamic delivery forecasts for each year. This involved:

- Assuming scale-up rates based on the Milton Keynes' pilot area (the most mature pilot);
- Once scaled up, delivery rates would grow at the forecast market growth of the "q-commerce" market until 2032;[42] and
- After that year, deliveries would grow at the slower rate of the supermarket online grocery delivery market.[43]

Estimates of net margin per delivery were provided by Starship Technologies. This included current estimates for the UK, and those for Finland, a more mature market where PDDs had been rolled out nationwide over 2-3 years.[44] This estimated value was multiplied by the predicted outturn in deliveries over the period to calculate added value to the PDD operator in each neighbourhood and year.[45]

To determine additionality, this value was adjusted by deliveries that would not have happened without PDD rollout. Counterfactual scenarios modelled were:

1) The customer would use another delivery service to make the purchase (delivery is not additional economic activity);
2) The customer would make the purchase by travelling to the shop instead (delivery is additional economic activity); or
3) The customer would not make the purchase at all (delivery is additional economic activity and induces additional spending).

These scenarios were modelled based on internal survey data shared by Starship, conducted in 2024.[46] In response to the question 'If Starship delivery was not available, how would you get your shopping?', the following answers were mapped onto each scenario:

42 This covers mainly small grocery orders that typically arrive less than an hour after order, including services such as Getir and Zapp. This is a fast-growing sector, and is predicted by Coherent Market Insights to grow in the UK at 19.6% CAGR between 2025 and 2032: https://www.coherentmarketinsights.com/industry-reports/uk-quick-e-commerce-market. The market was estimated at over £7 billion in the UK in 2025 by the same report.

43 This is forecast by McKinsey to grow at 5.40% CAGR from 2025: https://www.mckinsey.com/industries/retail/our-insights/state-of-grocery-europe . This market was estimated at £25 billion in 2022 by Savill's UK Grocery Report: https://www.savills.co.uk/research_articles/229130/379213-0/spotlight--uk-grocery-report---2025

44 Finnish revenues and costs were used to forecast the likely economies of scale UK would enjoy with a nationwide rollout. Specific UK costs (cost of onsite labour, and payment processing fees, which do not apply in Finland) were retained. A key assumption is that wireless charging is rolled out in the UK, and docks can be installed on UK high streets. This saves significant onsite costs that would otherwise affect long-term viability.

45 Net margin is assumed to be equivalent to value added, given it is a monetary assessment of outputs minus intermediate costs (operating expenditure).

46 Sample size = 300. Sample covered customers from six pilot areas. Responses were weighted by frequency of use of the service (asked in the survey).

1) "Order a delivery from another company (Eg. Deliveroo, Uber Eats)" - 14% of (weighted) responses;

2) "Walk to get groceries" or "Drive to a different supermarket" – 80%; and

3) "Go without" – 7%.

These responses were additionally assumed to vary by level of grocery accessibility in each area. Responses were split by pilot area and varied by area's predicted grocery accessibility.[47]

This was aggregated up to the local authority level to determine the direct GVA impact of PDDs in each place. The following second-order GVA impacts were calculated:

- The indirect GVA impact using ONS Input-Output tables;[48]
- The induced GVA impact using Input-Output tables;[49] and
- Further GVA impact of additional spending in supermarkets facilitated by PDD deliveries.[50]

As these results were built up from the LSOA level, this allows statement of economic impacts by parliamentary constituency, local authority, combined authority, and aggregate results for the UK (as well as specific investigations for delivery deserts).

Jobs, wages and direct investment

Based on information from Starship Technologies, legislation to allow the operation of PDDs in the UK would lead to i) setting up of operations and servicing roles in several maintenance hubs and ii) direct investment and manufacturing roles to onshore PDD production to the UK. From this information, maintenance hubs were modelled in Milton Keynes and Leeds (which have pre-existing hubs) with additional hubs in Sunderland, Wigan, Cardiff, Swindon, and Havering. Manufacturing is modelled as occurring in Milton Keynes. However, these do not necessarily mark the precise locations of these hubs if legislation were to be passed. All analysis on local jobs and direct investment effects are to be taken as indicative.

47 Grocery accessibility data was not available at the pilot area geography. To proxy this, we used (weighted) response to the survey question "What do you think are the main benefits to Starship deliveries in your area?" that chose option "Without robots, we wouldn't have same-day grocery delivery". 37% chose this response on average, but proportions ranged between 10% in Leeds and 56% in Oldham. This variation was then mapped onto grocery accessibility

48 This uses the GVA multiplier for SIC Code 82: Business Support Services (Starship Technologies' industrial classification). See https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesdetailed

49 As ONS does not publish "Type II multipliers", need to calculate these effects, this analysis used multipliers (again for SIC code 82) published by Scottish Government Input-Output tables (https://www.gov.scot/publications/input-output-latest/) as a proxy to scale ONS direct GVA multipliers.

50 See additional spending section in this Annex for methodology for high street spending induced by PDDs. The proportion of this spending assumed to be value-added economic activity is assumed to be 3%, based on a 2024 report by the Competition Markets Authority on UK supermarket competitiveness: https://assets.publishing.service.gov.uk/media/66a3326dab418ab055592d95/Groceries_2.pdf. Indirect and induced impacts were then added to this by reference to Input-Output table GVA multipliers for SIC code 47 (Retail trade services).

Starship Technologies provided estimates of i) direct investment; ii) numbers of different servicing roles; and iii) manufacturing roles required to deliver a fixed volume of robots by 2029. Predicted deliveries were used to model the actual UK demand for robots over the period to adjust these numbers.

It was assumed that areas with deliveries needed a minimum number of PDDs to operate, and afterwards robot numbers scaled with delivery demand.[51] This was fitted to global delivery data from 2023 and estimates of Starship's global PDD fleet in that year, to estimate the distribution of robots across areas with different delivery numbers, and then applied to predicted deliveries in each area.[52]

For servicing jobs:

- Each maintenance hub was assumed to be responsible for all PDDs in local authorities closer to that hub than any other. This was used to estimate the distribution of predicted servicing roles needed in each hub.

- It was assumed that the servicing roles would not create new jobs, but rather in aggregate replace demand for delivery drivers proportional to the number of deliveries crowded out by PDDs across the country. Cumulative wage impacts were therefore calculated by comparing the average wage of servicing roles (information taken from Starship Technologies estimates) with the driver roles they would be "replacing".[53]

For manufacturing jobs:

- It was again assumed that new manufacturing roles would not be created, but rather replace existing roles in the Advanced Manufacturing sector in the South East of England. Cumulative wage impacts were calculated by comparing wages of different manufacturing roles (provided by Starship Technologies) and matching them to distributions of earnings in the sector in the South East.[54]

Estimates for direct investment were scaled in the same way.[55]

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51 The relationship between varying delivery demand and number of "deliverers" needed to service these deliveries is a standard problem of Queueing Theory and is sensitive to delivery distances, density of demand, and preferences on lateness. A rule of thumb is that the number of deliverers increases at a decreasing rate with growth of deliveries – there are economies of scale (see: https://optimization-online.org/wp-content/uploads/2020/11/8125-1.pdf ; https://pmc.ncbi.nlm.nih.gov/articles/PMC9365926/). We assume this simple relationship of a minimum threshold plus scaling with to mimic this relationship while retaining tractability.

52 The result was scaled by 0.5 in contiguous delivery areas to account for PDD efficiencies across space (e.g., being able to move robots to nearby areas at low cost to meet demand).

53 Through research on job listing websites and supermarket websites, the average UK delivery driver wage is assumed to be £25,000 (in 2025 prices). All wage impacts are assumed accrued to the maintenance hub local authority.

54 This uses data from ONS Annual Survey of Hours and Earnings: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/regionbyindustry2digitsicashetable5. The "outside option" for entry level roles was assumed to be minimum wage, and outside options for other roles to be reported wages in this dataset at a reasonable percentile to match the occupational level of the corresponding PDD manufacturing role. It was assumed that all wage benefits would accrue to Milton Keynes local authority.

55 It was also assumed that all direct investment benefits would accrue to the manufacturing location (i.e., Milton Keynes).

Additional spending

The number of deliveries in each area that would generate additional grocery spending (i.e. the actual transaction, rather than use of a delivery service, would not have happened without PDDs), was calculated through estimates based on prevalence of "scenario 3" (customers who would go without otherwise). These were multiplied by average delivery value figures, provided by Starship Technologies.

This analysis assumes this response is reliable, in that customers would truly forgo these purchases and not compensate by increasing spending in other areas locally (e.g. clothes or leisure activities) or adding on missing goods to subsequent grocery purchases.[56]

Note this component models additional spend on local high streets specifically, and does not account for resulting changes in other spending or saving activity.

Productivity

This estimates the potential time saved for workers from using PDDs and resulting economic benefits. The modelling approach was as follows:

1) The predicted number of deliveries in each area and year was combined with i) average delivery distance; ii) predicted distance of customers to their nearest shop based on grocery accessibility, iii) propensity to go to the shops in the absence of PDDs (by walking and by car), and iv) timings of trips based ii) and iii) to estimates total hours saved in each area.[57]

2) This was adjusted to estimate total working hours. This involved Starship Technologies' data on the proportion of orders made during typical working hours (65%) and the proportion of customers who were working (60% from the survey), including further adjustments for moving shopping trips outside of working hours and bundling with other purchases.[58] This was aggregated up to the local authority level.

3) ONS sub-regional productivity data on aggregate GVA and hours worked was projected forward to 2035.[59] In the future scenario with PDDs, it was assumed that any working hours saved would be used to generate more output at existing productivity (i.e. GVA per hour) levels. This generates GVA uplift in each local authority based on time saved.

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56 Both seem reasonable assumptions as a) it is unlikely that customers would replace "essential" groceries with less essential purchases (e.g., leisure activities) and b) those who would "go without" tended to be in areas with low grocery accessibility, so options to make purchases by other means would be limited.

57 i) was provided by Starship Technologies, ii) combined this distance with relationships between accessibility and average distance to grocery options (see https://www.tandfonline.com/doi/epdf/10.1080/09593969.2021.2017321?needAccess=true) and iii) from Starship Technologies' customer survey data.

58 Specifically, it was assumed that one in four of working hour purchases via PDDs which would otherwise involve a trip to the shops would be moved to non-working hours instead. Additionally it was assumed a further half of these remaining trips in absence of PDDs would be bundled with other purchases.

59 See: "Regional gross domestic product: local authorities" dataset: https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductlocalauthorities and "Subregional productivity: labour productivity indices by local authority district" dataset: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/datasets/subregionalproductivitylabourproductivityindicesbylocalauthoritydistrict

These GVA calculations based on time saved require stronger assumptions than the GVA impact from normal PDD operations, and so is presented separately.

Note productivity impacts based on increased grocery retailer output from using PDDs (e.g. enabling lower operating costs or speeding up purchases) is not modelled.

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