March 2023

# Artificial Intelligence Sector Study

## Research report for the Department for Science, Innovation & Technology (DSIT)

Perspective Economics

# Contents

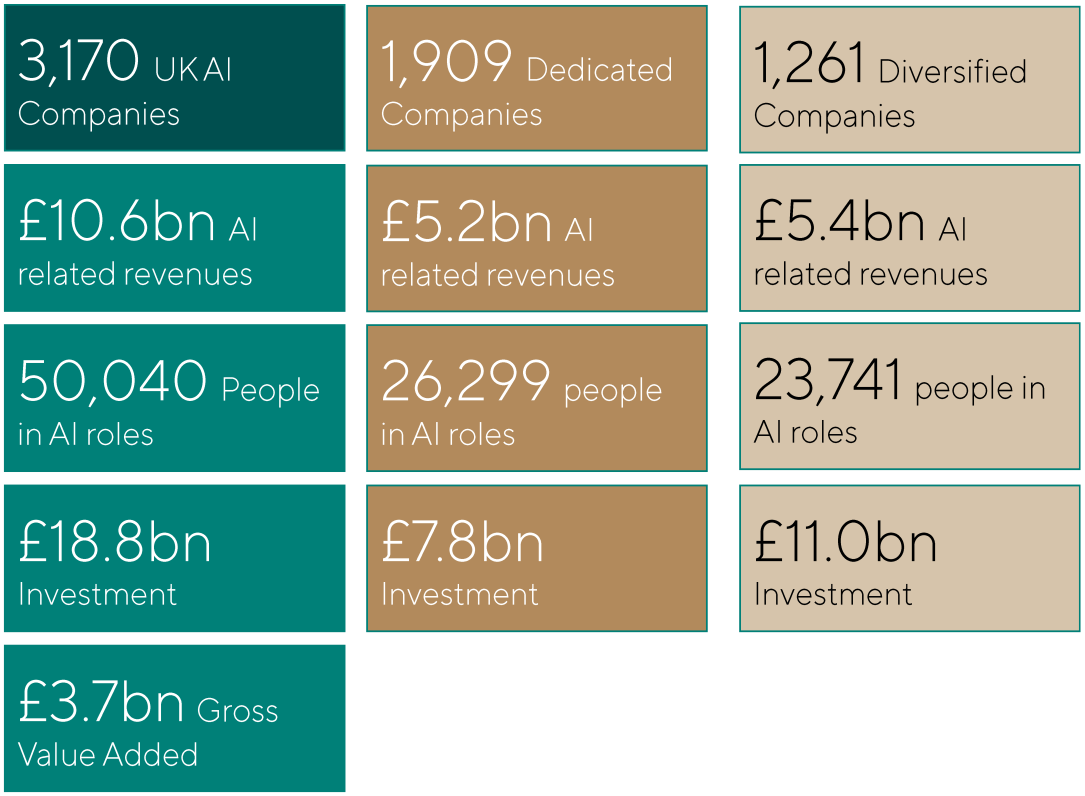
# I Executive Summary

The government commissioned Perspective Economics, glass.ai, Ipsos and academic experts to undertake a research study to better understand the profile of the UK AI Sector and its contribution to the UK economy. Based on a combination of extensive collection and analysis of secondary data and strategic qualitative research including a survey of 250 UK AI businesses, and 22 in-depth interviews with AI businesses and strategic stakeholders, this report provides a baseline set of data on the size and scale of the UK's AI sector, intended to support government's ongoing development and monitoring of key AI policies.

## I.1 Headline Sector Metrics

The study has identified a total of 3,170 UK AI companies that generated £10,6bn in AI related revenues, employed more than 50,000 people in AI related roles, generated £3.7bn in Gross Value Added and have secured £18.8bn in private investment since 2016.

Figure I.1 – Sector Headlines



## I.2 Key Findings

The report provides further breakdowns of these metrics across UK regions, and according to predicted AI business models and technological capabilities. Some of the most salient findings emerging from this baseline research include:

- A total of 3,170 active AI companies have been identified through the study.
- Of the 3,170 active companies identified through the study 60% are dedicated AI businesses and 40% are diversified i.e., have AI activity as part of a broader diversified product or service offer.
- Compared to similar studies into other emerging technology sectors, a greater proportion of diversified AI companies have been identified, highlighting the broad scope for development of AI technology applications by established technology companies across sectors.
- On average 269 new AI companies have been registered each year since 2011, with a peak in new company registrations in the same year as the AI Sector Deal (2018, n=429).
- Together, the data on company size and business model suggest that dedicated AI companies are both smaller and more dependent on AI products for revenue. Diversified AI companies are typically larger and likely to generate a greater proportion of revenues from less capital-intensive provision of AI related services.
- London, the South East and the East of England account for 75% of registered AI office addresses, and also for 74% of trading addresses. Just under one third of AI companies with a registered address outside of London, the South East and the East of England still have a trading presence in those regions, highlighting the apparent significance of those regions to development of the UK AI sector to date.
- While absolute numbers are smaller, the study has identified more notable proportions of wider regional AI activity in automotive, industrial automation & machinery; energy, utilities and renewables; health, wellbeing and medical practice, and agricultural technology.
- In the most recent financial year, annual revenues generated specifically from AI related activity by UK AI companies totalled an estimated £10.6 billion, split approximately 50/50 between dedicated and diversified companies.
- Across both dedicated and diversified AI companies, study estimates suggest that there are 50,040 Full Time Equivalents (FTEs) employed in AI related roles, 53% of which are within dedicated AI companies.
- Based on a combination of official company data, survey responses and associated modelling, AI companies are estimated to contribute £3.7bn in GVA to the UK economy. For large companies the GVA-to-turnover ratio is 0.6:1 (i.e., for every £1 of revenue, large AI companies generate 60p in direct GVA). GVA-to-turnover ratios among SMEs are much lower (0.2:1 for medium sized companies and negative for small and micro businesses), which reflects the capital intensive, high R&D nature of deep technology development.
- Since 2016, AI companies have secured a total of £18.8bn in private investment. 2021 was a record year for AI investment, with over £5bn raised across 768 deals, representing

an average deal size of £6.7m. Further, AI investment increased almost five-fold between 2019 and 2021.

- In 2022 dedicated AI companies secured a higher average deal value than diversified companies for the first time. However, data on AI investment by stage of evolution may also be signalling some tightening of investment available to Seed and Venture Stage companies and, given the significance of private investment for AI technology development evidenced by data on revenues and GVA, this could pose a risk to realising the potential within early-stage AI companies.

- The study highlighted a notable opportunity for companies operating in the AI implementation space to build teams of AI implementation experts that can support AI adoption opportunities across sectors. This adoption opportunity is supported by investment data, which highlights that in 2022 investments were made in 52 unique industry sectors, compared to investments across just 35 different sectors in 2016.

# 1. Introduction

Perspective Economics, in collaboration with Ipsos, glass.ai, and Professors Rob Procter (University of Warwick) and Roger Woods (Queen's University Belfast) were commissioned in August 2022 to deliver an assessment of the UK's artificial intelligence (AI) sector.

The aim of the study is to better understand the scale, profile and economic contribution of UK's AI Sector, and to provide a baseline set of data that can support government's ongoing development and monitoring of key AI policies.

AI technologies have been in development for decades, however their transformative potential is being increasingly realised through development, application and public debate regarding evermore sophisticated machine learning software. This report is therefore timely given the importance of government policy regarding the ethical and regulatory parameters within which AI technologies are developed and applied in the UK.

## 1.1. Methodology & Sources

The study has been designed to provide insight into the following set of core research questions:

- How much does the UK's AI Sector contribute to the UK economy, including revenue, employment, Gross Value Added (GVA), exports and R&D spending?
- What is the composition of the UK's AI sector, in terms of business size, location, and product offering?
- What have been the drivers of growth in the market, and what are the key upcoming challenges?

It is anticipated that the research will be replicated in subsequent years and as such, the methodology for data collection and analysis is wholly transparent and repeatable.

## 1.2. Approach

The study uses a mixed methods approach, combining academia, policy and investment spheres. Key methodological steps are summarised below, with fuller detail provided in appendices to the report.

Stage 1 – Collation of initial data inputs: a long-list of AI companies deemed to be potentially within the scope of the study was identified from numerous sources, predominantly via web intelligence generated by Glass.ai's web-reading capabilities. Just under one third of companies were also identified via other sources including but not limited to Bureau van Dijk's FAME, Beauhurst, Crunchbase, Lightcast and FDI Markets.

Stage 2 – Initial classification and filtering: A set of key words and categories were identified through a combination of automated classification using Glass.ai language models and workshop sessions with representatives from academia, industry, government and the core

study team. The long-list of potentially in-scope firms was refined and filtered to provide a shortlist of 3,170 in-scope AI companies.

Stage 3 – Survey design and administration: a detailed business survey was designed with input from the study steering group, including representatives from DSIT and academic and commercial research expertise. The survey was administered via multiple channels, including via telephone, e-mail and web-hosting. A total of 250 responses were received.

Stage 4 – Data augmentation: a series of manual data quality checks were conducted across key metrics (revenue, employment, location, classification) by both the core study team and DSIT analysts. Company data was then augmented using multiple data sources, providing a consistent set of key metrics for each UK AI business.

Figure 1.1 – Shortlisting & Augmentation Overview


*Source: Perspective Economics*

Stage 5 – Regional & sub-sectoral analysis: more granular data on the trading locations of in-scope AI companies was gathered through web-intelligence and proprietary data sources, enabling a more detailed analysis of the trading presence of UK AI companies locally, and internationally.

Stage 6 – Sector modelling: The short-listed AI company set was used to produce analyses of the number, scale and location of UK AI companies, incorporations, investment, R&D expenditure and exports.

Stage 7 – Qualitative interviews & case studies: in-depth follow-up interviews were conducted with 10 AI companies that responded to the survey. Findings were combined with those from 10 in-depth semi-structured strategic stakeholder interviews to address qualitative research questions regarding strengths, weaknesses, opportunities, challenges and risks to the UK AI sector.

Stage 8 – Analysis & reporting: findings from the quantitative and qualitative research were synthesised through steering group discussions and qualitative analysis sessions and triangulated to inform this baseline report.

## 1.3. Interpretation of Data

Artificial Intelligence activity in the UK is not defined by a formal Standard Industrial Classification (SIC) code[1]. This study therefore uses experimental methods to identify and quantify AI activity across traditional economic sectors. The approach and methodology are

[1] SIC codes are the current system of classifying business establishments and other statistical units by type of economic activity in which they are engaged.

consistent with those employed to deliver analyses of the UK cyber security sector annually since 2018[2]. The data used to inform the study includes:

- Identification of AI firms according to an agreed taxonomy using AI driven language models applied across websites, news, social media, academic and official sources.
- Enrichment of web data using open and proprietary data sources including Companies House (company name, registration number, locations, incorporation date), Bureau van Dijk FAME (revenue, employment, profitability, remuneration, R&D spend) and Beauhurst (external grants, fundraisings, accelerator attendance, M&A activity).

Across this report, percentages from the quantitative data may not add to 100% due to rounding and / or the option to select multiple responses to certain survey questions. It is also important to note that the survey data is based on a sample of AI companies and are therefore subject to sampling tolerances. The overall margin of error for the sample of 250 AI companies (within a population of 3,170 companies) is between c.3 and c.6 percentage points at a 95% confidence level. The lower end of this range (3 percentage points) is used for survey estimates closer to 10% or 90%. The higher end (6 percentage points) is used for survey estimates around 50%. Data from the 22 qualitative consultations is intended to be illustrative of the key themes affecting AI activity in the UK generally, rather than a statistically representative view of AI sector businesses or investors.

## 1.4. Acknowledgements

The authors would like to thank the DSIT team for their support across the study. DSIT and the report authors would also like to thank all those who contributed to the research, including those who took part in in-depth strategic stakeholder interviews, responded to the business survey, or otherwise offered intelligence and insights to the study.

**Note: This report uses experimental methods to define, scope and measure the scale of the UK's AI sector. We therefore welcome comments and feedback regarding the methodology or findings herein, through contacting** digital-analysis-team@dcms.gov.uk**.**

[2] DSIT (2022) Cyber Security Sectoral Analysis 2022, accessible at [https://www.gov.uk/government/publications/cyber-security-sectoral-analysis-2022]

# 2. UK Artificial Intelligence Sector Profile

The National AI Strategy describes Artificial Intelligence (AI) as the *"fastest growing deep technology in the world, with huge potential to rewrite the rules of entire industries, drive substantial economic growth and transform all areas of life"*[3]. Recognising challenges, limitations and questionable value of trying to tightly define AI, the AI regulation policy paper – Establishing a pro-innovation approach to regulating AI[4] – describes AI as *"a general-purpose technology like electricity, the internet and the combustion engine."* It defines the core characteristics of AI as the 'adaptiveness' and 'autonomy' of the technology i.e., that AI technology can operate on the basis of instructions which have been learnt rather than programmed, and that can be autonomously applied within dynamic and fast-moving environments.

## 2.1. Defining the UK Artificial Intelligence Sector

The analyses contained in this report are based on a commercially oriented taxonomy of AI activity in the UK. The 'commercially oriented' distinction is made given the commercial nature of the language used to inform this study (drawn from web and trade-based descriptions of company activity), vis-à-vis more technical terminology that is currently being used in parallel activity to better understand research-related technological AI developments. As discussed further overleaf, the study segments companies according to an agreed taxonomy, including a delineation between 'dedicated' and 'diversified' AI companies. Table 2.1 provides an illustration of some of the most prominent dedicated and diversified AI companies identified.

Table 2.1 – Key AI Sector Contributors – Dedicated & Diversified

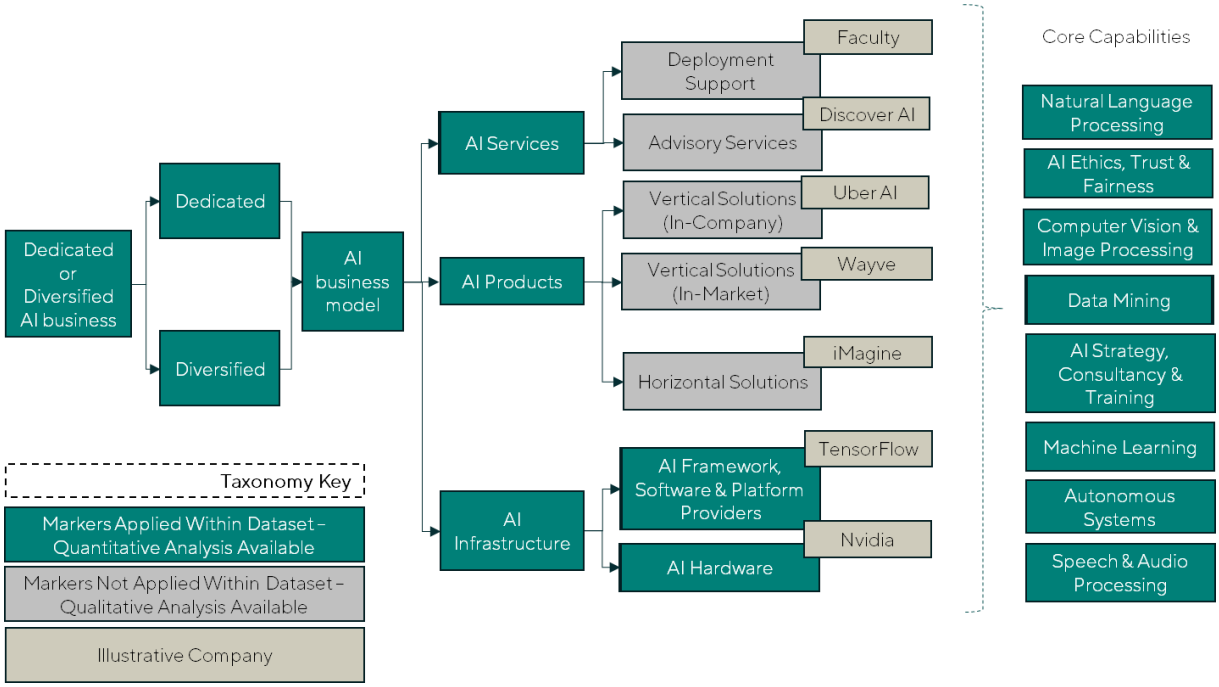
| | Dedicated | | Diversified |
|---|---|---|---|
| 1 | DeepMind | 1 | Facebook UK |
| 2 | LimeJump | 2 | IBM UK |
| 3 | LoopMe | 3 | Microsoft |
| 4 | Peak | 4 | Google UK |
| 5 | Ivefi.ai | 5 | Accenture |
| 6 | Lendable | 6 | Amazon |
| 7 | Equipped AI | 7 | Deloitte |
| 8 | Improbable | 8 | Vodafone |
| 9 | Exscientia | 9 | Cognizant |
| 10 | Tractable | 10 | BT |

*Source: Glass.ai, Perspective Economics*

[3] DSIT (2021) National AI Strategy, Department for Science Innovation & Technology.
[4] https://www.gov.uk/government/publications/establishing-a-pro-innovation-approach-to-regulating-ai/establishing-a-pro-innovation-approach-to-regulating-ai-policy-statement

The taxonomy used to describe AI activity in this study is illustrated in Figure 2.1. Salient points to note regarding the taxonomy are discussed below Figure 2.1, and the full taxonomy is also available to view in the appendices to this report.

Figure 2.1 – UK AI Taxonomy




*Source: Perspective Economics*

For ease of reference, salient points regarding the sector taxonomy include:

- Pre-requisites for inclusion: To be included in the study companies must be registered and have an active presence in the UK.
- Dedicated vs Diversified AI companies: at the highest level, the taxonomy segments the business population according to whether they are a dedicated AI company, or whether AI activity makes up a smaller proportion of a much broader commercial business offering. Dedicated AI companies are considered to be businesses that provide a proprietary AI technical service, product, platform or hardware as their primary revenue source.
- AI Business Model: at a lower level the taxonomy segments between creators of AI infrastructure[5], developers of AI products[6] and AI service providers[7]. Adopters of AI products or services developed by others are considered to be outside the scope of this study to avoid double counting and to help ensure that the analysis is predominantly focussed on value added to the UK economy by AI sector activity.

[5] Including hardware, frameworks, software, libraries and platforms.
[6] Companies producing bespoke, value adding AI solutions marketed and sold as products.
[7] Companies offering skills and expertise to support the adoption of AI products.

- AI Capabilities: the analyses contained in the report segment AI sector activity according to the main technological capability that underpins business models. While many of the companies identified employ multiple AI capabilities, language models were adjusted to identify both the foremost AI capability, as well as all other capabilities mentioned. Machine Learning is a generic term that underpins all other capabilities. It is included as a category here because in many instances descriptive company information (the basis of classification) does not further specify technical capabilities.
- Industries: to support comparative analyses with SIC based economic data each company is also assigned to a single industry which is derived from and can be mapped back to SIC Codes.

In addition, each in-scope company has been classified into industry sectors using Glass.ai's proprietary topic ontologies. The most prominent industry sectors referred to in Section 3 are listed below and a summary of companies assigned to both Glass.ai sectors and Standard Industrial Classification (SIC) codes are available in the appendices.

- Computer Software
- Information Technology and Services
- Biotechnology, Life Sciences & Pharma
- Financial Services
- Professional Services
- Wider Health & Medical Practice
- R&D and Scientific
- Automotive, Industrial Automation & Machinery
- Energy, Utilities & Renewables
- Agricultural Technology

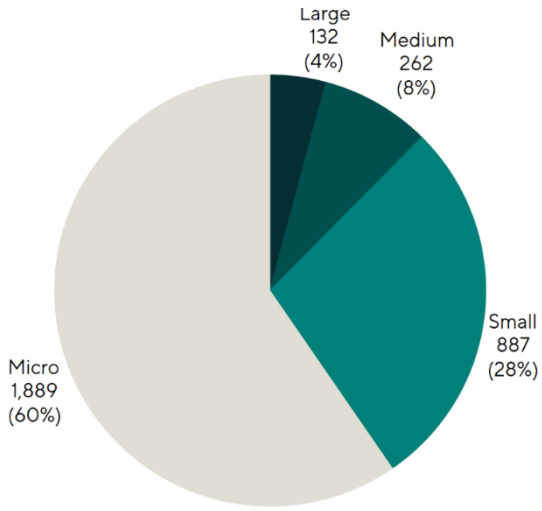
## 2.2. Number of UK AI Companies

Based on a combination of AI driven web intelligence, and collation of company data from numerous open and proprietary sources including Companies House, Bureau van Dijk, Beauhurst and Lightcast, we estimate that there are currently **3,170 active companies** in the UK providing AI infrastructures, products and services. As previously stated, this focusses specifically on value-added by the AI sector and does not therefore include the wider value added by adoption of AI technologies across other sectors.

### 2.2.1. Registered Companies by Size

Ninety-six percent of the companies identified are SMEs; 60% of all companies are micro businesses (Figure 2.2).

Figure 2.2 – Size Profile of UK AI Companies




*Source: Glass.ai, Perspective Economics (n=3,170)*

Consultation with strategic stakeholders from across industry, academia and policy spheres pointed to the presence of a significant number of large technology firms as a key strength of the UK's AI ecosystem, deemed to be at least in part due to the UK's reputation for high quality scientific research and innovation. This assertion is supported by a comparison of the size of companies in the AI sector vis-à-vis the broader UK business population[8] (Table 2.1). The table below evidences that the AI sector has a greater concentration of large, medium and small businesses than the general UK Business population.

Table 2.1 – AI Size Profile Comparison

| Size | UK Business Population Estimates (2022) | Percentage | AI Sectoral Analysis | Percentage |
|---|---|---|---|---|
| Large (250+ employees) | 7,675 | <1% | 132 | 4% |
| Medium (50-249) | 35,940 | 3% | 262 | 8% |
| Small (10-49) | 217,240 | 15% | 887 | 28% |
| Micro (1-9) | 1,187,045 | 82% | 1,889 | 60% |
| **All Businesses with at least 1 employee** | **1,447,900** | **100%** | **3,170** | **100%** |

*Source: ONS, Glass.ai*

[8] UK Business Population Estimates (2022): Available at: https://www.gov.uk/government/statistics/business-population-estimates-2022

### 2.2.2. Dedicated & Diversified AI Companies

Of the 3,170 active companies identified through the study 60% are dedicated AI businesses and 40% are diversified (i.e., have AI activity as part of a broader diversified product or service offer, Figure 2.3).

Figure 2.3 – Dedicated and Diversified AI Companies

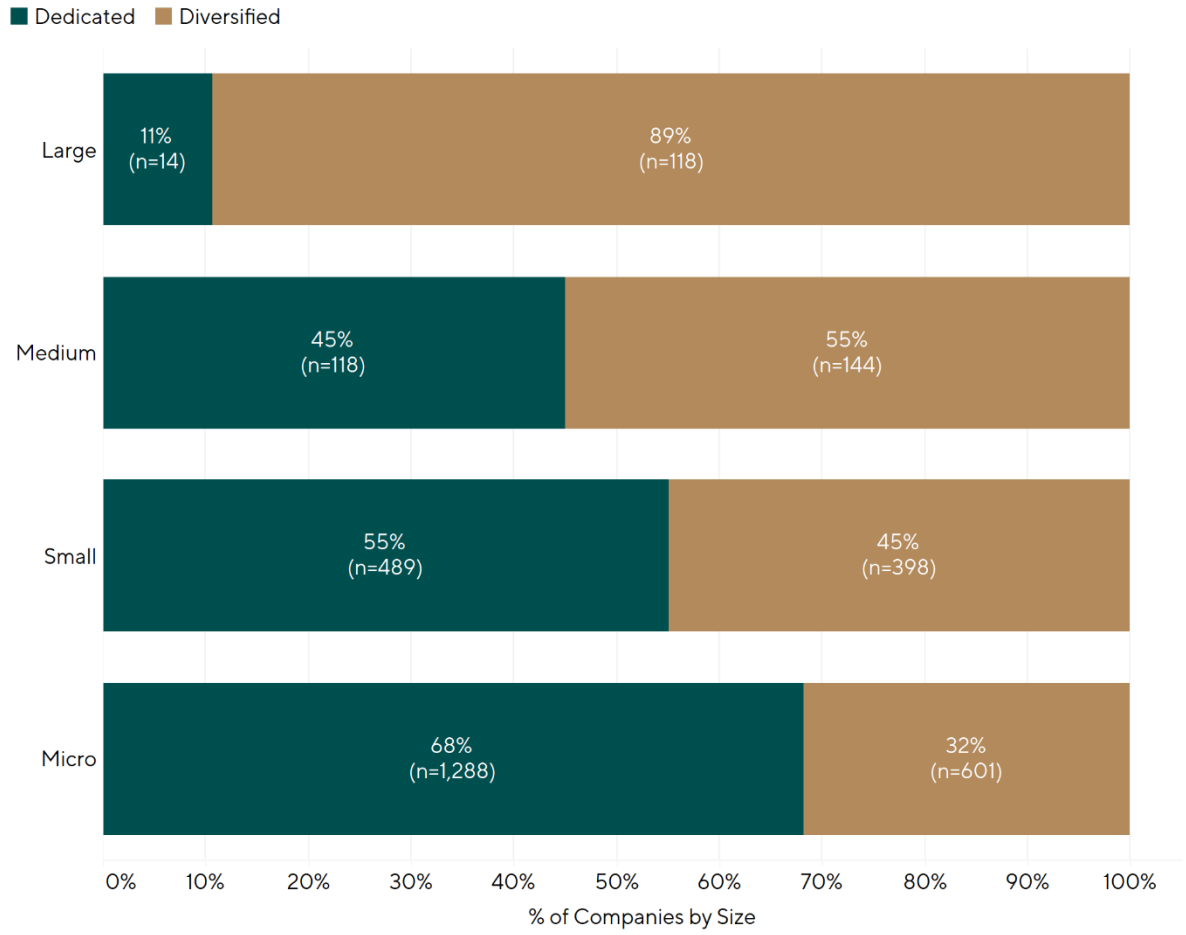

*Source: Glass.ai, Perspective Economics (n=3,170)*

In comparison to other similar studies the proportion of diversified companies within the AI sector is higher. This is indicative of the comparatively broad scope for AI technology applications across sectors, and points to an intense focus on development of AI technology among both dedicated companies (e.g., DeepMind, Improbable, Benevolent AI) and established, diversified technology companies with much broader service offers (e.g., Amazon, Google, Microsoft, IBM)[9].

Figure 2.4 overleaf shows that most large AI companies are diversified (89%, n=118), whereas the majority of micro-AI companies are dedicated, meaning that AI is core to their business model (68%, n=1,288).

[9] It is worth noting here that, given the breadth and varying scale of AI activity, it is not possible to delineate dedicated and diversified AI firms solely on the basis of the proportion of AI related revenue or employment within companies. Companies with relatively small AI teams can be dedicated AI companies and by the same token, companies with large AI teams can be diversified. Therefore instead, the study used a combination of data on AI related employment and a detailed manual review of company descriptions as the basis of final decisions on whether or not a company falls into the dedicated or diversified category.

## Figure 2.4 – AI Company Size



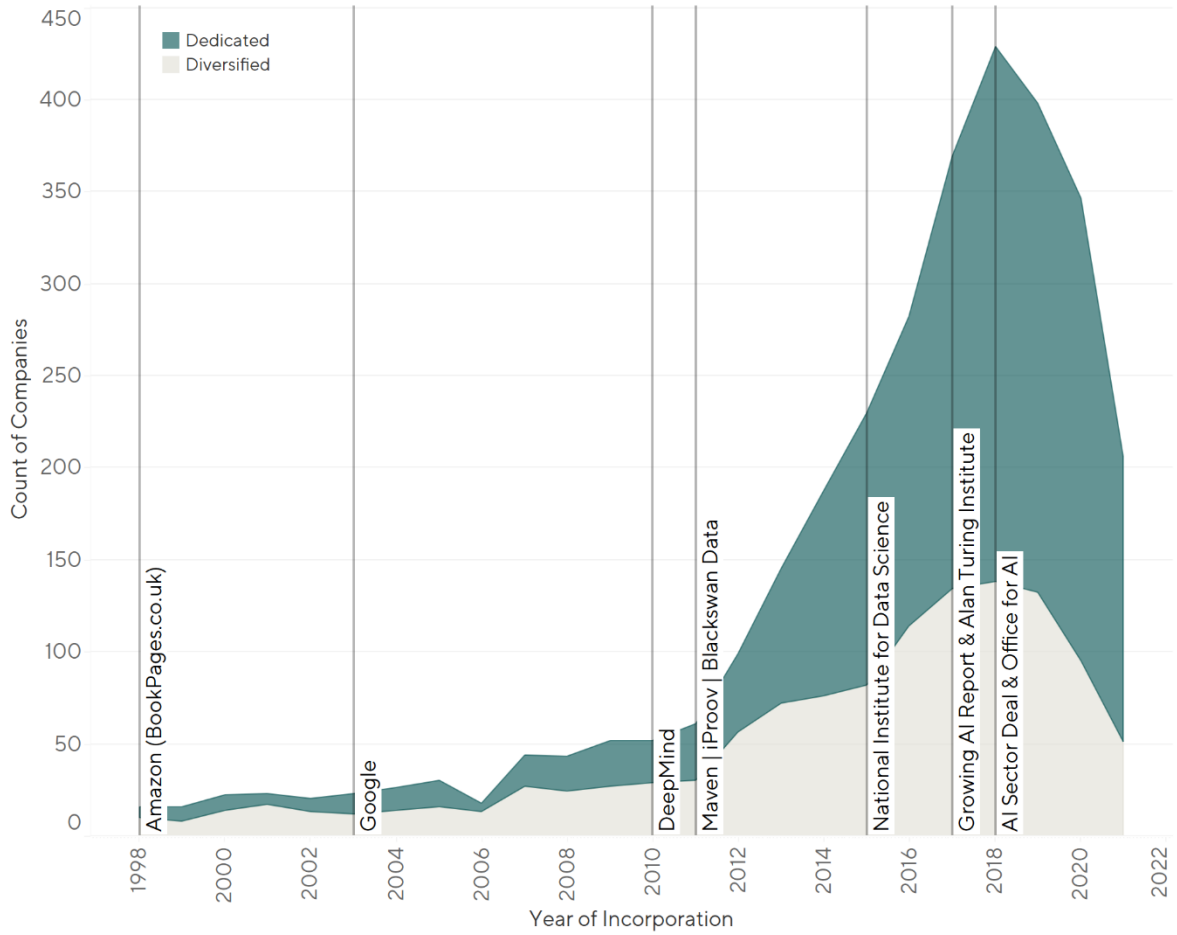

*Source: Glass.ai, Perspective Economics (n=3,170)*

### 2.2.3. AI Company Registrations

Analysis of incorporation dates across the population of AI companies shows significant growth in AI company registrations since 2011. On average, 269 new AI companies have been registered each year since 2011, with a peak in new company registrations in the same year as the AI Sector Deal (2018, n=429) and smaller numbers of new company registrations since (Figure 2.5 overleaf)[10].

[10] Analysis excludes 2022 due to data gaps associated with the normal lag in availability of company data.

Figure 2.5 – AI Company Registrations

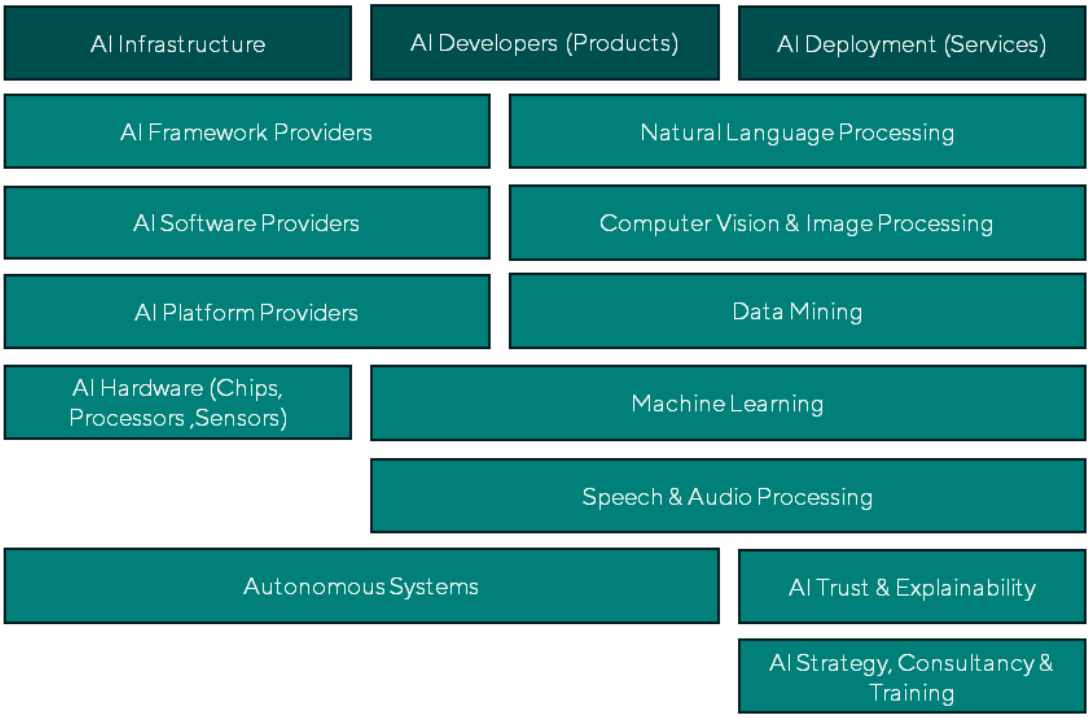



*Source: Perspective Economics, Glass.ai, Companies House (1998 – 2021 | n=3,030 companies incorporated since 1998)*

### 2.2.4. Predicted AI Business Model

The taxonomy can be used to better understand the profile of the AI sector according to the broad focus of AI activity (i.e., infrastructure, products or services) and at a lower-level, categorisation of the core capability of in-scope companies. Figure 2.6 overleaf presents the two main taxonomy levels as an excerpt for ease of reference. Analyses that follow focus on the business models and capabilities of companies included in the final dataset. Each company is assigned to a single business model and capability based on the highest probable categorisation using the language models developed by Glass.ai.

Figure 2.6 – AI Business Models & Capabilities




*Source: Glass.ai, Taxonomy Workshop Outputs*

Across the entire population 82% of companies fall within the business model categories of AI products and infrastructures (72% and 11% respectively), with the remaining 18% engaged predominantly in providing AI-related services[11]. A greater proportion of dedicated AI companies primarily produce AI related products (75% of dedicated companies compared to 66% of diversified companies). Together, the data on company size and business model suggest that dedicated AI companies are both smaller and more dependent on the success of the AI products they are developing. Diversified AI companies are typically larger and likely to generate a greater proportion of revenues from less capital-intensive provision of AI related services. Dedicated AI companies may therefore be at greater risk of failure in the event of adverse macro economic conditions, market specific adjustments such as reductions in capital allocation in other sectors or investor hesitance, negative sentiment towards AI technology and / or ineffectual sectoral policies.

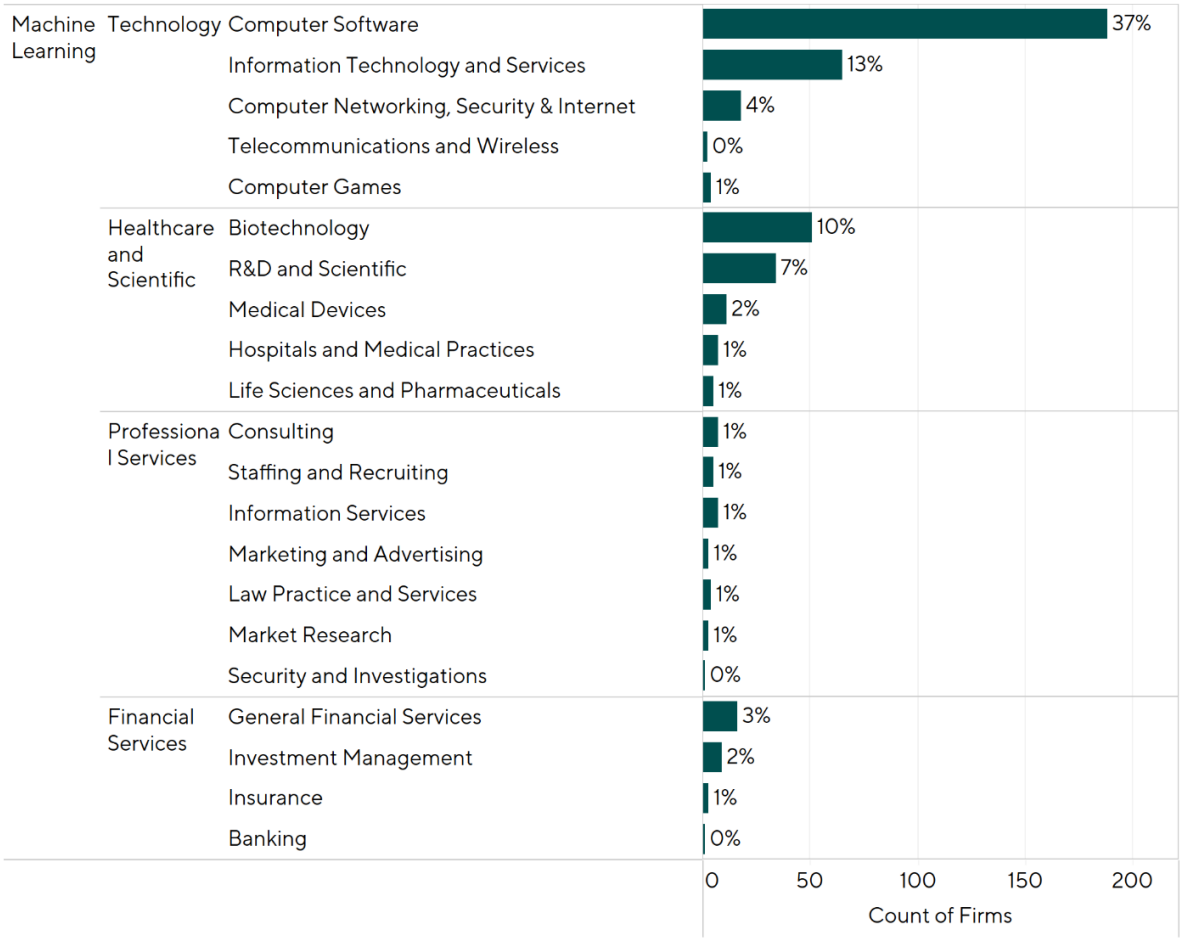
### 2.2.5. Predicted AI Capabilities

The analyses below consider results of Glass.ai's assignment of predicted capabilities to a subset of 1,607 dedicated companies that have AI products or infrastructures as the core of their business models[12]. Among this subset of dedicated AI product and infrastructure providers almost two thirds (64%, n=1,022) cite development of AI driven platforms and software or 'machine learning' as the basis of core business activity.

[11] Offering strategic advice, consultancy and training, or advisory support for implementing AI products.
[12] The majority of dedicated companies offering AI related services have either 'strategy, consultancy and training' or 'ethics, trust and fairness' as predicted capabilities and do not therefore offer additional insight here.

Machine learning is a commonly used term within company descriptions, and is often the online term used to describe AI-related activity, partly due to commercial sensitivities, and partly due to the more generic nature of publicly facing descriptions of activity. Further disaggregation of this category will be required, however to provide further insight into the activity of these companies, 86% operate in a relatively small number of sectors, including computer software and IT, biotechnology, and professional and financial services, as illustrated in Figure 2.7 below.

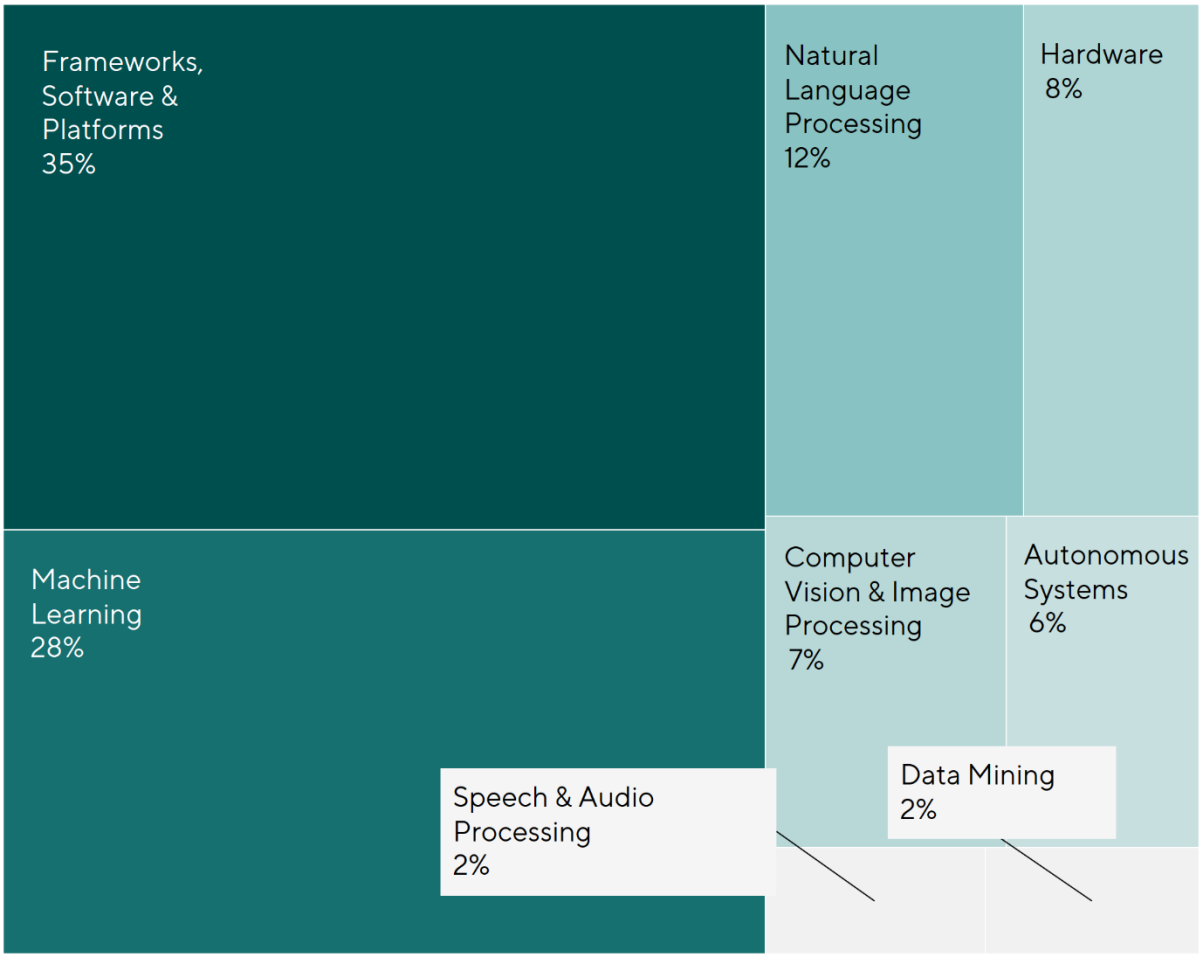
Figure 2.7 – Breakdown of Machine Learning Companies by Industry and Sub-Industry




*Source: Glass.ai, Perspective Economics (n=514 companies with 'machine learning' capability)*

Smaller proportions of dedicated AI product and infrastructure providers cite other, more specific capabilities such as Natural Language Processing (12%), Computer Vision and Image Processing (7%), Autonomous Systems (6%) or Speech and Audio Processing (2%) (Figure 2.8).

Figure 2.8 – AI Capabilities




*Source: Glass.ai, Perspective Economics (n=1,607 dedicated product and infrastructure providers)*

With respect to AI services, a majority of dedicated companies are involved in general strategy, consultancy and training, and a relatively small proportion are specifically concerned with ethics, trust and fairness.

### Taking a Lead on AI Assurance

As AI technologies advance at an ever-increasing rate and generate more public debate, there is an increasing imperative (both ethical and commercial) to ensure that the development and application of AI technologies is ethical, trustworthy and fair.

Strategic stakeholders consulted to inform this study returned positive sentiment regarding the policy landscape surrounding AI in the UK. In particular, they highlighted UK strength in efforts to create a credible yet still pro-innovation assurance AI ecosystem. Numerous examples of positive progress towards effective AI assurance were cited in the research, including:

- The Centre for Data Ethics and Innovation's (CDEI) AI assurance roadmap and AI Assurance Guide which promote and support the use of AI assurance to ensure effective governance and ethical use of AI services.
- The AI Standards Hub, led by The Alan Turing Institute with the British Standards Institution and National Physical Laboratory.
- The AI Council, made up of industry representatives (including from companies such as Google, Microsoft and DeepMind) to advise government on AI policy.

Within the study dataset seventeen dedicated AI assurance companies were identified, two thirds of which have been founded since 2017 (n=11). These companies generated more than £34m in revenue in the latest financial year and have raised £18m in private investment since 2016, including companies like Smarter Human.

Founded in 2017, Smarter Human's mission is the ethical and compliant use of artificial intelligence. Smarter Human offers products and services for companies to make their use of AI and machine learning ethical and legislatively compliant, including with respect to AI governance, algorithmic bias and explainability.

From a commercial perspective, legislative developments in other countries, including the AI Bill of Rights in the US and the EU AI Act, for example, are expected to create significant opportunities which study consultees believe UK companies are well-placed to benefit from.

Beyond potential commercial opportunities, study consultees suggested that strong progress on AI assurance offers much wider benefits – providing the UK with a 'credible voice' on AI within international discourse and contributing to the attractiveness of the UK as a location for AI companies that have purpose and a long-term vision. Organisations such as CDEI and the Alan Turing Institute continue to work on maturing both individual mechanisms of assurance such as certification, techniques, and regulatory principles. Based on the Office for AI policy paper, work is also ongoing to understand how all of those components can effectively link together to deliver a layered AI assurance system that adds value both to AI businesses and UK citizens.

### 2.2.6. Development and adoption of AI across sectors

Development and adoption of AI technologies across sectors has been described by strategic external stakeholders as non-linear and inconsistent, even within comparatively high-adoption sectors. While there are many strong AI use cases across sectors, inconsistencies in adoption are seen as posing a risk to the advancement of AI technologies more generally.

Consultation with strategic stakeholders highlighted strong AI use cases in the UK with respect to drug discovery and pharmaceuticals, wider healthcare, financial technology and logistics. However, consultees were also keen to point out that, even within sectors that have had strong adoption of AI technologies to date, there were barriers to wider adoption. This meant adoption tended to happen in 'pockets' of activity.

Barriers included a lack of access to data on which to train new AI products, a lack of sector-specific information about the performance and efficacy of AI products, and an unwillingness from customers to adopt new, disruptive technology (especially if run alongside existing processes). Healthcare was highlighted as a case in point (see the case study below).

Further, while this study focuses primarily on the activity of companies that have AI products and services at their core, interviews also highlighted the significant role that adoption plays within AI product development and innovation. Encouraging adoption of AI technologies across and within sectors was expected to drive AI product development and innovation, as well as demand and supply of AI products and services.

*"As a sector becomes more aware of AI and use cases, you will start to see more people dabbling, that will catalyse others. That in turn will demonstrate the demand, that will increase the supply." Academic Stakeholder*

Stakeholders and businesses suggested more public sector contracts would lead to greater adoption and result in enhanced feedback loops. The result would be greater sector-specific expertise and experience being combined with AI, leading to products and services that more closely meet the needs of customers in that sector, which would in turn improve the AI market for that sector.

*"You would then get real end-user problems that need solving." AI business*

## AI for Healthcare

Artificial Intelligence has the capability of enhancing healthcare and improving patient experiences. AI-driven technologies can be used to revolutionise the healthcare system by helping it to run more efficiently and reducing the workload on healthcare staff.

In 2021 the Department of Health and Social Care invested £36 million in thirty-eight AI projects aimed at enhancing patient care and accelerating diagnosis, including:

- Chest X-ray analysis – an AI algorithm that can fast-track the diagnosis of suspected lung cancer patients.
- eHub – AI technology that can triage and automate GP requests.
- Wysa – an AI application that can be used for early intervention and support for mental health.

NHS England has created several innovative AI related initiatives, including the NHS AI Lab, focussed on the safe adoption of artificial intelligence in health and care, an ambitious pilot to improve the ethical use of AI in healthcare, aiming to eradicate algorithmic biases, and the AI in Health and Care Award which has funded 89 of the most promising AI technology projects since 2020, across the spectrum of development, from initial feasibility to evaluation within the NHS.

Despite these developments strategic stakeholders were keen to stress the need for ongoing efforts to alleviate barriers to development and adoption of AI for health and social care, including access to data and data governance.

*"Healthcare is getting a big push, but there is still a big gap in how policy can help to address issues in adoption of AI in healthcare – governance is a big one."*

Within the study dataset a total of 262 dedicated healthcare-oriented AI companies were identified. These companies account for around one third of dedicated AI revenues and one fifth of employment (£1.7bn in revenue and approximately 4,500 employees). The health and life sciences sector includes some of the largest UK AI companies, such as DeepMind, Exscientia, as well as a cohort of innovative SMEs.

Ultromics Ltd is a leader in AI for echocardiography that has secured over £43 million in investment, including NHS funding as a winner of the AI in Health and Care Award. Ultromics uses AI to tackle the most common cardiac imaging modality, allowing for detection of heart failure at an earlier stage and risk stratification.

# 3. Location of UK AI Companies

This section presents an analysis of the registered addresses and active office locations of all UK AI companies. Registered address refers to the location of registered offices and active office locations refer to other trading addresses and offices across the UK.

Understanding the location of AI activity helps to identify notable clusters, the characteristics of those clusters, and can therefore support evidence-based targeting of regional supports.

The study has identified 3,170 registered addresses and a further 2,343 trading addresses. In order to provide a comprehensive view of all AI activity Section 3.1 uses all location data (registered and trading addresses together) referred to as 'trading locations' (n=5,513). Section 3.2 uses registered trading addresses only (n=3,170) to better understand the locus of sectoral activity across regions.

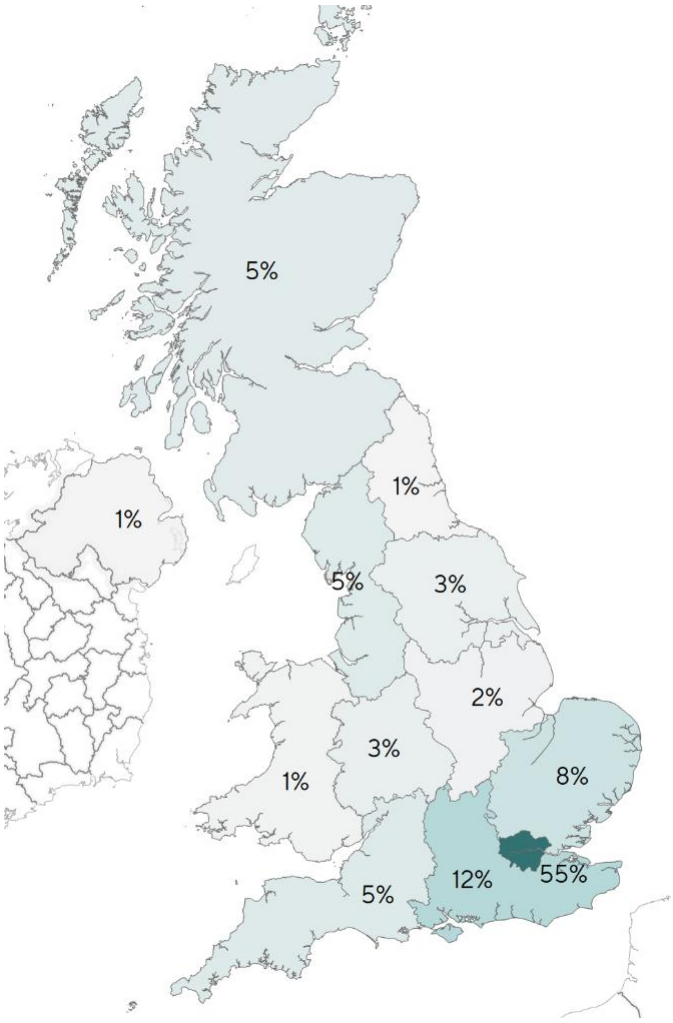
## 3.1. AI Activity by UK Region

Fifty-five percent of AI trading locations are in London. A further 20% are in the South East and East of England, leaving approximately one quarter of AI trading locations spread across other regions. The South East, North West and Scotland each account for around 5% of AI trading locations.

In other sectoral studies that apply comparable methods, while the number of registered offices tends to be concentrated in London and the South East, analysis of trading addresses has tended to present a more balanced regional picture. That does not appear to be the case for the AI sector.

London, the South East and the East of England[13] account for 75% of registered AI office addresses, and also account for 74% of trading addresses. Just under one third of AI companies with a registered

Figure 3.1 – Regional AI Activity




Source: Glass.ai (n=5,513 trading locations)

[13] Also referred to as 'The Golden Triangle'

address outside of London, the South East and the East of England still have a trading presence in those regions. The concentration of AI companies in the south and east of England is likely due to several factors that have influenced UK AI sector development to date including, for example, prominent UK AI sectors (e.g., within financial and wider professional services) and the significant role of Venture Capital (VC) and Private Equity (PE) funding, believed to be more accessible in London.

## 3.2. Regional AI Activity by Sector

Sectoral classifications assigned by Glass.ai to each AI company show that just under half (46%, n=1,451) of all UK AI companies operate within the software development and information technology and services sectors, as would be expected. Beyond those two substantive sectors, biotechnology life sciences and pharma, financial and wider professional services, wider health and medical practice, and R&D and scientific companies account for just over one quarter of the AI companies identified (28%, n=881).

London, the South East and the East of England account for almost 90% of all financial services focussed AI companies and 80% of companies focussed on wider professional services activities. Other UK regions account for larger proportions of AI-oriented computer software and information technology companies (23% and 26% respectively); biotechnology, life sciences and pharma; and R&D and scientific companies (both with 27% of activity outside London, the South East and the East of England). While absolute numbers are smaller, the study has identified more notable proportions of wider regional AI activity in automotive, industrial automation & machinery (44%); energy, utilities and renewables (39%); health, wellbeing and medical practice (30%) and agricultural technology (46%)[14].

Table 3.1 provides a summary of AI sectoral activity across regions within and outside London, the South East and East of England. The analysis offers a starting point for considering targeted, sector-based support for further development of core AI activity and for supporting the adoption of AI technologies across UK regions.

[14] Ns = 39, 25, 37 and 13 respectively. Agricultural technology not shown due to comparatively small number, however the most notable proportions of agricultural AI activity are in the Southwest, East Midlands, Scotland and Northern Ireland.

Table 3.1 – AI Sectoral Activity Across Regions

| Sector | Outside London, South East & East of England (#) | Outside London, South East & East of England (%) | London, South East & East of England (#) | London, South East & East of England (%) |
|---|---|---|---|---|
| Computer Software | 217 | 23% | 742 | 77% |
| Information Technology and Services | 129 | 26% | 363 | 74% |
| Biotechnology, Life Sciences & Pharma | 65 | 27% | 176 | 73% |
| Financial Services | 27 | 13% | 189 | 88% |
| Professional Services | 41 | 20% | 162 | 80% |
| Wider Health & Medical Practice | 37 | 30% | 87 | 70% |
| R&D and Scientific | 26 | 27% | 71 | 73% |
| Automotive, Industrial Automation, Machinery | 39 | 44% | 50 | 56% |
| Internet | 15 | 22% | 54 | 78% |
| Energy, Utility & Renewables | 25 | 39% | 39 | 61% |
| Computer Networking and Security | 14 | 24% | 44 | 76% |
| Consulting | 16 | 32% | 34 | 68% |

*Source: Glass.ai (n=2,662 of 3,170 companies)*[15]

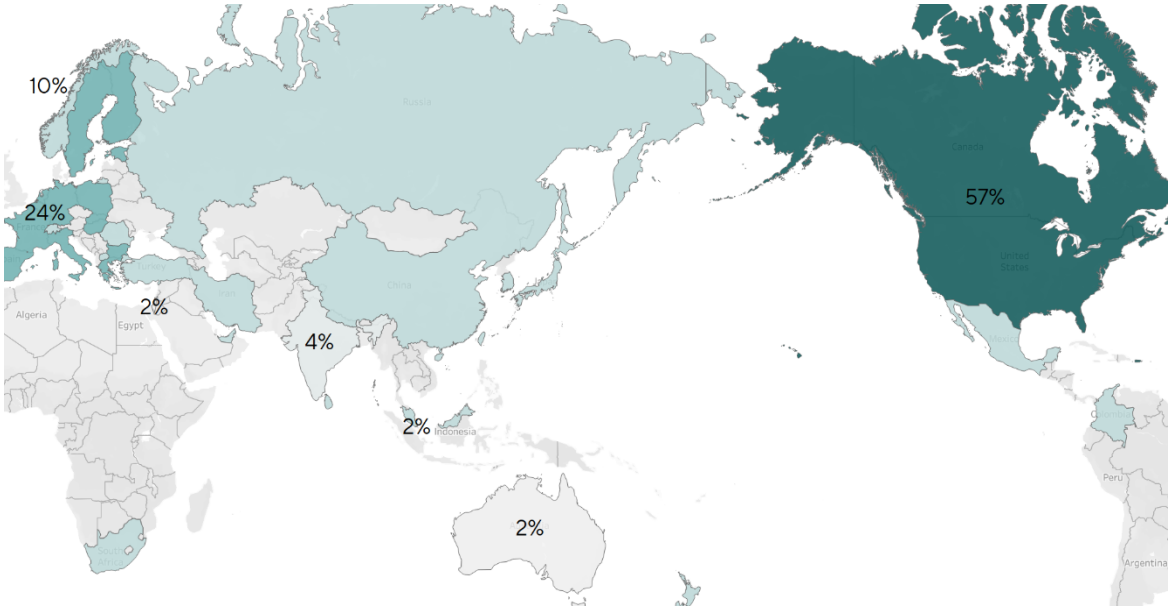
## 3.3. International Activity

A total of 311 (10%) of the AI companies identified are headquartered outside of the UK. International ties within the UK AI sector are strongest with North America, particularly the US which accounts for 53% of internationally headquartered UK AI companies (n=168). Just under a quarter of internationally headquartered AI companies are in Europe, with smaller proportions headquartered in India (4%), Canada (3%), Australia, Israel and Singapore (each home to 2% of internationally headquartered UK AI companies).

In the qualitative stakeholder interviews, some key reasons were suggested for why companies from the US (and elsewhere) might locate in the UK. These included the UK and US sharing a common language; the UK's time zone making it a useful location for co-ordinating international activities; having access to a high density of world-leading universities with strong experience in AI research and development; having access to other headquarters of major international organisations from a range of sectors, such as finance, biotech, retail and telecoms; having access to UK business support programmes; and the UK having a straightforward tax structure and good legal system, which makes it an attractive environment for establishing a business.

[15] Only sectors that comprise at least 50 companies are included in the analysis.

Figure 3.3 – Internationally Headquartered UK AI Companies




*Source: Glass.ai, Perspective Economics (n=311)*

Further analysis of international office locations shows that around one in five (n=561) UK headquartered companies have a total of 998 international offices in 80 countries. Just under one third of these offices are in North America, thirty percent are in the EU and just under 10% are in India.

### 3.3.1. AI Imports & Exports

Beyond international ties denoted by international headquarter locations there are three further sources of data on international trade, namely analysis of international office locations, responses to export related questions asked within the business survey, and trade data based on relevant harmonised system (HS) commodity codes. There are limitations to each of these sources, for example, analysis of international office locations may not fully capture trade in commodities, the business survey sample is relatively small and skewed towards SMEs, and trade data only captures commodities (not services) and includes data for re-sellers. Therefore, while it is not possible to provide definitive analysis of trade in AI products and services within the scope of this study, the paragraphs below offer an illustration of UK AI trading activity.

Fifty-one percent of survey respondents indicated that they exported. Of those, approximately 60% of respondents generated at least half of company revenues from export activity. Prominent export markets include the EU (37% of respondents), the US (34% of respondents) and Asia Pacific (20% of respondents)[16].

[16] Respondents could select more than one export market.

When asked about barriers to exporting, of the 128 survey respondents who indicated that they had some experience of exporting, respondents pointed to lack of knowledge or networks for international trade (28%, n=36), lack of finance or insurance for exporting (27%, n=34), competition with other countries (22%, n=28), regulatory barriers (17%, n=22) and administrative costs (15%, n=19).

Of the 1,916 dedicated AI companies included in the study, experimental Beauhurst data on trading activity indicates that 169 have export activity and 244 are dependent on imports of some description (9% and 13% respectively)[17]. There is therefore clearly a disparity between the representation of trading activity between the business survey (51% exporters) and Beauhurst data (9% exporters).

Figure 3.4 – Perceived Export Barriers


[17] Note that further analysis of specific commodity codes would be required to better understand important dependencies.

# 4. Economic Contribution of UK AI Companies

This section presents baseline estimates of the economic profile and contribution of AI companies to the UK economy. Findings are based on modelling from both reported company data where available, and estimates derived from survey data for smaller firms.

## 4.1. Estimated Revenue

In the most recent financial year, annual revenues generated by UK AI companies totalled an estimated £10,646 million (rounded to £10.6 billion).

This revenue estimate relates to revenue attributable to AI activity only. The following subsections set out revenue by size, by dedicated/diversified categorisation, and by key company offer.

### 4.1.1. Revenue by Company Size

Seventy-one percent of all UK AI revenues (£7.6 bn) are generated by large firms, highlighting the significance of these firms given that they make up just 4% of the overall population.

This includes several very large, well known technology companies with broad product and service offerings such as Microsoft, Google and IBM (among others) as well as some larger dedicated AI companies such as DeepMind and Quadrature.

Small and medium sized companies together account for just over a quarter of UK AI revenues (£2.8bn, 26% combined, approximately £1.4bn and 13% for each) and micro-AI companies account for approximately 2% of AI revenues (£230m).

The analysis highlights the extent to which AI sector economic contributions are driven by large well-established technology companies, and the disparity between capital allocation within ‘big-tech’ companies, and AI SMEs that rely more heavily on external finance to support AI product and service development. Further analysis on investment is available in Section 5, however by way of illustration here, 75% of all investment in dedicated AI companies has gone to micro businesses and SMEs.

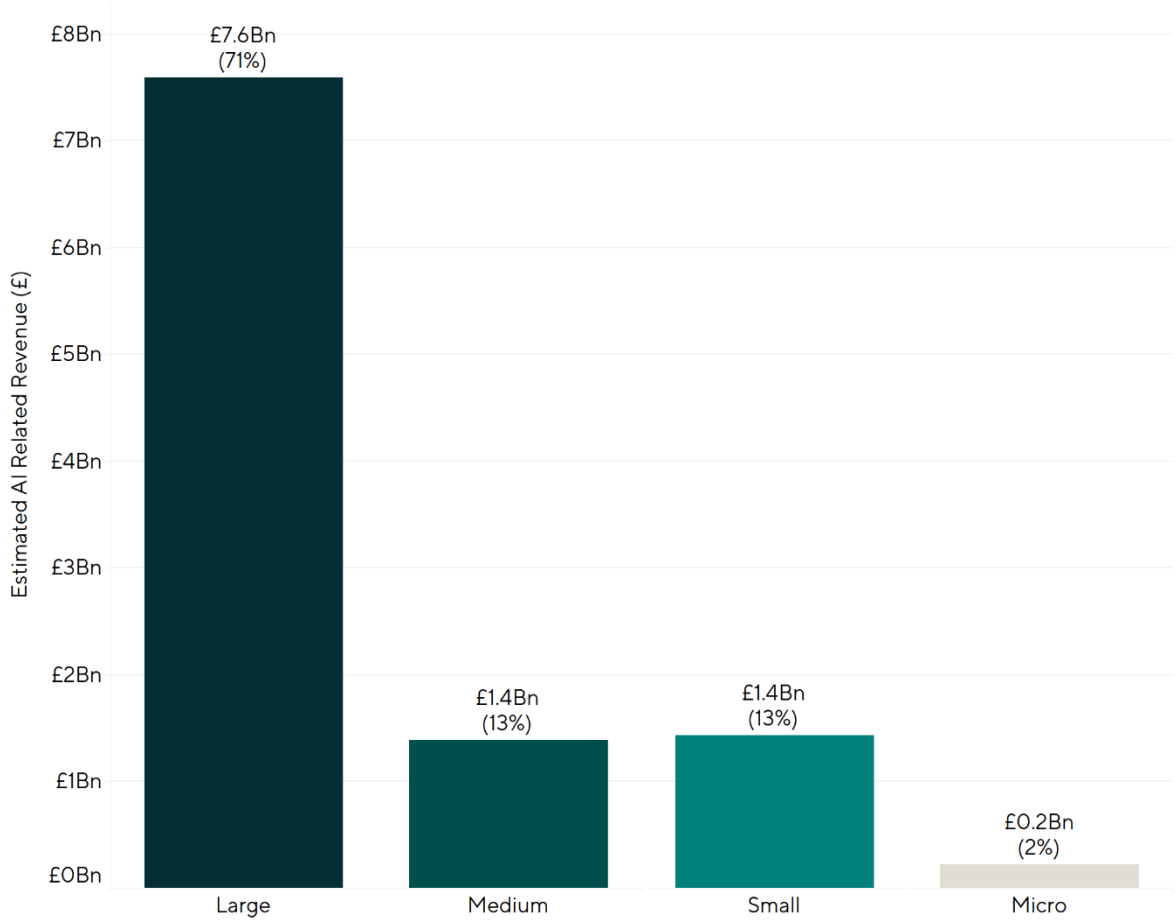
In the qualitative interviews, small pre-revenue AI businesses faced challenges to developing their product or service. Key reasons included a lack of access to external finance, and a lack of access to skills and talent.

Small AI businesses were reliant on external finance to establish themselves and their offer. A lack of access to external finance meant they spent longer in the pre-revenue stage, with time and resources being directed towards obtaining finance rather than business development. Getting and retaining the right skills was also a challenge to growth due to the salary demands of candidates, and competition from larger companies. One business reported considering reducing team sizes because their investment was running out.

Those who had managed to secure first-round funding felt that subsequent funding rounds would be challenging due to a risk averse culture among UK venture capitalists, especially compared to other markets such as the US and France. As a result, small businesses said they had looked outside the UK to grow. For example, one AI business had sought second round investment from France, while another business had turned to the US to raise venture capital.

*"The US is more entrepreneurial. It's much more about taking on risk. That's why we're raising VC in the States." AI business*

Figure 4.1 – UK AI Revenue by Firm Size




*Source: Glass.ai, Perspective Economics (n=3,170)*

### 4.1.2. Revenue within Dedicated / Diversified AI Companies

Segmentation of revenue by size and according to whether the firm is understood to be a 'dedicated' or 'diversified' AI company shows that dedicated companies are driving sector revenues.

While large, diversified companies account for a majority of overall revenues within that size band, on a per firm basis (right-most column), revenues among dedicated AI companies are notably higher across every size band.

Table 4.1 – Revenue of Dedicated & Diversified AI Companies by Size

| Size | Ded / Div | Number of Firms | Estimated AI Related Revenue | % of Total AI Revenue | AI Revenue Per Firm |
|---|---|---|---|---|---|
| Large | Dedicated | 14 | £2,673M | 35% | £190.91M |
| | Diversified | 118 | £4,924M | 65% | £41.73M |
| Medium | Dedicated | 118 | £1,132M | 82% | £9.59M |
| | Diversified | 144 | £256M | 18% | £1.78M |
| Small | Dedicated | 489 | £1,224M | 86% | £2.50M |
| | Diversified | 398 | £207M | 14% | £0.52M |
| Micro | Dedicated | 1,288 | £191M | 83% | £0.15M |
| | Diversified | 601 | £39M | 17% | £0.07M |

Source: Glass.ai, Bureau van Dijk (n=3,170)

### 4.1.3. Revenue by Product / Service Offering

AI companies have been allocated to one of three business models – infrastructure, products or services – by applying Glass.ai's language models to descriptive information for each company. 'Infrastructure' refers to companies providing either hardware or providers of frameworks, toolkits, or platforms that enable the development of AI solutions and / or self-service use. 'Products' refers to AI tool or system made available to an end user that typically has a specific application for customers within a defined market. 'Services' refers to support for implementation of AI solutions, strategy, consultancy or training regarding AI adoption. Note that companies have been assigned to an individual business model category on a best fit basis to support analysis by product and service grouping.

Analysis of AI sector revenues across high-level product and service offerings shows that two thirds of AI sector revenues (£7.1bn) are generated by companies predominantly offering AI products.

Table 4.2 – Revenues by Business Model Grouping

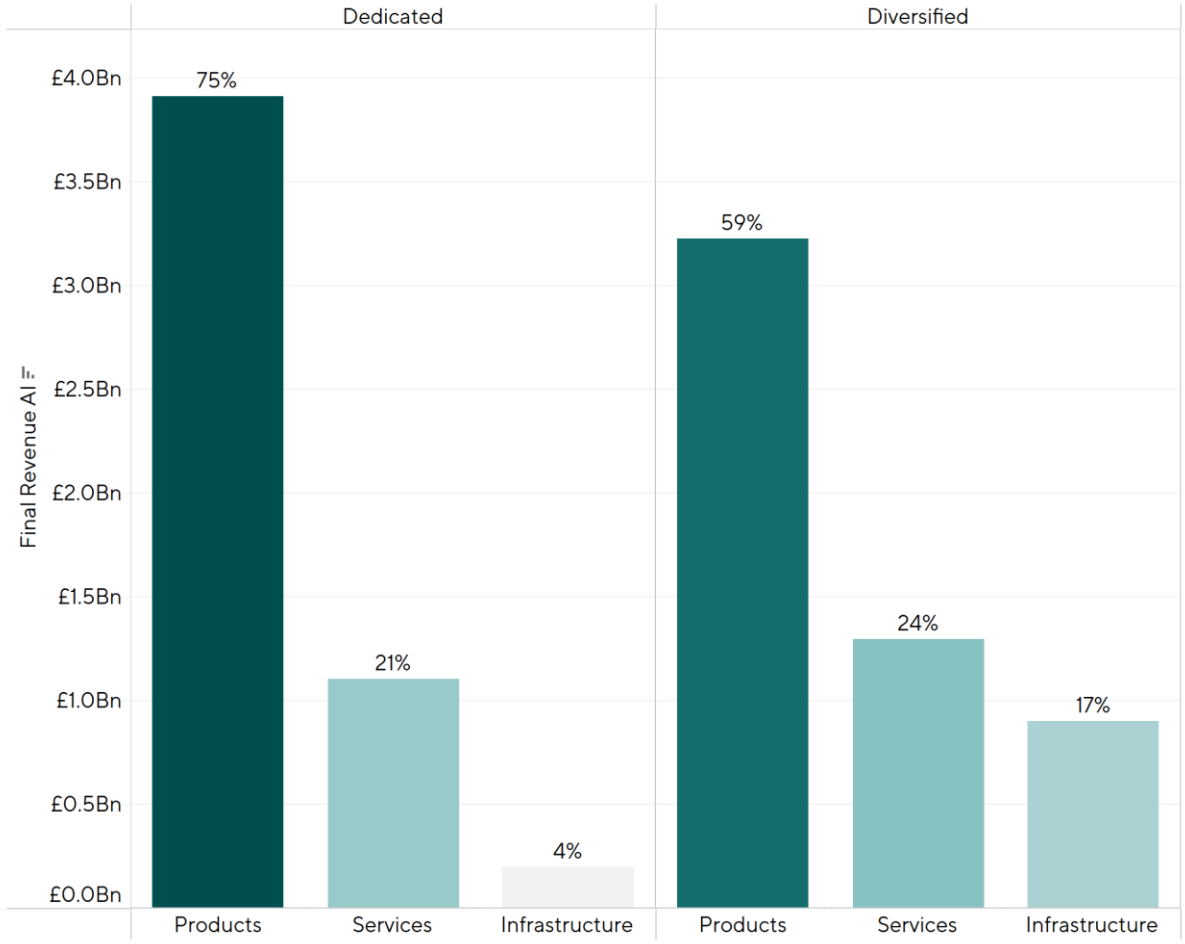
| Business Model Grouping | Number of Firms | Estimated AI Revenue | % of Firms | % of Revenue | AI Revenue Per Firm |
|---|---|---|---|---|---|
| Infrastructure | 335 | £1,099M | 11% | 10% | £3.3M |
| Products | 2,270 | £7,143M | 72% | 67% | £3.1M |
| Services | 565 | £2,404M | 18% | 23% | £4.3M |

*Source: Glass.ai, Bureau van Dijk*

The concentration of revenues associated with AI product development intensifies among dedicated AI companies, where approximately 75% of revenues are linked to AI products (£3.9bn), compared to 59% of revenues among diversified AI companies (£3.2bn).

AI services account for approximately one quarter of revenues among all AI companies (23%, £2.4bn) and for just over one fifth (21%, £1.1bn) of revenues among dedicated firms (Figure 4.3).

Figure 4.3 – Revenues by Broad Product / Service Offer

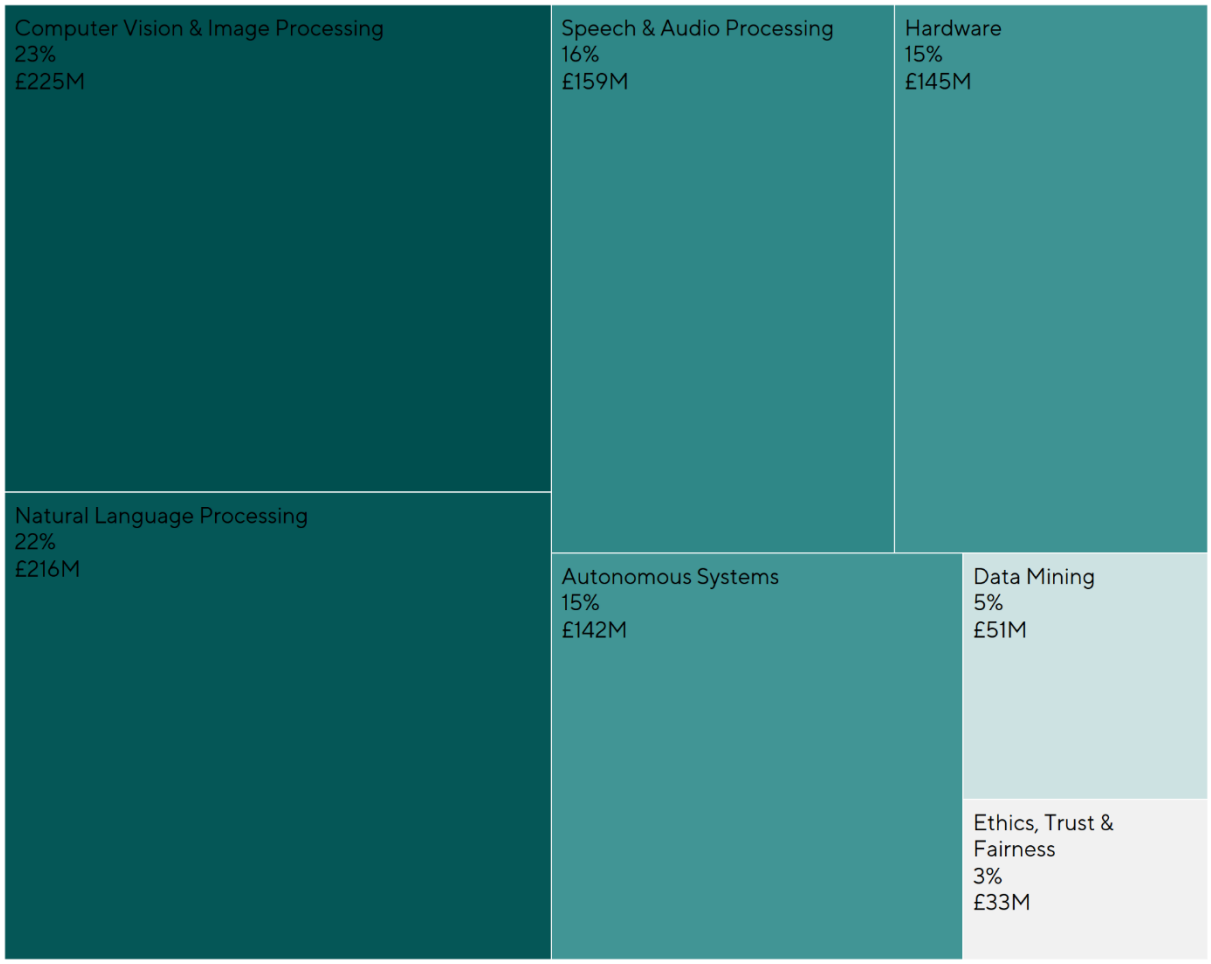



*Source: Glass.ai, Perspective Economics (n=3,170)*

### 4.1.4. Revenue by Technical Capability

At the lower taxonomy level of AI capabilities, dedicated companies that cite machine learning as a core capability account for the largest share of revenue (39%, £2.1bn). Providers of frameworks and platforms account for one quarter of revenues among dedicated AI companies (£1.3bn), and those offering strategy, consulting and training services account for just under one fifth of dedicated AI revenues (17%, £903m). Collectively, companies that cite more technical core capabilities account for just under £1bn (18%) of revenues among dedicated AI firms (Figure 4.4).

Figure 4.4 – Revenues by Technical Capability




*Source: Glass.ai, Perspective Economics (n=670)*

## 4.2. Estimated Employment

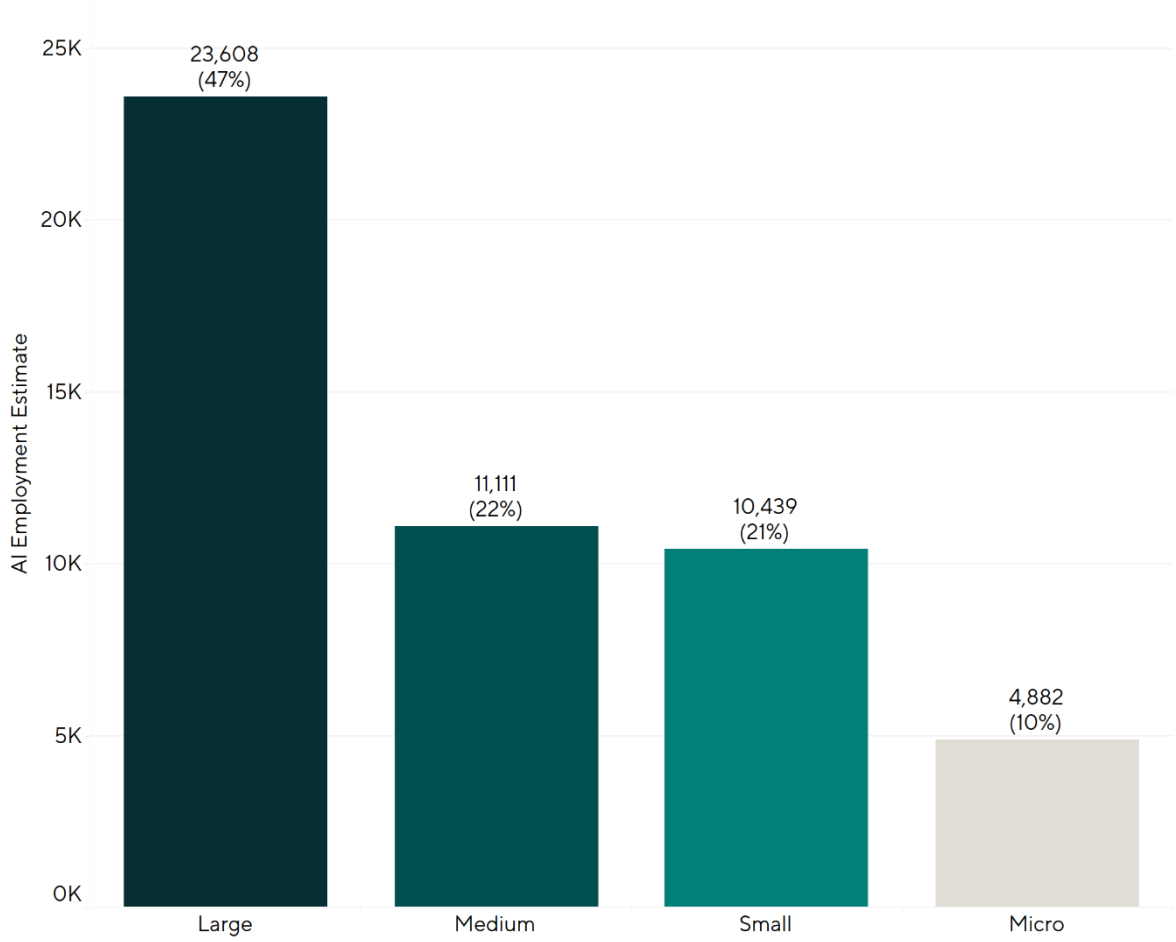
Across both dedicated and diversified AI companies, study estimates suggest that there are a 50,040 Full Time Equivalents (FTEs) employed in AI related roles across the 3,170 companies identified[18]. A summary of the approach used to produce employment estimates is provided in the methodological appendix.

### 4.2.1. Employment by Company Size

Forty-seven percent of AI roles are within large companies. This represents a notably smaller proportion when compared to other similar studies and suggests that, despite accounting for a much smaller proportion of revenues, micro, small and medium sized AI businesses have a relatively large employment base. As discussed further in Section 4.3, this investment in talent among pre-revenue and early-stage AI SMEs leads to negative GVA figures in some cases.

[18] Note that this figure relates to those employed in AI related roles only. While estimation methods are not the same, to provide a sense of scale, the number of AI FTEs represents approximately 3% of DSIT's Digital Sector estimate in 2022.

Figure 4.5 – Employment by Company Size




*Source: Glass.ai, Perspective Economics (n=50,040)*

### 4.2.2. Employment in Dedicated and Diversified Companies

Forty-seven percent of all AI related employment is within diversified AI companies (n=23,741) and 53% of employment is within dedicated AI companies (n=26,299). While large, dedicated AI companies account for just 8% of total employment, they employ by far the greatest number of people in AI related roles per firm, and are therefore significant contributors to the sector, both economically and in terms of talent development and retention. Dedicated AI micros and SMEs account for just under half (45%) of total AI roles.

Table 4.3 – Dedicated & Diversified AI Employment by Company Size

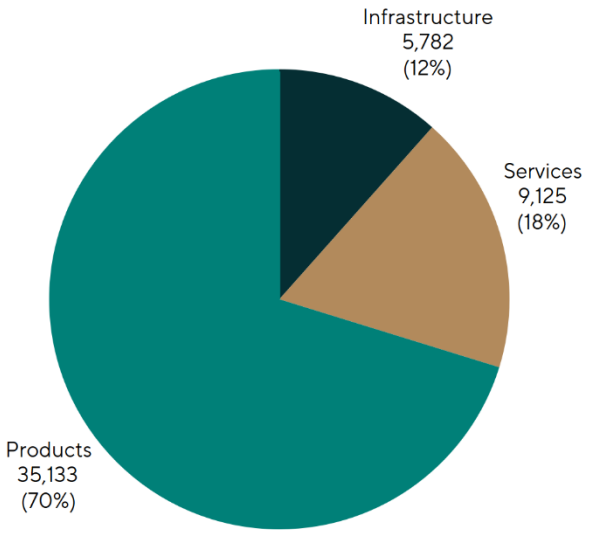
| Ded / Div | Firm Size | % of Total Employment | AI Employment Estimate | Number of Firms | AI Employees Per Firm |
|---|---|---|---|---|---|
| Dedicated | Large | 8% | 3,975 | 14 | 284 |
| | Medium | 18% | 9,161 | 118 | 78 |
| | Small | 18% | 9,031 | 489 | 18 |
| | Micro | 8% | 4,132 | 1,288 | 3 |
| Diversified | Large | 39% | 19,633 | 118 | 166 |
| | Medium | 4% | 1,950 | 144 | 14 |
| | Small | 3% | 1,408 | 398 | 4 |
| | Micro | 1% | 750 | 601 | 1 |

Source: Glass.ai, Perspective Economics

### 4.2.3. Employment by Business Model Grouping

Approximately 70% of AI related roles across both dedicated and diversified AI companies are within firms predominantly focussed on providing AI products (Figure 4.6).

Figure 4.6 – Employment by Business Model




*Source: Glass.ai, Perspective Economics (n=50,040)*

Analysis of revenues per employee across the three business model groupings (infrastructure, products and services) shows that revenue generation is higher among AI service providers (£260k per employee) than it is among either infrastructure providers or product developers (Table 4.4) – likely due to the presence of pre-revenue and early stage companies involved in infrastructure and product development, and the relative intensity of labour involved in developing AI products and infrastructures.

Table 4.4 – Revenue Per Employee by Business Model Grouping

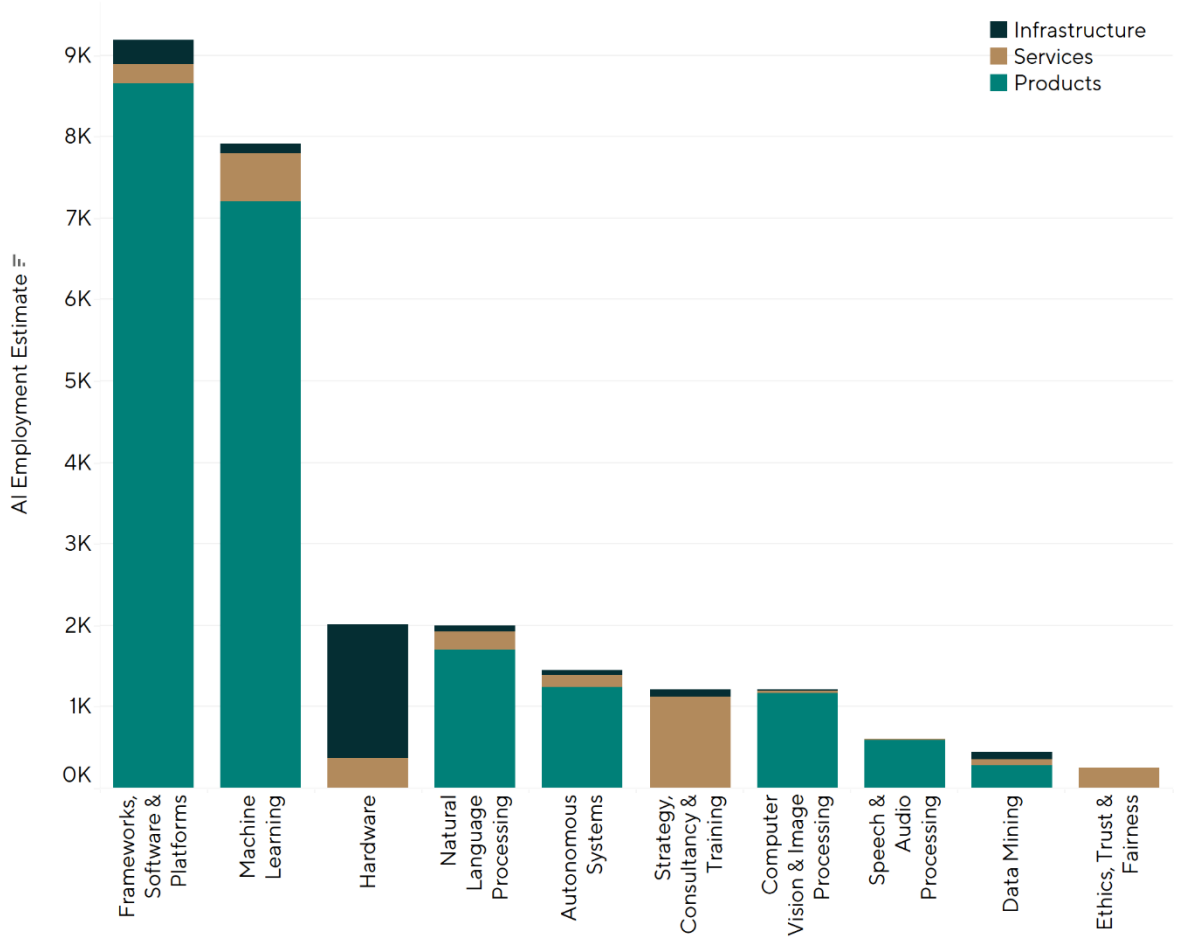
| Business Model Grouping | AI Employment Estimate | Estimated AI Related Revenue | Revenue Per Employee |
|---|---|---|---|
| Infrastructure | 5,782 | £1,099,359,584 | £190,135 |
| Products | 35,133 | £7,142,551,654 | £203,300 |
| Services | 9,125 | £2,404,160,493 | £263,470 |

*Source: Glass.ai, Bureau van Dijk*

Using more granular AI capabilities (among dedicated AI companies only) approximately two thirds of AI related employment (65%) is within companies whose primary capability has been tagged as either ‘Frameworks, Software & Platforms’ or ‘Machine Learning’.

Beyond those two broader capabilities, approximately 10% of employment is within companies providing computer vision, image processing or autonomous systems products and services, 8% is within AI hardware companies and the same proportion is within companies that offer Natural Language Processing. Other capabilities such as speech and audio processing, data mining and ethics account for smaller employment contributions (between 1% - 5%).

Figure 4.7 – Employment by Core Capability




*Source: Glass.ai, Perspective Economics (n=26,299)*

## 4.3. Estimated Gross Value Added

Gross Value Added (GVA)[19] is used as a measure of the productivity of individual companies, sectors or broader industries. Any increase in GVA can highlight an improvement in the performance of a firm or a sector, as evidenced through higher profitability or enhanced earnings.

Based on a combination of company accounts, survey responses and associated modelling, AI companies are estimated to contribute £3.7bn in GVA to the UK economy. This represents approximately 20% of most recent DCMS GVA sector estimates[20].

Figure 4.8 provides an overview of AI related revenues and GVA by size of firm. For large companies the GVA-to-turnover ratio is 0.6:1 (i.e., for every £1 of revenue, large AI companies generate 60p in direct GVA). A GVA-to-turnover ratio of this order is consistent with those found in established sectors[21]. However, as cited by several businesses and strategic sector stakeholders and evidenced by investment data (Section 5), development and scaling AI products and services is capital intensive, typically requiring external investment (particularly for SMEs) and long lead times[22].

As such, GVA among AI SMEs is driven more by remuneration of highly skilled people than by profits. In fact, among dedicated AI companies, in many cases operational losses outweigh employee remuneration, leading to negative GVA values and emphasising the significant role that private investment plays in the development of the sector.

GVA-to-turnover ratios among SMEs are understandably much lower (0.2:1 for medium sized companies and negative for small and micro businesses), but are reflective of the capital intensive, high R&D nature of deep technology development.

[19] GVA = Gross Profit, Employee Remuneration, Amortisation and Depreciation
[20] Noting differences in estimation methods, DCMS GVA sector estimate (excluding Tourism) for September 2022 was £19.3bn.
[21] DSIT (2022) Cyber Security Sectoral Analysis 2022, accessible at [https://www.gov.uk/government/publications/cyber-security-sectoral-analysis-2022]
[22] Analysis of timeframes between incorporation and profitability among ten of the largest dedicated AI companies in our set suggests that lead times to profitability typically take a minimum of 3 and an average of 7 years to generate profits.

Figure 4.8 – AI Related Revenue & GVA by Firm Size


*Source: Glass.ai, Perspective Economics (n=3,170)*

## 4.4. Summary of Economic Contribution

Table 4.5 overleaf provides a summary of key economic metrics including the number and size of AI companies, associated AI driven revenues, GVA and AI-related employment.

Large AI companies – both dedicated and diversified – make a major contribution to the UK economy. At £190k, GVA per employee among large AI companies is higher than estimates produced using similar methods within other emerging technology sectors. Disaggregated to large, dedicated AI companies only, GVA per employee increases to more than £400k.

Capital intensity, limited revenue generation and long product development lead times weigh on GVA estimates for AI SMEs. If left purely to a tightening market for private investment there is a risk that some genuinely innovative UK AI SMEs are forced to scale back operations and / or pivot to service-oriented business models that are not capital intensive and do not involve long product development lead times.

Table 4.5 – Summary of AI Economic Activity

| | | Firm Size | | | | |
|---|---|---|---|---|---|---|
| | | Large | Medium | Small | Micro | Grand Total |
| Number of Firms | # | 132 | 262 | 887 | 1,889 | 3,170 |
| | % | 4% | 8% | 28% | 60% | 100% |
| AI Related Revenue (£'000s) | # | 7,597,142 | 1,387,471 | 1,430,814 | 230,645 | 10,646,072 |
| | % | 71% | 13% | 13% | 2% | 100% |
| AI Related GVA (£'000s) | # | 4,487,227 | 274,480 | -923,564 | -147,045 | 3,691,098 |
| | % | 122% | 7% | -25% | -4% | 100% |
| AI Related Employment | # | 23,600 | 11,100 | 10,400 | 4,900 | 50,040 |
| | % | 47% | 22% | 21% | 10% | 100% |
| Employees Per Firm | # | 179 | 42 | 12 | 3 | 16 |
| Revenue Per AI Employee (£) | # | 321,800 | 124,900 | 137,000 | 47,200 | 212,800 |
| GVA per AI Employee (£) | # | 190,000 | 24,700 | -88,500 | -30,100 | 73,800 |

*Source: Glass.ai, Perspective Economics (figures may not sum due to rounding)*

# 5. Investment in UK AI Companies

This section provides insight into the investment raising activity of UK AI companies included in the study. It draws on investment data from the Beauhurst platform, which tracks announced and unannounced investments in high-growth UK companies[23].

## 5.1. Investment to Date

At the aggregate level (among both dedicated and diversified AI companies) 2021 was a record year for AI investment, with over £5bn raised across 768 deals, representing an average deal size of £6.7m. Further, AI investment increased almost five-fold between 2019 and 2021.

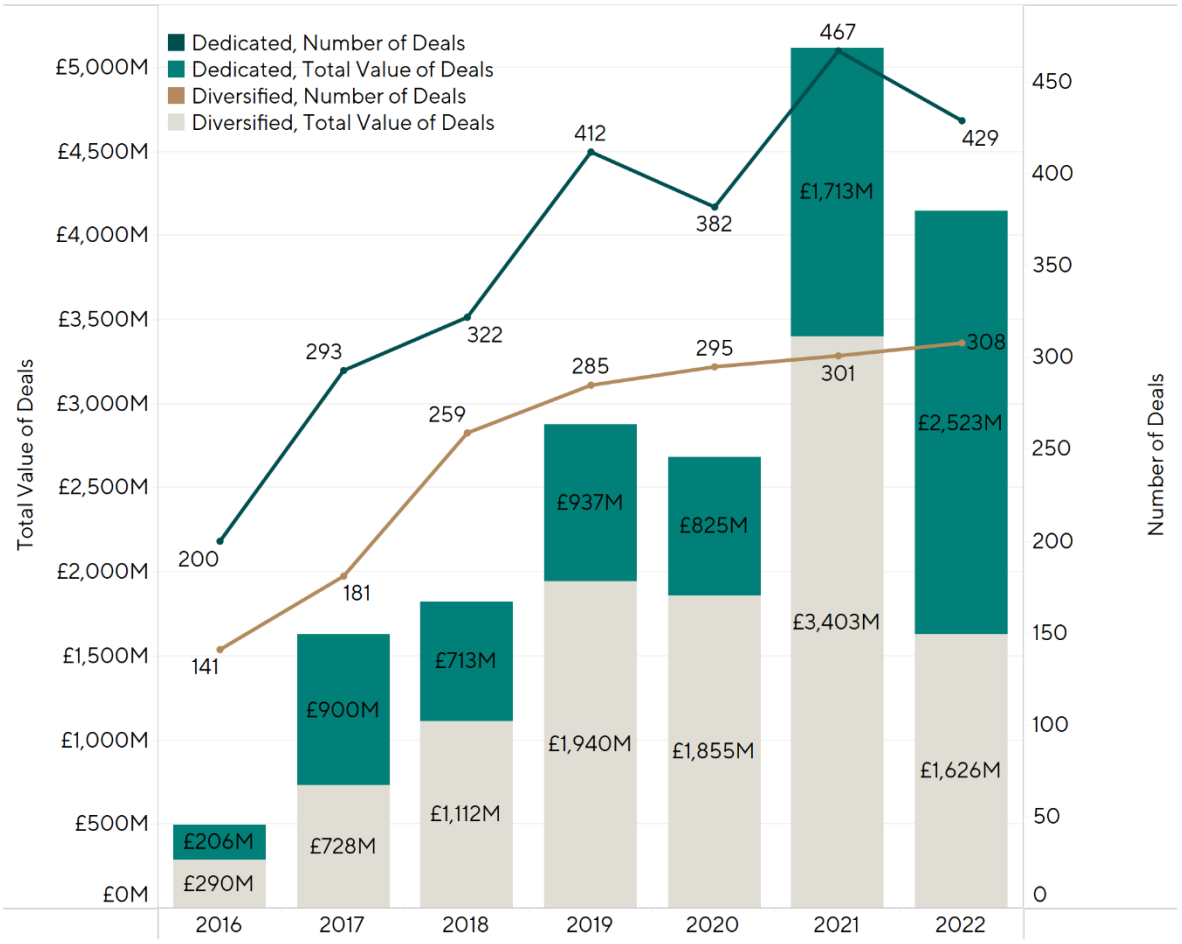
Both the total number of deals and deal values fell back slightly in 2022, however as discussed in more detail below, there are positive signs across both dedicated and diversified AI companies in terms of deal numbers (which held up for diversified AI companies) and deal values.

### 5.1.1. Investment in Dedicated / Diversified AI Companies

Figure 5.1 provides a breakdown of deal numbers and values across dedicated and diversified AI companies. It shows that dedicated AI companies have typically received a higher number of lower value investments than diversified companies. However, in 2022, despite an 8% reduction in the number of deals overall, dedicated AI companies received just over 60% of total investment and secured a higher average deal value than diversified companies for the first time[24]. This supports the assertion made by investor interviewees that AI is 'hypergrowth' and is consistent with Beauhurst's 2022 investment round-up which also suggests that AI fared better than other tech sectors, such as Fintech, Life Sciences and Digital Security[25].

[23] Beauhurst algorithms collect information from Companies House, business websites and news articles. Data is also provided via data partnerships with granting bodies, investors, advisors and universities. Data is manually verified by Beauhurst staff members.
[24] For the first time since 2016 – the first year for which investment data was accessed to inform the study.
[25] Beauhurst (2022) The Deal FY 2022, Beauhurst

Figure 5.2 – Investment in Dedicated & Diversified AI Companies



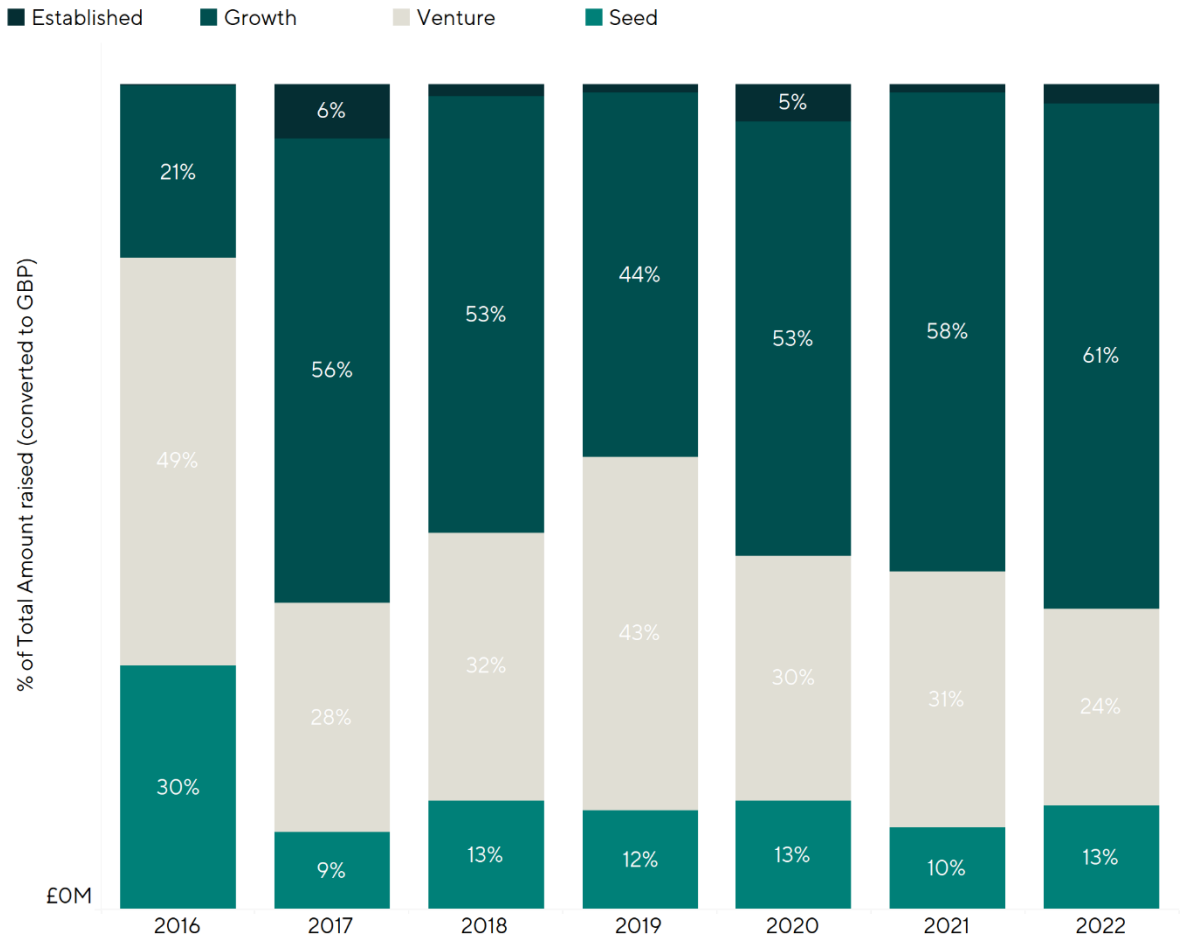

*Source: Glass.ai, Beauhurst, Perspective Economics (n=4,275 deals, 1,431 companies)*

### 5.1.2. Investment by Stage of Evolution

Investment raising companies can be categorised according to the stage of their investment raising journey – from Seed to Established Stages. Seed Stage companies are typically young start-ups, with low employee count, valuation, and total equity investment raised. Venture Stage companies have developed their business models and technology over multiple years, typically securing investment and a valuation in the millions. Growth Stage companies have generally been operating for more than five years and expanded to multiple locations, and Established companies have been trading for more than five years and typically reported large consecutive profits or high turnovers.

Analysis of Beauhurst data on investment by stage of evolution suggests that as the AI market develops, the share of investment secured by dedicated AI companies at Seed and Venture stages has almost halved, from 79% of the total in 2016 to just 36% in 2022 (Figure 5.3).

Figure 5.3 – Investment by Stage of Evolution (2016 – 2022 | % of Total Investment in Year)

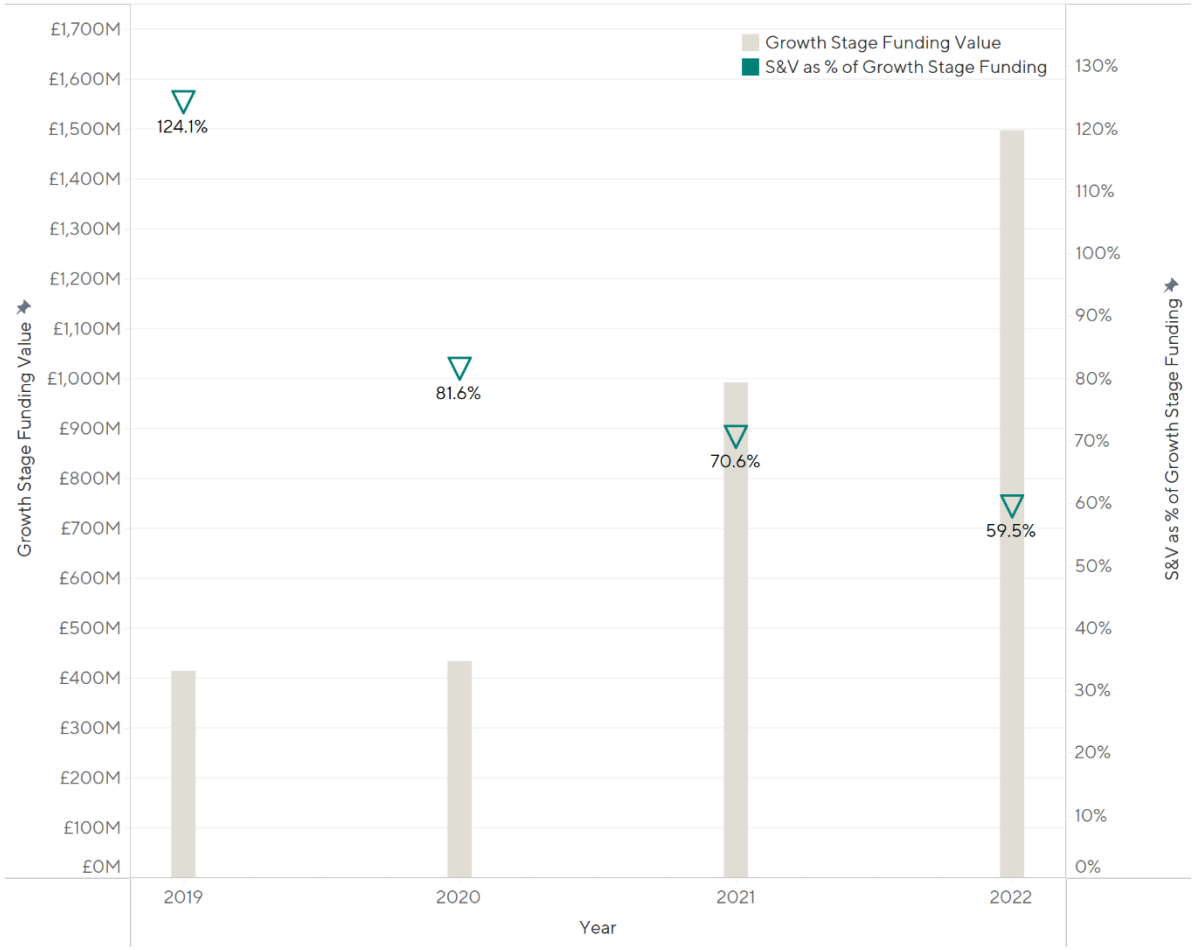



*Source: Glass.ai, Beauhurst, Perspective Economics (11,144 deals)*[26]

Further analysis shows that this is due to a significant increase in the value of Growth Stage funding which, in 2016, was just 3% of 2022 levels, compared to Seed and Venture Stage funding which was 18% of its 2022 level. However, since 2019 Seed and Venture Stage funding has been shrinking as a proportion of Growth Stage funding (Figure 5.4). This may reflect increasing maturity of the AI investment market, or shortening investor time preferences, and may also signal some relative tightening of the market for Seed and Venture Stage AI funding.

[26] **Seed:** A seed-stage company is a young start-up, with low employee count, valuation, and total equity investment raised. There may still be uncertainty as to whether its product or service has an adequate market, or it may be working to gain regulatory approval. The most common sources of funding for this stage of company are grant-awarding bodies, crowdfunding platforms, and angel investors. **Venture:** Venture-stage companies have developed their business models and technology over multiple years, typically securing investment and a valuation in the millions. They will likely have some revenue and may be expanding their initial product range. Venture rounds typically involve private equity and venture capital funds, although may tap into crowdfunding. **Growth:** When a company has been operating for more than five years, and has grown to multiple offices, they're more likely to have reached the Growth stage of evolution. A growth-stage company will also have regulatory approval and is likely bringing in significant revenue and investment, with a valuation in the millions. It will be continuing to expand its product range and international activities. **Established:** An established-stage company has been trading for 15+ years, or 5-15 years with a three-year consecutive profit of £5m+ or turnover of £20m+. As you may expect, these businesses usually have several offices and a widely recognised brand. Funding at this stage is often deployed by corporates, private equity firms, banks and specialist debt funds, or major international investors.

## Figure 5.4 – Seed & Venture vs Growth Stage Funding




*Source: Beauhurst*

In the qualitative interviews, AI businesses had used a range of investment sources. At the Seed and Venture Stage, businesses reported using personal funds, investment from friends and family, angel investment and grants (for example, from Innovate UK or universities). This stage of funding was primarily used to establish the business and for research and development of their product or service (including creating prototypes). Businesses described challenges in accessing other types of funding, for example, loans that required evidence of profitability or revenue, which early start-ups could not provide.

At the growth stage, AI businesses reported using or seeking angel investment and venture capital as these businesses wanted larger amounts (typically £1 million or more) to scale up. This involved investment for developing marketing and sales skills so they could sell their product or service beyond their earlier referral networks. There was a feeling that the UK preferred grant funding, which was considered less appealing to later investors. This created a gap for 'productisation' or scale-up funding, which typically require larger amounts, with some businesses reporting going beyond the UK (for example, to the US or France) to fund their growth stage. In addition, there was a perception that UK venture capitalists tended to be risk-averse, which has been exacerbated by recent economic uncertainty.

*"It's a cascading effect. If you don't have the funding, then you can't hire the best talent in the market and you have to compromise on that, [but] then you compromise on growth as well." AI business*

AI businesses also highlighted the benefits of non-financial investment at both early and growth stages, in particular support with establishing a business, creating a business plan to help win investment, and market intelligence. One business described needing to strike a balance between having investors with the right sectoral expertise without giving up too much of the business at an early stage.

*"The priority was finding investors who have some sector knowledge, but not to get too diluted before the following round when investors wouldn't look favourably if the founders had a minority stake." AI business*

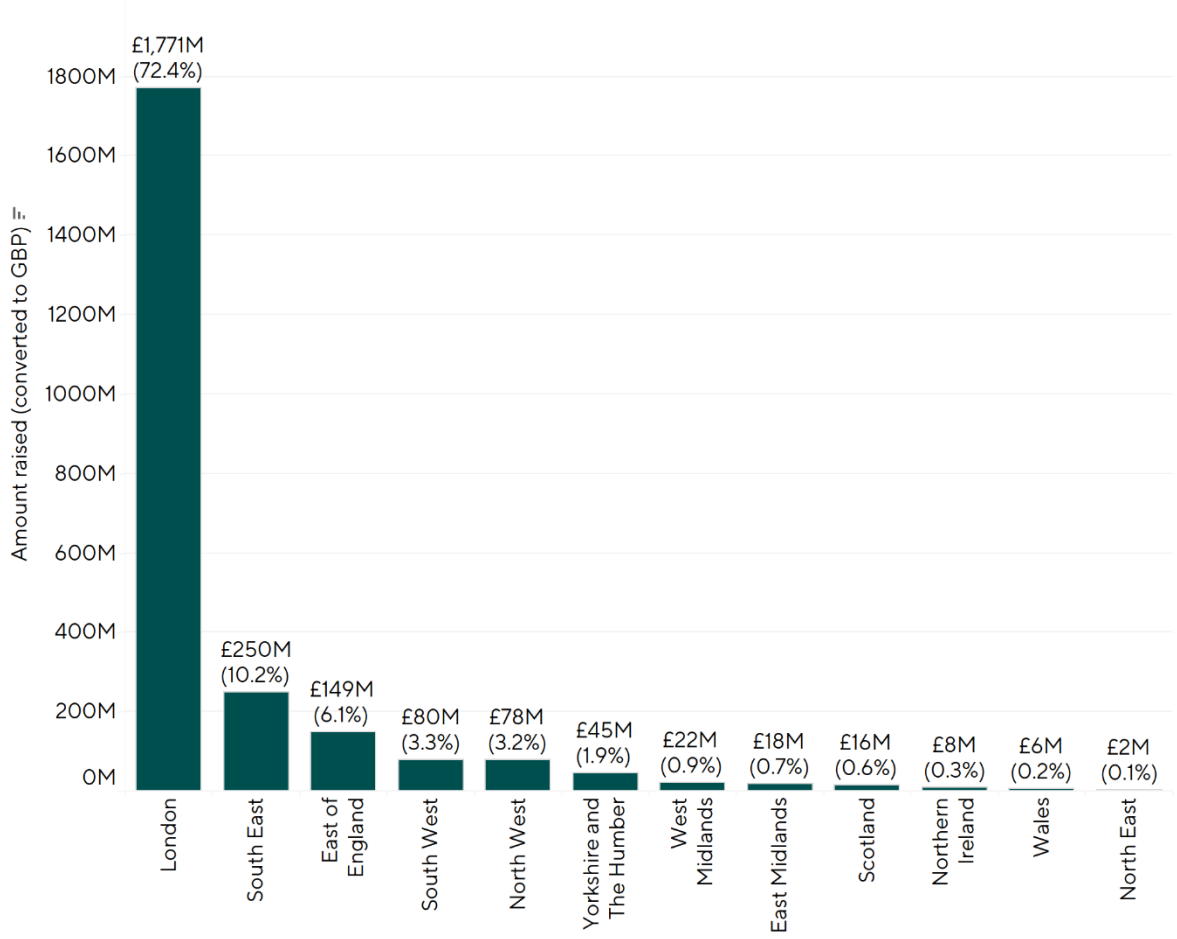
### 5.1.3. Investment by Location

Analysis of trading location data (Section 3) suggested that a significant proportion of all UK AI companies were either registered in or trading in London, the South East and the East of England.

This regional profile is mirrored within investment data. Beauhurst's 2022 report notes that *"from a regional equality perspective the distribution of equity funding in the UK has worsened, with the South of England claiming the vast majority (72%) of investments* [and that] *London secured the greatest proportion of announced equity deals on record"*.

Investment raising by dedicated AI companies in 2022 shows a similar skew, with c.89% of investment values and 78% of deals secured by companies in London, the South East and the East of England (Figure 5.4). This suggests that investment deals into companies outside of London, the South East and the East of England are less common and of lesser value.

Figure 5.4 – Investment in Dedicated AI Companies by Region (2022 | Values, £m)




*Source: Glass.ai, Beauhurst, Perspective Economics*

This was reflected in the qualitative interviews. While AI businesses and stakeholders highlighted the benefits of being located near to university cities and towns for access to talent and research and development, there was a feeling that investment opportunities were primarily located in and around London and the South East. London was also considered a leading international investment hub, which potentially concentrates investment activity even further.

*"Outside the US, London remains the place where most investments are being made ... There is a history, a significant number of VCs in London … But other countries are upping their game." AI business*

### 5.1.4. Investment by Business Model, Industry and Capability

Eighty percent of all AI investment (£6.3bn) has been in companies that are primarily focussed on developing AI products. Fourteen percent of investment has gone to companies that produce AI infrastructures and just under 6% has gone to service-oriented AI companies.

In SIC code terms, just under 90% of AI related investment has gone to companies registered under the ten SIC codes set out below (Table 5.1).

This aligns with insights from the qualitative interviews, which suggested developing products is more 'investment heavy'. This meant that AI products took more money and time to develop and be ready for market, resulting in potentially longer pre-revenue stages for businesses that only offer products (and not services). As a result, some businesses reported pivoting during product development so that they also began offering services. This allowed them to be revenue-generating more quickly.

*"If you are creating a product, it's very investment heavy. You can't just depend on the customer, who won't pay you until you see the product working." AI business*

Another business suggested this difference between products and services in terms of investment of time and money meant there was a risk that product-only AI start-ups might be tempted to get their product into market quickly, even if it was of a lower quality. They felt this would drive down the quality of the AI product market and might create challenges for quality assurance. To address this sort of challenge, one business felt funding structures should be more flexible to more easily allow AI businesses to pivot their offerings, while another suggested there was a gap for more 'productisation' funding in the UK, which could allow businesses the necessary time to develop a viable and high-quality product.

Table 5.1 – AI Investment by SIC Code (2022 | Values, £m)

| SIC Code Description | AI Related Investment (£m) |
|---|---|
| Other information technology service activities | £1,800m |
| Business and domestic software development | £1,700m |
| Ready-made interactive leisure and entertainment software | £654m |
| Other research and experimental development on natural sciences and engineering | £604m |
| Other professional, scientific and technical activities n.e.c. | £467m |
| Other information service activities n.e.c. | £400m |
| Other business support service activities n.e.c | £328m |
| Other software publishing | £246m |
| Activities auxiliary to financial intermediation n.e.c. | £236m |
| Information technology consultancy activities | £171m |

*Source: Beauhurst*

### AI for Net Zero

The AI Council's Roadmap[27] highlights how AI technologies can help deliver the UK's net zero goals. AI technologies have the potential to benefit the UK by helping to develop cleaner systems and reach net zero carbon emissions by, for example, solving real-time control of the electricity distribution network, or accelerating materials science towards new, more efficient renewable energy storage materials.

AI has already contributed to the fight against climate change, with technologies being used to monitor illegal deforestation[28] and develop our understanding of Arctic ice loss[29].

In 2022 the Government launched a £1.5 million AI programme for reducing carbon emissions as part of the £1 billion Net Zero Innovation Portfolio[30]. The AI for Decarbonisation programme provides an opportunity for AI technologies to decrease energy costs and create high value jobs. The programme is aimed at projects that ease the UK's transition to renewable energy, make energy more productive and decrease the emissions of the agricultural sector.

Within the study dataset, companies such as Cervest and Arenko offer examples of the commercial application of AI to climate and net zero-related challenges.

Cervest's climate intelligence platform provides businesses, governments and financial institutions with the climate intelligence required to identify climate risks. Cervest has secured over £25 million in investment, with their Earth Science AI technology providing a unique standardised and science-based view of climate risk across the world.

Arenko uses AI to identify and unlock the value of batteries and renewables, with the aim of helping to build a sustainable and zero-carbon grid globally. Arenko has also secured over £25 million in investment towards its AI technologies for Net Zero, such as the Nimbus-Asset and Nimbus-Exchange.

Analysis of investment across sectors assigned by Glass.ai shows that a majority of funding has gone to computer software companies (47%, £3.7bn). One third of investment (£2.6bn) has gone to companies classified as being involved in biotechnology, information technology, general financial services and insurance.

[27] Office for Artificial Intelligence, Department for Business, Energy & Industrial Strategy, and Department for Digital, Culture, Media & Sport (2021) AI Roadmap. https://www.gov.uk/government/publications/ai-roadmap

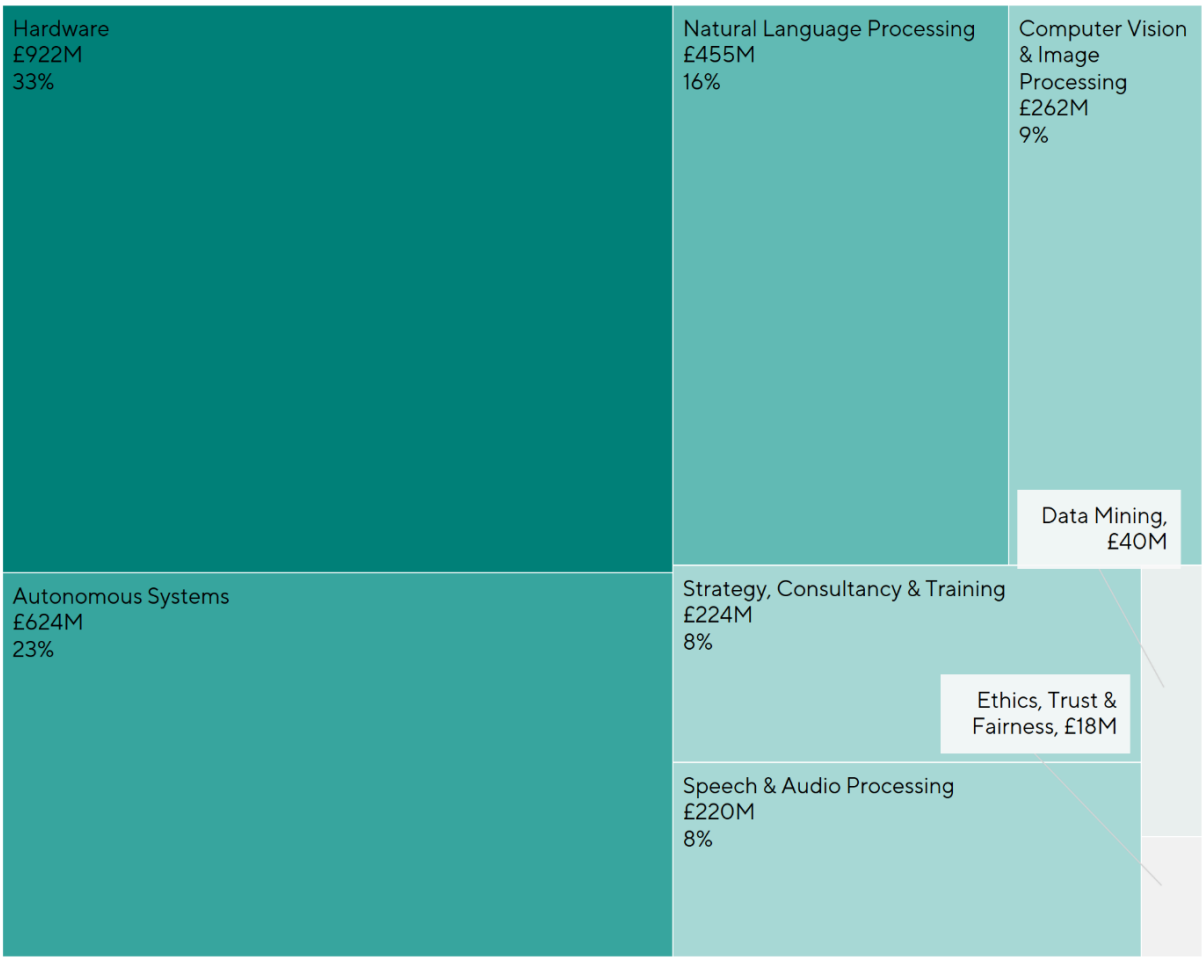
[28] TensorFlow (2018) The fight against illegal deforestation. https://blog.google/technology/ai/fight-against-illegal-deforestation-tensorflow/

[29] The Alan Turing Institute (2022) Understanding Arctic Sea ice loss. https://www.turing.ac.uk/research/research-projects/understanding-arctic-sea-ice-loss

[30] Department for Business, Energy & Industrial Strategy and George Freeman MP (2022) Government launches £1.5 million AI programme for reducing carbon emissions. https://www.gov.uk/government/news/government-launches-15-million-ai-programme-for-reducing-carbon-emissions

Across lower-level AI capabilities, just under two thirds of investment has gone to companies that cite AI frameworks and platforms or machine learning as a key capability. Beyond those two more generic capabilities, investment has been highest in AI hardware and autonomous systems (12% and 8% of total investment respectively). Figure 5.4 illustrates the scale of investment in companies citing less common AI capabilities.

Figure 5.4 – Investment in AI Capabilities (2016-2022 | Values, £m)




*Source: Glass.ai, Beauhurst, Perspective Economics (£2,765M, 35% of total)*

## 5.2. Investment Market Dynamics

The analysis of AI investment presented in this section suggests that the AI companies included in this study are bucking the prevailing investment trend. While UK AI companies are certainly not immune to tightening economic conditions, both investment data and investor sentiment provide reasons to be optimistic about the future of AI in the UK. 2021 was a record year for AI investment, with over £5bn raised across 768 deals, AI investment increased almost five-fold between 2019 and 2021, faring better than investment in other technology sectors.

However, data on AI investment by stage of evolution may also be signalling some tightening of investment available to Seed and Venture Stage companies and, given the

significance of private investment for AI technology development evidenced by data on revenues and GVA, this could pose a significant risk to realising the potential within early-stage AI companies.

*"It's a strange time – AI is definitely 'hyper-growth' but it's out of whack with the investment cycle; it's like investing in VC companies in 2002. A lot of tech companies are struggling to raise follow-on funding and therefore pivoting towards more immediately profitable business models".*

AI Study Investor Interviewee

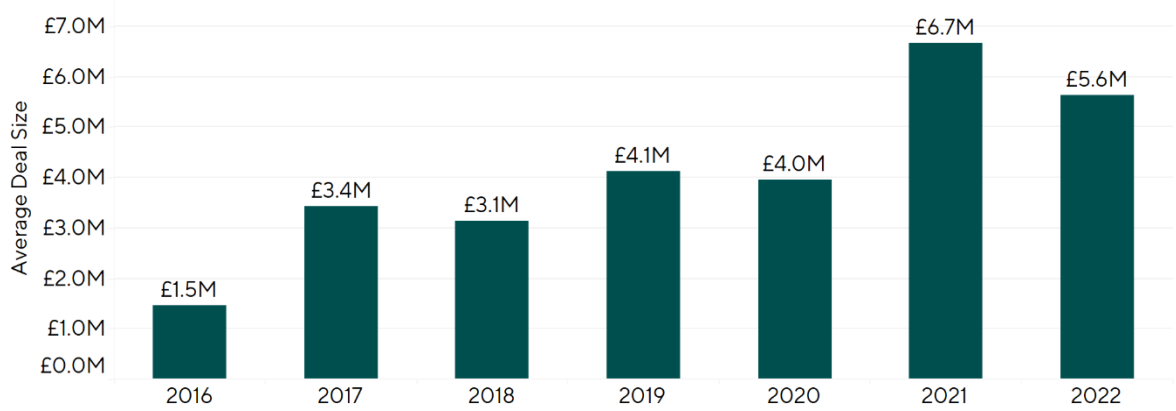
*"I have also spoken to VCs who don't know how their fund-returner is going to exist now and, therefore, expect raising the next round to be very tricky."*

Beauhurst Market Commentary

### 5.2.1. Investors & Funding Sources

Average deal size data for AI companies included in this study shows a trend towards fewer, larger-sized deals (Figure 5.5). As with the trend towards greater volumes of investment in Growth Stage companies, increasing deal sizes may signal a maturing of the AI market, maturing of the UK investment market more generally (with economies of scale becoming increasingly important), and / or shortening investor time preferences.

Figure 5.5 – Average Deal Size (All Firms, 2016-2022 | Values, £m)




*Source: Beauhurst*

The trend in AI investment deal sizes is consistent with analyses contained in Beauhurst's 2022 investment round-up, which also suggests that larger deals – specifically those between £10m and £50m – increased in number, reflecting a broader structural change in UK investment from more smaller equity rounds which made up 40% - 50% of deals between 2012 and 2016, but just one third of deals in 2021 and 2022.

As indicated within our analysis, Beauhurst notes that this change in the volume of smaller deals may add further challenge to AI start-ups and micro businesses that rely on smaller funding amounts to gain traction. The most prominent funders of UK AI activity (in terms of investment value) include SoftBank (Japan), Andreessen Horowitz (US), Baillie Gifford (GB), Amadeus Capital Partners (GB), Temasek (Singapore) and Molten Ventures (GB).

### 5.2.2. Investment Drivers, Challenges & Opportunities

In the private equity market, investors consulted to inform the study highlighted a notable opportunity for companies operating in the AI implementation space to build teams of AI implementation experts that can support AI adoption opportunities across sectors. This adoption opportunity is supported by investment data, which highlights that in 2022 investments were made in 52 unique industry sectors, compared to investments across just 35 different sectors in 2016[31].

According to investment data providers PitchBook, demand for capital globally outstripped supply by almost 150% in some cases in Q4 2022[32]. As such, the broader investment market now favours investors. However, while the VC market tightened considerably in the latter half of 2022, investment in AI appears to have held up comparatively well. As such, there may be scope for UK AI companies to benefit from some investor hesitance and the investment reserves that it has created. However, investments in 2023 will almost inevitably be met with more stringent due diligence. In this investment landscape, for earlier stage start-ups, micros and SMEs, getting onto investor radars will prove increasingly challenging; actually leveraging investment will be even more so.

[31] Data for dedicated AI companies only (n=11,144 deals), Glass.ai sectors.
[32] PitchBook Analyst Note 26th January 2023, “When dry powder stays dry”.

# 6. Future AI Sector Development

This section provides a brief overview of recent AI sector development activity before summarising the challenges and potential opportunities identified through the research that has informed this study.

## 6.1. Recent Sector Developments

Published in 2021, the National AI Strategy overseen by the Office for AI, has three strategic pillars:

- Investing in and planning for the long-term needs of the AI ecosystem.
- Supporting the transition to an AI-enabled economy, capturing the benefits of innovation in the UK and ensuring AI benefits all sectors and regions.
- Ensuring effective and appropriate governance of AI technologies that encourages innovation and investment, while protecting the public and fundamental values.

The Strategy contains 39 actions, most of which are expected to be delivered by early 2023. Many of the actions identified within the Strategy are well aligned to perceived AI sector needs and opportunities identified through analysis and via consultation with businesses and strategic stakeholders. For example:

- On the issue of long-term skills and professional development study contributors pointed to skills gaps across all sectors, the lack of a suitably robust skills pipeline and limited AI related knowledge and capability across all levels of organisation structures.
- With respect to regional opportunities for investment, analysis of both location and investment data shows a concentration of AI related activity in London, the South East and the East of England. Strategic stakeholders also noted regional disparities and pointed to opportunities for bolstering regional support via, for example, better understanding unique regional academic and industrial strengths, and via the development of 'hub and spoke' research and innovation clusters.
- Regarding building international relationships, strategic stakeholders noted the size of the UK market as a limitation, predominantly in terms of opportunities to scale AI companies. Analysis of Beauhurst data shows that out of 1,649 tracked AI companies, approximately 9% have exporting activity[33].
- Stakeholders pointed to AI for healthcare as an obvious opportunity for the UK to take advantage of a comparatively centralised healthcare system. However, this potential is constrained by data access challenges and adoption of AI technologies is perceived only to be happening in 'pockets' of the healthcare ecosystem.

[33] Note that the figures here are based on Beauhurst's own tagging of AI companies. While we expect considerable overlap with the set of companies identified within this study, the two company sets are not the same. The analysis of export activity among Beauhurst tagged AI companies is provided for illustrative purposes to provide further insight to considerations regarding the scale of the UK market and the current and potential future role of export activity.

- Stakeholder perspectives highlighted effective stimulation of AI adoption as either a barrier to or enabler of further technological development and associated economic benefits. To that end, offering practical examples and engagement events regarding diffusion of AI technologies is a start, but further consideration of the role for AI adoption will be required.
- Lastly, concerning the significance of effective AI governance, strategic stakeholders raised numerous issues. High profile 'questionable' use cases, such as the Facebook-Cambridge Analytica scandal, were recognised as setting AI back – with increasing public awareness comes increasing scrutiny and a need to build and maintain public trust. Lack of certainty and / or coordination around AI regulation and standards was perceived as presenting a major barrier yet, at the same time, balancing a pro-innovation approach with effective regulation and standards was recognised as being something of a tightrope. Offering certainty regarding the coordination of AI regulation and standards, through the Digital Regulation Cooperation Forum (DCRF) for example, was seen as being a potential enabler. On the commercial side of AI ethics, trust and fairness, the tightening investment market may force an acceleration in getting AI products to market, and with that comes increased risk of lower adherence to regulation and standards.

## 6.2. Potential Future Support

With respect to future investment and support initiatives, strategic stakeholders were at pains to stress the pace at which the international AI innovation landscape is moving, and the need for continued urgency within UK research and innovation policy simply to keep pace.

To that end, some strategic stakeholders saw an opportunity for creating a dedicated AI Innovation Programme, or and AI Adoption Programme, with regionally designed and delivered sector specific supports via, for example, Turing Research and Innovation Clusters, building a more detailed regional picture, and better connecting capabilities across regions.

Consultation with AI companies and strategic stakeholders pointed to the potential of an increased role for public procurement of commercial contracts to support the development of AI products in a managed and relatively secure environment. They felt public sector organisations and non-AI businesses needed a greater understanding of the potential of AI to encourage both procurement and adoption. The significant role of AI adoption was once again highlighted, with a call for supports to further accelerate adoption both among lagging sectors but also among lagging 'pockets' within sectors that are further ahead on AI adoption.

In addition, there was a feeling that UK businesses could benefit from being able to access some unique UK public sector data sources, such as in healthcare, in an ethical way. They suggested this would allow UK businesses to be world-leading developers in rapidly growing technology sectors, such as health and lifestyle technologies.

*“Opening up a lot of data sources ethically, having an open attitude and companies sharing data back with customers – it’s a window or opportunity to be world-leading.” AI business*

AI businesses suggested there could be further centralised support for navigating the evolving AI landscape. This could include centralised job boards, information on funders and investors and information on universities and their research interests. Resources like this would help raise awareness of funding and research options among young businesses, which would in turn help to improve access to the relevant networks. In addition, AI businesses reported a gap in non-technical advice and support, particularly for growth stage businesses. Access to niche sector advice and marketing experience was felt to be especially important.

*"We want scale up advice – how do you go from £1 million to £100 million? The kind of advice and support we need we are not getting. It's highly specialist, you won't meet people [with these skills] at an event." AI business*

## 6.3. Sector Challenges & Opportunities

Many of the perceived challenges and opportunities for AI in the UK have been referred to elsewhere throughout the report. For ease of reference, the most salient challenges and opportunities, as perceived by a combination of AI businesses and strategic stakeholders as summarised in the sub-sections below.

### 6.3.1. Key Challenges

- A reticence to adopt AI technology. Key drivers of this reticence are low public trust[34] due to gaps in knowledge and limited understanding of AI, and restricted access to data. This evidences an associated need for ongoing monitoring, validation and transparency of AI models.

> *“Inability to encourage adoption within ‘lagging’ sectors will further stifle progress in those sectors.” Stakeholder*

- Access to markets and new customers (both UK and international) including a need for increased volumes of AI relevant public contracts.

> *“The government should take a stake in things, back some things that support its agenda and objectives, create some support for the things it wants to back." AI business*

- Access to funding and capital, particularly more flexible funding, and smaller funding rounds that are critical for helping start-ups and micro businesses to gain traction.

[34] https://www.gov.uk/government/publications/public-attitudes-to-data-and-ai-tracker-survey-wave-2

> *"Grant structures are not flexible enough. New tech is fluid. The path you take is not necessarily the one you thought you were going to take." AI business*

- Skills gaps, skills shortages, an anticipated division of labour across AI technology sub-sets and the comparatively high cost of talent in the UK.

> *"We're working with people in Italy who are a third of the cost in the UK. The cost of talent in the UK is much, much higher. We couldn't have [developed the product] here." AI business*

- The heightened risks and challenges that face AI micro businesses and SMEs in terms of availability of capital, product development lead times, access to data, competing demands on Founder time and an associated inability to have the views of micro businesses and SMEs effectively represented within important policy and regulatory development agendas.

> *"Capacity, resources and competition for talent are squeezing SMEs out." Stakeholder*

- The need for industry experience and expertise to bridge a gap between customers and AI businesses and the associated risk posed by the drawing of talent from AI product development to AI implementation and advisory roles.

> *"We need new kinds of professionals in healthcare and other markets." Stakeholder*

- Lack of clarity regarding the coordination and application of AI regulation and standards, the significant risk posed by an unmanaged proliferation of regulation and standards across sectors, and the importance of being aligned with key international markets such as the US and the EU.

> *"How do we effectively regulate and legislate without driving strategically important AI companies out of the UK?" Stakeholder*

- The need for ongoing public dialogue to alleviate concerns about the capability and future implications of AI technology, to build trust and facilitate a more open, trustworthy data environment.

> *"[It's about] ensuring AI is used as a supplement not a replacement in areas where human interaction is very important." Stakeholder*

### 6.3.2. Future Opportunities

- Leveraging strength in finance, healthcare, pharma and an early lead in AI verification and assurance presents comparatively unique opportunities for UK AI.

> *"The UK has an almost unique data resource [the NHS and patient databases]. Having robust data governance and rules in place will allow researchers to use these data in a legal and ethical way for health and health-related opportunities like wellness, wellbeing, drug discovery, wearable devices – combining it with NHS records)." Stakeholder*

- Division of labour around AI tools and services, professional development (targeted at adopters) and increasing the overall talent pool will help the UK keep pace with international markets.
- Removing barriers to wider adoption within prominent AI sectors such as healthcare, smart cities, robotics and materials, and encouraging adoption within lower adoption sectors such as agriculture and manufacturing.

> *"The ethics issue is the biggest blocker to wide-scale adoption. Most stories in the press are negative. It is a comms issue as well as a framework issue – people need to understand the benefits." Stakeholder*

- Continuing to invest in earlier stage R&D will help maintain the UK's value within the wider international market for AI technologies.

> *"The UK bats above its weight in tech and AI, but we need to keep this going just as it's really beginning to take off … like the way the Web exploded in the 90's … The UK needs to be agile and ask how to make this tech work for us." Stakeholder*

- Joining up capability across regions, increasing the focus on collaborative and later stage research and innovation.

> *"[We need to support] collaboration between industry, academia, policy and think-tank experts. There's an appetite in the industry to engage with this sort of collaboration." Stakeholder*

- Developing and coordinating effective systems of standards, emphasizing proportionate pro-innovation and layered standardization frameworks, and engineering bias out of models.
- Supporting further technological developments including but not limited to tooling ease of adoption, low data models, edge computing, intelligence in devices and embedded AI.

## 6.4. Further Sector Analysis, Monitoring & Evaluation

This study has identified a series of data sources, indicators and methods to provide a baseline understanding of the UK AI Sector. The key metrics and estimation methods included in the study can be used in future iterations to understand trends regarding economic contributions that relate specifically to AI activity (i.e., AI related revenue, employees in AI roles, AI related GVA and investment metrics).

However, the study has also identified opportunities for further refinement (such as further disaggregation of the sector taxonomy) and has highlighted issues that warrant further exploration, including but not limited to:

- The role of private investment within the UK's early-stage AI ecosystem, and the extent of risk that this poses to AI companies of different types and at different stages of development.
- Early trends regarding the instance of negative GVA among many of the companies identified at this stage, the challenges this presents for understanding GVA at the firm-level, and the journey of dedicated AI companies to profitability and positive GVA.
- Like-for-like analysis of employment trends across sectors, more in-depth analysis of AI roles and the inferences this may provide for understanding progress on AI adoption.
- The prevalence of London, the South East and the East of England as a location for AI activity and the opportunities for building AI ecosystems aligned to regional characteristics and existing AI strengths across UK regions.