Understanding social sciences, humanities and arts for people and the economy (SHAPE) R&D in the UK and internationally

Isabel Flanagan, Dominic Yiangou, Cecilia Ang, Sarah Parkinson, Susan Guthrie
Preface

The British Academy commissioned RAND Europe to conduct a research project on ‘Understanding the social sciences, humanities and arts for people and the economy (SHAPE)’ Research and Development (R&D) in the UK and internationally’. The project was commissioned in response to concerns that current definitions of business R&D used in UK government datasets do not fully capture the extent and role of SHAPE R&D in the UK economy (Hasan Bakhshi, Breckon and Puttick 2021). The recent UK Innovation Strategy highlights R&D as a key part of the government’s agenda as it aims to increase annual public investment in R&D to £22 billion by 2035 (BEIS 2021). A narrow definition of R&D, which does not fully recognise the contribution of the arts, humanities and social sciences, risks undervaluing the contribution of SHAPE R&D (Hasan Bakhshi, Breckon and Puttick 2021). This is particularly concerning considering the UK economy is largely service-based, and risks missing out on SHAPE contributions to the Government’s target of 2.4% of GDP being invested in R&D by 2027 (Hutton 2021; BEIS 2021).

This report aims to further investigate these issues and develop a fuller picture of the way SHAPE R&D is understood and captured in the UK economy and more widely. A mixed methods approach is taken through five work packages (WPs). Data collection methods include: a literature review (of grey and academic literature), interviews (conducted among R&D experts internationally and experts from key R&D industries in the UK), and data analysis (of publicly available datasets). Evidence across these methodologies is triangulated to identify key messages pertaining to SHAPE R&D in the UK and internationally. For the international comparative analysis, five countries (Denmark, Netherlands, Portugal, Spain and Switzerland) were selected based on the inclusiveness of their R&D definitions regarding SHAPE subjects, their comparability to the UK and the availability of, and access to, data regarding these countries. This report also includes analysis of key R&D industries in the UK: arts, entertainment and recreation; financial and insurance activities; information and communication; manufacturing; professional, scientific and technical activities; and wholesale and retail. These industries were chosen based on their high levels of R&D expenditure, contributions to the wider UK economy and overlap with SHAPE subjects and skills.

RAND Europe is an independent, not-for-profit policy research organisation based in Cambridge, UK which has a mission to improve policy and decision making through research and analysis. Our interdisciplinary team of researchers conduct rigorous policy-oriented research for clients across the public, private and third sectors.

1 Social sciences, humanities and the arts for people and the economy (SHAPE) is a collective name for ‘subjects which help us make sense of the human world, to value and express the complexity of life and culture, and to understand and solve global issues.’ (BA 2022) This report will include a consideration of SHAPE subjects and skills and their relationship to R&D in the UK.
The definitions of business R&D used in UK government datasets do not fully capture the extent and role of SHAPE R&D in the UK economy (Hasan Bakhshi, Breckon and Puttick 2021). The government’s recent R&D agenda aims to increase annual public investment in R&D to £22 billion by 2035 (BEIS 2021). However, by implementing a narrow definition of R&D, the government risks undervaluing the contributions of SHAPE R&D (Hasan Bakhshi, Breckon and Puttick 2021). This is particularly concerning considering the UK economy is largely service-based, and risks missing out on SHAPE contributions to the government’s target of 2.4% of GDP being invested in R&D by 2027 (Hutton 2021; BEIS 2021). This report was commissioned by the British Academy to understand the varying definitions being used for SHAPE R&D, and the implications of these definitions in terms of capturing SHAPE R&D’s contributions to the economy and society. A mixed methods approach was used to gather evidence across six UK sectors and five international comparators.

SHAPE R&D in the UK

Several cross-cutting themes were identified based on our analysis of SHAPE R&D in the UK:

- **R&D spend in the UK is growing, and business R&D makes up a significant proportion of expenditure**: The UK’s 2021 Innovation Strategy announced plans for the largest R&D budget ever, at £39.8 billion for 2022-2025, reflecting the government’s target to increase the UK’s R&D spending to 2.4% GDP by 2027 (BEIS 2021). The business sector accounts for 54% of all UK R&D funding and 67% of all R&D performed in the UK.

- **Definitions of R&D impact estimates of R&D within data collection exercises and reporting mechanisms in the UK**: For example, R&D datasets differ slightly between the Business Enterprise Research and Development (BERD) and HM Revenue and Customs (HMRC). Generally, the level of recorded R&D expenditure is higher in HMRC datasets than in BERD data, although this can vary significantly between sectors. This may be the result of differences between definitions, but also differing practices in assessing R&D tax credits and interpretation of R&D definitions.

- **Business R&D is concentrated in a small number of key sectors, most of which employ large numbers of ‘non-science’ graduates**: In 2020, three UK industries (professional, scientific and technical, manufacturing, and information and communication) accounted for more than three-quarters of all business enterprise R&D expenditure (BERD). Estimates show across the top five R&D performing sectors, four employed more ‘non-science’ than ‘science’ graduates in
2020. As SHAPE subjects are included within ‘non-science’ graduates, this points to the importance of SHAPE subjects in R&D-heavy sectors.

- **Business R&D activity can be defined in many different ways, but for UK stakeholders STEM activities are front-of-mind when defining R&D**: How R&D activity is defined, and how data is collected, varies across data collection exercises. Although STEM subjects represent only one portion of R&D, STEM is often front of mind when many stakeholders’ think about R&D definitions and activities, in line with the HMRC definition for the purposes of tax credits. However, there is broad agreement around the importance of SHAPE R&D to sectors in the UK. This indicates that for some key stakeholders, there may be an opportunity to raise awareness around SHAPE R&D and broaden implicit definitions of R&D beyond just STEM subjects.

- **A person-centric approach to R&D, that recognises and measures human capital within the UK’s R&D ecosystem, may be a way of recognising the importance of SHAPE R&D**: Any effective R&D ecosystem or R&D project needs a range of skills, knowledge and experience. Within the UK’s R&D tax filing process, human capital (e.g. salaries) is identified as a key ‘indirect cost’ and is a place where the contributions of SHAPE expertise can be claimed for under the tax relief system. Understanding who contributes to R&D projects and the wider R&D ecosystem is a way of identifying the contributions of SHAPE subjects and expertise.

- **R&D employment data suggests SHAPE R&D comprises a small proportion of all business R&D, although this measure is limited**: Available data points to SHAPE comprising only a small amount of R&D employment. Recognising a wider range of roles that support R&D and are vital to the R&D ecosystem, such as managers, directors and senior officials, administrative and secretarial roles, and sales and customer service roles, may more fully capture the importance of SHAPE subjects.

- **Collaboration is key to SHAPE R&D**: For example, this can include collaborations between creative and technology sectors, which are both strengths within the UK and important for industries such as music and video gaming. However, some sectors conducting this type of collaborative R&D (between SHAPE and STEM subjects) report that it can be harder to claim UK R&D tax credits.

- **Several sectors in which SHAPE plays an important role have a low level of engagement with R&D tax credits**: Several sectors where SHAPE R&D may be occurring (e.g. arts, entertainment and recreation, and wholesale and retail trade sectors) have lower levels of engagement with R&D tax credits. This may be due to low levels of awareness and engagement with R&D support mechanisms. This suggests that R&D in these sectors may be under-captured in official datasets. Additional clarity and broader R&D definitions that encompass SHAPE activities may better promote recognition of R&D activities in sectors that are key to the UK economy.
International comparisons

We also looked at five international comparators (Netherlands, Portugal, Switzerland, Denmark and Spain) to understand how they define and recognise SHAPE R&D. Key observations from the international comparative analysis include:

- **Some other countries use a more inclusive definition of R&D than the UK, often without mentioning SHAPE subjects specifically:** Most countries use a definition of R&D that is closely linked to the Organisation for Economic Co-operation and Development (OECD) Frascati Manual or EU definitions. These are comparable to the UK’s definition when measuring business expenditure on R&D (BERD), which is based on the Frascati Manual, although they are more inclusive than the definition used for the purpose of R&D tax credits (by HMRC), which explicitly excludes SHAPE R&D. However, SHAPE subjects are often not specifically mentioned in R&D definitions, and so their inclusion is implicit rather than explicit.

- **Data on R&D is typically captured using surveys that rely on self-assessments:** Most countries produce some data on business R&D (including BERD and R&D employment) using surveys, so estimates rely on self-reporting of what R&D activities have taken place.

- **Tax credits are commonly used and provide a useful dataset on R&D expenditure:** Across the comparator countries analysed, R&D tax credits were the key mechanism used to incentivise business R&D investment, although direct research funding and other forms of incentive likely also play a role in shaping R&D activities. As SHAPE subjects are often included in tax relief schemes in comparator countries, this type of R&D is also incentivised, although the degree to which this is practically claimed likely differs by sector.

- **Very few countries produce breakdowns of SHAPE and non-SHAPE R&D, which makes international comparisons difficult:** There are very limited data on SHAPE R&D specifically at the international level, as only a small number of countries capture information at this granular level. The data that is available indicates a relatively low level of activity within SHAPE R&D relative to STEM R&D, accounting for 5% or less of both R&D expenditure and employment. Although reliable data is not available, limited evidence suggests that the UK may be particularly active in SHAPE R&D relative to international comparators. This is an area for further exploration.

Recommendations

Based on this study, we have developed the following suggestions to improve how SHAPE R&D is recognised within the UK:

- **Capture information on SHAPE R&D in routine data collection:** At present, there is very limited data to assess the extent of SHAPE R&D in the UK. SHAPE R&D clearly plays a role in UK R&D and the wider economy, forming a key part of activities and products across many different sectors. However, without robust data collection at a sufficiently granular level, it is difficult to say where the UK stands in terms of SHAPE R&D internationally, what SHAPE-related skills are needed within the R&D landscape and how SHAPE R&D is supported and incentivised at a national level. As the extent to which private sector innovation is driven and supported by
SHAPE disciplines is currently unknown, this could be a missed opportunity for transformational policy. Collection of data that allows for the breakdown of the contributions of SHAPE and STEM disciplines to business R&D could provide a valuable data source to enable evidence-based policy making. There are international examples – including Portugal and Canada – where this data is routinely collected.

- **Make definitions of R&D clear and consistent and engage with key industry stakeholders to ensure clarity and understanding:** In order to collect accurate data on the extent of R&D in industry – both SHAPE and STEM – additional clarity is needed in the way R&D is defined. This is particularly pertinent since data relies on self-reporting by companies. In particular, SHAPE R&D definitions need to be clearer in order to provide people in these industries with the knowledge and vocabulary to both articulate R&D activities that already occur, and to encourage more SHAPE-related R&D activities. More widely, there may also be challenges in articulating collaborative and cross-disciplinary R&D activities, which can also limit the degree to which SHAPE R&D is recognised. Whatever the definition used for R&D, more engagement is needed with industry stakeholders to ensure the definition used is clear, well-understood, and can be practically implemented across contexts. Lack of clarity can have implications both for the consistency and quality of data to support evidence-based decision making, and the extent to which R&D incentives are effective in achieving their policy objectives.

- **Consider person-centred measures of R&D as well as measures of expenditure:** Our analysis has demonstrated the potential of person-centred approach to analyse SHAPE R&D activity in the absence of granular data on expenditure. Given the range and nature of contributions that SHAPE graduates can make to R&D activity across sectors, and the collaborative and interdisciplinary nature of much of business R&D, a person-centred approach is key to understanding SHAPE R&D. Potential future areas of research include: the R&D roles SHAPE subjects can contribute to, the movement of people into or between key SHAPE industries, the SHAPE skills required to undertake R&D, and the capabilities and expertise SHAPE can bring to the UK’s R&D ecosystem as a whole. A person-centric lens on R&D can be a key tool to analyse R&D activities and recognise SHAPE’s contributions.
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### Abbreviations

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<th>Description</th>
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<tbody>
<tr>
<td>AHSS</td>
<td>Arts, humanities and social sciences</td>
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<td>AI</td>
<td>Artificial intelligence</td>
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<tr>
<td>AR</td>
<td>Augmented reality</td>
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<td>BA</td>
<td>British Academy</td>
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<td>BEIS</td>
<td>Department for Business, Energy and Industrial Strategy</td>
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<td>BERD</td>
<td>Business Enterprise Research and Development</td>
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<td>BT</td>
<td>British Telecom</td>
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<td>CDTI</td>
<td>Centre for Industrial Development</td>
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<td>CIS</td>
<td>Community Innovation Survey</td>
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<td>DfE</td>
<td>Department for Education</td>
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<td>EU</td>
<td>European Union</td>
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<td>FOS</td>
<td>Field of science and technology</td>
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<td>FTE</td>
<td>Full-time equivalent</td>
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<td>GDP</td>
<td>Gross domestic product</td>
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<td>GDPR</td>
<td>General Data Protection Regulation</td>
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<td>GERD</td>
<td>Gross expenditure on R&amp;D</td>
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<td>HESA</td>
<td>Higher Education Statistics Agency</td>
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<td>HMRC</td>
<td>Her Majesty's Revenue and Customs</td>
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<td>HMT</td>
<td>Her Majesty's Treasury</td>
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<tr>
<td>ICT</td>
<td>Information and communications technology</td>
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<td>INE</td>
<td>Instituto Nacional de Estadística</td>
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<tr>
<td>IoT</td>
<td>Internet of things</td>
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<tr>
<td>IPTCTN</td>
<td>Survey on the National Scientific and Technological Potential</td>
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<td>KOF</td>
<td>Swiss Economic Institute</td>
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<tr>
<td>Acronym</td>
<td>Definition</td>
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<td>MSTI</td>
<td>Main science and technology indicators</td>
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<td>NISRA</td>
<td>Northern Ireland Statistics and Research Agency</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>OfS</td>
<td>Office for Students</td>
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<td>ONS</td>
<td>Office for National Statistics</td>
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<tr>
<td>R&amp;D</td>
<td>Research and development</td>
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<td>SHAPE</td>
<td>Social sciences, humanities and the arts for people and the economy/environment</td>
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<tr>
<td>SIC</td>
<td>UK Standard Industrial Classification</td>
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<td>SME</td>
<td>Small and medium-sized enterprise</td>
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<td>SOC</td>
<td>Standard Occupational Classification</td>
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<td>STEM</td>
<td>Science, technology, engineering and mathematics</td>
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<td>TRL</td>
<td>Technology readiness levels</td>
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<td>UKRI</td>
<td>UK Research and Innovation</td>
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<td>VR</td>
<td>Virtual reality</td>
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<tr>
<td>WBSO</td>
<td>Promotion of Research and Development act in the Netherlands</td>
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<td>WP</td>
<td>Work packages</td>
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1. Approach and methodology

The British Academy commissioned RAND Europe to conduct a research project on ‘Understanding the social sciences, humanities and arts for people and the economy (SHAPE) Research and Development (R&D) in the UK and internationally’. There are concerns that current definitions of R&D used in UK government datasets do not fully capture the extent and role of SHAPE R&D in the UK economy (Hasan Bakhshi, Breckon and Puttick 2021). This risks undervaluing the important contribution of SHAPE R&D, particularly considering that the UK economy is largely service-based, and risks underestimating the role of SHAPE R&D in contributing to the government’s target of 2.4% of GDP being invested in R&D by 2027 (Hutton 2021). This study considers the varying R&D definitions being used in the UK that recognise or impact SHAPE subjects and skills, using comparisons between different sectors and countries to try to understand the implications of these R&D definitions.

1.1. Purpose and aims of study

The aim of this study is to further investigate these issues to develop a fuller picture of the way in which SHAPE R&D is understood and captured in the UK and more widely, and the reasons underlying these definitions. Social Sciences, Humanities & the Arts for People and the Economy (SHAPE) is a collective name for ‘subjects which help us make sense of the human world, to value and express the complexity of life and culture, and to understand and solve global issues’ (British Academy, 2022). This report considers SHAPE in several ways: (i) thinking about how knowledge of SHAPE subjects can support R&D and (ii) thinking about how people with SHAPE skills or coming from SHAPE degree backgrounds, can support R&D processes. This report will therefore describe the way in which SHAPE subjects and skills are understood and captured in UK R&D. The results of this report will inform the British Academy’s work on SHAPE R&D, as well as how SHAPE R&D is included in the government’s innovation strategy. We investigated the following research questions:

• How is R&D data from SHAPE disciplines collected and counted in the UK economy and business sectors and how does this vary by sector?
• Does UK R&D data collection adequately recognise R&D activities taking place in sectors most closely related to SHAPE subjects, and does this vary by industry (particularly in the services sector)?
• What barriers prevent these activities from being categorised as R&D (e.g. the implications of using tax credits as primary incentives for R&D)?
• How do practices in the UK compare to those in other countries when it comes to reporting and classifying R&D?
• Based on a deeper understanding of the evidence, how might systems of R&D classification be reformed or re-evaluated to better account for SHAPE R&D activities?

1.2. Research approach

To answer these questions, we have taken a mixed methods approach comprising of desk research, interviews and secondary data analysis. The study focuses on current approaches to measuring SHAPE R&D from two perspectives: an international comparative perspective and a cross-sector perspective within the UK. Analysis of national and international datasets allows comparisons to be drawn across these two analytical lenses.

Figure 1 provides an overview of our approach to the work with five work packages (WPs): scoping (including initial literature review), international comparisons, data analysis, sector analysis, and analysis and reporting. Below, methodologies for each of these work packages are described in more detail.

Figure 1: Project outline

1.2.1. WP1: Scoping

The purpose of the scoping work package was to finalise and refine our methodological approach through two tasks: an inception meeting with the British Academy and a targeted review of literature.
In February 2022, the British Academy and RAND Europe had a formal inception meeting to discuss aims, approaches and timelines. During this meeting, two related studies were discussed: one study commissioned by the British Academy and conducted by Frontier Economics, and one study conducted by Nesta and the Creative Industries Policy and Evidence Centre on business R&D in SHAPE subjects (H Bakhshi, Breckon and Puttick 2021a). In response to this, information sharing calls were organised between RAND Europe and Frontier Economics to discuss both research projects. The Nesta study was also reviewed to ensure that the current study did not reproduce information that was already available.

Following the inception meeting, RAND Europe conducted a targeted literature review. Sources were identified using (i) literature provided by the British Academy to review, (ii) literature that had been included in the study by Nesta and the Creative Industries Policy and Evidence Centre and the reference lists of those sources (referred to as ‘snowballing’) and (iii) searches in Google and Google Scholar.

Search terms were developed and tested in Google and Google Scholar. This strategy was used based on the importance of grey literature (including from the UK government and OECD) for the research questions for this study, which is better covered by Google and Google Scholar results than academic literature databases such as Scopus and Web of Science. A search string was developed considering variations on the following concepts from the research questions:

- **Research and Development** → R&D, R&I
- **Classification and measurement of Research and Development activities** → definition, define, measure, measures, classifications, classify, survey, data
- **Arts, humanities and social sciences** → arts, humanities, humanity, social sciences, AHSS

Two researchers worked in parallel to test four possible search strings, considering the quantity and quality of the search result outputs. Based on an assessment of the relevance and extent of the results obtained, the following search string was agreed:

\[(R&D \text{ OR } R&I) \text{ AND (Definition OR Define OR measure OR measures OR classifications OR classify OR survey OR data)} \text{ AND (arts OR humanities OR humanity OR "social sciences" OR AHSS).}\]

The acronym SHAPE was not included in this search string as: (i) during testing this term brought up too many non-related reports, (ii) the term is very specific to British Academy and UKRI activities, and (iii) the key areas of SHAPE were captured through the arts, humanities/humanity, social sciences terms. To screen the search results, a set of inclusion/exclusion criterion was created (see Table 1). The aim of the literature review was to provide high-level insights on R&D classifications and measurements related to SHAPE subjects, so the exclusion criteria was minimal to allow the inclusion of high-level or general papers discussing R&D definitions and SHAPE subjects. Papers that specifically focused on key countries or sectors of interest were also included. Two researchers conducted this process in parallel, each reviewing the top 50 Google and Google Scholar results. The two researchers then met to compare lists and confirm the final list of literature for inclusion.
Table 1: Inclusion and exclusion screening criteria

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<th>Inclusion</th>
<th>Exclusion</th>
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<tr>
<td><strong>Database</strong></td>
<td>Google and Google Scholar</td>
<td>All others</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>2012-2022</td>
<td>Pre-2012</td>
</tr>
<tr>
<td><strong>Geography</strong></td>
<td>All countries (with a specific focus on the UK and the countries of interest for this study in WP2)</td>
<td>None</td>
</tr>
<tr>
<td><strong>Sectors</strong></td>
<td>All sectors (with a specific focus on the sectors of interest for this study in WP4)</td>
<td>None</td>
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</table>

The final shortlist of 25 literature sources was then created in consultation with the British Academy. The extraction of this final list of 25 sources was completed and key findings were reported to the British Academy (summarised in Section 1.3 below). The extraction of data was based on an analysis template with each research question, to quickly identify which sources spoke to the relevant research question. Results from this work package went on to inform the international comparisons (WP2) work packages, by providing background information and initial data on each focus country. Results also informed the UK sector analysis (WP4) with any sector specific information noted down in the extraction template, helping to inform the short list of chosen sectors.

The literature review also had a direct impact on the data analysis (WP3) with one specific paper, ‘Understanding R&D in the arts, humanities and social sciences’ by Hasan Bakhshi, Jonathan Breckon and Ruth Puttick, directly informing the methodology of the project’s data analysis. The paper described the process of using the Standard Industrial Classification (SIC) codes and SHAPE graduates entering these sectors to identify the sectors most associated with SHAPE subjects (Hasan Bakhshi, Breckon and Puttick 2021). Our data analysis builds on this approach. This study was commissioned and funded by the British Academy.

1.2.2. WP2: International comparisons

Different countries take differing approaches to (i) how R&D is defined and (ii) how those definitions are implemented in national data collection systems. To understand differences in R&D approaches between countries, we selected five countries to explore in detail (Denmark, Netherlands, Portugal, Spain and Switzerland). These countries were selected based on the inclusiveness of their definitions of R&D regarding SHAPE subjects, their comparability to the UK (e.g., substantial services sector, strong R&D capabilities, developed economies), and availability of information around SHAPE R&D from publicly available sources and interviews. Our approach to selecting countries was also informed by the report by Nesta and the Creative Industries Policy and Evidence Centre in order to avoid overlap with this study.

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4 The ‘Understanding R&D in the arts, humanities and social sciences’ paper by Hasan Bakhshi, Jonathan Breckon and Ruth Puttick was also published within the Journal of the British Academy. This paper used the term Arts, Humanities and Social Science (AHSS) but this term uses the same disciplines as SHAPE subjects. This indicated the paper would be an appropriate source to inform the data analysis approach for this report.
Interviews
We contacted key experts from government statistical agencies and/or R&D policy authorities within each country for a semi-structured interview on the topic of SHAPE R&D, with the goal of conducting one to two interviews per focus country. Although we conducted at least one interview per country (with the exception of Spain), it was challenging to secure engagement and several rounds of invitations and follow-up emails were needed. The low number of interviews completed per each country is a key limitation of the study. Information about interviewees is provided in Table 2 below.

Table 2: Description of interviewees for international comparisons

<table>
<thead>
<tr>
<th>Country</th>
<th># of interviews conducted</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>1</td>
<td>This interviewee works at a research institute, focusing on statistical and quantitative data in Dutch scientific research systems. Within their role, they analyse the developments of research systems over time while being bound to consistent standards and definitions.</td>
</tr>
<tr>
<td>Portugal</td>
<td>1</td>
<td>This interviewee is a senior member of the research and strategy team within the ministry of economy in Portugal. They regularly conduct research and analysis to aid policy implementation and design. A great deal of this policy deals with R&amp;D in Portugal, including definitions within policy schemes.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1 (with two interviewees)</td>
<td>The two interviewees are individuals from Switzerland, both of whom work in tax advisory services, including R&amp;D tax incentives, at a private firm.</td>
</tr>
<tr>
<td>Denmark</td>
<td>1</td>
<td>This interviewee is part of the Danish foreign ministry and the national investment promotion agency for Denmark. Their role puts them in charge of activities attracting investors from around Europe.</td>
</tr>
</tbody>
</table>

The references for each of these interviews are clarified in Annex B. Interviews were semi-structured, to allow interviewers to ask relevant follow-up questions and to adapt the interview to the participant’s specific area of expertise. Each interview covered the following topics:

- The definition of R&D adopted in national- and regional-level data collection
- The ways in which this is implemented across data collection mechanisms, and any differences by sector
- The reasons for this approach, including any interaction with R&D policy mechanisms
- Experiences of the advantages, disadvantages and any practical challenges with the approach taken
- How the data is used and the implications of this for R&D policy and strategy.
Interviews were audio recorded with the interviewee’s permission, and detailed notes were taken during and after the interview. Our approach complied with all General Data Protection Regulation (GDPR) and UK data regulation requirements.

Desk research
To fill gaps in our understanding of R&D definitions within relevant countries, we also conducted desk research. This desk research focused primarily on policy documents and grey literature relevant to each country’s policies and practices around SHAPE R&D, industrial policy and R&D data collection. We reviewed relevant documentation from the OECD compendium of information on R&D tax incentives and accompanying country-level reports. We also reviewed the EU innovation scoreboard for relevant information for the UK and each focus country.

1.2.3. WP3: Data analysis
This work package consisted of analysis and visualisation of publicly available datasets looking at R&D statistics in the UK and internationally. To identify relevant datasets, we first reviewed data availability in the UK and internationally through a series of online searches, as detailed in Table 3 below.

Table 3: Data sources reviewed by country and region

<table>
<thead>
<tr>
<th>Country/region</th>
<th>Data source organisation</th>
<th>Data source name</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>ONS</td>
<td>Gross domestic expenditure on research and development, UK</td>
</tr>
<tr>
<td>UK</td>
<td>ONS</td>
<td>Business enterprise research and development, UK</td>
</tr>
<tr>
<td>UK</td>
<td>ONS</td>
<td>Research and development expenditure by the UK government</td>
</tr>
<tr>
<td>UK</td>
<td>HM Treasury</td>
<td>R&amp;D Tax Reliefs</td>
</tr>
<tr>
<td>UK</td>
<td>ONS</td>
<td>Management practices and innovation</td>
</tr>
<tr>
<td>UK</td>
<td>BEIS</td>
<td>BEIS research and development (R&amp;D) budget allocations 2021 to 2022</td>
</tr>
<tr>
<td>UK (Northern Ireland)</td>
<td>NISRA</td>
<td>Research and Development</td>
</tr>
<tr>
<td>EU</td>
<td>European Commission</td>
<td>The 2020 EU Industrial R&amp;D Investment Scoreboard</td>
</tr>
<tr>
<td>EU</td>
<td>Eurostat</td>
<td>Research and development expenditure, by sectors of performance</td>
</tr>
<tr>
<td>Global</td>
<td>OECD</td>
<td>Measuring Tax Support for R&amp;D and Innovation: Indicators</td>
</tr>
<tr>
<td>Global</td>
<td>OECD.Stat</td>
<td>Science, Technology and Patents</td>
</tr>
<tr>
<td>Global</td>
<td>OECD</td>
<td>Research and Development Statistics (RDS)</td>
</tr>
<tr>
<td>Global</td>
<td>OECD</td>
<td>ANBERD [Analytical Business Enterprise Research and Development] database</td>
</tr>
</tbody>
</table>
UK data analysis
The overall aim of the UK data analysis was to analyse SHAPE R&D overall and by sector. This included two main tasks: (i) providing estimates for the number of graduates from SHAPE subjects entering the UK’s high R&D expenditure industries, and (ii) understanding the types of SHAPE skills and roles being used within the UK’s R&D sector.

Gradsutes
The first task included using the Higher Education Statistics Agency (HESA) graduate outcomes data from 2019/205 and the UK’s Business Enterprise Research and Development (BERD) dataset6 (HESA, OfS and DfE(NI) 2022; ONS 2021a). Comparing the BERD and HESA datasets can provide insights on SHAPE graduates entering industries performing R&D. Both the BERD and HESA datasets analyse data using the UK SIC hierarchy codes, providing a common variable through which we can compare the two datasets. However, the comparison of SHAPE graduates and R&D expenditure is an exploratory process and any results from this analysis should be treated with caution, as the number of SHAPE graduates entering R&D industries is only one indicator of overlap between SHAPE subjects and UK R&D. Other indicators could include the types of employment within the UK R&D industries (e.g. the employment of scientists and engineers versus other roles) and the types of research outputs R&D activities produce.

The HESA graduate outcomes 2019/20 dataset (HESA, OfS and DfE(NI) 2022) was chosen as it was the most recent, publicly available dataset describing graduate employment outcomes by industry and by subject matter. It analyses the data by graduates of ‘science subject areas’7 versus graduates of ‘non-science subject

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5 ‘Figure 11 - Standard Industrial Classification of Graduates Entering Work in the UK by Subject Area of Degree.’ HESA, OfS, and DfE(NI). 2022. As of 17 July 2023: https://www.hesa.ac.uk/data-and-analysis/sb263/figure-11

priseresearchanddevelopment
7 The HESA dataset defines science students as graduates from: medicine & dentistry, subjects allied to medicine, biological sciences, veterinary science, agriculture & related subjects, physical sciences, mathematical sciences, computer science, engineering & technology, architecture, building & planning. This clarification of science subject areas is the same classification as the JACs science marker (SET/STEM) (https://www.hesa.ac.uk/support/documentation/jacs).
areas, providing calculations of graduate outcomes by percentages of graduates entering each industry. Although this is not a perfect measure of SHAPE and STEM graduates, HESA data classifies graduates in this way, and so data availability limits our ability to precisely capture SHAPE graduates. The definition of ‘non-science graduates’ is broad and can include students from a range of disciplines including law, business and administrative studies, mass communications and documentation, languages, historical and philosophical studies, creative arts and design, or education degrees, and in this analysis is used as a rough estimate of SHAPE contributions to different sectors. The analysis helps indicate which UK industries with high R&D expenditure are more heavily influenced by ‘science graduates’ and which are supported by other subjects.

To compare the numbers of ‘science’ and ‘non-science’ graduates entering each sector, the HESA percentages were converted into estimates of the number of students entering each industry. Estimated number of ‘science/non-science graduates’ entering the industry = ‘total number of science/non-science graduates entering full time employment’ * ‘% of science/non-science graduates entering specific UK industries’. These results should be treated as an indicative result as they do not account for any margin of error from rounding or weighting applied to the publicly available data. Of the known 2019/20 graduate outcomes, the data shows that 230,595 graduates entered full-time employment, with 104,595 from ‘science subject areas’ and 126,000 from ‘non-science subject areas’ (HESA 2020). Additionally, we did not conduct any formal statistical comparisons of the numbers of ‘science’ and ‘non-science’ graduates entering each sector, or apply weights to the data, and thus we do not report whether any differences are statistically significant. Therefore, this analysis should be treated as indicative estimates that provide insights as to which industries are hiring ‘non-science graduates’ and which subjects these ‘non-science graduates’ studied. The analysis results rarely placed emphasis on the humanities and arts subjects for ‘non-science’ graduates, but this may be due to small numbers (as there are not as many graduates in those subjects and no weighting was applied to the results), indicating that this is an area that could be explored further (potentially through qualitative methods).

The BERD dataset (ONS 2021a) is collected through a survey from UK businesses and enterprises that perform R&D, and provides information on industry expenditure on R&D. As the HESA data considered 2019/20 graduates, BERD outcomes from 2020 were analysed in order to reflect the R&D industries the year these graduates entered the market. This also means these results are a snapshot of the R&D industry before the UK economy underwent significant changes (i.e. COVID-19 pandemic). Past reports on SHAPE R&D have raised questions about the recognition of SHAPE within the BERD dataset. The role and impact of SHAPE subjects on R&D is not explicitly defined across UK business sectors, with no clear universally accepted definition of what constitutes the social sciences and humanities (Hasan Bakhshi, Breckon and Puttick 2021). UK policymakers’ definitions of R&D do not recognise SHAPE R&D, with SHAPE being excluded from policy from the Department for Business, Energy and Industrial Strategy (BEIS), Her Majesty’s Revenue & Customs (HMRC), and Her Majesty’s Treasury (HMT) (Hasan Bakhshi, Breckon and Puttick 2021). As BEIS, HMRC and HMT explicitly exclude SHAPE from definitions of R&D firms.

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8 The HESA dataset defines ‘non-science graduates’ as graduates from: social studies, law, business & administrative studies, mass communications & documentation, languages, historical & philosophical studies, creative arts & design, education and any combined arts or social science courses.
are less likely to report these types of R&D within data collection processes (Hasan Bakhshi, Breckon and Puttick 2021). Participants in these R&D surveys may themselves be unsure of what constitutes SHAPE R&D (Hasan Bakhshi, Breckon and Puttick 2021). Also, small business may not always be well covered in the BERD, justified on the grounds that they only account for a small amount of R&D activity. This justification may be valid within certain sectors, but in sectors like the creative industry there are typically less capital-intensive forms of R&D with smaller units of organisation (Hasan Bakhshi, Breckon and Puttick 2021). All this has led to concerns that SHAPE's contribution to wider UK R&D statistics could be undercounted and undervalued in these datasets (Hasan Bakhshi, Breckon and Puttick 2021), as we are further investigating in this study.

Roles and skills

There are various ways to measure employment as it relates to R&D. The OECD’s Frascati Manual of international standards provides one way of understanding R&D personnel, suggesting that this type of personnel includes ‘people who perform R&D, the highly trained scientists and engineers (researchers), technicians with high levels of technical experience and training, and supporting staff who contribute directly to carrying out R&D projects and activities in R&D-performing statistical units’ (Belt, Ri and Akinremi 2021). R&D personnel can undertake one or more of the following tasks:

- Perform scientific and technical work for an R&D project (setting up and carrying out experiments or surveys, building prototypes, etc.)
- Plan and manage R&D projects
- Prepare interim and final reports for R&D projects
- Provide internal services for R&D projects (e.g. dedicated computing or library and documentation work)
- Provide support for the administration of the financial and personnel aspects of R&D projects (OECD 2015).

From here, R&D personnel are classified as researchers, technicians or supporting staff (Belt, Ri and Akinremi 2021). The classification of these categories depends on the tasks performed, rather than the job title, and does not include a consideration of an individual’s experience in their role or their seniority (Belt, Ri and Akinremi 2021). However, in the UK there are concerns that smaller firms may be underrepresented by the approach that the Frascati Manual specifies, as they may not have the same delineation of roles and degree of specialisation as larger businesses.

Along with the Frascati Manual classification, there are other ways the UK considers employment in R&D. In the UK, R&D jobs are based on the Standard Occupational Classification (SOC) (Belt, Ri and Akinremi 2021; ONS 2020). Under the SOC, R&D employees are found mainly under ‘professional occupations’ and ‘associate professional occupations’ (Belt, Ri and Akinremi 2021). This may include scientists, engineers, higher education teaching professionals, technicians and R&D managers (Belt, Ri and Akinremi 2021). There are concerns this occupational classification excludes supporting staff who contribute to R&D projects, which risks not fully recognising the range of R&D business activities conducted in the UK by people in different roles (Belt, Ri and Akinremi 2021). This is an issue in the UK, as the majority of R&D
is performed by businesses (Hutton 2021; ONS 2021b). Additionally, business R&D typically focuses on applied research (accounting for 41% of business R&D expenditure in 2019) and experimental development (accounting for 49% of business R&D expenditure in 2019) rather than basic research (at 10% of business R&D expenditure in 2019) (Belt, Ri and Akinremi 2021). This more applied and developmental research focuses on improving products, services and production methods, which may not require scientists in the same way as basic research (Belt, Ri and Akinremi 2021).

Data on roles and skills for R&D mainly drew on data from the UK’s Labour Force survey, which was published as two reports: *The UK’s business R&D workforce: skills, sector trends and future challenges* (Belt, Ri and Akinremi 2021) and *The R&D Pipeline* (Hogarth 2021). Additional analysis was conducted to isolate the types of roles that require knowledge of SHAPE subjects (i.e. the social sciences, arts and humanities), including considering the Labour Force survey results regarding different R&D Employment types by 4-digit SOC codes (Hogarth 2021). These roles were grouped into different categories: ‘STEM’ (with a direct connection to a science or engineering specialism); ‘Non-STEM’ (with a direct connection to the arts, humanities or social sciences); and ‘Other’ roles (where the titles and jobs descriptions are ambiguous so may be filled by employees with either SHAPE and/or STEM backgrounds to complete the role effectively). This analysis resulted in indicative results that considered the proportion of STEM, Non-STEM and Other roles in the R&D sector in the UK.

**International data analysis**

We also analysed data relevant to each comparator country (see WP2), relying on EU and OECD datasets. The analysis provides insights across each of the comparator countries, considering questions like: Which industries are top performing in R&D in each country? and: How do these industries benefit from SHAPE or SHAPE R&D? To answer the first question, we compared each comparator country’s R&D expenditures by industry through the OECD ANBERD database, patent statistics and personnel by sector.9,10,11 This was complemented by an in-depth analysis of top-performing companies within these top-performing industries in each country, considering of each company’s R&D spending, R&D intensity and R&D one-year growth.12

**1.2.4. WP4: Sector analysis**

We selected the following sectors to understand differences in how SHAPE R&D is defined between sectors and industries in the UK:

- Arts, entertainment and recreation
- Financial and insurance activities

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• Information and communication
• Manufacturing
• Professional, scientific and technical activities
• Wholesale and retail.

These sectors were chosen based on their high R&D expenditure and contributions to the wider UK economy, as well as their potential overlap with SHAPE subjects and skills. This selection was informed by the literature review and data analysis results.

Interviews
To supplement the information available from WP3 data analysis around sector-specific information, we conducted interviews with representatives of different sectors within the UK, with the goal of conducting two to three interviews per sector. We focused on professional bodies and membership organisations to achieve a cross-cutting sector-level review, rather than a more limited picture for specific individual companies. In some sectors we struggled to secure interviewees and so relied more heavily on desk research (described below). Table 4 provides an overview of interviewees for the sector analysis work package.

Table 4: Description of interviewees for sector analysis

<table>
<thead>
<tr>
<th>Sector</th>
<th># of interviews conducted</th>
<th>Description of interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts, entertainment and recreation</td>
<td>4</td>
<td>For the Arts, entertainment and recreation sector, it was easier to find people who were interested in discussing SHAPE R&amp;D than in other sectors. As a result, we attained a sample of four interviewees from different areas across the sector, including the music industry, gaming industry and the creative sector more generally.</td>
</tr>
<tr>
<td>Financial and insurance activities</td>
<td>3</td>
<td>For the sector of Financial and insurance activities, we were able to speak to professionals with deeper insight into the financial aspects associated with R&amp;D activities in multiple private sectors. The sample of three interviewees, two from financial consulting and one from a leading industry body within fintech, added a tax-centred approach to R&amp;D, both within the financial sector specifically but also relating to other sectors.</td>
</tr>
<tr>
<td>Information and communication</td>
<td>0</td>
<td>Despite conducting considerable amounts of desk research to identify potential interviewees, and reaching out to many people, we were not able to find experts within this sector who were willing to participate in this study. Therefore, this analysis relies solely on desk research. As such, there may be limitations to the analysis.</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2</td>
<td>Interviewees connected to the manufacturing sector included a representative from a fashion and textile industry body and an R&amp;D tax specialist whose current work focuses mainly on the manufacturing sector, including collaborations with a key manufacturing industry body.</td>
</tr>
<tr>
<td>Professional, scientific and technical activities</td>
<td>2</td>
<td>Interviewees for this sector include two industry body representatives, one from the biotech industry and one from the engineering industry. With knowledge of R&amp;D-specific matters, these sources were able to provide an overarching perspective on the topic relating to different industries.</td>
</tr>
</tbody>
</table>
The references for each of these interviews are clarified in Annex B. Interviews for the sector analysis were semi-structured, and covered the following topics:

- Definitions of R&D employed within each sector
- The policy landscape around R&D for specific sectors
- Impact of R&D definitions within each sector.

Interviews were audio recorded with the interviewee’s permission, and detailed notes were taken during and after the interview. Our approach complied with all GDPR and UK data regulation requirements.

Desk research

To supplement interviews, desk research was conducted within each sector, focusing on grey literature around the contribution of SHAPE R&D within each sector and definitions of R&D. Grey literature sources included public and governmental webpages and policy documents, as well as reports and articles from industry bodies and R&D tax specialist businesses. For most of the sectors, evidence from these sources was triangulated with data from interviews to ensure consistency and robustness. The information and communications sector and wholesale and retail sector, however, were analysed based only on desk research as appropriate interviewees were not found and secured for these sectors.

1.2.5. WP5: Analysis and reporting

Within each work package, results were analysed thematically. For each country and sector within WP2 and WP4, results were analysed first within each country and sector to understand key differences and particularities, and then across countries and sectors to understand overarching themes and commonalities. Results from across all work packages were then analysed, triangulating evidence from different sources against the study questions.

1.3. Limitations

While the study was successful in gathering evidence through publicly available datasets, desk research and interviews, there were some key limitations that should be highlighted. Specifically, recruitment for this study was a challenge, and interviewees were drawn from a small pool of R&D experts identified through desk research. It may be that other stakeholders not consulted within this study have different views on R&D and SHAPE R&D, and so the views represented in this report may not capture the full breadth of opinions and experiences. To mitigate this effect, the research team conducted thorough desk research to confirm the information presented by interviewees. Where an interviewee presented an argument or
opinion, the research team flagged it in the report as an opinion rather than presenting it as confirmed fact. Overall, the small number of interviews should be considered when assessing the results of this study.

Additionally, there were some limitations around data availability and analysis, which are explained throughout this report. For the international data on SHAPE R&D, data is limited. The OECD database was selected due to its wider array of R&D indicators and number of international comparators, although this database is not without limitations and does not include all countries. We reviewed the percentages of gross domestic expenditure on R&D (GERD) by business which is expended on social sciences, art and humanities, as well as percentages of business enterprise R&D personnel classified as within the social sciences, arts and humanities field of research. To help compare R&D across comparator countries, we also considered OECD R&D data relating to the percentage of BERD performed in services industries, R&D expenditure, and R&D tax incentives statistics. However, these are not perfect measures of true SHAPE R&D expenditure and are likely to be underestimates. UK data analysis relied heavily on R&D graduate and labour data, including data from HESA which uses their definitions of ‘science’ and ‘non-science’ graduates and SIC industry codes. These are rough measures which may not fully capture the degree to which SHAPE and STEM subjects contribute to R&D, which we reflect on throughout the report (see Section 1.2.3 for more detail).
2. SHAPE R&D within the UK

Box 1: Main findings: SHAPE R&D within the UK

Definitions impact BERD and HMRC reporting of £ R&D figures: The definitions used for R&D expenditure in the collection of BERD data and for HMRC tax credits are different. Generally, HMRC reporting of R&D expenditure is higher than BERD data estimates. This is partly unexpected as HMRC definitions are, on paper, more exclusionary than the BERD definitions of R&D. However, this discrepancy varies by sectors, indicating potential differences in definitions and in practices assessing R&D tax credits in response to the BERD survey responses.

Business R&D is concentrated in a small number of key sectors, many of which employ large numbers of ‘non-science graduates’. This can be used as a rough indication of SHAPE graduates (see footnote below): In 2020, the top UK industries with the highest expenditure on R&D in UK businesses were the ‘professional, scientific and technical activities’, ‘manufacturing’ and ‘information and communication’ sectors, accounting for more than three-quarters of all BERD. Estimates show across the top five R&D performing sectors in 2019, four employed more ‘non-science’ than ‘science’ graduates.

Business R&D activity can be defined in many different ways, but for UK stakeholders STEM activities are often front-of-mind when identifying R&D definitions and activities: The interviews we conducted demonstrated that STEM was front-of-mind when identifying R&D definitions and activities, and this finding was consistent across all interviews conducted across UK industries. This is in line with how HMRC defines R&D for the purposes of tax credits, though it is not clear to what extent the HMRC definition is a driver of stakeholder perceptions. This strong association for many stakeholders indicates an opportunity to improve awareness that SHAPE is also an important area of R&D.

R&D employment data suggests SHAPE R&D comprises a small proportion of all business R&D according to national data collection exercises on employment, although this measure is limited: There are a range of R&D occupations where people are directly involved in R&D activity or providing R&D-relevant skills. Current definitions of R&D occupations use the SOC code system, which does not account for people providing additional administrative support (which is perhaps an area for further research to understand if any other SHAPE occupations could be added to this selection of SOC R&D occupations). Current (narrow) definitions of R&D occupations include a range of employment roles, of which the majority are related to STEM (62%) or management, teaching, lab technicians or other roles (37%) and only 3% are directly related to SHAPE. Analysis of R&D sectors of employment show, across the four devolved nations, that 11-13% of R&D personnel are conducting R&D on social sciences and humanities. However, to meet future R&D skills demand, a range of diverse business activities, skills, knowledge and experience are needed to conduct any R&D activity. More research is needed to understand whether this is a true measure of SHAPE R&D employment, or whether data collection mechanisms simply fail to capture this type of employment accurately.

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13 The definition of ‘non-science graduates’ comes from the HESA graduate outcomes 2018/19 dataset (HESA, OfS, and DfE(NI) 2021). It is a broad term to include a range of disciplines including key SHAPE subjects. ‘Non-science graduates’ studied law, business and administrative studies, mass communications and documentation, languages, historical and philosophical studies, creative arts and design or education degrees.
There are many examples of collaboration between SHAPE subjects, and between SHAPE and STEM subjects, contributing to the UK economy: For example, collaboration between the creative industries and technology sectors are a key growth area for SHAPE R&D. The UK has strong creative industries, and the emergence of new technologies and services opens new areas of opportunity for these industries. This is seen most clearly in the music and video gaming industries, which utilise and develop complex technologies (which may be typical to STEM R&D activities) but at their core are promoting creative products. However, industries with these types of collaborative R&D (between SHAPE and STEM subjects) report that it can be harder to claim UK R&D tax reliefs for their innovations.

Several sectors in which SHAPE plays an important role have a low level of engagement with R&D tax credits: Notably companies in the ‘arts, entertainment and recreation’ and ‘wholesale and retail trade’ sectors were highlighted by interviewees as typically not being aware of, or engaged with, R&D support mechanisms. In both sectors there was a noted lack of awareness that some activities could qualify for R&D tax benefits. It was also noted that, for smaller organisations and retailers, there was a lack of resources to invest in the knowledge and expertise to identify how to qualify for R&D tax benefits. For the ‘arts, entertainment and recreation’ sector there was an additional question over competing tax reliefs, as creative industry tax reliefs are more generous and easier to qualify for than R&D tax reliefs. The low engagement with R&D in these sectors touches on issues of awareness but also motivation; understanding why an organisation in these sectors might apply for R&D tax relief will therefore be key to increasing engagement with R&D activities and tax credits.

To provide context to the rest of the report, it is first important to identify and understand the different R&D definitions used in the UK and internationally. Box 2 provides an overview of the main R&D definitions used across the world.

**Box 2: Global R&D definitions**

(i) **Frascati Manual definition of R&D:**
The Frascati Manual explicitly defines R&D as follows: ‘Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.’ The activities relating to R&D must be novel, creative, uncertain, systematic and reproducible and/or transferable (OECD 2015). The term R&D covers three activities: basic research, applied research and experimental development. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Applied research is original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes (OECD 2015).

(ii) **Oslo Manual definition of innovation:**
The Oslo Manual provides standards for collecting and interpreting data on innovation. It is used to facilitate international comparability and acts as a tool for experimentation and research on innovation measurement. The Oslo Manual guidelines are primarily aimed at supporting national statistical offices in designing, collecting and publishing measures of innovation to meet a range of research and policy needs (OECD and Eurostat 2018). The Manual is also used by various countries to inform their definitions of R&D, which will be explored further in Section 3: SHAPE R&D internationally.

‘An innovation is a new or improved product or process [or combination thereof] that differs significantly from the unit’s previous products or processes and that has been made available to potential users [product] or brought into use by the unit [process]. Innovation activities include all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm. A business innovation is a new or improved product or business process [or combination thereof] that differs significantly from the firm’s previous products or business processes and that has been introduced on the market or brought into use by the firm. A product innovation is a new or improved good or service that differs significantly from the firm’s previous goods or services and that has been introduced on the market. A business process innovation is a new or improved
2.1. R&D within the UK

2.1.1. Different measurement approaches produce different estimates of UK R&D expenditure

As set out in Box 2, the definitions used for R&D expenditure in the collection of BERD data and for HMRC tax credits are different. We also find that the level of R&D expenditure reported as part of R&D tax credit claims differs quite significantly from BERD data, and that these differences vary in extent between sector, as shown in Figure 2. Generally, the level of expenditure based on HMRC data is estimated as higher than BERD data estimates, which is unexpected given that the definition is – at least on paper – more exclusionary than the BERD definition of R&D. However, the discrepancy varies significantly between the sectors. This may partly result from differences in definition, but could also reflect differing practices in accessing R&D tax credits and in the BERD survey response.
Figure 2: Clustered bar chart comparing R&D expenditure figures from BERD (2020) and HMRC R&D tax credit data (2019-2020). Data sources: (HMRC 2021; ONS 2021a)

2.1.2. R&D spend in the UK is growing

For many years, the UK’s investment spending remained fairly consistent at approximately 1.7% of the country’s total GDP; in 2019, R&D spending was £38.5 billion, which translated to 1.74% GDP (Hutton 2021). However, the UK government’s 2021 Innovation Strategy created a target of increasing R&D expenditure to 2.4% GDP by 2027 (BEIS 2021). To support the delivery of this Innovation Strategy, the government recently announced plans for the largest R&D budget to date with a total of £39.8 billion set aside for R&D from 2022 to 2025 and spending set to increase by £5 billion to £20 billion per annum by 2024-2025 (GOV.UK 2022). This investment supports the vision of the UK emerging as a ‘science
superpower\textsuperscript{14} focusing on the UK’s competitive advantages in research areas and new and emerging technologies.\textsuperscript{15}

The government’s investment in R\&D also contributes to the ‘Levelling Up’ agenda, introduced through a White Paper in February 2022 (GOV.UK). This agenda refers to the current existence of innovation clusters within the UK, and the need to spread opportunity and uplift regions that are not yet fulfilling their innovation potential (BEIS 2021). At present, although gross domestic expenditure for R\&D is distributed across the four devolved nations (Figure 3), it is uneven, and there is evidence of some concentration within ‘innovation cluster’ areas in London, the Southeast and East of England, compared to regions in the north of the country (see Table 5). As such there is a drive to substantially increase investment in R\&D – and to spread that across different areas of the UK – with business sector R\&D playing a significant role in that increased investment. If more SHAPE R\&D were conducted, or if the SHAPE R\&D currently being conducted were better counted in national data collection exercises, investment in SHAPE R\&D could contribute to these national figures around expenditure and R\&D activity.

\textbf{Figure 3: Filled UK map with gross domestic expenditure on R\&D in 2019, by £ million (Published 4 August 2021). Data source: (ONS 2021b)}

\vspace{1cm}

\textsuperscript{14} The UK as a ‘science superpower’ is a grand vision for the UK’s science and innovation ecosystem to make the UK a world-class research and innovation system. It is part of the Prime Minister’s announcement of the UK’s intention to be a science superpower by 2030, ‘placing science, innovation and technology at the heard of his vision for the UK’. Making the UK’s science and technology comparable to the UK’s financial science, ‘a central hub of the global economy, and the country that the world’s most innovation people and firms make their home’ (BEIS 2021; Johnson 2021)

\textsuperscript{15} This has also been informed by the British Academy’s Scientific superpower workshop held on the 30\textsuperscript{th} March 2022.
Table 5: UK gross domestic expenditure on R&D by region in 2019 (Published 4 August 2021). Data source: (ONS 2021b)

<table>
<thead>
<tr>
<th>UK Nations</th>
<th>Gross domestic expenditure on R&amp;D (£ million)</th>
<th>% of total UK gross domestic expenditure on R&amp;D (Total (100%) = 38,520)</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>34,132</td>
<td>88.6%</td>
</tr>
<tr>
<td>Scotland</td>
<td>2,789</td>
<td>7.2%</td>
</tr>
<tr>
<td>Wales</td>
<td>794</td>
<td>2.1%</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>805</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regions in England</th>
<th>Gross domestic expenditure on R&amp;D (£ million)</th>
<th>% of total gross domestic expenditure on R&amp;D by regions in England (Total (100%) = 34,132)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast England</td>
<td>7,529</td>
<td>22.1%</td>
</tr>
<tr>
<td>East of England</td>
<td>6,895</td>
<td>20.2%</td>
</tr>
<tr>
<td>London</td>
<td>6,351</td>
<td>18.6%</td>
</tr>
<tr>
<td>Northwest England</td>
<td>2,977</td>
<td>8.7%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>2,917</td>
<td>8.6%</td>
</tr>
<tr>
<td>Southwest England</td>
<td>2,596</td>
<td>7.6%</td>
</tr>
<tr>
<td>East Midlands</td>
<td>2,368</td>
<td>6.9%</td>
</tr>
<tr>
<td>Yorkshire and the Humber</td>
<td>1,757</td>
<td>5.2%</td>
</tr>
<tr>
<td>Northeast England</td>
<td>742</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

2.1.3. Business R&D makes up a significant proportion of R&D spend in the UK

Although more traditionally associated with higher education institutions or specialists research centres, a significant proportion of UK R&D is funded and conducted by businesses. As seen in Figure 4, the Business Enterprise sector has the highest level of R&D funding and is also the top-performing R&D sector. Figure 4 shows UK R&D investment and performance is driven by the private sector. The left-hand side of this diagram represents R&D funding (in £ amounts) by various UK sectors, and the right-hand side of the diagram shows sectors performing R&D (in £ amounts). R&D in the UK is funded and performed by various public, private and overseas players with many interdependencies between these different organisations (The British Academy et al. 2021).

In 2019, the business sector funded £20.7 billion of R&D in the UK and performed £25.9 billion worth of R&D activities (Hutton 2021). This equates to 54% of total R&D funding in the UK, and 67% of total R&D activities performed in the UK in that year (Hutton 2021; ONS 2021b). Businesses in the private sector that performed R&D in 2019 received 78% of the funding from the private sector, but were also supported by overseas R&D funding (15%), government funding (5%) and UKRI (2%) (ONS 2021b). This large contribution from businesses in the private sector in terms of funding and conducting R&D indicates the sector’s impact on the wider UK economy and its ability to convert R&D into products (Hogarth 2021). Understanding SHAPE R&D in the private sector is therefore key, as business enterprises make up a large proportion of UK R&D funding and activities and are key contributors to the UK’s overall economy.
Figure 4: Sankey diagram of UK R&D in 2019, by sectors funding R&D and sectors conducting R&D. Data source: (ONS 2021b)
2.1.4. Business R&D is concentrated in a small number of key sectors

In the UK, business expenditure on R&D is fairly concentrated. In 2019, just five enterprise groups (which are enterprises under the same owner) accounted for 15% of expenditure on R&D performed by UK businesses (The British Academy et al. 2021). Additionally, 2019 data shows the top 100 enterprise groups (which are enterprises under the control of one owner) accounted for 47% of business R&D expenditure and employed one third of R&D personnel (Belt, Ri and Akinremi 2021). Firms that consistently invest in R&D are thought to be 13% more productive than firms that don’t invest in R&D (The British Academy et al. 2021). According to the UK’s BERD dataset organised by SIC\textsuperscript{16} codes, in 2020, the top UK industries with the highest expenditure on R&D performed in UK businesses were: ‘professional, scientific and technical activities’, ‘manufacturing’ and ‘information and communication’. The ‘arts, entertainment and recreation’ sector is identified as the eighth highest sector investing in R&D, investing £325 million in 2020 (see Figure 5), although ambiguity remains over whether this figure fully captures the extent of SHAPE R&D in this sector, due to the definitions used within the BERD dataset (Hasan Bakhshi, Breckon and Puttick 2021).

\textsuperscript{16} To facilitate further analysis, these sectors have been reclassified from the SIC Division to the SIC Hierarchy codes, found in: ‘UK Standard Industrial Classification (SIC) Hierarchy’. Office for National Statistics. As of 24 August 2022: https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html. For more information, please review the methodology section.
2.1.5. **Key R&D industry sectors employ high numbers of SHAPE graduates**

One way to identify UK industries performing R&D in SHAPE subjects is to consider how many SHAPE graduates enter into these industries (H Bakhshi, Breckon and Puttick 2021b). In the 2019/20 academic year, there was a total of 800,335 Higher Education qualifications achieved, of which 327,940 were from ‘science subject areas’ and 472,395 were from ‘non-science subject areas’ (HESA 2021). The graduate outcomes survey for 2019/20 collected data among 374,875 graduates (HESA 2022c). These students and the following graduate outcomes survey were impacted by the pandemic, but the survey recorded little overall change since the start of the pandemic and differences were less marked between 2018/19 and 2019/20 than the previous year. The survey recorded that 57% of graduates (230,595) were in full-time employment, of which 104,595 were from ‘science subject areas’ and 126,000 were from ‘non-science subject areas’ (HESA 2022b). Data are also available on the employing industries that these graduates

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17 To facilitate further analysis, these sectors have been reclassified from the SIC Division to the SIC Hierarchy codes, found in: ‘UK Standard Industrial Classification (SIC) Hierarchy’. Office for National Statistics. As of 24 August 2022: [https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html](https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html).

For more information, please review the methodology section.

18 ‘Graduate outcomes’ refers to activities and perspectives of graduates approximately 15 months after they complete their Higher Education (HE) studies (HESA 2022a). The sample consists of graduates who achieved a HE qualifications from HE providers in the UK or Further Education Colleges (FEC) in England, Wales or Northern Ireland (HESA 2022a). This study uses data related to the graduate outcomes from 2018/19.
entered into (HESA, OfS, and DfE(NI) 2022), visualised in Figure 6 below. These data show that SHAPE\textsuperscript{19} graduates are directly contributing to key industries in the UK, including some industries with high levels of R&D activity.

If we compare these graduate outcomes to the industry sectors with high levels of R&D expenditure (as shown in Figure 7), we find that of the top five industries with the highest expenditure on R&D performed in UK businesses in 2020, four had more ‘non-science’ than ‘science’ graduates entering the industry (from the academic year 2019/20). For a more detailed analysis of the distribution of ‘non-science graduates’\textsuperscript{20} across industry, please see Annex A.

\textsuperscript{19} This insight is derived from analysis on ‘science’ versus ‘non-science’ graduates entering into various UK industries. Definitions of ‘non-science graduates’ may not perfectly align with SHAPE graduates, as mentioned in the methodology section of this report. For more information, please refer to Section 1.2.3.

\textsuperscript{20} Science students are defined as graduates from: medicine and dentistry, subjects allied to medicine, biological sciences, veterinary science, agriculture and related subjects, physical sciences, mathematical sciences, computer science, engineering and technology, architecture, building and planning.

\textsuperscript{21} Non-science students are defined as graduates from: social studies, law, business and administrative studies, mass communications and documentation, languages, historical and philosophical studies, creative arts and design, education and any combined arts or social science courses.
Figure 7: Comparison of bar charts with BERD data on expenditure on R&D performed in UK businesses (2020) and estimates from HESA graduate outcomes data (2019/20), categorised by SIC codes. Data sources: (HESA, OfS, and DfE[NI] 2022), (ONS 2021a)

<table>
<thead>
<tr>
<th>R&amp;D industries categorised by SIC industry codes</th>
<th>2020 Expenditure on R&amp;D performed in UK businesses (Blue = R&amp;D expenditure (£ million))</th>
<th>Estimated number of 2019/20 graduates entering full time employment in industry positions (Green = science students, Red = non-science students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional, scientific and technical activities</td>
<td>9,567</td>
<td>12,551/16,380</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>8,977</td>
<td>7,322/3,780</td>
</tr>
<tr>
<td>Information and communication</td>
<td>3,968</td>
<td>7,322/8,820</td>
</tr>
<tr>
<td>Wholesale and retail trade; repair of motor vehicles and motorcycles</td>
<td>1,265</td>
<td>7,322/12,600</td>
</tr>
<tr>
<td>Financial and insurance activities</td>
<td>578</td>
<td>3,138/5,040</td>
</tr>
<tr>
<td>Construction</td>
<td>429</td>
<td>3,138/1,200</td>
</tr>
<tr>
<td>Administrative and support service activities</td>
<td>420</td>
<td>2,092/6,300</td>
</tr>
<tr>
<td>Arts, entertainment and recreation</td>
<td>325</td>
<td>2,092/5,040</td>
</tr>
<tr>
<td>Human health and social work activities</td>
<td>189</td>
<td>11,340/36,608</td>
</tr>
<tr>
<td>Mining and quarrying</td>
<td>179</td>
<td>0/0</td>
</tr>
<tr>
<td>Water supply; sewerage, waste management and remediation activities</td>
<td>134</td>
<td>0/0</td>
</tr>
<tr>
<td>Electricity, gas, steam and air conditioning supply</td>
<td>103</td>
<td>1,046/0</td>
</tr>
<tr>
<td>Other service activities</td>
<td>99</td>
<td>1,046/2,520</td>
</tr>
<tr>
<td>Transportation and storage</td>
<td>74</td>
<td>1,046/1,260</td>
</tr>
<tr>
<td>Public administration and defence; compulsory social security</td>
<td>53</td>
<td>4,184/10,080</td>
</tr>
<tr>
<td>Accommodation and food service activities</td>
<td>52</td>
<td>3,138/6,300</td>
</tr>
<tr>
<td>Real estate activities</td>
<td>32</td>
<td>1,046/1,260</td>
</tr>
<tr>
<td>Agriculture, forestry and fishing</td>
<td>18</td>
<td>0/0</td>
</tr>
<tr>
<td>Education</td>
<td>0</td>
<td>10,460/30,240</td>
</tr>
</tbody>
</table>
2.1.6. **R&D employment provides an alternative measure of R&D activity in the UK**

R&D activity can also be explored by looking at the level of employment. Section 2.1.5 demonstrated there is a large number of ‘non-science graduates’ entering into key industries with high R&D expenditures. However, further clarification is needed to identify the type of roles SHAPE graduates enter, and whether SHAPE graduates are being hired for their expertise in arts, sciences, humanities or other SHAPE-related subjects, or for their broader skills. Therefore, this section considers how SHAPE is directly contributing to R&D employment. There is data available that allows us to look at the level of SHAPE R&D as a proportion of all R&D activities based on employment. Two approaches to assessing the level of R&D employment in the UK are set out in the recent ‘R&D pipeline’ report for BEIS (Hogarth, 2021): by occupation, and by sector of employment.

R&D occupations are jobs that are engaged in the process of conducting R&D and the selection of these occupations is based on the selection laid out in the Hogarth (2021) report. The list of R&D occupations in Table 6 references the SOC code system, which is the common classification of occupational information in the UK. Using this SOC code system facilitates further analysis of SHAPE R&D employment (in Figure 8 and Figure 9). The selection of these SOC codes is narrower than the OECD definition of R&D roles, which includes recognition of researchers, technicians and other support staff (Hogarth 2021; OECD.Stat 2022). The analysis below is therefore focused on jobs where people are involved in R&D activity and providing skills that are directly related to R&D, rather than providing administrative support. This is perhaps an area for further research, to understand if any other SHAPE occupations could be added to this selection of SOC R&D occupations.

**Table 6: R&D occupations referenced by SOC 2010**

<table>
<thead>
<tr>
<th>Code</th>
<th>Occupation title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2111</td>
<td>Chemical Scientists</td>
</tr>
<tr>
<td>2112</td>
<td>Biological Scientists and Biochemists</td>
</tr>
<tr>
<td>2113</td>
<td>Physical Scientists</td>
</tr>
<tr>
<td>2114</td>
<td>Social and Humanities Scientists</td>
</tr>
<tr>
<td>2119</td>
<td>Natural and Social Science Professionals not elsewhere classified</td>
</tr>
<tr>
<td>2121</td>
<td>Civil Engineers</td>
</tr>
<tr>
<td>2122</td>
<td>Mechanical Engineers</td>
</tr>
<tr>
<td>2123</td>
<td>Electrical Engineers</td>
</tr>
<tr>
<td>2124</td>
<td>Electronics Engineers</td>
</tr>
<tr>
<td>2126</td>
<td>Design and Development Engineers</td>
</tr>
<tr>
<td>2127</td>
<td>Production and Process Engineers</td>
</tr>
<tr>
<td>2129</td>
<td>Engineering Professionals not elsewhere classified</td>
</tr>
<tr>
<td>2311</td>
<td>Higher Education Teaching Professionals</td>
</tr>
<tr>
<td>3111</td>
<td>Laboratory Technicians</td>
</tr>
<tr>
<td>2150</td>
<td>Research and Development Managers</td>
</tr>
</tbody>
</table>
To facilitate considering how this fits with SHAPE R&D, we divided these roles into three categories: (i) STEM roles, which have a direct connection to a science or engineering specialism; (ii) Non-STEM roles, which have a direct connection with the arts, humanities or social sciences; or (iii) Other roles, which are occupations that may be filled by employees with SHAPE and/or STEM background (see Figure 8).

**Figure 8: Categorisation of R&D Employment types by 4-digit SOC, 2017-2019 (Hogarth 2021)**

[Diagram of employment types]

Considering employment types through these categories, estimates show STEM roles make up the majority of R&D employment and account for 62% of R&D employment across the UK. In comparison, non-STEM roles account for 3% of R&D employment across the UK, and ‘other’ employment roles account for 37% of the R&D employment across the UK (Figure 9).
Hogarth (2021) provided an alternative way to assess R&D employment, which is an industry-based approach. In this approach, R&D activity is designated based on sectors where the principal activity of firms or workplaces is R&D, using SIC subsectors (as set out Table 7). Using this sector-based approach, analysis in each of the four devolved nations in the UK shows that around 11-13% of R&D personnel are conducting R&D on social sciences and humanities (Figure 10). However, it could be suggested this is likely a partial picture as there will be significant amounts of R&D ongoing in sectors that are not R&D-led, and it is unclear if the data captures activities where an approach to R&D (even when STEM-focused) may utilise a blend of STEM and SHAPE inputs.
### Table 7: R&D sectors of employment SIC 2007

<table>
<thead>
<tr>
<th>Class and subclass</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.1</td>
<td>Research and experimental development on natural sciences and engineering</td>
</tr>
<tr>
<td>72.11</td>
<td>Research and experimental development on biotechnology</td>
</tr>
<tr>
<td>72.19</td>
<td>Other research and experimental development on natural sciences and engineering</td>
</tr>
<tr>
<td>72.2</td>
<td>Research and experimental development on social sciences and humanities</td>
</tr>
</tbody>
</table>

### Figure 10: Stacked bar chart depicting R&D Employment distribution by SIC codes in devolved nations in the UK, 2017-2019 (Hogarth 2021)

#### 2.1.7. R&D employment in the UK is growing and changing

More broadly, UK employment in R&D\(^{23}\) was relatively flat between 1998 and 2008, but since 2009 R&D employment has been steadily increasing (Belt, Ri and Akinremi 2021). Analysis of ONS R&D data shows this growth in R&D employment sits within the larger trend of a general rise in total employment in the UK (Belt, Ri and Akinremi 2021). Although, the share of R&D employment has matched, and is sometimes greater, than this rise in total employment. In 2001, there were an estimated 686,000 R&D workers, but this steadily increased so that by 2019 there were 1,026,000 R&D workers in the UK (Belt, Ri and Akinremi 2021). In 2019, the number of employees working in UK businesses and completing R&D tasks was recorded at a high of 263,000 full-time equivalent (FTE) positions (ONS 2021a; Hogarth 2021). It is expected that the demand for R&D personnel will continue to increase in the future. Estimates suggest that

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\(^{22}\) Base: England (115,773), Wales (4,105), Scotland (15,738), Northern Ireland (2,579).

\(^{23}\) These figures are based on results from the Labour Force Survey (LFS) which considers various R&D occupations (Belt, Ri and Akinremi 2021).
by 2027 as many as 382,000 R&D roles would need to be filled (Hogarth 2021). To achieve the government’s R&D roadmap to 2.4% GDP expenditure on R&D by 2027, skills and training will need to be included alongside other investments (Hogarth 2021).

We also see wider trends and changes in the R&D employment landscape, including a shift towards an increasing share of technicians, who accounted for 29% of total R&D employment in 2019, compared to 17% in 2005 (Belt, Ri and Akinremi 2021). In addition, reports on the UK’s R&D workforce recognise that R&D ‘cannot be regarded as solely the domain of those educated to a high level often in STEM subjects. R&D is much broader than that and includes a number of support functions which are essential to its performance’ (Hogarth 2021). Commentators have noted the key to business innovation is human capital with a combination of skills, competencies, knowledge and experience (Belt, Ri and Akinremi 2021).

These broad skills are needed to support the creation, development and commercialisation of ideas, as well as the identification and exploration of new technologies (Belt, Ri and Akinremi 2021). The need for wider transferable skills and business skills to effectively conduct R&D is also widely highlighted (Belt, Ri and Akinremi 2021; Emsi 2018; Hunter, Cushenbery and Friedrich 2012). This points to the need for a diversification in the skills base for those conducting R&D.

2.2. SHAPE within R&D industries in the UK

To further understand SHAPE R&D within different UK industries, this study includes further analysis of several sectors in the UK. These were selected based on our analysis of sector-level R&D activity and involvement of ‘non-science graduates’ in those sectors as set out in Section 2.1.5. The findings described below are based primarily on desk research and interview data relating the following sectors:

- Arts, entertainment and recreation
- Information and communication
- Financial and insurance activities
- Professional scientific and technical activities
- Wholesale and retail trade
- Manufacturing

In each section, we begin a brief overview of insights from the data analysis task (WP3) relating to each sector of interest. Note that for two sectors (information and communication, and wholesale and retail), we were not able to obtain interviews, so the information provided for these sectors is more limited.

2.2.1. Arts, entertainment and recreation

Broadly, the arts, entertainment and recreation sector refers to business activities relating to culture, entertainment and recreation. These activities may take the form of sports events, gambling and gaming, music creation and performances, as well as radio and television broadcasting (ONS). Hence, some of these

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24 This projection includes replacement demand (Hogarth 2021).
activities overlap with the information and communication sector (discussed below), such as in radio and television broadcasting. This sector is not among the most R&D intensive, but the following analysis will show that many activities fall within a grey area, where they are not directly classified as R&D but may contribute to R&D activities.

Insights from data analysis
Arts, entertainment and recreation is listed as the eighth industry in the BERD expenditure on R&D performed in 2020. However, there is clearly a high degree of overlap between the sector and SHAPE subjects. Indeed, there are more than twice as many ‘non-sciences’ than ‘science’ graduates entering this industry (estimated number of ‘non-science graduates’ entering the industry is 5,040, compared to 2,092 ‘science graduates’). These ‘non-science graduates’ are most likely to come from design, creative and performing arts degrees (estimated at 1,852 students).

<table>
<thead>
<tr>
<th>Summary of key data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate of BERD of annual R&amp;D spend (2020): £325m</td>
</tr>
<tr>
<td>R&amp;D spend based on HMRC tax credit data (2019-2020): £1,260m (^{25})</td>
</tr>
<tr>
<td>Estimated number of ‘science graduates’ entering sector (2019/20): 2,092</td>
</tr>
<tr>
<td>Estimated number of ‘non-science graduates’ entering sector (2019/20): 5,040</td>
</tr>
</tbody>
</table>

R&D definitions and R&D data
According to interviews we conducted, generally understood definitions of R&D varied within the arts, entertainment and recreation sector. One account referred to R&D within the music industry as human-centric, recognising the R&D activities involved in building human talent and talent development (INT-SEC-01). Additionally, this perspective raised the human centred behavioural research that goes into understanding music audiences, to predict what music will resonate with groups of people and how consumers want to listen to music (INT-SEC-01).

Although many research activities within this sector are closely linked with SHAPE disciplines, activities specifically referred to as R&D were often associated with technological innovation. For example, immersive technology was referred to as key area of R&D within the creative sector (INT-SEC-10), as well as technological development of software and hardware for music consumption (INT-SEC-01; INT-SEC-02). Some interviewees suggested activities conducted within the creative sector are often not considered R&D (INT-SEC-10), reflecting the exclusion of some of these activities and topics from HMRC definitions for the purpose of tax credits.

Several interviewees raised the fact that activities, services and products often fell between different sectors. In the music industry, for example, activities involved in the service of Apple Music are spread across multiple sectors and industries, including the information technology industry, which is more recognised for involving R&D activities (INT-SEC-01). Moreover, such grey areas were particularly pronounced within the gaming industry where, for example, creative animation and hardware involved in video games is highly driven by technological innovation, activities that could be understood as part of the technology.

\(^{25}\) For more information on why BERD and HMRC estimates of R&D spend differ, please see section 2.1.1.
sector. Such R&D is closely reliant on STEM disciplines, such as physics, and are more likely to qualify for R&D tax benefits (INT-SEC-04). At the same time, research associated with SHAPE disciplines was viewed as essential to understand how people engage with video games. This includes, for example, how online relationships are built between players, which can be vital for the success of a video game, as well as how the gaming industry is conceived of and its cultural value (INT-SEC-04). Although these SHAPE-related activities do not qualify as R&D according to the HMRC definition, our data suggests they are still recognised as R&D among sector representatives, at least informally (INT-SEC-04).

Barriers around SHAPE R&D and impact of SHAPE R&D definitions

Formally, the recognition of SHAPE R&D through data collection was less common in the arts and entertainment sector, which, according to some, results in this R&D being neglected despite its importance (INT-SEC-01; INT-SEC-04). One route through which UK R&D is recorded is HMRC tax claims (INT-SEC-07; INT-SEC-08; INT-SEC-03). However, claiming R&D tax reliefs is uncommon within the arts, entertainment and recreation sector, as many R&D activities conducted in this sector do not align with HMRC definitions (INT-SEC-01; INT-SEC-04; INT-SEC-10). Moreover, according to our interviewees, there is a lack of independent systems within the sector to collect data on R&D activities (INT-SEC-01; INT-SEC-02). This was mentioned as a negative side-effect of the current HMRC definitions of R&D, resulting in the sector’s R&D activities being underrepresented (INT-SEC-01).

According to industry experts, many businesses within the sector are unaware that they might be able to access R&D-related incentives and benefits (INT-SEC-01; INT-SEC-10). Additionally, the success of applications may depend on the ability to describe their activities with the right words to fit the criteria, for which some businesses do not have the sufficient knowledge, or resources to employ an external expert (INT-SEC-10). This lack of knowledge could be addressed by more promotion of the R&D system by the government (INT-SEC-01; INT-SEC-10).

Several of the experts we interviewed agreed that an advantage to including SHAPE subjects within the HMRC R&D definition for tax purposes is that this could incentivise the sector to invest more in innovation activities that would benefit the development of the sector (INT-SEC-01; INT-SEC-02; INT-SEC-04). Nevertheless, while many innovation activities do not receive support for R&D, the sector receives other forms of support (INT-SEC-01; INT-SEC-11; INT-SEC-04). For example, creative industry tax reliefs are available to promote culturally relevant productions in the UK (GovGrant 2022a) which, according to one expert interviewee, tended to be more generous and easier to qualify for than R&D tax reliefs (INT-SEC-11).

2.2.2. Information and communication

According to the UK SIC hierarchy, the information and communication sector includes publishing activities, motion picture and sound recording activities, radio and TV broadcasting and programming activities, telecommunications activities, information technology activities, the processing of data and other information service activities (ONS). While this sector is relatively broad, and SHAPE is often drawn on in collaborations, investment tends to focus on technology, as seen with examples from Vodafone and British Telecom (BT). However, there are also significant aspects of R&D related to this sector that may rely on
SHAPE expertise, spanning considerations from equitable and ethical access to new technologies through to user-centred design or legal and regulatory frameworks for implementation.

Insights from data analysis
In the information and communication sector, it is estimated there are more ‘non-science graduates’ entering the industry than ‘science graduates’, but the difference is not substantial. The information and communication sector is among the top five industries ‘non-science graduates’ are likely to enter after graduation, mostly from business and administrative, creative arts and design (estimated 2,945 business and administrative students and 1,852 design and creative and performing arts) as well as media, journalism and communications (estimated 1,170 graduates), social sciences (estimated 919 graduates) and languages (estimated 768 graduates).

<table>
<thead>
<tr>
<th>Summary of key data</th>
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<tbody>
<tr>
<td>Estimate of BERD of annual R&amp;D spend (2020): £3,988m</td>
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<tr>
<td>R&amp;D spend based on HMRC tax credit data (2019-2020): £7,745m</td>
</tr>
<tr>
<td>Estimated number of ‘science graduates’ entering sector (2019/20): 7,322</td>
</tr>
<tr>
<td>Estimated number of ‘non-science graduates’ entering sector (2019/20): 8,820</td>
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</table>

R&D definitions and data collection
Within the UK, the IT sector has little available information on R&D on a broad scale. Even at the firm level, while annual reports often showcase areas of R&D activity (Vodafone, 2008), there is a lack of defining criteria in relation to what these firms constitute as R&D. As a result, firms may self-define what constitutes R&D in a more subjective manner, which may affect what R&D is reported in the Information and Communication sector. For example, larger firms with better resourced R&D departments may count R&D differently from SMEs, particularly in terms of the extent to which SHAPE-related activities are described as R&D. This has the potential to present a skewed representation of what R&D is taking place in the sector.

Despite this, many activities within this sector (e.g. software development and projects involving bespoke methodologies and unique architecture solutions) may qualify for R&D tax credits (GovGrant, 2022). In 2019-20, there were over 19,000 R&D tax credit claims from this sector, with an average claim value of £79,211 (HMRC, 2021). As previously mentioned, the HMRC’s web guidance on claiming R&D tax reliefs states that in order to qualify for an R&D tax relief, the firm must have ‘looked for an advance in science and technology’ (HMRC, 2020). Therefore, while examples of SHAPE R&D and activity may occur in the sector, they may not meet the criteria for R&D tax credits. Qualifying R&D expenditure in this sector may include the development of new operating systems and languages, new encryption techniques, new security techniques that do not follow conventional methodologies, the developmental and testing phases of systems, devices and processes, and the integration of new systems (GovGrant, 2022). Based on these activities, the concept of novelty also seems key to the definition of R&D within this sector.
Barriers around SHAPE R&D and impact of SHAPE R&D definitions

Looking at more localised examples of IT sector firms, it is clear that although much of the R&D activity that occurs in this sector would be considered technological and less related to SHAPE subjects, SHAPE R&D clearly plays a role. For example, Vodafone, one of the UK’s leading information technology firms has established the Vodafone Institute for Society and Communications. Within this, R&D is conducted on a wide ranging portfolio, from AI and human rights, to COVID-19 impact surveys (Vodafone Institute, 2022), suggesting an example of where SHAPE subjects are included in R&D in the information and communications sector.

As an immediate response to the COVID-19 pandemic, Vodafone conducted R&D activity in order to develop a novel, ‘Future Ready’ framework (Vodafone, 2021). This framework is based on the outcomes of research, both internally and externally, which confirmed that office-based employees, while missing the social aspect of working, strongly supported remote working opportunities (Vodafone, 2021). This provided the company with the ability to adjust their work policy, to allow for hybrid-remote working in order to maintain productivity in their organisation (Vodafone, 2021). The development of this novel framework is closely related to SHAPE subjects, including analyses of customer experience, behavioural insights, ethical considerations, economic assessments and a socially oriented research focus (Vodafone 2021).

BT conducts extensive amounts of R&D mostly related to technical sciences and innovative technologies, such as quantum computing, IoT, digital security and 5G (BT 2022). Much of this R&D is conducted in collaboration with public institutions, such as universities, research institutes and government departments. This R&D activity is often funded (or co-funded) by UK and EU bodies such as the European Commission, Celtic-Next, Innovate UK and the European Space Agency (BT, 2022). Over the last five years, BT has made an investment to R&D of over £2.8 billion (BT Group, 2022).

These examples suggest companies are utilising SHAPE knowledge and expertise to consider the intersection of communication and social impact, as well as collaboration with SHAPE experts (from universities, research institutions or government). The graduate analysis also confirms that this sector is open to taking in large numbers of both ‘science’ and ‘non-science’ graduates. This perhaps suggests that SHAPE knowledge and expertise are key to R&D in this sector. Indeed, there are a number of questions and issues relevant to SHAPE subjects in this sector, such as ethical considerations around technology and audience insights. These activities can improve the products and services this sector provides by making them more aligned with consumer and societal needs and improving understanding of the impact of information and communication technologies.

2.2.3. Financial and insurance activities

The financial and insurance activities sector, as categorised within the SIC hierarchy, operate through businesses such as asset holding companies and funds, insurance companies, pension funds, central banks and other financial services providers (ONS). This includes the financial technology (fintech) industry, which reaches across other sectors as well, such as the professional scientific and technical activities sector discussed next.
Insights from data analysis

Estimates indicate there are more ‘non-science graduates’ entering the financial and insurance sector than ‘science graduates’. However, the financial and insurance industry is not the most common destination of graduates, as it is estimated just under 10,000 2019/20 graduates (both ‘science’ and ‘non-science’) entered the industry. The ‘non-science graduates’ entering the industry are predominately coming from business and management studies backgrounds and social studies degrees (estimated 3,313 business and management studies and 1,379 social science graduates). These numbers might indicate that SHAPE subjects, either related to SHAPE R&D or in other contexts, play a central role in the sector.

### Summary of key data

- **Estimate of BERD of annual R&D spend (2020): £578m**
- **R&D spend based on HMRC tax credit data (2019-2020): £3,130m**
- **Estimated number of ‘science graduates’ entering sector (2019/20): 3,138**
- **Estimated number of ‘non-science graduates’ entering sector (2019/20): 5,040**

### R&D definitions and data collection

Among professionals within the financial sector, definitions of R&D were generally aligned with the HMRC definitions for tax purposes. This was particularly true among those who worked directly with the financial aspects of R&D activities (e.g. in R&D tax credits) (INT-SEC-03; INT-SEC-11). While research activities related to SHAPE disciplines were recognised as important for various functions and achievements of the sector, they were typically not referred to as R&D specifically. As in other sectors included in this study, R&D appeared to be intuitively associated with technology or other STEM-related disciplines by sector stakeholders (INT-SEC-03; INT-SEC-05; INT-SEC-11), while SHAPE subjects were less associated with R&D.

When asked about R&D related to arts, humanities and the social sciences, some of the interviewees veered away from the financial sector and referred to the creative sector instead. For example, two interviewees began the interview by flagging that because they were not working with the creative or arts sectors, they might not be able to contribute much to the discussion of R&D related to SHAPE disciplines (INT-SEC-03; INT-SEC-11). This may be explained by the fact that these interviewees worked specifically with R&D tax matters, which could make them more likely to associate R&D with HMRC’s definition. It may also be indicative that SHAPE R&D is less recognised as occurring within the financial services sector.

Nevertheless, some research and development activities related to SHAPE subjects were recognised upon further probing. Within the fintech industry, for example, design was mentioned as a key area of R&D for developing smartphone apps (INT-SEC-05). Behavioural science is another discipline mentioned in relation to smartphone apps, as well as other services where user experience is important (INT-SEC-05). Economics, ethics and law were other subjects mentioned in relation to research and analytical activities, although not in relation to R&D necessarily (INT-SEC-05). Finally, our evidence suggests that SHAPE R&D in this sector often tends to be associated with the human skills involved in R&D, including the learning, thinking and labouring required to facilitate innovative activities (INT-SEC-05; INT-SEC-03).
Within the financial sector, the main R&D data collection referred to is through the HMRC applications for R&D benefits. This means that arts, humanities and social sciences disciplines tend to be excluded from these numbers, because they do not fall into the category of R&D expenses eligible for tax reliefs (INT-SEC-03; INT-SEC-11). Moreover, some companies within this sector may refrain from applying due to the lengthy and sometimes costly process involved, as well as lack of awareness of eligibility (INT-SEC-05). That being said, professionals within this sector highlighted how the system is more flexible than it might appear, and that there are ways in which organisations can frame activities so that they qualify for R&D tax credit, even though they might not directly relate to the advancement of science or technology (INT-SEC-11). This includes practical costs or ‘indirect costs’ that occur in relation to technically qualifying as R&D activities, such as staff salary costs (INT-SEC-03). Although this is a grey area, if the costs can be fully supported as contributing towards the wider R&D claim, they should be eligible for tax reliefs (INT-SEC-03). These costs typically do not constitute a large part of the wider R&D claim, and many companies end up not claiming for these costs because they are unaware of their eligibility (INT-SEC-03).

**Barriers around SHAPE R&D and impact of SHAPE R&D definitions**

Different risks were associated with widening the government’s R&D definitions to explicitly include SHAPE R&D. There are concerns about expanding the definition of R&D too broadly to include activities or people not directly involved in R&D. For example, there is a grey area in the legislation around claiming people for R&D tax credits (INT-SEC-05; INT-SEC-11). For an R&D tax credit you can claim people and their time if they are directly doing the research for R&D, which are the ‘core R&D team’ (INT-SEC-05; INT-SEC-11). The legislation also allows R&D tax credits to include people who may directly support an R&D research project, like project management, finance, etc. (INT-SEC-05; INT-SEC-11). These claims are called ‘indirect qualifying activities’ as they are not directly R&D but are claimable (INT-SEC-11). However, this is an area of concern for R&D tax experts, as the definition of ‘indirect qualifying activities’ is broad and can be abused or overused to include a wide array of people, ultimately costing the R&D tax credit system money (INT-SEC-11). Increasing costs through these ‘indirect qualifying activities’ is something the National Audit office and ONS are aware of and monitoring (INT-SEC-11). It is considered best practice to only include people who provide direct support to the R&D project, and it is frowned upon to include too many people, which would broaden the definition of ‘indirect qualifying activities’ unnecessarily (INT-SEC-11).

Additionally, there was a point raised about competing government reliefs. SHAPE industries are already eligible for eight different creative sector reliefs (INT-SEC-11). These creative sector reliefs can be more generous than R&D tax reliefs, in terms of rate of credit they pay out (INT-SEC-11). The legislation stipulated that a company cannot claim for two different types of reliefs on the same expenditure (INT-SEC-11). This means that in some cases, like video game development and TV production, a company has to claim for R&D tax credits over a creative sector relief (INT-SEC-11). There is also a question of motivation for the company, with the creative sector reliefs being more generous, if a company had to choose, they may not be motivated to claim the R&D reliefs over the more generous creative sector reliefs (INT-SEC-11).
Based on our evidence, the contributions of SHAPE R&D were generally recognised within the financial sector. Companies in this sector were also well versed in seeking support and reward for their R&D activities (INT-SEC-03; INT-SEC-05; INT-SEC-11). Some experts believed that including SHAPE R&D in official government definitions of R&D would incentivise such activities (INT-SEC-03). Others maintained that most R&D activities within the sector would take place regardless, as these are important for the development of business. In other words, the systems might help accelerate innovation already occurring and reward companies for their R&D, but its influence on the sector’s R&D activities is less clear (INT-SEC-03; INT-SEC-05).

2.2.4. Professional scientific and technical activities

Insights from data analysis

There are more ‘non-science graduates’ than ‘science graduates’ entering the professional, scientific and technical activities sector, which is the second most popular industry for ‘non-science’ students to enter after graduation.26 Most ‘non-science graduates’ are entering the industry from business and management courses and law degrees (estimated 5,890 business and management graduates, and 4,860 law graduates), along with the social sciences (estimated 2,298 graduates) design, and creative and performing arts (estimated 1,567 graduates) and languages and area studies (estimated 838 graduates).

Although many within the sector view the professional scientific and technical activities sector as, in a sense, centred on STEM R&D, the large number of ‘non-science graduates’ operating within the sector may indicate an under recognised high presence of SHAPE-related R&D.

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<thead>
<tr>
<th>Summary of key data</th>
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<tr>
<td>Estimate of BERD of annual R&amp;D spend (2020): £9,567m</td>
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<tr>
<td>R&amp;D spend based on HMRC tax credit data (2019-2020): £10,425m</td>
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<tr>
<td>Estimated number of ‘science graduates’ entering sector (2019/20): 12,551</td>
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<tr>
<td>Estimated number of ‘non-science graduates’ entering sector (2019/20): 16,380</td>
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R&D definitions and data collection

Based on our evidence, R&D in the professional, scientific and technical activities sector is to a large extent associated with activities related to sciences and technology. These activities play a central role in the sector, with many organisations dedicated specifically to conducting such R&D, for example biotechnology companies working on developing a new medical product, or an engineering company developing technological features of self-driving cars (INT-SEC-08; INT-SEC-09). Such spaces tend to be dominated by STEM R&D. Within this sector, there are different frameworks for understanding R&D, with the most common one referred to as the technology readiness levels (TRLs), which was developed by NASA and is used to assess whether a technology is ready to go into production (Royal Academy of Engineering, 2022). However, all of the primary frameworks used within the sector are constructed and centred around STEM R&D (INT-SEC-09).

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26 Education is the most popular industry for non-science graduates to enter after graduation (for the 2018/19 cohort).
When SHAPE-related R&D does occur, organisations often do not recognise it as such (INT-SEC-09; INT-SEC-08). This may be due to the fact that so much of what classifies as R&D according to the official HMRC definition occurs within the sector (INT-SEC-08; INT-SEC-09), which means that organisations more frequently are exposed to those criteria when considering or claiming for tax credits.

Nevertheless, there is consensus that SHAPE subjects play an important supporting role to the R&D activities that occur within organisations in this sector. Market research is one such key SHAPE-related field that contributes to and influences R&D activities. Biotech companies, for example, need to understand the needs and attitudes of patients, as well as the processes doctors must manage for patient treatments, to develop products that meet the challenges facing the healthcare system (INT-SEC-08). Furthermore, public acceptance, regulation and ethics are other components involved in R&D processes across the sector. Even though these activities are integral to the R&D, they are typically not associated with definitions of R&D. Additionally, they are often outsourced to other sectors, such as market research agencies, or conducted through academic partnerships, rather than conducted within the organisations connected to the industry themselves (INT-SEC-08).

Data collection on R&D activities within this sector is done through HMRC’s records of tax credit claims as well as the UK’s BERD survey by ONS (ONS 2021a; INT-SEC-08). Compared to other sectors, R&D activities within this sector seem to be relatively well represented in these numbers given that they often fit the official HMRC definition of R&D. Experts in this sector highlighted the discrepancy between the two R&D figures from HMRC and ONS as outlined in section 2.1.1, attributing this to the problematic sampling of the ONS data. While HMRC numbers are viewed as more representative for the sector, some scepticism was directed towards a potentially wider issue of overinclusion. Specifically, a respondent suggested that some activities may have been wrongfully classified as R&D due to tax advisors pushing the limits of HMRC’s criteria to maximise tax benefits, and that such cases thrive on the limited number of tax inspectors but might been questioned or disqualified if spotted (INT-SEC-08), although this reflection was regarding R&D more broadly rather than SHAPE R&D specifically.

Barriers around SHAPE R&D and impact of SHAPE R&D definitions

Government grants and tax benefits offered to organisations conducting R&D are valued within the professional, scientific and technical activities sector, although their role in incentivising R&D is disputed. Some believe that R&D and innovation activities will take place regardless of these incentives, especially within industries in the sector that are heavily focused on R&D. Consequently, including SHAPE subjects in HMRC R&D definitions may not incentivise increased investment in SHAPE R&D, according to one interviewee’s views (INT-SEC-08).

However, even though organisations may pursue their R&D activities regardless of grants and tax benefits, there are also considerations around the wider international landscape. Many organisations within this sector, for example those in the life sciences industry, operate on the global level, and one interviewee suggested that offering attractive benefits for R&D activities might incentivise more organisations to stay in, or move to, the UK (INT-SEC-08). From this perspective, failing to recognise SHAPE R&D within government definitions may entail losing SHAPE-related R&D activities to other countries, making the UK less competitive in this field.
Moreover, one interviewee in this sector raised one potential risk of expanding the official government R&D definition to include SHAPE subjects, relating to the transition of data collection on R&D activities. Specifically, the increased amount of recorded R&D activity entailed in broadening the definition could be misunderstood as an increase in overall R&D activity, undermining the need for further enhancement of national R&D activity (INT-SEC-09). In other words, new government targets for R&D must be adjusted based on any broadening of R&D definitions (INT-SEC-09).

2.2.5. Wholesale and retail trade

The wholesale and retail trade sector consists of wholesale and retail sales of goods, as well as the supply of services involved in this sales process. In other words, this sector covers sales and the last stages of merchandise distribution. This includes, for example, activities associated with trade of goods, such as sorting, mixing, assembling, packaging and storing of goods (ONS).

Insights from data analysis

There are more ‘non-science graduates’ than ‘science graduates’ entering the wholesale and retail industry. The wholesale and retail industry is the third most likely industry ‘non-science graduates’ will enter, primarily from business and management studies or the design, and creative and performing arts (estimated 5,154 business and management graduates, and 2,707 design, and creative and performing arts graduates). To a lesser extent, students are also entering the industry from social sciences degrees (estimated 1,608 social science graduates).

Although this presence of ‘non-science graduates’ in the sector suggests that SHAPE subjects have a central role, the question remains as to whether these graduates contribute to R&D in the sector. The following analysis shows that SHAPE subjects likely contribute to many key R&D activities in the sector that may not be currently recognised as R&D.

![Summary of key data](image)

R&D definitions and data collection

The wholesale and retail trade sector has undergone substantial transformation during the past few decades. The shift to more environmentally conscious (Clark 2020) and more tech savvy consumers, for example, has forced businesses to innovate new products and sales channels to remain relevant and thrive. Consequently, R&D activities are key for the sector. At the same time, businesses often do not recognise their R&D activities as such. According to experts within the sector, this leads to R&D tax credits being underclaimed, which has been attributed to misleading guidance by HMRC and general underpromotion of the benefits (Young 2020).

For retailers, product development is a central focus of R&D activities. Retail products need to be constantly updated and adapted based on ever-changing consumer trends and preferences (Hallam 2020). For
example, increasing concerns about the environment mean that retail organisations must innovate to develop more sustainable products (Clark 2020; Catel-Arutyunova 2022). Customer experience is another key factor that has become an especially relevant focus of R&D with the rise of e-commerce, which was further accelerated due to lockdown, and may be connected to SHAPE disciplines. According to some industry experts, R&D around software development, content personalisation and payment technologies within these spaces are also likely to qualify for HMRC R&D tax reliefs (Young 2020).

Although these fields are primarily associated with STEM subjects – a criterion necessary to qualify for R&D tax reliefs – there are several ways in which SHAPE subjects may play a role. Innovations within product development not only depend on scientific or technical solutions, but also on a deep understanding of the trends, behaviours and needs among consumers. As mentioned earlier, these factors are continuously changing, and if a business fails to meet the needs of the consumer, it will not matter if a product is technically or scientifically advanced (Hallam 2020). Website and app development, for example, are aspects of modern e-commerce (Hallam 2020) and depend heavily on the discipline of design (INT-SEC-05). E-commerce platforms are not only essential to provide a convenient route to purchase but are also increasingly used to create certain customer experiences for a brand (FARFETCH). Consequently, although not explicitly described as such, many key fields of R&D within this sector appear to relate to SHAPE disciplines.

**Barriers around SHAPE R&D and impact of SHAPE R&D definitions**

In the absence of other information, it is assumed that the data collection on R&D activities within this sector are mainly through the BERD survey (ONS 2021a) and HMRC’s tax credit applications. This means that SHAPE R&D activities may be overlooked in the data collection on R&D activities across the sector, as these are excluded from the HMRC criteria for R&D classification (HMRC 2020; H Bakhshi, Breckon and Puttick 2021b). Furthermore, as some experts believe that much of the R&D activity that occurs does not qualify for tax reliefs (Young 2020) it might be the case that both STEM and SHAPE R&D are underrepresented in this sector.

### 2.2.6. Manufacturing

In general terms, activities within the manufacturing sector involve physical or chemical transformation of raw products (materials, substances or components) into new products, with the new product being the output. These outputs of the manufacturing activities may be in the form of goods ready for purchase, or a component used for further manufacturing, along with alteration, renovation or reconstruction of goods. Examples include manufacturing of machinery and textiles or production of plastic goods (ONS).

**Insights from data analysis**

There are more ‘science graduates’ than ‘non-science graduates’ entering the manufacturing sector. Even though manufacturing was not a common graduate destination for ‘non-science graduates’, there were some ‘non-science graduates’ which entered the industry, mostly from business and management studies (estimated 2,577 graduates). There are also some students coming from the design, and creative and performing arts degrees (estimated 855 graduates) and social sciences (estimated 460 graduates). Given the high presence of ‘science graduates’ within the industry, R&D conducted within the sector is likely STEM-
dominated. This is reinforced by the accounts in the following analysis, which show that general perceptions of R&D are usually associated with STEM subjects.

Just over half of R&D workers in the UK work in manufacturing, although there has been a percentage decrease in the number of R&D personnel employed in manufacturing, down from 61% in 2013 to 55% in 2019 (Belt, Ri and Akinremi 2021), in line with global trends.

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<th>Summary of key data</th>
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<tr>
<td>Estimate of BERD of annual R&amp;D spend (2020): £8,977m</td>
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<tr>
<td>R&amp;D spend based on HMRC tax credit data (2019-2020): £14,115m</td>
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<tr>
<td>Estimated number of ‘science graduates’ entering sector (2019/20): 7,322</td>
</tr>
<tr>
<td>Estimated number of ‘non-science graduates’ entering sector (2019/20): 3,780</td>
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R&D definitions and data collection

According to interviewees, R&D definitions within the manufacturing sector tend to be associated predominantly with STEM R&D, and focus on product development and improvement, and process innovation (INT-SEC-07; INT-SEC-06). However, recognition of SHAPE R&D as important for the sector varies across different industries within the sector. For example, within the textile industry SHAPE R&D related to design is a core element of advancements within the industry. Such activities can fall within the grey area between different sectors, in this case the arts and manufacturing sector. Pure manufacturing activities, on the other hand, tend to be more related to STEM R&D (INT-SEC-06).

Moreover, SHAPE R&D relating to the manufacturing sector is often conducted in collaboration with, or is outsourced to, other sectors. For example, activities such as economic modelling are often done by consultants or financial services on behalf of manufacturing businesses (INT-SEC-07). Additionally, both SHAPE and STEM R&D is often conducted in collaboration with academia or other research institutions (INT-SEC-03; INT-SEC-06; INT-SEC-07). Organisations may employ a PhD researcher for a period of time to conduct studies on the process performance of a particular product before it is taken to the market (INT-SEC-03).

R&D experts report rarely coming across companies within the manufacturing sector undertaking SHAPE R&D that qualify for British government support in the form of tax reliefs or grants (INT-SEC-07; INT-SEC-03). Therefore, these activities tend to be less represented in the data collection of R&D activities in the sector. However, R&D claims may be made on indirect costs, as in many other sectors, including staff costs related to people from SHAPE backgrounds (INT-SEC-03; INT-SEC-06).

Barriers around SHAPE R&D and impact of SHAPE R&D definitions

As within the previous sectors, there is consensus within the manufacturing sector that SHAPE subjects are important for the UK economy as a whole, regardless of whether SHAPE R&D is specifically conducted by companies in the manufacturing sector (INT-SEC-07; INT-SEC-06; INT-SEC-03). Additionally, including SHAPE R&D in government definitions of R&D is viewed as a potential way to incentivise further SHAPE R&D (INT-SEC-03; INT-SEC-07). Hence, while SHAPE was not typically associated with R&D, we found a general openness to changing this generally held perception.
Changing official government R&D definitions to include SHAPE subjects, however, was seen as operationally challenging because of the perceived less tangible nature of SHAPE subjects as compared to STEM R&D. R&D activities for which costs are typically claimed, such as increased processing speed of computers and reduced process time for mobile phone manufacturing, are concrete and measurable. R&D and innovations which would be related to SHAPE subjects, such as ethics and user experience, are less concrete and more difficult to measure. Hence, including these in official government R&D definitions may introduce more vagueness into the system (INT-SEC-07). This would entail several challenges for government, such as the aforementioned risk of abuse of the HMRC R&D tax claim system (INT-SEC-11).

2.3. Cross-cutting themes for SHAPE R&D in the UK

Below, we reflect on cross-cutting themes from our analysis of SHAPE R&D in the UK. This is primarily based on desk research, sector analysis and data analysis tasks.

2.3.1. For UK stakeholders STEM activities are front-of-mind when thinking about R&D definitions and Business R&D activities, reflecting narrow HMRC definitions for R&D

From interviews, it is clear that STEM is at the centre of how many sectors in the UK consider R&D, with a focus on technological innovations, tangible outputs from R&D activities and concrete improvements to products, processes and services (INT-SEC-03; INT-SEC-11; INT-SEC-07; INT-SEC-08; INT-SEC-09). Some of these outputs may be less quantifiable and less visible in SHAPE R&D, despite broad agreement around the importance of SHAPE R&D to sectors in the UK (INT-SEC-07). SHAPE R&D is often viewed as important, but is typically not front-of-mind when discussing R&D within the sector (INT-SEC-08; INT-SEC-07). This is reinforced by the HMRC definition of R&D applied to data collection. There is a potential gap in understanding of SHAPE R&D that needs to be addressed in order to provide people in these industries with the knowledge and vocabulary to both articulate R&D activities that already occur, and to encourage more SHAPE-related R&D activities.

2.3.2. Human capital is a key element for any R&D ecosystem, suggesting a more person-centric approach to R&D

Human capital is key to innovation, bringing the skills, competencies, knowledge and experience needed for R&D projects (Belt, Ri and Akinremi 2021). Interviews with UK stakeholders highlight the need for a ‘person-centric’ approach to R&D, meaning looking at how SHAPE subjects relate to the people (and the human capital) that contributes to the R&D landscape. For example, interviewees highlighted the importance of recognising human capital (e.g. salary costs) in the R&D tax filing process when claiming ‘indirect’ costs (INT-SEC-03; INT-SEC-11). These costs typically do not constitute large part of the wider R&D claim, and many companies end up not claiming for these costs because they are unaware of their eligibility (INT-SEC-03). This is a place where the contributions of SHAPE experts can be claimed within the R&D tax relief process (INT-SEC-03; INT-SEC-11). However, experts warned against expanding the definitions of ‘indirect costs’ too broadly, with concerns of misusing the tax relief system (INT-SEC-11;
The analysis included in this report of the graduates entering the UK’s R&D sector and types of R&D labour demonstrate how a person-centric approach can be implemented to understand R&D in the UK.

2.3.3. SHAPE R&D and SHAPE graduates contribute to many R&D-related sectors

Some UK industries are heavily influenced by SHAPE, such as the arts and entertainment industry (INT-SEC-01; INT-SEC-02; INT-SEC-04; INT-SEC-10). However, there are also subjects and sectors that are less closely related to SHAPE, in which SHAPE R&D and SHAPE graduates play a key role. As shown in our data analysis, ‘non-science graduates’ enter R&D intensive sectors in high numbers and come from a wide range of SHAPE-related sectors including business studies, law, creative arts and design. From interviews with members of different sectors in the UK, it is clear that even in sectors that seem less related to SHAPE, SHAPE R&D can contribute greatly to products, services and processes within these sectors (INT-SEC-05; INT-SEC-09; INT-SEC-06; INT-SEC-07; INT-SEC-03).

2.3.4. Several sectors in which SHAPE R&D plays an important role have a low level of engagement with R&D tax credits

Perhaps reflecting the current definition of R&D employed by HMRC, we note that several sectors which employ large numbers of SHAPE graduates, and in which our evidence suggests SHAPE R&D may be occurring, have low levels of engagement with R&D tax credits. Notably companies in the arts, entertainment and recreation and the wholesale and retail trade sectors were highlighted by interviewees as typically not being aware of, or engaged with, this support mechanism, and indeed this is reflected in the HMRC data. This suggests that the level of R&D in these sectors – whether STEM or SHAPE – may be under-captured in official data. Additional clarity and a broader definition of R&D to encompass SHAPE activities may promote better recording and understanding of the level of R&D activity in these two sectors, which are key to the UK economy.

2.3.5. R&D business activities need a range of skills, knowledge and experience

It is accepted that the R&D workforce in the UK should not focus solely on STEM expertise, and that SHAPE expertise and transferable skills related to R&D are also needed for a well-functioning business and innovation environment (INT-SEC-09; INT-SEC-01; INT-SEC-10). Along with researchers, a range of support functions and technical experts are also essential to R&D activity and contribute to the UK’s R&D-related economy, including managers, directors and senior officials, administrative and secretarial roles, sales and customer service roles. These include people with the business acumen to develop and commercialise ideas, as well as a range of disciplinary expertise and transferable skills. This is reflected in the share of researchers employed in R&D in the UK, which fell from 64% in 2005 to 50% in 2019 (Belt, Ri and Akinremi 2021), suggesting a range of other roles accounting for the rest of R&D employment.
2.3.6. Collaborations are key to SHAPE R&D

Collaborations between creative industries and technologies\(^\text{27}\) are key to supporting business growth and innovation in the UK and could be supported further through R&D schemes. Within the sectors that conduct less SHAPE R&D, such as the manufacturing sector and the professional, scientific and technical activities sector, SHAPE-related activities are often outsourced to other sectors, such as by using market research agencies or consultancies (INT-SEC-09; INT-SEC-07; INT-SEC-03). These findings suggest that collaborations are often necessary for SHAPE R&D to take places, utilising both the new technologies and the creative skills developed through SHAPE expertise.

The UK has strong creative industries, and the emergence of new technologies and services opens up new areas of opportunity for these industries. For example, the music industry has typically evolved as technology developed, from vinyl, to CDs, to digital (INT-SEC-01). Today, innovations are coming out of the music industry – building online platforms, wider collaborations with manufactures, or developing ways to manage personal data – and inputs from SHAPE disciplines are needed to keep up with new social trends and ways of consuming music (INT-SEC-01). A similar trend is noted in the video games sector, where the industry is very focused on technological innovations (INT-SEC-04). These innovations can be heavily influenced by the optimisation of new technologies (e.g. VR, AR and new hardware) and developing simulations using physics to create visually appealing games (INT-SEC-04), while still being a fundamentally creative and arts-based endeavour (INT-SEC-04).

Industries with this type of collaborative R&D (between SHAPE subjects and STEM subjects) report that it can be harder to claim for UK R&D tax reliefs for their innovations. As such, they may not qualify, or they may spend more time trying to establish whether their work fits into the R&D tax credit schemes (INT-SEC-01; INT-SEC-04).

\(^{27}\) In the UK, this intersection of creative industries and technology is being promoted by the Creative Industries Council's CreaTech, for the representation creative skills and emerging technology to support business growth and investment (INT-SEC-01; 'CreaTech - The Creative Industries' n.d.).
3. SHAPE R&D internationally

Box 3: Main findings: SHAPE R&D internationally

Other countries use a more inclusive definition of R&D than the UK: Most countries use a definition of R&D that is closely linked to either the OECD Frascati Manual definition or the EU definition.28,29 These are comparable to the UK’s definition for the purpose of BERD (which is based on the Frascati approach) but more inclusive than the definition used by HMRC for the purposes of R&D tax credits, which explicitly excludes SHAPE R&D.

However, the inclusion of SHAPE in definitions of R&D is often implicit rather than explicit: Although most countries do not actively exclude SHAPE R&D in the definitions they employ, its inclusion is typically implicit rather than explicit, meaning that SHAPE subjects are not specifically mentioned. This can lead to a lack of clarity, and the extent to which SHAPE R&D is included in data will be dependent on interpretations and perceptions which may vary across sectors and business types as well as individuals. One exception is Portugal, where data is explicitly captured on SHAPE R&D as distinct from STEM R&D.

Data on R&D is typically captured using surveys: Most countries produce some data on business R&D (including BERD and R&D employment) using a survey approach. This is therefore reliant on self-reporting and understanding current R&D definitions.

Tax credits are commonly used and produce another dataset on R&D expenditure: Across the comparator countries analysed, R&D tax credits were the key mechanism used to incentivise business R&D investment, typically in combination with direct funding of R&D activities in the business sector. In contrast to the UK, SHAPE disciplines are typically (at least implicitly) eligible. This produces additional data on R&D expenditure by country but differences in eligibility and data collection processes between countries limits comparability.

Very few countries produce breakdowns of SHAPE and non-SHAPE R&D, making international comparisons difficult: There are very limited data on SHAPE R&D specifically at the international level as only a small number of countries capture information at this granular level. However, there are a number of countries that do capture these data. The data that are available indicate a relatively low level of activity of SHAPE R&D relative to STEM R&D.

3.1. Data on SHAPE R&D internationally

3.1.1. Data on SHAPE R&D is limited

Due to the way in which R&D is defined internationally and limitations in data collection mechanisms, the data available to make cross-country comparisons on the level of SHAPE R&D is relatively limited.

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28 OECD Frascati Manual definition is: ‘Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise
OECD data shows that only a few countries report on SHAPE R&D (Figure 11), and within those countries, SHAPE R&D is low, at around 5% or less. Similarly low levels of SHAPE R&D are demonstrated when reviewing SHAPE R&D employment in industry (Figure 12). However, these data are limited to a small number of countries and may be inaccurate due to a lack of clarity around definitions as described previously. Additionally, the UK is not included in this data, making cross comparisons challenging. Interestingly, the figures reported in Figure 11 and Figure 12 are significantly lower than data provided on UK levels of SHAPE R&D employment as indicated in section 2.1.6, which was around 11-13% of all R&D roles, perhaps suggesting a comparative advantage, although no firm conclusions can be reached due to the limited nature of the data available.

Figure 11: Bar chart with percentages of GERD by business expended on social sciences, art and humanities, 2018. Unallocated (e.g. capital) expenditure excluded. Limited number of countries included due to data availability. Source: (OECD MSTI)

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portugal</td>
<td>5.05%</td>
</tr>
<tr>
<td>Latvia</td>
<td>4.75%</td>
</tr>
<tr>
<td>Chile</td>
<td>4.65%</td>
</tr>
<tr>
<td>Poland</td>
<td>1.74%</td>
</tr>
<tr>
<td>Mexico</td>
<td>1.28%</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>1.02%</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1.01%</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.88%</td>
</tr>
<tr>
<td>Turkey</td>
<td>0.65%</td>
</tr>
<tr>
<td>Canada</td>
<td>0.20%</td>
</tr>
</tbody>
</table>

new applications of available knowledge.' The activities relating to R&D must be novel, creative, uncertain, systematic and reproducible and/or transferable (OECD 2015).

29 EU definition is: ‘Main concepts and definitions used for the production of R&D statistics are given by the Frascati Manual (2015). Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge (Frascati Manual, 2015).’ (Eurostat 2022).
3.1.2. A relatively high proportion of UK R&D is in service industries

Another interesting comparison can be made by looking at the proportion of R&D conducted in service industries across different countries. These industries will likely conduct a mix of SHAPE and STEM R&D, but this provides an indicative picture of the extent to which SHAPE disciplines may have a role to play in a country’s R&D landscape. Notably, we see that Portugal (which has a high level of SHAPE R&D based on official statistics) conducts a relatively large proportion of its R&D in service industries, supporting this potential link. According to these data, the UK conducts over 60% of its R&D in service industries, reflecting the UK’s economy, which is more based on service industries than comparator countries such as Portugal, Spain, Denmark and Switzerland (Figure 13). Data on the Netherlands is not in this dataset so cannot be compared. As highlighted above, most of these service industries employ more ‘non-science’ than ‘science’ graduates and hence may be dependent on SHAPE skills and expertise.
Figure 13: Bar chart depicting percentage (%) of BERD performed in service industries by country, with UK and comparator countries highlighted. Data source: (OECD MSTI 2022)\textsuperscript{31}

\textsuperscript{30} UK in green and comparator countries in blue within Figure 13.

\textsuperscript{31} ‘Main Science and Technology Indicators.’ OECD MSTI. 2022. As of 17 July 2023: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB
3.2. Country analysis

To further understand SHAPE R&D internationally, this study included a closer investigation of the following countries:

- The Netherlands
- Portugal
- Switzerland
- Denmark
- Spain.

The findings described below are based primarily on desk research and interview data for each country. It should be noted that only one interview was conducted for each of the countries above, with the exception of Spain, where results are based on desk research only. While the interviewees were experts in R&D practices in their respective countries, the data from these interviews should be treated with caution. Where possible, secondary data and desk research has been used to confirm the opinions presented by the interviewees. Table 9 provides a high-level summary of all findings from the international comparisons analysis.

Figure 14 provides an overview of each comparator country’s indirect government support through R&D tax incentives as a percentage of GDP (OECD MSTI 2022). It shows that since 2013, the UK has been steadily increasing its tax incentives, as has Portugal though at a slower rate. The Netherlands has consistently relatively high indirect tax incentives at around 0.15% of GDP, but with slightly more invested between 2016 and 2017. In comparison, Denmark and Spain have a lower percentage of indirect government support with R&D tax incentives, although the analysis below will outline the activities these countries complete to support GDP. Switzerland’s figures are missing from this figure, but this is to do with the reporting of figures, as the Swiss National Science Foundation reported Switzerland investing around 3.15% GDP in R&D (SNSF 2021) and interviews confirm the use of tax incentives in the Swiss R&D ecosystem. With the UK government’s investment in tax incentives so high, and increasing, further breakdown of these investments (by STEM and SHAPE) disciplines may be useful, following the lead of Portugal, which reports on the social sciences, arts and humanities (Figure 11 and Figure 12) and also has high levels of indirect government support through tax incentives (Figure 14).
Figure 14: Indirect government support through R&D tax incentives, as % of GDP, between 2009 and 2019 (OECD MSTI 2022) (Switzerland figures not available)

Table 8: Effective tax rates for R&D, 2020 (OECD MSTI 2022)

<table>
<thead>
<tr>
<th>Country</th>
<th>Effective average tax rate for R&amp;D</th>
<th>Preferential tax treatment to R&amp;D (EATR)</th>
<th>Cost of R&amp;D capital</th>
<th>Preferential tax treatment to R&amp;D (cost of capital)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>16.2</td>
<td>-3.95</td>
<td>1.62</td>
<td>-1.52</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>15.92</td>
<td>-7.2</td>
<td>0.37</td>
<td>-2.88</td>
</tr>
<tr>
<td>Portugal</td>
<td>7.59</td>
<td>-16.98</td>
<td>-6.09</td>
<td>-7.44</td>
</tr>
<tr>
<td>Spain</td>
<td>8.41</td>
<td>-14.53</td>
<td>-2.64</td>
<td>-5.81</td>
</tr>
<tr>
<td>Switzerland</td>
<td>19.44</td>
<td>0</td>
<td>3.15</td>
<td>0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>11.46</td>
<td>-5.92</td>
<td>0.91</td>
<td>-2.19</td>
</tr>
</tbody>
</table>
### 3.2.1. Country analysis summary of findings

**Table 9: Summary table of international country analysis**

<table>
<thead>
<tr>
<th>Country</th>
<th>Gross R&amp;D expenditure</th>
<th>Sector R&amp;D levels</th>
<th>Is SHAPE included in R&amp;D definitions?</th>
<th>Is SHAPE recognised in R&amp;D data collection?</th>
<th>Policy mechanisms that support SHAPE R&amp;D</th>
<th>Broader trends in the R&amp;D policy landscape relevant to SHAPE R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Netherlands</strong></td>
<td>€18.4bn</td>
<td>33% (public), 67% (private)</td>
<td>Yes (implicit)</td>
<td>→ Surveys are used to measure private sector R&amp;D activities, organised by the Central Bureau of Statistics.</td>
<td>→ Tax incentivisation is the main source of government support for R&amp;D, but they broadly exclude SHAPE R&amp;D.</td>
<td>→ SHAPE R&amp;D is highly valued in the public sector but is less recognised in the private sector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ R&amp;D definitions were adjusted for SHAPE-related innovations and outputs from the public domain (e.g., universities and research institutions).</td>
<td>→ Surveys follow the Frascati Manual within which SHAPE R&amp;D activities may be counted.</td>
<td>→ But public institutions receive substantial funding from the government within which SHAPE subjects are a key area of R&amp;D for Dutch universities.</td>
<td>→ SHAPE isn’t automatically excluded from R&amp;D incentives for private projects, but it is harder to qualify as projects need to demonstrate the unambiguous nature and content of R&amp;D activities performed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE R&amp;D may also be counted as intangible assets.</td>
<td></td>
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</tr>
<tr>
<td><strong>Portugal</strong></td>
<td>€3.234bn</td>
<td>55% (public), 45% (private)</td>
<td>Yes (explicit)</td>
<td>→ SHAPE is explicitly included in R&amp;D definitions. Portugal uses a broad definition, which leads to increased inclusion of SHAPE activities.</td>
<td>→ A hybrid tax scheme is used, with both volume and incremental tax credits.</td>
<td>→ Previous R&amp;D definitions were too broad but updating the definitions to the Frascati Manual definitions allows R&amp;D to occur in a wide range of fields with a high degree of freedom.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE is recognised in R&amp;D definitions, as Switzerland has tailored their definitions to closely align to the Frascati Manual.</td>
<td>→ R&amp;D data is collected through two surveys: the Community Innovation Survey (CIS) and the Survey on the National Scientific and Technological Potential (IPCTN).</td>
<td>→ SHAPE is included in this tax scheme by default as there is no criteria around subject or topic.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE subjects can be included but SHAPE R&amp;D is more likely to be recognised within data of public sector activities.</td>
<td>→ Surveys focus on innovation and novelty, but they also ask about ‘other’ types of R&amp;D which may include SHAPE activities.</td>
<td>→ SHAPE R&amp;D can also qualify based on expenditure type.</td>
<td></td>
</tr>
<tr>
<td><strong>Switzerland</strong></td>
<td>€24.5bn</td>
<td>29% (public), 71% (private)</td>
<td>Yes (implicit)</td>
<td>→ SHAPE is recognised in R&amp;D definitions, as Switzerland has tailored their definitions to closely align to the Frascati Manual.</td>
<td>→ Tax incentives are the main policy mechanism that support R&amp;D.</td>
<td>→ Previous R&amp;D definitions were too broad but updating the definitions to the Frascati Manual definitions allows R&amp;D to occur in a wide range of fields with a high degree of freedom.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE is included by default in R&amp;D definitions. The definition aligns closely to EU R&amp;D definitions, which recognises SHAPE activities, and recognise public-private R&amp;D collaborations, which often include SHAPE based collaborations.</td>
<td>→ R&amp;D data is collected through two surveys: the Business Enterprise Sector R&amp;D survey and the Swiss Economic Institute (KOF) for Business Cycle Research Innovation survey.</td>
<td>→ It is challenging for SHAPE R&amp;D to be recognised within these tax incentives programmes, as they focus on economic value and profit from tangible products and innovations.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE subjects are measured under ‘Fields of Science’, a measure which is only available for public sector R&amp;D activities.</td>
<td>→ Surveys focus on innovation and novelty, but they also ask about ‘other’ types of R&amp;D which may include SHAPE activities.</td>
<td>→ Certain sectors, like the financial services, may be more likely to demonstrate tax incentive requirements for SHAPE R&amp;D.</td>
<td></td>
</tr>
<tr>
<td><strong>Denmark</strong></td>
<td>€10.3bn</td>
<td>38% (public), 62% (private)</td>
<td>Yes (implicit)</td>
<td>→ R&amp;D spend is measured in relation to GDP, following the Frascati Manual guidelines.</td>
<td>→ A tax credit scheme (Skattekreditordningen) is the main policy mechanism to support R&amp;D activities.</td>
<td>→ Denmark has effectively translated subjects from academia to more commercial areas, including commercialisation of quantum computing and Green Energy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE is included by default in R&amp;D definitions. The definition aligns closely to EU R&amp;D definitions, which recognises SHAPE activities, and recognise public-private R&amp;D collaborations, which often include SHAPE based collaborations.</td>
<td>→ R&amp;D data for SHAPE subjects are measured under ‘Fields of Science’, a measure which is only available for public sector R&amp;D activities.</td>
<td>→ SHAPE subjects are included by default under these tax credit schemes, as a range of R&amp;D expenditures qualify.</td>
<td>→ A lack of clarity around R&amp;D definitions disadvantages SMEs which have smaller departments and can be less aware of what will qualify as R&amp;D.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE activities, and recognise public-private R&amp;D collaborations, which often include SHAPE based collaborations.</td>
<td></td>
<td>→ SHAPE activities can also qualify for incentives if they relate to R&amp;D to improve processes and early-stage R&amp;D activities.</td>
<td></td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td>€15.4bn</td>
<td>44.2% (public), 54.8% (private)</td>
<td>Yes (implicit)</td>
<td>→ A mixed methods approach is used for R&amp;D data collection, led by The Instituto Nacional de Estadística (INE).</td>
<td>→ Tax credit schemes (Skattekreditordningen) is the main policy mechanism to support R&amp;D activities.</td>
<td>→ Spain’s R&amp;D system has undergone a series of reforms since 2012. Post-2012 reforms include a review of the R&amp;D administrative processes and a greater focus on R&amp;D strategies overlapping with social issues (gender, accountability and social impact).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ There is no explicit inclusion of SHAPE activities or subjects, but broad R&amp;D definitions allow for inclusion of SHAPE activities.</td>
<td>→ Data collection methods follow the Frascati Manual meaning that SHAPE activities may be accounted for, although there is no explicit inclusion in these guidelines.</td>
<td>→ SHAPE subjects are included by default under these tax credit schemes, as a range of R&amp;D expenditures qualify.</td>
<td>→ Like the UK, Spain is currently focusing on increasing R&amp;D investment to 2.1% GDP by 2027.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>→ SHAPE activities can also qualify for incentives if they relate to R&amp;D to improve processes and early-stage R&amp;D activities.</td>
<td></td>
</tr>
</tbody>
</table>
3.2.2. The Netherlands

**Summary of key data**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross R&amp;D expenditure:</td>
<td>€18.4bn (Netherlands statistics 2020)</td>
</tr>
<tr>
<td>Public/private R&amp;D levels:</td>
<td>33% (public) 67% (private) (Netherlands statistics 2020)</td>
</tr>
<tr>
<td>Tax credit rates (%):</td>
<td>40* (for eligible R&amp;D costs up to €350,000), 16 above €350,000</td>
</tr>
<tr>
<td>SHAPE R&amp;D inclusion:</td>
<td>Yes [implicitly stated]</td>
</tr>
</tbody>
</table>

**Defining R&D**

The interviewee from the Netherlands highlighted that R&D definitions in the Netherlands centre around contributions towards innovation, which excludes certain research and research-adjacent activities undertaken by companies who do not produce innovation (INT-INTER-01). For example, activities requiring regular monitoring that do not necessarily pursue new products or knowledge contributions (such as weather forecasting), do not fit the innovation criteria (INT-INTER-01). Other excluded activities include market research, administrative tasks and software maintenance (Hansen and Geijtenbeek 2020). This suggests that in the Netherlands, novelty is a prerequisite to innovation and by proxy R&D, in line with the UK definition (and OECD Frascati guidance).

To account for the fact that STEM may be more closely related to the conventional principles of innovation compared to SHAPE subjects, the Netherlands adjusted its (Oslo Manual) definition of innovation to account for public domain (e.g. universities and research institutes) innovations (INT-INTER-01), which tend to include greater SHAPE-based innovation, particularly in the output of social sciences and economics (Statista 2020). However, this applies primarily to R&D activities in the public sector, rather than those in the private sector.

**R&D data and collection**

In the Netherlands, an adapted version of the Frascati Manual is used to collect R&D data. The interviewee suggested this provides a standardised approach that allows departments to know exactly what activities constitute R&D (INT-INTER-01). This definition of R&D may include certain SHAPE R&D activities, in that it does not solely focus on the tangible outputs less commonly associated with SHAPE R&D. For example, if an intangible asset (an identifiable, non-physical, non-monetary asset) (IFRS 2022) is further developed into a novel, intangible asset, the process is considered innovative and is therefore considered to be R&D (KPMG 2017).

Aside from public associations in the Netherlands, private entities and non-profits fund a great deal of research that is subject to R&D data collection by the Central Bureau of Statistics (CBS 2022), which uses questionnaires to ask private organisations to report on their R&D activity. The CBS’s definition of R&D is based on the Frascati Manual, specifying the involvement of SHAPE disciplines in R&D activity (INT-INTER-01).

**R&D policy landscape**

Tax incentivisation is the main source of government support for R&D (in general) and SHAPE R&D in the Netherlands (KPMG 2017). The interviewee highlighted that the focus of R&D differs between sectors.
(INT-INTER-01). For example, R&D projects in STEM subjects have some of the highest rates of funding to boost the country’s presence in this area (INT-INTER-01). Outside the public domain, the WBSO (Promotion of Research and Development act), is the main policy instrument for encouraging and incentivising the scope and expenditure of private R&D (European Commission 2022) through a programme of tax credits. Here, two types of R&D project are defined as eligible for support:

1. **Development projects**: which develop ‘technically new (components of) physical products, physical production processes or software’

2. **Technical scientific research**: which consists of ‘explanatory research that is technical in nature’.

As such, this approach broadly excludes SHAPE R&D from being eligible for support. Indeed, some activities specifically defined as ineligible include market research, policy studies and strategic studies, the analysis and assessment of existing production processes, the formulation and testing of non-technical specifications, and the formulation or determination of functional requirements and preconditions.

Public institutions in the Netherlands, such as universities and research institutes, receive a large proportion of R&D funding from the Department of Education, Science and Culture (NL Times 2022). Within these public organisations, around 40% of total Dutch R&D takes place (EURAXESS NETHERLANDS 2016), a great deal of which consists of SHAPE R&D. For example, in Dutch universities, behavioural and social sciences and economics make up the biggest fields by subject area, amounting to over 100,000 students and researchers (Statista 2020).

**Impacts of R&D definitions and policy**

The interviewee suggested that Dutch definitions of R&D ensure consistency through the establishment of standardised reference points, enabling regular monitoring of investments and developments over time, with the ability to make international comparisons (INT-INTER-01). These definitions also value SHAPE R&D for the purposes of tax relief in the public sector, in universities and research institutes (INT-INTER-01). However, the criteria for R&D in private tax-related contexts such as the WBSO seem less encouraging of SHAPE R&D activities as outlined above. This is in part due to the fact that private projects must demonstrate an unambiguous nature and content of R&D activities performed, as well as clear time frames and the novel aspect of any R&D conducted (Hansen and Geijtenbeek 2020). While this doesn’t necessarily mean SHAPE R&D activities cannot qualify, it does mean a larger proportion will not, as a great deal of this type of R&D activity is perceived as less tangible, with more ambiguity and uncertainty in timeframes (INT-INTER-01).

According to the interviewee, SMEs tend to benefit less from tax policy compared to larger firms in the Netherlands (INT-INTER-01), and the returns from R&D tax relief are often not enough to cover the cost of R&D activity. However, this does not stop SMEs from pursuing and reporting R&D (INT-INTER-01), and they account for 63% of the R&D tax support provided (as of 2019).³²

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3.2.3. Portugal

<table>
<thead>
<tr>
<th>Summary of key data</th>
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<tbody>
<tr>
<td>Gross R&amp;D expenditure: €3.234bn (Statistics Portugal 2020b)</td>
</tr>
<tr>
<td>Public/private R&amp;D levels: 55% [public] 45% [private] (Statistics Portugal 2020b)</td>
</tr>
<tr>
<td>Tax credit rates (%): Volume: 32.5, (47.5 for start-ups*) Increment (on top of volume): 50</td>
</tr>
<tr>
<td>SHAPE inclusion: Yes (explicit, with reported figures on social science, arts and humanities)</td>
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</tbody>
</table>

Defining R&D

The interviewee from Portugal highlighted that R&D in Portugal is generally defined as a process leading to new knowledge and innovation (INT-INTER-02), and that the Portugal R&D definition aligns with the EU definition that ‘all systematically performed creative work aimed at expanding knowledge, including the knowledge of humankind, culture and society, as well as the use of this stock of knowledge in new applications’. While the Frascati Manual definition is widely used to define R&D in Portugal, the interviewee for Portugal reported that not all R&D needs to explicitly meet this definition to be counted as R&D for the use of data collection (INT-INTER-02). This is a more inclusive approach than the UK’s, allowing for recognition of a wider range of R&D, including SHAPE subjects. Although this increases the inclusion of SHAPE subjects in qualifying R&D, the interviewee suggested it may risk overinclusion in some cases, creating a broader grey area of R&D recognition due to the intangibility of some subjects’ R&D outputs (INT-INTER-02). This has been seen in activities surrounding market research activity, where it is difficult to distinguish what facets contribute to new knowledge or tangible outputs, for example marketing strategy, customer analysis and consumer insights (INT-INTER-02).

R&D data collection

Data on R&D in Portugal is collected through a number of surveys capturing information on a range of indicators, such as R&D expenditure and personnel, GERD by GDP, GERD performed by state, higher education institutions and private non-profit institutions by geographic location, and proportions of persons employed full-time in R&D activities by region (Statistics Portugal 2022). There are two main R&D data collection methods: (i) the Community Innovation Survey (CIS) is one of the main ways Portugal captures R&D and innovation data for the indicators listed above. These indicators and data statistics can be used for international comparisons, as well as to respond to national commitments to collect and disseminate science and technology data (Statistics Portugal 2020); (ii) the Survey on the National Scientific and Technological Potential (IPCTN) provides official R&D statistics in Portugal, measuring all

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business and private enterprises, public enterprises and private not-for-profit institutions (PORDATA 2022b; DGEEC). The IPCTN is an annual survey measuring human resources and expenditure on R&D, while the CIS is a biennial business survey measuring the characteristics of companies’ innovation activities (ANI 2022). Both are informed by criteria set out by EUROSTAT (ANI 2022).

Compared to previous methodologies, which were more subjective, post-2016 surveys follow a revision of the Oslo Manual definition of business innovation and R&D. This definition reduces innovation to two categories: product innovation and process innovation. Product innovation is defined as ‘a new or improved good or service that differs significantly from the enterprise’s previous goods or services and that has been introduced on the market,’ while process innovation is defined as ‘a new or improved business process for one or more business functions that differs significantly from the enterprise’s previous business processes and that has been brought into use by the enterprise’ (Statistics Portugal 2020).

As in the UK, the majority of R&D in Portugal is conducted in business, accounting for around 57% of R&D expenditure in 2020 (PORDATA 2022a). However, there is also significant public sector research in universities and research institutes, within which a great deal of theoretical research is conducted (PORDATA 2022a). Portugal also measures FTE R&D researchers in government, higher education and private not-for-profit institutes (excluding business enterprises), which are classified by ‘fields of R&D’ or ‘field of science and technology (FOS)’ (PORDATA 2021).34 The delineation between these different subject areas is informed by the Frascati Manual and updated FOS classifications (DGEEC/MEC 2007) (PORDATA 2022a). These fields of R&D are where SHAPE is recognised through the measurement of ‘social sciences and humanities and arts’ (PORDATA 2021).

R&D policy landscape
The main policy incentive for R&D in Portugal is a hybrid tax credit scheme, meaning it comprises both volume (income tax offsets, payroll tax credits and social security exemptions) and incremental tax credits, the latter of which target tax credits to R&D expenditure above a certain baseline amount (OECD 2021b). However, the interviewee clarified that these incentives do not define explicit criteria around the subject or topic of R&D, and so SHAPE subjects are included in these schemes by default (INT-INTER-02).

Tax credits in Portugal often use expenditure as a criterion for qualification. The eligible expenditures are currently: machinery, equipment, staffing (on the basis that they play a role in R&D) and intangibles (OECD 2021b). The interviewee confirmed these expenditures may encompass R&D conducted on SHAPE-related subjects, and this type of R&D can therefore qualify for tax credits (INT-INTER-02). This is also true for design processes that require elements of technical science and art. Firms applying for tax credits can decide what kind of expenditure they wish to reference; however, some expenditure (e.g. building costs) is far harder to justify as R&D (INT-INTER-02).

Impacts of R&D definitions and policy
The interviewee from Portugal suggested that the methodology used in R&D qualification in Portugal follows the Oslo Manual, which does not limit R&D to natural science and technological fields, but tends

34 Categories include: the natural sciences, medical and health sciences, engineering and technology, agricultural and veterinary sciences, social sciences and humanities and arts, and unknown (PORDATA 2021).
to focus more on method, expenditure and actions that lead to the process of R&D (INT-INTER-02.). This opens up a broader spectrum of qualifying R&D activities and helps to further encourage public and private entities to invest in R&D.

A noteworthy drawback to Portugal’s R&D policy comes from increased state intervention, where the state approves and provides grants and tax credits to projects. According to one interviewee, the state is more likely to finance projects that are in line with state policy, and which the state judges to be ‘better’ (INT-INTER-02.). Some see this state interference as potentially harmful due to the government’s lack of knowledge of R&D happening within companies, and the implications in terms of private sector autonomy (INT-INTER-02). The balance between R&D priorities guided by the state, versus individuals or private companies, may affect the degree to which SHAPE R&D is conducted, the questions SHAPE R&D answers, and whose interests and needs are taken into account when deciding to conduct R&D.

3.2.4. Switzerland

Summary of key data

| Gross R&D expenditure: €24.5bn (SwissInfo 2021) |
| Public/private R&D levels: 29% (public) 71% (private) (SwissInfo 2021) |
| Tax credit rates (%): 150% maximum deduction for qualifying R&D expenses incurred in Switzerland |

Defining R&D

The interviewee from Switzerland suggested that in the past, Swiss R&D has been defined by a broad definition of basic, applied and experimental development and innovation, mainly centred on the development of products and processes (INT-INTER-03a.). However, this was seen as ambiguous and lacking in detail, and has been revised. Today, the Frascati Manual definition for R&D has been integrated into the existing method, which is also used in application for the Swiss R&D tax model (INT-INTER-03a.). This model recognises SHAPE activity within the definition for R&D but does not necessarily dictate the extent to which SHAPE activities are counted in official data or accepted in tax policy. R&D in Switzerland is further seen as a contribution to the basis of innovation, and therefore to novelty in product development, services and technologies, aiding in continued economic growth (KPMG 2016).

R&D data collection

The interviewee confirmed that companies and firms complete R&D data collection surveys to self-assess whether a project meets the requirements of R&D (INT-INTER-03b). The Business Enterprise Sector R&D survey is used in Switzerland to count a large proportion of private R&D data at firm levels (Federal Statistical Office 2022). Instructions for filling out this survey clarify the definition of R&D with direct reference to the EU’s definition of R&D.35 However, clarifications of this definition place particular emphasis on R&D as the ‘completion of projects based on new discoveries and scientific and/or technological progress and intended to clarify uncertainties’ (Office Federal Statistical 2022a). Additionally,  

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branches of R&D activity are clarified to include food, chemistry, pharmacy, metallurgy, machinery, high-tech instruments, information and communications technology (ICT) manufacturing, ICT services and other branches (Office Federal Statistical 2022b). This list of branches suggests a more scientific and technical focus, however, the survey also collects data on R&D expenditure compared against pre-defined ‘R&D objectives’ that relate to wider social issues, such as health, agriculture, environment, energy, industrial production and technology and defence (Office Federal Statistical 2022c). This could be an area of potential overlap area for topics related to SHAPE.

The Swiss Economic Institute (KOF) for Business Cycle Research Innovation survey aims to run every three years (KOF Innovation Survey 2022). This survey has multiple aims, including providing descriptive, normative and explicative analysis to assess levels of innovation capability in the Swiss economy and support policy decision making (KOF Innovation Survey 2022). The survey is conducted by the ETH Zürich, a public research university, on behalf of the State Secretariat for Economic Affairs (SECO). The survey uses the ETH Zürich corporate panel of KOFs, which provide a sample of 6,500 firms covering the manufacturing industry, construction and the commercial area of the service sector (ETHZ 2022). Results are segmented by type of industry: high-tech industry, low-tech industry, modern services and traditional services (SECO 2015).

Prerequisites for R&D data in Switzerland are in accordance with the Frascati Manual definition, and so require research to be novel and innovative in some manner, which is not always easy for firms and businesses to prove (INT-INTER-03a), particularly for SHAPE R&D. The surveys give particular attention to technical, physical and natural sciences in qualifying expenditure. However, they also leave room for ‘other’ types of R&D research, which may include SHAPE subjects (Federal Statistical Office 2022). This can incentivise firms to conduct SHAPE R&D since it can be recognised in data collection to inform tax policy.

**R&D policy landscape**

The main policy incentive for R&D in Switzerland is through tax incentives. The Swiss R&D tax model is focused on R&D tax deductions to recognise and reward companies investing in R&D-oriented projects (KPMG 2021). Qualifying activities include development of new manufacturing techniques, development of new processes to reduce environmental impacts, value engineering and process improvement, experimental trials and progressive software development (KPMG 2021). The Swiss industries most affected by incentives are the technology, media and telecom sectors, consumer industries, energy, finance, life sciences and healthcare, and public services (Krivinskas, Stutzmann, and Parmentier 2020).

The interviewee, who was an expert in R&D tax incentives in Switzerland, suggested that from this tax perspective, attention is given to new products and innovation (tangible outputs, with tangible returns) (INT-INTER-03a). The tax incentives are usually linked to R&D that creates economic value and profit in some way (INT-INTER-03b). It can be more challenging to demonstrate the connection between SHAPE R&D and tangible or profitable services and products, which appears less clear than with STEM subjects (INT-INTER-03b), according to the interviewee. The interviewee did not consider whether, or in what situations, SHAPE expertise may be critical to enabling a new product. However, they did suggest that some sectors may be better to demonstrate this requirement for SHAPE R&D, such as the financial
sector where improvement in processes is demonstrable. These areas of R&D are less tangible, but still qualify for R&D tax relief (INT-INTER-03b).

The qualifying standards for R&D tax deduction in Switzerland include attention to ‘scientific’ research and ‘knowledge-based innovation’, which includes basic and applied research, and the development of new products and services (Krivinskas, Stutzmann, and Parmentier 2020). Activities such as drawing/design, preparation of models, construction, prototyping and pilot planning are included in qualifying R&D (Krivinskas, Stutzmann, and Parmentier 2020).

Impacts of R&D definitions and policy

The interviewee suggested existing Frascati Manual definition offers an opportunity to leverage more potential R&D activities by building on an existing definition of R&D rather than starting from scratch (INT-INTER-03b). This definition also creates conditions allowing R&D to happen in wide-ranging fields, with greater freedom to execute R&D (INT-INTER-03b). According to the interviewee, liberal regulations paired with a good talent pool give firms access to skilled workers, incentivising greater investment in R&D (INT-INTER-03b). This would not necessarily be possible with a narrow definition of R&D from the government, limiting the scope of activities conducted within the private sector that can be counted as R&D.

3.2.5. Denmark

<table>
<thead>
<tr>
<th>Summary of key data</th>
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<tbody>
<tr>
<td>Gross R&amp;D expenditure: €10.3bn (DenmarkStatistics 2020)</td>
</tr>
<tr>
<td>Public/private R&amp;D levels: 38% (public) 62% (private) (DenmarkStatistics 2020)</td>
</tr>
<tr>
<td>Tax credit rates (%): 22 (corporate income tax rate). 30 (enhanced R&amp;D tax allowance)</td>
</tr>
<tr>
<td>SHAPE inclusion: Yes (implicit)</td>
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</table>

Defining R&D

The interviewee from Denmark that suggested the broad definition for R&D in Denmark does not explicitly state the inclusion of SHAPE subjects, but they are included by default (INT-INTER-04). Denmark’s (English translated) definition of R&D states that ‘research and development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications’ (Statistics Denmark 2022), which is similar to the EU definition. As suggested by Frascati Manual, three types of R&D are distinguished under this broad definition: basic research, applied research and experimental development (Statistics Denmark 2022). The interviewee suggested that for the business enterprise sector, the Danish R&D definition is largely based on companies developing new technologies and novel solutions, typically in collaboration with universities and research institutes (INT-INTER-04). In many cases, commercial entities may collaborate with universities, particularly with social sciences and business schools (INT-INTER-04).

R&D data collection
The purpose of public R&D data collection in Denmark is to analyse the scope of R&D activities undertaken within public sectors, which then informs the measurement of R&D spend in relation to GDP (Statistics Denmark 2022). R&D surveys are conducted annually using the Frascati Manual guidelines for defining R&D and tend to have high reliability and response rates (99% among 700 institutions) (Berg 2022). Private R&D data collection in Denmark follows the same model, adopting the Frascati Manual guidelines for defining R&D, and measures R&D activities occurring in the private sector. By using the Frascati Manual definition for R&D, Denmark includes SHAPE subjects in its R&D data collection methods, as the Frascati Manual recognises SHAPE activity as R&D (OECD 2015).

R&D statistics are also segmented by sector (business enterprise, higher education, government, and private non-profit), and the delineation between these sectors is informed by a distinction between market versus non-market activities (Statistics Denmark 2022). R&D statistics for the higher education and private non-profit sectors are also described by fields of science, which include: natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences, and humanities (Statistics Denmark 2022). The recognition of social sciences and humanities in the fields of sciences is where SHAPE activities can be measured, but only for the higher education and private non-profit sectors.

R&D policy landscape
The interviewee highlighted that Denmark is a high-cost country with a highly skilled workforce, where companies compete on knowhow in the service and technology sectors (INT-INTER-04). Key government strategies to improve R&D and innovation-related activities include strong tax incentives for R&D in companies, universities and research institutes (INT-INTER-04).

The R&D tax credit scheme in Denmark offers companies in a tax loss position the chance to earn a refund for deficit-related R&D expenditure (OECD 2021a). The scheme, ‘Skattekreditordningen’, was implemented in 2012 and applies to all R&D expenditure targeted at developing significantly improved or new products, materials, services, systems or mechanisms (European Commission 2022). The interviewee suggested these expenditures are not all tangible and, as a result, while there is no explicit criteria to qualify subject areas for R&D tax incentives, SHAPE subjects are seen to be eligible for tax incentives by default (INT-INTER-04). It is also worth noting (due to the perceived less tangible or concrete nature of SHAPE activity) that intangible outputs and activities, such as improved processes, can also qualify for R&D tax incentives (INT-INTER-04). Moreover, early-stage and developmental R&D also tend to be more intangible in terms of outputs and impacts, but are included in R&D schemes (European Commission 2022).

Impacts of R&D definitions and policy
The interviewee highlighted the benefits of the R&D tax incentives. R&D tax incentives encourage larger companies to have clear structures to show what R&D activities they are doing, however, this is often difficult for SMEs (INT-INTER-04). There is a push for companies to conduct R&D that falls into the R&D definition for tax purposes, which for SMEs can be quite ambiguous due to smaller R&D departments (INT-INTER-04). While this is true for the whole array of R&D activity, it is more prominent for SHAPE activities, as grey areas associated with R&D outputs/processes that are perceived as less tangible
or quantifiable will be amplified in SMEs with small R&D departments. They may therefore be discouraged from conducting these types of activities due to uncertainties about how they meet the qualifying guidelines for R&D activity.

Larger companies will conduct R&D no matter what, but for SMEs, a lack of clarity in R&D definitions for tax incentives can be constraining (INT-INTER-04). Some companies perform activities they believe will qualify for R&D incentives yet do not; this is most prevalent in SMEs who are often less aware of the state of play in defining R&D compared to larger companies with bigger R&D departments. (INT-INTER-04).

Aside from the drawbacks of Denmark’s R&D tax policy, it has been able to elevate certain subjects that are commonly based in academia and research to a more commercial area (INT-INTER-04). For example, quantum computing is for the most part academic in nature, but commercialisation of quantum computing R&D has been encouraged through tax incentives, leading to additional R&D in this area among businesses (INT-INTER-04).

Denmark’s R&D policy has impacted the economy through new innovation and productivity (INT-INTER-04). The economic benefits of Denmark’s R&D policy were highlighted by one interviewee who explained that increased R&D in the Green Energy space led to the creation of a whole industry in Denmark (INT-INTER-04). Currently, Denmark is considered a ‘laboratory for green energy’, with 50% of Danish electricity generated by green sources (Denmark.dk 2022). However, this example is more closely associated with non-SHAPE subjects.

3.2.6. Spain

<table>
<thead>
<tr>
<th>Summary of key data</th>
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<tbody>
<tr>
<td>Gross R&amp;D expenditure: €15.4 bn (statistica 2019)</td>
</tr>
<tr>
<td>Public/private R&amp;D levels: 44.2% (public) 45.8% (private) (UK Science and Innovation 2021)</td>
</tr>
<tr>
<td>Tax credit rates (%): Volume: C: 25, +17 (R&amp;D staff); ME &amp; Intangibles: 8 Increment (on top of volume): C: 17.40 (full-time research staff)</td>
</tr>
<tr>
<td>SHAPE inclusion: Yes (implicit)</td>
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Defining R&D

R&D development is understood as the ‘application of the results of investigation activities aimed to produce new materials, products or design new production processes or methods, as well as substantial technological improvement of materials, products, processes and previously existing systems’ (Ministry of Finance, Spain 2004; European Commission 2022). Qualifying research for Spain’s innovation tax credit system includes ‘original planned investigation that seeks to discover new knowledge and greater understanding in the science and technology’ (Ministry of Finance, Spain 2004; European Commission 2022). These definitions for R&D seem to account well for many different types of outputs and processes although they do not explicitly mention SHAPE subjects. Whilst they do not explicitly exclude or include SHAPE subjects, they do mention the design and improvement of products and processes, which are commonly associated with SHAPE activities. In addition, all industries are eligible for R&D tax credits,
including industries closely related to SHAPE subjects (Olmos and Garzesi 2020). While these definitions relate specifically to the tax credit system, they are an indication of how R&D is defined in Spain.

**R&D data collection**

The Instituto Nacional de Estadística (INE) collects statistics on Spain’s scientific research and technological development (R&D) through a mixed methods process. This data is passed on to the relevant offices, including Ministerial Departments, independent bodies and administrative bodies (INE 2020a). INE’s R&D statistics measure the allocation of economic and human resources by sector to inform national science policies (INE 2020b; 2021). The sharing of data by the INE ensures data use is in accordance with international standards and supports comparisons between countries (INE 2020b; 2021). The INE website confirms that the methodology for collecting R&D statistics directly follows the recommendations set out by the OECD in the Frascati Manual (INE). For the purposes of INE data collection, R&D includes ‘the body of creative work undertaken systematically with the objective of increasing the volume of knowledge, including knowledge of man, culture and society and the use of this knowledge to create new applications.’ Furthermore, ‘for an activity to be an R&D activity, it must satisfy five core criteria. The activity must be: novel, creative, uncertain, systematic, transferable and/or reproducible.’ (INE 2020a).

The INE reports statistics about R&D by sector (e.g. public administration, private non-profit institutions, higher education and business) (INE 2020a; 2020b). The 2019 data set included a sample size of 50,153 companies, 900 public administration centres (including public hospitals), 77 universities, 145 centres of higher education and 347 private non-profit institutions (INE 2020a).

**R&D policy landscape**

Spain offers tax deductions for qualifying R&D expenditure, as well as research tax credits for technological innovation (Olmos and Garzesi 2020). Spain’s fiscal incentives for R&D and innovation are highlighted as good practice, as they offer a generic scheme (which does not target any type of business, region or activity) that simplifies the system (European Space Agency 2022). Spain also offers a cash refund option, to carry over all or parts of R&D expenditure, giving firms flexibility to invest where they like (European Space Agency 2022). Spain’s R&D tax incentives are considered some of the most generous among OECD countries, but the administrative processes are considered burdensome and time consuming (European Commission 2022).

Spain’s R&D fiscal incentives are administrated by the Ministry of Economy and Competitiveness, which recently established a new research agency, the Centre for Industrial Development (CDTI) (European Commission 2022). The CDTI funds industrial R&D projects and manages international, interdisciplinary programmes (European Space Agency 2022). Activities include fostering international cooperation programmes, implementing government technology policy, defining a set of funding programmes, project evaluation and project follow-up (European Space Agency 2022). The types of activities the CDTI completes also suggest a place where SHAPE knowledge (multiple languages or being able to understand multi-cultural/global perspectives and policy environments) and methodological expertise (for evaluations) support the R&D system (Ministry of Finance, Spain 2004).
Impacts of R&D definitions and policy
Pre-2012, Spanish R&D expenditure was increasing, but the financial and economic recession led to a drop in GERD (European Commission 2022). This led to a series of new strategies to strengthen the coordination of R&D and innovation policies (European Commission 2022). Spain’s post-2012 innovation and R&D strategies overlap with social issues (such as gender, accountability and social impact) and focus on the structure of administrative processes, suggesting a potential influence of SHAPE issues.

Spain has a very strong science and innovation base, with a plethora of important R&D activities taking place in universities, research institutes and centres around the country, making Spain a key partner for the UK (SIN UK 2021). Spain’s total R&D investment increased by roughly 6% since 2019, accounting for 1.47% of their GDP in 2020 (a 1.25% increase since 2019). This increase can be attributed to a rise in R&D expenditure, of which, 44.2% of R&D investments came from the public sector (SIN UK 2021). Spain’s Strategy for Science, Technology and Innovation 2021-2027 has also laid out a plan to increase Spain’s public and private R&D investment to 2.1% GDP by 2027 (SIN UK 2021). This is currently being acted upon, with the recent January 2022 announcement of Spanish government doubling its direct funding for public-private R&D projects, allocating a total budget of €375 million (Keating 2022).

Evaluations of Spain’s R&D tax policy have shown positive impacts in varying sized firms (mostly medium and large high tech), however SMEs were less likely to apply for tax incentives, as they were often unaware of them; this significantly lowers the rate of R&D take-up in Spain, as SMEs make up a predominant part of the Spanish economy (Corchuelo and Martinez-Ros 2009). Small, financially constrained firms tend to use R&D subsidies more than tax incentives, however SMEs with intellectual property rights protection on innovative products were more likely to adopt R&D tax incentives (Busom, Corchuelo Martínez-Azúa and Martinez Ros 2012).

3.3. Cross-cutting themes for SHAPE R&D internationally and comparison to the UK
3.3.1. International comparator countries use more inclusive definitions of R&D than the UK, but the inclusion of SHAPE is often implicit within these R&D definitions
Across most countries, the concept of novelty and the creation of new knowledge, innovation and production is considered important in the definition of R&D. This is consistent with the official government definitions (HMRC 2020) and general understanding of R&D in the UK. Furthermore, SHAPE subjects and activities are not explicitly discussed in definitions of R&D, although it is often included implicitly or by default. For example, the Frascati Manual is commonly referred to for R&D criteria, particularly in the context of R&D tax incentives and data collection. The Frascati Manual includes SHAPE activity in its definition of R&D, and, by proxy, most countries include SHAPE subjects in their R&D definitions by default. One exception is Portugal, where SHAPE is explicitly included in the definition of R&D and data is captured specifically on SHAPE R&D expenditure in business. This differs from the UK, where official R&D definitions are limited to scientific and technological advancements, and explicitly exclude SHAPE-related subjects from the definition (HMRC 2020).
The differences between sectors in how they understand and recognise R&D, as discussed in the previous chapter, apply both internationally and in the UK. R&D is often easier to conceptualise in the context of the Frascati definition in sectors that are more related to technical expertise in STEM subjects, compared to SHAPE R&D which is perceived by some stakeholders to be less technical, despite SHAPE subjects also including technical expertise. This can make it difficult to recognise and value SHAPE R&D, both in sectors that are used to dealing with more easily defined forms of R&D, and sectors where R&D is less widely considered and conceptualised.

3.3.2. Data on R&D is typically captured using surveys and relies on self-assessment

Surveys are often used for R&D data collection among public sector institutions, with private sector entities often also required to submit information to record their R&D activities. In most cases, surveys are subject to self-assessment to decide whether activities conducted fall into the category of R&D, which can cause inconsistencies in R&D expense claims, tax credits and data collection. This is similar to UK methods of collecting BERD data (INT-SEC-07; INT-SEC-11). This approach can be problematic where definitions of R&D are unclear.

The data collected from surveys in the countries included in this study are used by governments to inform R&D-related metrics, such as analysing the amount of and scope of R&D activity, GERD by GDP, and GERD performed by state, higher education institutions and private non-profit institutions by geographic location. The main data collection of R&D activities within these countries, therefore, impacts important government decisions, similar to how HMRC and ONS data are used by government bodies in the UK (HMRC 2021; INT-SEC-08; INT-SEC-03).

3.3.3. R&D tax credits are the key policy mechanism to support business R&D across countries

Among those consulted in this study, R&D tax incentives were seen as the main policy mechanism associated with encouraging R&D, with each country of analysis having implemented them in some form. This is similar to the UK, where HMRC tax returns are central to discussion of the R&D policy landscape, although the UK is unique in that government also provides a substantial amount of grants to incentive R&D activities (INT-SEC-03; INT-SEC-07). Nevertheless, unlike in the UK, SHAPE R&D is – at least implicitly – included in the tax relief schemes of the countries discussed in this section, although the degree to which this is practically claimed likely differs by sector. As a key mechanism to drive R&D, the extent and clarity of the definitions of R&D associated with tax credit mechanisms are likely to be an important driver of the measurement and conceptualisation of R&D.

Cross-country OECD analysis suggests that tax credits are an effective mechanism to promote R&D, with every extra unit of R&D tax support translating to 1.4 extra units of R&D, on average (OECD 2020). Tax credits also increase the level of human resources that firms report dedicating to R&D. However, it is also highlighted that this input additionality is much larger for small and medium sized firms than for large companies, and the additionality for firms in highly R&D-intensive industries (e.g. scientific R&D, pharmaceuticals) is very low. Analysis also suggests that there is a similar level of additionality for direct R&D government funding measures and that there may be complementarity of direct and indirect support measures. This implies a policy mix, balancing tax credits with direct funding, is likely to be beneficial.
3.3.4. Making international comparisons of SHAPE R&D is challenging due to limited data

There are very sparse data to enable international comparisons of SHAPE R&D. What data are available indicate that SHAPE R&D makes up a small proportion of business R&D in most countries, at least according to recorded statistics. However, many countries, the UK included, report a significant proportion of R&D occurring in the service sector, and where data are available it appears this may be linked to a higher reported proportion of SHAPE R&D.
4. Conclusions

Based on our analysis of SHAPE R&D across sectors in the UK, and comparisons internationally, we can identify several key findings and observations. Many of these findings align with other studies in the area of SHAPE R&D, reinforcing and validating previous findings, whilst others provide new and novel insights. Below, we separate findings from this study that confirm results from related studies, and those that represent novel contributions to the field.

4.1. Confirming results from related studies

4.1.1. Business R&D activity can be defined in many different ways, but for UK stakeholders STEM activities are front-of-mind when thinking about R&D, in line with the HMRC definitions

BERD data on expenditure is defined and collected differently from HMRC data based on R&D tax credit claims and provides a different estimate of expenditure. R&D employment also provides an alternative measure of R&D activity, whether by occupation or sector of activity. Our interviews suggest that STEM is central to implicit understandings of R&D across sectors. This is in line with the way R&D is defined by HMRC for the purposes of tax credits, though it is not clear to what extent the HMRC definition is a driver of stakeholder perceptions.

4.1.2. Other countries use a more inclusive definition of R&D than the UK, though the inclusion of SHAPE is often implicit rather than explicit

Most countries use a definition of R&D that is closely linked to either the OECD Frascati Manual definition or the EU definition. These are comparable to the UK’s definition for the purpose of BERD (which is based on the Frascati approach) but more inclusive than the definition used by HMRC for the purposes of R&D tax credits, which explicitly excludes SHAPE R&D. Although most countries do not actively exclude SHAPE R&D in the definitions they employ, its inclusion is typically implicit rather than explicit. This can lead to a lack of clarity, and the extent to which SHAPE R&D is included in data will be dependent on interpretations and perceptions, which may vary across sectors and business types as well as individuals, particularly since data is typically based on self-assessment through surveys. Of the countries included in this report, one exception is Portugal, where data is explicitly captured on SHAPE R&D as distinct from STEM R&D.
4.1.3. Despite the UK being active in SHAPE R&D, data for direct international comparison is limited

Interviewee data and UK data (of graduates and R&D roles) suggest the UK is active in SHAPE R&D, but robust and consistent measures that would allow for comparison across countries are not available. UK employment data indicates around 11-13% of UK R&D is in SHAPE disciplines. In addition, the proportion of UK R&D conducted within service industries is over 60%, which is also high compared to international comparators. There is very limited data on SHAPE R&D specifically at the international level as only a small number of countries capture information at this granular level. What data are available indicate a relatively low level of activity relative to STEM R&D, with SHAPE R&D accounting for 5% or less of both R&D expenditure and employment in countries where data are available. While the evidence is limited, the UK’s activities in the service industry and general SHAPE R&D activities indicate the UK could be particularly active in SHAPE R&D relative to international comparators, although data needs to be collected and analysed to confirm this hypothesis.

4.2. Novel contributions of this study

4.2.1. A more person-centred lens can be one route to help recognise SHAPE contributions to R&D

Typically, definitions of R&D activity focus on measures of expenditure, but analysing the role and movement of people, and the skills and capabilities they may bring to the role, can be a useful lens to analyse SHAPE’s contributions to R&D. The R&D ecosystem requires a range of skills and business acumen to effectively conduct, organise and commercialise R&D. Additionally, R&D expenditure can include a range of costs related to the salaries of people supporting R&D projects (counted by tax experts as either direct or indirect costs), as well as the training and utilisation of human talent (INT-SEC-01; INT-SEC-03; INT-SEC-11). This report used this person-centric approach to R&D by analysing who was entering the UK’s key R&D industries (i.e. graduates) and the types of roles people were filling within R&D projects. This approach went on to highlight the role of SHAPE graduates and SHAPE experts in key UK R&D industries. This person-centric approach may have the additional benefit of acknowledging the increasingly interdisciplinary nature of research and avoid a siloed analysis of the nature of R&D. Understanding and recognising the key role of people within R&D suits SHAPE R&D analysis, which is primarily interested in using key subjects to help make sense of the human world and recognise the complexity of life and culture. People continue to sit at the centre of the R&D process, so using a person-centric lens for analysis of R&D activities may continue to highlight the key contributions of SHAPE R&D.

4.2.2. SHAPE disciplines make a significant contribution to key R&D-intensive sectors

Business R&D is highly concentrated within just five enterprise groups (enterprises under the same owner) accounting for 15% of expenditure on R&D performed in UK businesses in 2019 (The British Academy et al. 2021). Analysis of 2020 R&D expenditure demonstrated that three industries accounted for 75% of all R&D (professional, scientific and technical activities, information and communication, and manufacturing sectors). Analysing graduate employment across sectors, we find that across the top five R&D performing sectors, four employed more ‘non-science’ than ‘science’ graduates in 2020. The roles
taken on by those graduates are unknown – and indeed many may not be working explicitly in R&D. However, qualitative evidence suggests that there are examples of SHAPE graduates and SHAPE R&D playing an important role in R&D and innovations across sectors, and that R&D business activities need a range of skills, knowledge, and experience.

4.2.3. Several sectors in which SHAPE plays an important role have a low level of engagement with R&D data collection and tax credit systems

Notably, interviewees from the arts, entertainment and recreation and wholesale and retail trade sectors highlighted that they were not typically aware of, or engaged with, R&D support mechanisms. Although this is based on a small number of interviews, it may signal that a lack of awareness may be limiting engagement with R&D data collection processes and tax credits. One reason for this may be the importance of collaboration in SHAPE R&D. Some sectors, such as arts, entertainment and recreation, highlight that innovation is often collaborative, incorporating both SHAPE and STEM R&D. Industries with this type of collaborative and cross-disciplinary R&D report that it can be harder to claim for UK R&D tax reliefs for their innovations. However, there was also a point raised about motivation. For some smaller organisations, finding resources to help identify, count, and claim for R&D activities remains challenging; this is concerning since evidence suggests the additionality of tax credit schemes is more significant in smaller firms. Additionally, many organisations in the arts, entertainment and recreation already qualify for the lucrative creative industry tax reliefs that can be easier to qualify for than R&D tax credits. For organisations and businesses heavily involved in SHAPE activities, being aware of and building motivation to use R&D systems will be key to increase engagement with these mechanisms. Equally, it may be worth considering whether alternative mechanisms may be relevant to support R&D in a diverse range of sectors, beyond tax credits.
4.3. **Recommendations**

Based on our conclusions and observations we identify the following key recommendations to improve the understanding and recognition of SHAPE R&D in the UK.

4.3.1. **Capture information on SHAPE R&D in routine data collection**

At present, there is very limited data to assess the extent of SHAPE R&D in the UK. SHAPE R&D clearly plays a role in UK R&D and the wider economy, forming a key part of activities and products across many different sectors. However, without directly reporting on business enterprise R&D in the social sciences, arts and humanities, it is difficult to say where the UK stands in terms of SHAPE R&D internationally. Additionally, businesses need resources and the right expertise (i.e. tax accountants and access to R&D experts) to help identify R&D activities and support the government R&D incentive mechanisms. Understanding the extent and importance of SHAPE R&D to UK businesses is critical in enabling effective strategic planning in terms of skills needs across a range of policy areas from education to immigration. At present, there is a key strategic focus on strengthening the STEM skills base in the UK to enable private sector innovation and growth. However, the extent to which private sector innovation is also driven and supported by SHAPE disciplines is currently unknown, which could be a key differentiator for UK businesses and a missed opportunity for transformational policy as a result. Collection of data that allows for the breakdown of the contributions of SHAPE and STEM disciplines to business R&D could provide a valuable data source to enable evidence-based policy making. Although international data on this topic is limited there are exemplar countries – including Portugal and Canada (Figure 13) – where these breakdowns are collected routinely.

4.3.2. **Make definitions of R&D clear and consistent, and engage with key industry stakeholders to ensure clarity and understanding**

In order to collect accurate data on the extent of R&D in industry – both SHAPE and STEM – additional clarity is needed in the way R&D is defined. This is particularly pertinent since data relies on self-reporting by companies. In particular, a potential gap is identified in understandings of SHAPE R&D that needs to be addressed in order to provide people in these industries with the knowledge and vocabulary to both articulate R&D activities that already occur, and to encourage more SHAPE-related R&D activities. More widely, there may also be challenges in articulating collaborative and cross-disciplinary R&D activities, and there is an indication that sectors engaging with this type of R&D may be less likely to access tax credit support, whether due to challenges in eligibility given the narrow definition of R&D employed, or a wider lack of engagement and understanding of the process. This emphasises the importance of an appropriate policy mix, combining tax credits with alternative incentive mechanisms, including direct R&D support. In addition, there is a lack of clarity on the extent and distribution of R&D expenditure due to substantial differences in BERD and HMRC data. Better alignment of the definitions between these mechanisms could help improve clarity. Whatever the definition used for R&D, more engagement is needed with industry stakeholders to ensure the definition used is clear, well-understood, and can be practically implemented across contexts. Lack of clarity can have implications both for the consistency and quality of data to support
evidence-based decision making, and the extent to which R&D incentives are effective in achieving their policy objectives.

4.3.3. Consider person-centred measures of R&D as well as measures of expenditure

Our analysis has demonstrated the potential of person-centred approach to analyse SHAPE R&D activity in the absence of granular data on expenditure. Given the range and nature of contributions that SHAPE graduates can make to R&D activity across sectors, and the collaborative and interdisciplinary nature of much business R&D, a person-centred approach is key to understanding SHAPE R&D. Further analysis is needed to understand the R&D roles SHAPE can contribute to, the movement of people into/between key SHAPE industries, the SHAPE skills required to undertake R&D, and the capabilities and expertise SHAPE can bring to the UK’s R&D ecosystem as a whole. A person-centric lens can be a key tool to analyse R&D activities and recognise SHAPE’s contributions.
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———. 2022b. 'Figure 10 - Graduate Outcomes by Subject Area of Degree and Activity | HESA.' 2022. As of 17 July 2023: https://www.hesa.ac.uk/data-and-analysis/sb263/figure-10.


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Annex A. Additional data table for UK graduate analysis

Table 10 below provides additional data regarding UK graduate outcomes. This table is ordered (highest to lowest) by R&D expenditure performed in UK businesses for 2020 and the breakdown of data includes the estimated* number of graduates’ outcomes for the academic year 2019/20 by ‘science’ vs ‘non-science’ graduates and the ‘non-science’ disciplinary backgrounds (HESA, OfS, and DfE(NI) 2020; ONS 2021a). Red highlighting indicates which graduate group has more students entering the industry, ‘science’ or ‘non-science’ graduates. Green highlighting indicates the number of students entering each industry by ‘non-science’ discipline, from greatest the number of students (dark green) to the least (white).
Table 1: Summary of estimated SHAPE R&D graduate outcomes analysis

<table>
<thead>
<tr>
<th>2020 expenditure on R&amp;D performed in UK businesses (£ million)</th>
<th>Estimated 2019/20 graduate outcomes*</th>
<th>Estimated 2019/20 non-science graduate outcomes by disciplines*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Science graduates</td>
<td>Non-science graduates</td>
</tr>
<tr>
<td>Total number of 2019/20 graduates in full time employment</td>
<td>104,595</td>
<td>126,000</td>
</tr>
<tr>
<td>Professional, scientific and technical activities</td>
<td>9,567</td>
<td>12,551</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>8,977</td>
<td>7,322</td>
</tr>
<tr>
<td>Information and communication</td>
<td>3,988</td>
<td>8,820</td>
</tr>
<tr>
<td>Wholesale and retail trade; repair of motor vehicles and motorcycles</td>
<td>1,265</td>
<td>12,600</td>
</tr>
<tr>
<td>Financial and insurance activities</td>
<td>578</td>
<td>3,138</td>
</tr>
<tr>
<td>Construction</td>
<td>429</td>
<td>3,138</td>
</tr>
<tr>
<td>Administrative and support service activities</td>
<td>420</td>
<td>3,138</td>
</tr>
<tr>
<td>Arts, entertainment and recreation</td>
<td>325</td>
<td>2,092</td>
</tr>
<tr>
<td>Human health and social work activities</td>
<td>189</td>
<td>36,608</td>
</tr>
<tr>
<td>Mining and quarrying</td>
<td>179</td>
<td>0</td>
</tr>
<tr>
<td>Water supply; sewerage, waste management and remediation activities</td>
<td>134</td>
<td>0</td>
</tr>
<tr>
<td>Electricity, gas, steam and air conditioning supply</td>
<td>103</td>
<td>1,046</td>
</tr>
<tr>
<td>Other service activities</td>
<td>99</td>
<td>1,046</td>
</tr>
<tr>
<td>Transportation and storage</td>
<td>74</td>
<td>1,046</td>
</tr>
<tr>
<td>Public administration and defence; compulsory social security</td>
<td>53</td>
<td>4,184</td>
</tr>
<tr>
<td>Accommodation and food service activities</td>
<td>52</td>
<td>3,138</td>
</tr>
<tr>
<td>Real estate activities</td>
<td>32</td>
<td>1,046</td>
</tr>
<tr>
<td>Agriculture, forestry and fishing</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Education</td>
<td>0</td>
<td>10,460</td>
</tr>
</tbody>
</table>

*Estimated number of students = "total number of science/non-science students graduating from specific courses" * % of science/non-science students graduating specific courses and entering the industry, these estimated numbers should be treated as indicative results. (Total number of science students entering full time employment: 1,080,590; total number of non-science students entering full time employment: 1,262,500).
Each interview was given a unique code. Each code indicated whether the interview was being conducted for the sector analysis or the international comparisons analysis. Code INT-SEC- indicates a sector interview and INT-INTER- indicates an international comparisons interview. The full list of interview codes is below.

Table 11: Interview codes

<table>
<thead>
<tr>
<th>Sector interviews</th>
<th>Interviewee code</th>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>INT-SEC-01</td>
<td>Arts, entertainment and recreation sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-02</td>
<td>Arts, entertainment and recreation sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-03</td>
<td>Financial and insurance sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-04</td>
<td>Arts, entertainment and recreation sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-05</td>
<td>Financial and insurance sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-06</td>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-07</td>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-08</td>
<td>Professional and scientific sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-09</td>
<td>Professional and scientific sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-10</td>
<td>Arts, entertainment and recreation sector</td>
<td></td>
</tr>
<tr>
<td>INT-SEC-11</td>
<td>Financial and insurance sector</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>International interviews</th>
<th>Interviewee code</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>INT-INTER-01</td>
<td>The Netherlands</td>
<td></td>
</tr>
<tr>
<td>INT-INTER-02</td>
<td>Portugal</td>
<td></td>
</tr>
<tr>
<td>INT-INTER-03</td>
<td>Switzerland</td>
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</tr>
<tr>
<td>INT-INTER-04</td>
<td>Denmark</td>
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