Understanding Createch R&D

ISBN: 978-1-913095-75-8

Josh Siepel, Hasan Bakhshi, Martha Bloom, Jorge Velez Ospina

December 2022

Creative Industries
Policy & Evidence Centre
Led by nesta

About the Creative Industries Policy and Evidence Centre

The Creative Industries Policy and Evidence Centre (The Creative Industries PEC) works to support the growth of the UK's Creative Industries through the production of independent and authoritative evidence and policy advice. Led by Nesta and funded by the Arts and Humanities Research Council as part of the UK Government's Industrial Strategy, the Centre comprises a consortium of universities and one joint enterprise from across the UK They are: Birmingham, Cardiff, Edinburgh, Glasgow, Work Advance, London School of Economics, Manchester, Newcastle, Sussex, and Ulster. The PEC works with a diverse range of industry partners including the Creative UK.

To find out more visit **www.pec.ac.uk** and **@CreativePEC**

The PEC works with a diverse range of industry partners including the Creative UK. To find out more visit www.pec.ac.uk and @ CreativePEC The Creative Industries Policy and Evidence Centre (The Creative Industries PEC) is part of the Creative Industries Clusters Programme, which is funded by the Industrial Strategy Challenge Fund and delivered by the Arts and Humanities Research Council on behalf of UK Research and Innovation. The PEC has been awarded funding by the AHRC for an additional five years, and will have a new host organisation in 2023.

Acknowledgements

The authors gratefully acknowledge financial support from AHRC for this research. We are firstly grateful to all survey respondents who donated their time to help us with this research. We would also like to thank Bruce Tether and Eliza Easton at the PEC for their comments on an earlier draft of this report and Andrew Chitty, Christopher Smith and Paul Meller at AHRC for their feedback and support. Juan Mateos-Garcia kindly provided underlying data from his previous studies on GtR and Crunchbase data which were vital in providing our sample frame, and provided assistance in getting that data set up. We gratefully acknowledge James Murray of OMB Research for his support with the telephone interviews and survey design.

Supported by:

UKRI Arts and Humanities Research Council

INDUSTRIAL STRATEGY

nesta

MANCHESTER 1824 The University of Manchester

University of Glasgow

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

US UNIVERSITY OF SUSSEX

work advance

Newcastle University

Ulster University

THE UNIVERSITY of EDINBURGH

LSE

UNIVERSITY OF BIRMINGHAM

ARTS COUNCIL ENGLAND

This project is part of the Creative Industries Clusters Programme, which is funded by the Industrial Strategy Challenge Fund and delivered by the Arts and Humanities Research Council on behalf of UK Research and Innovation.

Creative Industries
Policy & Evidence Centre
Led by nesta

Understanding Createch R&D

Executive summary

Createch is a term that has been used broadly to characterise the role of technology-driven innovation in the creative industries. While createch's potential has garnered much attention, it has lacked precise definition and remains comparatively underexplored empirically. This report aims to propose a practicable definition of 'createch' business for researchers and policymakers that is easily implemented and scalable, and to understand the differences in R&D investments, activities and practices between createch (per our definition) and other technology firms.

We define createch as:

> 'Those creative businesses where the development of new technologies or the adaptation of existing technologies in a novel way is a significant part of their business, and where creative businesses do not include creative businesses working exclusively in the IT/software sub-sectors.'

We operationalise this definition through a firm survey of 361 R&D-active companies in the UK, including 158 createch and 203 other technology companies, most of whom we identify through their receipt of public R&D support through UK Research and Innovation (UKRI). Respondents are interviewed about their business activities, their technology areas, organisation of R&D, staffing for R&D, access to and barriers to R&D activity.

We find that in many ways, createch and other tech businesses appear to have similar characteristics: for example, in size, growth and level of R&D spend. But we find that the technologies they use and the way they organise their R&D activity differ significantly. Createch firms are much more likely to use user-centred design technologies and virtual production activities. And their R&D spending is significantly more likely to consist of staff or contractor time rather than spending on equipment or infrastructure. Createch companies are also more likely to employ R&D workers that are distributed across roles that do not have R&D in their job titles, and createch companies employ more freelancers to work on R&D than tech companies do.

On this basis, we argue that createch companies show many characteristics of the wider tech sector, and should be recognised as such, but that the differences we identify also point to key implications for policymakers. In the first instance, and most obviously, because UK createch firms have a not dissimilar recent growth trajectory to that of other tech firms, their future growth potential should be prioritised, in the same way UK policymakers have prioritised other tech firms in recent years.

A second broad policy implication of our work relates to publicly funded R&D support. The most common barrier to R&D identified by both createch and other tech firms is in accessing the finance for it. Policymakers designing intervensions to help createch companies overcome financial market failures should pay particular attention to the differing ways in which they organise their R&D, such as the fact that staff costs account for a greater share of investment and that disproportionate amounts of R&D activity are undertaken by workers who are not traditional R&D specialists (as reflected in the absence of the term in their job descriptions).

The fact that proportionately larger numbers of createch firms do not set dedicated R&D budgets presents obvious challenges for R&D accounting. This must be addressed if createch firms are to benefit from R&D tax relief. Recognition by HMRC and its tax inspectors that createch R&D has these particular features would be a tangible step towards ensuring more ccompanies are able to access this tax relief. Moreover, our findings suggest that acknowledging the importance of Arts, Humanities and Social Sciences (AHSS) R&D, by ending its exclusion from the scope of R&D tax relief would appear to have benefits across the wider tech sector, not just for createch companies.

The distinctive features of R&D in createch businesses also points to the value of targeted createch R&D programmes, building on the experience of the Creative Industries Clusters Programme and Audience of the Future Fund. The Arts and Humanities Research Council's (AHRC) new Co-STAR research and innovation infrastructure initiative is a further example of how funders can support companies to invest and expand their createch R&D activities.

1

Introduction

The UK's creative industries and technology sectors are two of the nation's growth success stories, and their stories are intertwined. The creative industries play a substantial role in the economy and have been a major source of growth, with GVA in real terms increasing 43.6% from 2010 to 2019 compared with 17.7% for the whole economy, and employment at 2.2 million creative industries jobs in 2021, an increase of 42.2% from 2011.[1]

Even discounting the inclusion of IT and software in the UK's creative industries definition, real GVA of non-IT and software creative industries increased 31.4% from 2010 to 2019. Equally, the UK's technology sector has been a tremendous source of dynamism, with UK tech companies predicted to have a total valuation of £1.3 trillion in 2023 compared with a total valuation of £53.6 billion in 2012,[2] with fundraising of UK tech firms expected to exceed £50 billion in 2023, compared with £1.9 billion in 2012. The growth in these two sectors has gone hand in hand: for example, developments in AI such as deep learning and generative adversarial networks (GANs) have led to progress in automatic creative content generation, while the demand for sophisticated 3D graphics in computer games has been a key factor in the development of the graphics processing unit (GPU), which is important for computer graphics and for computationally intensive tasks in AI and digital cryptocurrencies.[3]

While the stellar growth performance of these two sectors has been recognised by policymakers over the past decade,[4] the potential of businesses straddling both sectors – 'createch' firms – is receiving increasing attention.[5] Broadly speaking, the term 'createch' has been used to characterise the potential of technology-based innovation in the creative industries.[6] Sitting alongside similar '-tech' neologisms such as fintech and edtech, createch has recently been a topic of considerable interest for its potential to bring cutting-edge elements of technology into the creative industries.

The term has been widely used to refer to work drawing upon, for instance, immersive, virtual/mixed/augmented reality and related technologies, but the scope and potential of createch is both broader and, to date, more ill-defined than this. This report proposes a definition of what a createch business is, and shows the differences in R&D investments, activities and practices between createch (per our definition) and other technology firms.

Despite the considerable interest and growing enthusiasm from policymakers, createch and its antecedents remain under-explored by researchers. There have been a small number of pieces of work that have considered specific dimensions of createch. For instance, the Creative Industries Policy and Evidence Centre (Creative PEC) 2019 report 'The Creative-digital skills revolution'[7] identified 'createch skills', looking at 35 million job adverts, and highlighted those skills that are most reliant both on creative and tech skills, pointing to occupations whose job adverts mention those skills most frequently (citing graphic designers, photographers, audio-visual and broadcasting equipment operators, artists, arts officers and producers, and product and clothing designers).

The Tech Nation/Creative Industries Council's 2021 Createch Reports on investment[8] and skills[9] found that despite the COVID-19 pandemic, createch companies had raised over £980m in equity finance in 2020, with job adverts in createch roles increasing by 16% from 2017-2019, compared with overall labour market growth of 3.3%. More recently, the University for the Creative Arts's 2022 Createch in the UK report[10] focused on sustainability activities among createch businesses in the UK.

AHRC's investment in understanding createch R&D

In response to the need to better understand createch and its implications, the AHRC commissioned the Creative PEC to undertake a programme of research to better understand the createch sector.[11] The first phase of the research involved an experimental mapping of createch publicly funded R&D projects using data from UKRI's Gateway to Research, and of createch companies using data from Crunchbase.

The first report from this phase[12] used a number of createch-related keywords to analyse all UKRI-funded R&D projects between 2007 and 2020. The report identified 2,542 createch R&D projects involving just over 4,000 organisations. It found that publicly funded createch R&D activity was roughly evenly split between firms in the creative industries, as captured by the Standard Industrial Classification (SIC) codes in the official DCMS definition,[13] and companies outside of the creative industries. It also highlighted that createch R&D projects have a higher level of disciplinary crossover than other creative industries projects outside createch, and that createch R&D is more geographically concentrated (with London's 35.6% share of createch R&D projects one-third higher than its 26.7% share of non-createch R&D).

The second mapping report by Mateos-Garcia (2021b)[14] looked at company-level data using the commercial database Crunchbase. Using createch keywords, it identified 2,800 createch companies using the data, which made up 8% of companies in the dataset. It identified a potential funding gap for createch companies, finding that these companies in the sample generally raised less funds than similar businesses. By analysing Crunchbase data on the qualifications of key personnel employed by companies, it also showed that Arts, Humanities and Design subjects are disproportionately represented in createch businesses.

Research aims

The present study, as the second phase of the AHRC research, aims to build on these previous studies via the design and implementation of a dedicated firm-level R&D survey instrument. There are already a number of key findings in the previous research around the nature of createch R&D projects, in terms of their distribution, disciplinary orientation, and structures.

The specific contributions of our report are two-fold:

1. To propose a practicable definition of a 'createch' business for researchers and policymakers that is easily implemented and scalable.
2. To understand the differences in R&D investments, activities and practices between createch (per our definition) and other technology firms.

The aim of the research is therefore to better understand the extent to which createch R&D is a distinct phenomenon compared with R&D undertaken by tech firms, and by association whether firms engaged in createch R&D may be better understood as an extension of 'conventional' tech R&D businesses, or whether they are their own phenomenon. In so doing, it uses primary survey data to compare the R&D activities, investment levels and staffing of createch and other tech businesses.

2

What is a Createch firm? A proposed definition and methodology

As we indicate in the introduction, a key focus of our analysis is on defining createch firms. In this section, we discuss previous efforts to characterise createch, propose our own definition, and discuss how we operationalise it in this study.

Previous definitions of createch

Although createch is becoming increasingly prominent in policy discourse, definitions of what constitutes createch business activity have tended to be vague, relating in general to the use of technology among creative industries without focusing in more tightly. Table 2.1 below highlights the definitions used in the few aforementioned research reports analysing createch.

Table 2.1. Definitions of createch in previous research

Research	Definition
Tech Nation (2021)	Creative technology ('Createch') is used to describe new tech that seeks to improve and automate the delivery and use of creative services.
Mateos Garcia (2021a, 2021b)	We define createch R&D as the production of knowledge to deliver technological innovation in artistic, creative and cultural domains.
Charter and Davis (2022)	1. A growth-oriented business or organisation that is in either the Cultural Sector or Creative Industries (as defined by DCMS) that designs or delivers creative experiences, products, or services; and 2. Has technology assets that are central to the value proposition to investors, customers, and users. It is insufficient for a business to have creative talent producing content using off the shelf tools; there must be technology innovation or adaptation; and 3. Employs a business or operating model (processes and/or automation) that could only be efficiently and effectively delivered with digital technologies, such as those under the Industry 4.0 umbrella.

It is clear from Table 2.1 that different definitions address different aspects of createch. Tech Nation (2021) focuses on the technology itself and specifically its intended application. Mateos-Garcia's (2021a) definition refers to R&D activity, while Charter and Davis (2022) addresses createch businesses. A common feature of the definitions is that they require further assumptions before they can be operationalised. In large-scale data sets like Gateway to Research and Crunchbase this includes selecting a set of createch-related keywords to identify createch projects/businesses.[15] In Charter and Davis's (2022) definition, careful manual screening of potential businesses is needed to establish that they meet specific criteria. By contrast, in what follows we propose a definition that has the merits of simplicity and of being reasonably straightforward to operationalise using a survey instrument.

A new definition of createch

Our focus in this report is createch R&D, and for our definition we assume that in order for a company to be createch, that it: 1) Must do technology-related R&D; 2) Those activities must form a significant part of its business; and 3) It must have substantial operations within a creative industries sub-sector beyond or in addition to IT/software. We explain these in more detail below:

1. **Must do technology-related R&D**. This includes both the development of new technologies or novel adaptation of existing technologies, echoing the OECD's definition of experimental development which recognises both knowledge creation directed at producing new products or processes and knowledge creation directed at improving existing products and processes.[16]
2. **Technology-related R&D forms a significant part of business activities**. Here we emphasise that companies that do technology-related R&D according the definition above do so as a significant part of their business. This is meant to exclude companies that only occasionally innovate, or for whom R&D takes place but is ancillary to the company's core activities. This also crystallises the distinction made above that we are focusing on creators and adaptors of technology, rather than adopters.
3. **Must have substantial operations within a creative industries sub-sector beyond or in addition to IT/software**. Here we capture companies whose activities are those in the creative industries sub-sectors to capture the creative part of createch. This allows us to capture a relatively broad range of activities. We do, however, make the decision not to include companies whose activities are exclusively in IT/software in our createch sample. We do so because while we recognise the importance of IT/software businesses as part of the creative industries, our aim in this paper is to identify characteristics of createch R&D that are distinct from tech R&D. Including IT/software firms in our createch sample therefore risks diluting the distinctions as these companies are naturally more likely than other creative firms to also engage in more conventional forms of tech R&D. The methodology we describe below allows us to test whether the R&D undertaken by firms we identify as createch is indeed distinctive from R&D by companies only operating in the IT/software sectors. To anticipate our findings, we confirm that this is the case.

Taking these three considerationsin to account, the definition of createch businesses that we seek to operationalise in this report is that createch businesses are:

> 'Those creative businesses where the development of new technologies or the adaptation of existing technologies in a novel way is a significant part of their business, and where creative businesses do not include creative businesses working exclusively in the IT/software sub-sectors.'

It is apparent that our definition is perhaps narrower than other definitions in that it places R&D activity at the heart of the definition. For example, an architecture practice that uses an off-the-shelf VR tool without modifying it might be classed as createch using the Tech Nation definition, but would not be classed as createch according to our definition. However, an architecture firm that modified an open-source VR platform to better serve its clients would count in both cases.

Defining tech companies

By extension, for our definition of technology businesses, we adopt conditions 1 and 2, and use the inverse of condition 3, that is, the requirement that the firms are in the creative industries, to exclude companies with substantial operations in the creative industries. For the sample of technology companies here, seeing as we exclude companies from the createch definition this would then be:

> 'Those businesses who do not have substantial operations in creative industries sub-sectors apart from IT/software but where the development of new technologies or the adaptation of existing technologies in a novel way is a significant part of their business.'

Methodology: Identifying createch and tech companies

Identifying the survey sample frame

Identifying the sample frame for business R&D surveys can be challenging.[17] Only a small sub-sample of businesses conduct R&D, and those that do are more likely to do it on an ongoing basis, so randomly sampling the population of businesses is unlikely to capture companies that are making meaningful, regular investments in R&D.[18] One of the few ways to identify UK companies that are definitely to an extent R&D-active is through the UK government's Gateway to Research (GtR) portal.[19] This includes all businesses that have received public support for innovation from Innovate UK (e.g. through grants) or that have participated in any programmes funded through UK research councils (e.g. that have collaborated with universities on research projects). For this reason, we can reasonably infer that any company listed on GtR has a higher probability of being R&D-active.

For the purposes of the telephone survey we undertake, we also need to be able to identify samples of companies that are likely to be createch, as well as those that are likely to be tech companies. To do this, we use the coding of createch keywords as derived in Mateos-Garcia's (2021a) mapping report of createch R&D using GtR. Specifically, the approach used in that report involved first identifying creative firms participating in research collaborations using the SIC codes of companies obtained from Companies House, and second a topic modelling of the descriptions of the projects these creative firms were involved with to identify projects that focused on technology development. Companies associated with those projects were then considered to be createch. We use that list of companies as the starting point for our createch sample frame. We consider non-creative companies involved in tech development projects in GtR as tech. This process yields initial samples of 1,009 in the 'createch frame' and 2,070 in the 'tech frame'. Questions are then included in the survey questionnaire designed to ensure that createch and tech firms have been accurately identified.[20]

In particular, when companies are interviewed, we ask a number of screening questions to ensure they are the type of company we are seeking to interview. Most importantly, we ask if *"the development of new technologies or adaptation of existing technologies in novel ways is a significant part of (their business activities in the UK)"*. This is meant to capture companies for which technology is a key part of their business (e.g. by excluding companies for whom R&D is an auxiliary activity). Companies that say yes to this question proceed to the survey, and those that say no are not asked to continue.

Companies that say yes to the question are then asked if they have invested any financial resources or staff time into R&D in the past three years in the UK, using the OECD definition of R&D presented to them.[21] Companies that say no to this question are also screened out. The remaining companies can then be reliably considered to be R&D-active, technology companies according to our definition.

To capture whether companies are 'createch' as opposed to other types of tech company, we need a measure of creative activity. We therefore ask all interviewees who have had said yes to the previous questions whether any of the company's main activities include operating in any sub-sectors in the official DCMS creative industries definition.[22] We consider self-reporting to be a more reliable approach than SIC codes to classify firms' sub-sectoral operations in this context given the well-known inaccuracies in SIC codes for some parts of the creative industries.[23] Companies that say yes to any of these sub-sectors except for IT, software and computer services are then counted in our final createch sample. Companies that reply yes to the IT/software sub-sector, as well as at least one other creative sub-sector, are counted as createch. As discussed earlier those that reply yes to IT/software alone are counted as tech firms. Companies that say no to all of the creative sub-sectors are then assigned to the 'tech' sample.

Because there is a limited sample to begin with, we also seek to identify firms that are clearly createch but might not appear in the sample identified from GtR. For instance, as GtR counts companies receiving public R&D funding, it might miss companies that have to date only received private R&D funding. To address this, we supplement our sample using a set of companies from the commercial database, Crunchbase, as used in Mateos Garcia (2021b). There, we identified companies as being potentially involved in createch activities if the keywords derived from the topic modelling of GtR data mentioned above appeared in their Crunchbase profiles. For such companies, we follow the same filtering process as above, but to be cautious, given that Crunchbase is a database of companies, not companies engaging in R&D, any companies that are screened out by the survey's creative sub-sector questions are not added to the tech sample.

In addition to these companies, it is also likely that there are smaller companies engaging in createch R&D activities but which do not yet feature in either the GtR or Crunchbase databases. For this reason, we further supplement our createch sample using data kindly provided by the AHRC's Audience of the Future (AotF) Fund and Creative Industries Clusters Programme (CICP). Specifically, the AHRC supplied us with details of companies that had participated in R&D supported by these creative industries R&D programmes. Because companies were selected for AotF and CICP on the basis of being both R&D-active and creative, we consider these to be a priori createch companies. Therefore, while companies from this sample are required to follow the same survey filtering process as above, we do not require them to be screened by sector.

After implementing this procedure, our final sample size is as follows:

Table 2.2. Composition of sample

Sample type	Sample source	Count
Createch	Gateway to Research	100
	Creative Industries Clusters Programme	31
	Audience of the Future	10
	Crunchbase	17
Total Createch		158
Tech	**Gateway to Research**	**203**
Total		**361**

Validating the sample frame

Clearly, the definition used for createch is crucial for the success of our research, and for this reason it is important to provide further insights about the sample frame, and to explain why we feel this is a valid approach that yields useful distinctions. Below we present three alternative approaches to constructing our sample, and provide explanations as to why the approach we choose is considered superior.

SIC codes

As we explain above, our classification of sectors is based on companies' reporting their own activities rather than SIC codes.[24] But because we have SIC codes for the companies in our sample we can see how the samples correspond to the classification of creative industries (according to the DCMS definition) and tech industries (according to a classification originally proposed by Nesta/Tech UK, 2015).[25]

As Table 2.3 shows, 83% of companies in the createch sample are located in DCMS creative industries SIC codes, while 78% of tech companies have tech SIC codes. There is some crossover between the two – particularly among IT/software companies that we code as tech for reasons discussed above. There is a small share (7%) of createch companies that are neither in tech nor creative sectors, but many of these are based in sectors adjacent to supply chains for creative industries sectors, for instance fashion manufacturing, which is closely linked to the fashion design sector.

Table 2.3. Creative and tech companies by SIC code

	Createch	Tech	Total
Creative SIC	83%	22%	48%
Tech SIC	10%	78%	48%
Other SIC	7%	0%	3%

Notably, when we repeat our analysis (as presented in subsequent sections using our preferred createch/tech definition) using the creative industries/tech SIC code-based classifications, we find fewer robust results and less clear evidence of distinctions in R&D practices between the two groups. For this reason, we feel that our createch definition is more meaningful than one based on firms' SIC codes.

IT/software

We discuss above in some detail our pragmatic decision to class companies with creative industries activities only in IT/software sectors as part of our tech, rather than our createch, sample. Here we present some further detail about this classification. IT-software-only firms made up a quarter of all firms surveyed and 45% of tech companies specifically.

As a robustness check, we repeat the analysis in subsequent sections considering two alternative hypotheses: first, if we consider IT/software-only creative firms to be createch, and second ,if we consider IT/software-only creative firms as a class of companies in their own right. Repeating our analysis with IT/software as part of the createch sample does not produce results indicating a clear createch/tech distinction, supporting our earlier suggestion that including IT/software-only creative firms as createch muddies distinctive characteristics of createch where R&D is concerned. The picture is more complicated when treating IT/software-only creative businesses as their own group. While in most cases the results suggest that R&D characteristics between these firms and tech firms more generally are not significantly different, there are some interesting exceptions which we flag.

Self-perceptions of being 'Createch'

An altogether different approach to identifying createch firms is to simply ask companies directly whether they view themselves as createch. As part of the survey, and to help validate our identification strategy, we ask companies about whether they see themselves as either 'tech' and/or 'creative', with the idea that companies' perceptions might reflect the distinctions between createch and tech companies. As well as telling us something about the possible boundaries between createch and tech companies, these perceptions offer an independent way of validating our assignment of firms to either the createch or tech samples using the procedures discussed earlier.

Table 2.4. Companies identifying as creative, tech, both or neither
(bold significant at 0.05 level)

	Createch	Tech	Total
…a tech business	39%	48%	44%
…a creative business	**14%**	**3%**	**8%**
…a creative and tech business	44%	37%	40%
…neither tech nor creative	**3%**	**12%**	**8%**

Among the companies identifying only as creative, many of these came from the CICP/AotF sample rather than the GtR sample, suggesting perhaps that those companies may have been newer to tech R&D prior to their engagement with these programmes.

The high number of businesses identifying as both tech and creative in the sample (40% overall) is partly, but not wholly, accounted for by companies that identified as having substantive operations in the IT/software sub-sector: 43% of such firms identified as both creative and tech.

When we repeat the analysis presented in the following sections using companies' self-perceptions as the basis for distinguishing createch from tech firms, we again find fewer significant distinctions.

3

Technology, innovation and R&D practices

Technology

Given our focus on technology-intensive companies, one key aim of our study is to understand the technologies that are used by companies in our sample, and whether there are technologies that were more likely to be used by the companies that we have identified as createch using the procedure we have set out above. The technologies we list for firms to select from in the questionnaire are drawn from previous published studies on createch as well as input from the Challenge Director for the AotF and CICP programmes.[26]

Table 3.1.Use of technologies
(bold significant at 0.05 level)

	Createch	Tech	Overall
Advanced computing, including special and distributed computing, computer vision and signal processing	51%	45%	47%
Artificial Intelligence and machine learning, including generative content, synthetic media, natural language processing, GANs, cognitive computing, etc.	46%	36%	40%
Virtual, augmented or mixed reality, including haptics	**37%**	**14%**	**24%**
User centred design methods, including interactive, interface and service design	**61%**	**37%**	**48%**
Realtime game engines or virtual production technologies	**37%**	**8%**	**20%**
5G or other advanced network technology	25%	22%	23%
Crypto technologies, including blockchain and (NFTs)	**11%**	**1%**	**6%**

Table 3.1 shows that there are relatively high levels of penetration among advanced computing and artificial intelligence/machine learning techniques across both the createch and tech samples. The table also highlights those technologies that are especially common in createch as compared with the other tech firms. The differences in technology use highlighted in bold are also statistically significant when regressed against demographic controls, including employment, age, region and creative sector. User-centred design methods are the most widely identified form of technology used in the createch sample, with more than 60% of createch respondents using these technologies. While user-centred design methods are also the second most commonly cited technology among other tech firms,[27] the proportion of companies using these technologies is much lower, at 37%.

We also find substantially more use of virtual, augmented or mixed reality (VR/AR/MR), virtual production and realtime game engines, and, perhaps surprisingly, crypto technologies among createch businesses. In all of these cases the differences between createch and tech firms are statistically significant. 5G and other network technologies are used by similar shares of tech and createch businesses. Taken together, it appears that VR/AR/MR, user centred design and virtual production are defining technologies behind the createch sample, with 72% of respondens using one or more of those technologies.[28] Notably, this effect is not driven wholly by AotF, which was specifically targeted at VR/AR/MR companies and technology; adoption of these technologies is also more frequent in companies from the GtR and other samples. We also note that on average createch companies use more of these technologies (2.9) than those in the tech sample (2.1), but this finding may reflect the nature of the technologies we are asking about, as these are selected because of their relevance to createch.

The nature of innovation and R&D in createch and tech firms

Innovation can take many different forms; while product innovation (that is, new products or services) is perhaps most peoples' notion of innovation, others include: process innovations (e.g., new, improved ways of producing or distributing products or services); organisational or management innovations (e.g., new ways organising staff or managing workers); or marketing innovations (e.g., new ways of selling products). Previous work from the Creative Radar project has identified that creative industries businesses tend to be involved in a range of types of innovation beyond new product development. But do these trends from regular creative industries firms hold in createch firms, and are those innovation patterns in turn different from other tech companies?

Table 3.2. Types of Innovation between createch and tech
(bold significant at 0.05 level)

	Createch	Tech	Overall
...products or services	89%	86%	87%
...production processes or distribution activities	51%	41%	45%
...organisational or management practices	**52%**	**37%**	**43%**
...marketing practices	43%	32%	37%
None of these	3%	9%	6%

Table 3.2 suggests that there are differences in the % share of createch and tech firms innovating in organisational and management practices, but upon controlling for size, age, sector and region no statistically significant differences remain. On this basis, we conclude that the types of innovation that tech companies engage in are broadly in common with innovation patterns in createch firms.[29]

While the types of innovation appear to be relatively similar between the createch and tech samples, this does not necessarily speak to the nature of the innovations these companies are making. There is a growing body of evidence that explores those cases where innovations relate to design or aesthetics, rather than technology or functionality.[30]

Table 3.3. Functional and aesthetic nature of innovations
(bold significant at 0.05 level)

	Createch	Tech	Overall
Just functional or technical features	**20%**	**37%**	**30%**
Just aesthetic or design	0%	2%	1%
Both technical and aesthetic	**69%**	**46%**	**56%**

We ask firms about the extent to which their innovations are functional or aesthetic, and our results are partially in line with expectations, but in other ways perhaps surprising. As expected, the tech firms are more likely to identify their innovations as largely functional or technical in nature, and createch are more likely to report their innovations as being both functional and aesthetic. But, nearly half (46%) of the tech sample say their innovations are both technical and aesthetic, suggesting that aesthetic innovation, while more common in createch, is prevalent in other technology companies too. These results are also robust to conditional analysis controlling for demographic factors.

Organisation of R&D activity

Given our finding that createch companies are more likely to innovate along aesthetic as well as as functional lines, it is natural to ask whether the ways in which R&D itself is executed differs between the two groups.

We find that which individuals do R&D in the organisation, as well as how that R&D is funded, differs significantly between createch and other tech firms.

Tables 3.4 and 3.5 show that createch companies are significantly less likely to have a dedicated R&D department and are substantially more likely to have R&D undertaken by different people at different times, in contrast to having employees with official responsibilities for carrying out R&D. Createch companies are also less likely to have dedicated budgets for R&D, as seen in Table 3.5. This is consistent with evidence around budgeting practice in the creative industries, as seen in the 2020 DCMS Creative Industries R&D Survey.[31] Both of these findings are robust to the inclusion of control variables.

Together these are important findings, as they indicate a key difference from the model of R&D whereby specialised workers, spending a dedicated capital R&D budget, do R&D as part of their daily jobs.[32] The implications of this difference for createch firms are subject to interpretation; one is that it is potentially harmful for innovation, as it means that createch companies lack steady-state capacity for R&D investment. An alternative interpretation is that these companies might benefit from a more flexible approach to managing the resourcing of their R&D investment, in line with the well-known project-based nature of much creative industries activity.[33] In any case, such a flexible approach may make accessing formal sources of innovation finance, including R&D tax credits, more challenging[34] (as we discuss below).

Table 3.4. Who does R&D in your organisation?
(bold significant at 0.05 level)

	Createch	Tech	Overall
A dedicated R&D department	**8%**	**20%**	**14%**
Employees throughout the organisation with specific responsibilities for R&D, but not in a dedicated R&D department	41%	44%	43%
Different people at different times, i.e. there are no official responsibilities for carrying out R&D in your organisation	**51%**	**34%**	**41%**

Table 3.5. Use of specific R&D budgets
(bold significant at 0.05 level)

	Createch	Tech	Overall
Has an R&D budget	**25%**	**37%**	**32%**

When we compare annual investment levels in R&D between createch and tech (Table 3.6), we see that R&D spend in both createch and tech companies is substantial, as can be seen when expressing R&D as share of turnover: this measure of R&D intensity is very high, at 32% and 42% respectively. Createch firms invest significantly less (controlling for demographic factors) than other tech firms. However, this result is explained by the presence of companies in the CICP/AotF sample, which are generally smaller and have proportionately lower R&D spend levels (when only createch firms sourced from GtR are considered, R&D investment levels are still on average lower than in other tech firms but the difference is no longer statistically significant at the 5% level).

Interestingly, Table 3.6 also shows that R&D spend has on average broadly held up over two years amongst these companies.

Table 3.6. R&D spend of createch and tech companies
(bold significant at 0.05 level)

	Createch	Tech	Total sample
Mean R&D spend	**£344k**	**£194k**	£280k
Median R&D spend	£200k	£100k	£140k
Median R&D intensity (R&D spend as share of turnover)	42%	32%	36%
Median Growth in R&D over past two years	0%	0%	0%
None of these	**3%**	**9%**	**6%**

Beyond the issue of investment levels, a further question relates to how this R&D spending is allocated by createch and tech companies. Companies might choose to invest in equipment, for example, or invest in staff time for R&D. We ask companies to break down the relative share of their spending on R&D into different categories. Table 3.7 shows that compared with other tech firms, createch companies spend proportionately more of their R&D in the form of salaries and wages for R&D workers and significantly less on materials and supplies. These differences are significant to conditional analysis using demographic controls. The former is consistent with the view that R&D processes within the creative industries generally tend to be more human capital intensive than in other sectors if, say, practice-oriented experimentation is more interpretative and intuitive than R&D in other sectors (Bakhshi, 2022[35]).

Table 3.7. Mean percent R&D spending on areas of R&D activity
(bold significant at 0.05 level)

	Createch	Tech	Overall
Salaries and wages for workers doing R&D	**66%**	**55%**	**59%**
Materials, supplies and services used for R&D within the company	**13%**	**19%**	**16%**
Capital goods for R&D such as land, buildings, equipment, etc.	7%	9%	8%
Expenditure on R&D performed outside the company	14%	18%	16%

Collaboration partners

Another key mechanism by which firms engage in R&D is through collaboration with other partners. It is well established in the innovation studies literature that collaborations with suppliers and customers for R&D are a vital way through which knowledge is shared.[36] We ask our respondents about their collaboration partners, and the results in Table 3.8 show the share of companies collaborating with different types of partners.

Table 3.8. Percent respondents reporting collaborating with types of partners for R&D

	Createch	Tech	Overall
Suppliers or sub-contractors	69%	67%	68%
Clients or customers	75%	79%	77%
Other businesses in the same industry	56%	58%	57%
Universities or HEIs	61%	69%	65%
None of these	6%	6%	6%

The results confirm the importance of collaborations for R&D activity – for createch and other tech firms alike. But, interestingly, no significant differences in collaboration patterns are reported between the groups of companies. In particular, the most common form of R&D collaboration is with clients for both createch and tech companies, and high percentages of both firms report collaborating with universities and Higher Education Institutions (the latter not surprising given that most companies are identified through their participation in UKRI-funded R&D).

Fields of R&D

The reported importance of aesthetic innovation activities in both tech but especially createch firms discussed above underscores the interest in collecting data on the fields of knowledge of R&D and in understanding any differences in this regard between createch and other tech companies. It would appear ex ante that createch, given its creative component, might draw upon a wider range of knowledge domains. The prospect that createch firms might be drawing Arts, Humanities and Social Sciences (AHSS) as well as Scientific domains in their R&D is important from a policy perspective, as the official definition of R&D used by the UK Government currently for R&D tax relief purposes does not recognise R&D in AHSS fields.[37]

Asking businesses to provide quantitative information on R&D by knowledge domain is a cognitively demanding task, especially considering our finding that R&D is for many firms a distributed workforce activity. This is one reason why the OECD reports that relatively few countries publish data on R&D by field of knowledge in their R&D accounts.[38] Given this challenge, we consider our attempt to ask firms questions about the knowledge field of their R&D as experimental. To do this, we draw upon the 'Fields of R&D' (FORD) categories developed and used by the OECD[39] for classifying expenditure on R&D at national levels.

We begin by asking companies if their R&D draws on any of a number of stated fields, as described in Table 3.9. The findings confirm (unsurprisingly) that a substantial majority of companies in our sample – both createch and other tech – draw upon Science and Technology disciplines in their R&D activities. The results are robust to conditional analysis controlling for demographic factors as above.

Table 3.9. Percent companies drawing upon disciplines in their R&D
(bold indicates significant differences at the 0.05 level)

	Createch	Tech	Overall
Science & Technology (S&T)	**84%**	**93%**	**89%**
Any non S&T discipline	**71%**	**50%**	**60%**
Design	**60%**	**46%**	**52%**
Any Creative Arts, Humanities or Social Sciences disciplines	**48%**	**18%**	**32%**
Social Sciences	**25%**	**12%**	**17%**
Humanities	**16%**	**4%**	**9%**
Creative Arts	**38%**	**6%**	**20%**
Other	6%	4%	5%

The results confirm the importance of collaborations for R&D activity – for createch and other tech firms alike. But, interestingly, no significant differences in collaboration patterns are reported between the groups of companies. In particular, the most common form of R&D collaboration is with clients for both createch and tech companies, and high percentages of both firms report collaborating with universities and Higher Education Institutions (the latter not surprising given that most companies are identified through their participation in UKRI-funded R&D).

Table 3.10. Frequency of multiple disciplines in R&D
(bold significant at 0.05 level)

	Createch	Tech	Total
Science and Technology only	**28%**	**47%**	39%
S&T and one other discipline	**30%**	**36%**	34%
...and two other disciplines	**22%**	**14%**	18%
...and three other disciplines	**9%**	**2%**	5%
...and four other disciplines	**9%**	**0%**	4%
...and five other disciplines	**1%**	**0%**	1%

There is an established academic literature discussing the benefits of the combination of multiple skills for innovation; companies that are able to access a wide range of knowledge and skills are able to widen their search activities and thus identify novel solutions to problems.[40] Table 3.10 shows that createch companies are significantly more likely to draw upon more than one discipline in their R&D activities. These relationships are also significant when controlling for demographic factors. Taken together with the aforementioned literature, which points specifically to innovation dividends from the interplay of technological and creative skills,[41] this suggests that multidisciplinary or interdisciplinary innovation may be more important for createch than for other tech firms.

Intellectual property

There are a variety of ways in which innovative businesses can capture value from their innovations. These may include formal measures of protection, such as patents or copyright, or informal measures such as use of non-disclosure agreements, or trade secrecy. Given that the revenue generation of createch firms in our sample relies more on software, content and experiences, as well as business services, we would expect that createch firms would be less likely to patent compared with tech firms. This is confirmed in Figure 3.11 below, which shows use of different forms of IP in our sample.

Figure 3.11. Use of intellectual property
(bold significant at 0.05 level)

	Createch	Tech	Overall
Patents	**23%**	**46%**	**36%**
Trademarks	41%	45%	43%
Design rights	22%	22%	22%
Any formal IP (excluding copyright)	**58%**	**69%**	**65%**
Copyrights	55%	43%	48%
Any formal IP (including copyright)	72%	78%	75%
Non disclosure and confidentiality	86%	88%	87%
Informal means	75%	72%	74%

More broadly we find that createch companies are significantly less likely to protect their IP using formal measures of IP that require registration (e.g. patents, trademarks and design rights[42]). They are much more likely to use secrecy, non-disclosure and other informal techniques than those that require registration. While a substantial number of companies cite copyright as a form of IP they use, copyright's passive nature means that this could be interpreted as awareness of copyright as a means of protecting innovation, rather than its use per se.

On balance, these findings point to createch companies' relatively limited ability to directly appropriate value from their R&D, which then necessitates the need for informal modes of protection.

4

R&D workforce and staffing of innovative activities

We now consider the R&D workforces employed by createch and other tech companies. In particular, wee ask companies how many of their employees have R&D in their job description, and for those who do not have employees with R&D in their job description, how many employees work on R&D[43] (Table 4.1). The median company in both tech and createch samples employs four R&D workers, with no statistically significant difference between the groups (there are more marked differences in employment between GtR- and AotF/CICP-sourced createch firms, however again these differences are not significant). Among companies that do not have workers in R&D-specific roles, the figures are similar, with over 71% of respondents' employees working on R&D even if it is not in their job descriptions.

Table 4.1. Number of R&D workers
(bold significant at 0.05 level)

	Tech	Createch	Createch GtR	Createch AotF/CICP	Total Sample
Median number of workers with R&D in job description	4	4	4	2	4
Median R&D workers with R&D in job description as share of total workforce	63%	67%	75%	50%	67%
Median number of workers doing R&D but not in job description	4	5	6	3	4
Median share workers doing R&D but not in job description as share of total workforce	73%	67%	73%	60%	71%

Although the levels of staff involved in R&D, either in formal roles or not, are quite similar, it is important to consider the implications of this for the actual levels of spending. As shown below in Table 4.2, the differences in R&D spend per R&D worker between createch and tech firms is stark, with median R&D spend for R&D workers in the tech sample nearly twice that of those in the createch sample. This is significant to controls. The sample sizes in play in the table below are relatively small, nonetheless the clear suggestion is that createch companies are spending substantially less on R&D workers' wages – at least when it comes to specialist R&D workers. Intuitively, spending on wages per R&D worker are in general lower for workers without R&D in their job description, as such workers are likely to be doing R&D alongside their other roles.

Table 4.2. Median R&D spending on wages per R&D worker[44]
(bold significant at 0.05 level)

	Tech	Createch	Createch GtR	Createch AotF/CICP	Total Sample
Workers with R&D in job description	**£33k**	**£19k**	£18k	£25k	£28k
R&D workers without R&D in job description	£15k	£14k	£17k	£10k	£15k

R&D workers with PhDs

Understanding whether the higher educational qualifications of R&D workers are different between createch and other tech companies is another area of interest, insofar as it may be able to tell us something about how Higher Education can support their needs. Typically attention in the UK focuses on the flow of STEM PhDs into industry, less so the Arts, Design, Humanities and Social Sciences. To understand business R&D needs we ask companies about their employment of PhD workers. Table 4.3 shows that, on average, createch firms at 29% are less significantly likely than other tech firms (46%) to have workers with a PhD (and this is robust to the inclusion of control variables). Similarly, while founders are disproportionately likely to hold a PhD this is significantly more likely in tech firms (Table 4.4), again robust to controls. Notwithstanding these apparent differences between createch and tech companies, the data confirm the importance of PhD qualifications to the R&D workforce.

Table 4.3. Percent R&D workers with a PhD
(bold significant at 0.05 level)

	Createch	Tech	Overall
% R&D workers with a PhD	**29%**	**46%**	**40%**

Table 4.4. Percent companies with founder with a PhD
(bold significant at 0.05 level)

	Createch	Tech	Overall
Founder has a PhD	**36%**	**56%**	**46%**

For those companies that employ workers with PhDs, we ask about the research discipline of their PhDs. While companies with PhD workers in the tech sample are almost entirely from S&T backgrounds, a significantly lower number of createch companies (though still the clear majority at nearly 80%) have S&T backgrounds. Notably there is no particular prevalence of PhDs in AHSS subjects working in R&D in either createch or tech companies.

Freelancers in R&D

It is well known that freelance work is highly prevalent in the creative industries, with one in three workers in the UK's creative industries being self-employed.[45] While freelancers are common in many parts of the supply chain in creative industries, there is little previous evidence about what role freelancers play, if any, in creative industries R&D specifically.[46] To address this gap in knowledge we ask respondents to our survey about their use of freelancers.

Table 4.5. Percent companies using freelancers for R&D

	Createch	Tech	Overall
Use of freelancers for R&D	49%	44%	46%

Table 4.5 shows that nearly half of respondents across the whole sample say they make use of freelancers for R&D, which is substantially higher than we expected given the lack of attention in the previous literature. The levels of freelancer use for R&D is not significantly different between the createch and tech samples. In the tech sample, there is a significant disparity between IT and other tech firms, with 57% of IT companies using freelancers for R&D, compared to 33% of non-IT tech companies. Table 4.6 suggests that the numbers of freelancers used on average is however significantly greater in createch companies, a relationship that is significant also when controlling for employment, age, sector and size. It also shows that createch freelancers make up 40% of R&D workers and 33% for tech workers.

The high share of AotF/CICP companies containing freelancers is striking but is not robust to conditioning on firm demographics. Overall, this underscores the importance of freelancers in the R&D process in these companies. It also points to a puzzle, as the use of freelancers in knowledge production functions should be inherently riskier in createch firms given the difficulty of protecting innovations using formal IP protections, as discussed in the previous section. In particular, the prevalence of freelancers would seem to introduce for createch firms the possibility of unwelcome knowledge spillovers, as freelancers without specific loyalty to the company might take their insights from work with one company to their work with a rival. Given the weak appropriation environment in which these companies are operating,[47] this is a finding that bears further investigation. One possibility is that companies using freelancers manage the risks of misappropriation by greater use of non-disclosure agreements, and this is indeed what we find, with 91% of companies with freelancers for R&D using non-disclosure agreements, compared to 84% for those not using freelancers, which is robust to controls.

Table 4.6. Use of freelancers and R&D workers
(bold significant at 0.05 level)

	Tech	Createch	Createch GtR	Createch AotF/CICP	Overall
Mean number of freelancers working on R&D	**2**	**4**	**5**	4	3
Median number of freelancers working on R&D	2	2	3	2	2
Median Freelancers as share of overall R&D workforce (where employees have R&D in job descriptions)	33%	40%	33%	55%	33%

5

Access to public and private finance and barriers to R&D

We now look at access to other resources, particularly finance, used by companies and the barriers that they face. Finance has long been understood to be a barrier to R&D-intensive and innovative firms,[48] so we ask createch and other tech companies about their use of finance, including access to public sources of finance such as R&D tax credits given the potential relevance of the findings for policy.

R&D tax credits

We ask companies if they have applied for R&D tax credits in the past three years, and find that the clear majority (78%) of respondents have done so (Table 5.1).

Table 5.1. Companies applying for R&D tax credits

	Createch	Tech	Overall
Companies applying for R&D tax credits	82%	72%	78%
% of applicants for R&D tax credits who received them	96%	100%	98%

All 162 of the tech companies that have applied for R&D tax credits have received them, while the 4 companies that have been rejected are from the createch sample.

We ask the minority of companies that have not applied for R&D tax credits their reasons for not doing so, keeping in mind the limited sample size (only 44 createch firms and 36 tech firms), Table 5.2 presents the reasons most frequently given.

Table 5.2. Reasons cited by non-applicants for R&D tax credits for not applying for the scheme (bold significant at 0.05 level)

	Createch	Tech	Overall
Unaware of R&D tax credits	**18%**	**0%**	**10%**
Aware, but did not think they would qualify	**26%**	**54%**	**39%**
Aware, but did not have time, resource or expertise to complete the application	29%	29%	29%
Other reasons	24%	14%	19%

All of the companies saying that they are not aware of the R&D tax credit scheme are in the createch sample, which potentially points to a need for clearer messaging to these companies in the createch space about the availability of this tax credit. The most commonly cited reason across the samples is the concern that the company would not qualify, though it is more often cited by tech companies. Both the responses regarding awareness and perception of qualifying are robust when conditioned on control variables, but the limited numbers of observations mean that this finding should be treated with some caution. The other common concern is lack of time, resource and expertise to complete the application, which is similar across the two groups of companies.

Private and public finance

We ask companies about whether their business has obtained different sources of finance over the past three years. As expected, given the nature of our sample frame (which is based on companies receiving public support from UKRI and IUK), Table 5.3 shows that the most common form of finance was from public sources, followed by founders' personal capital and only then by private sources. We find no statistically significant differences in the experience of createch and other tech firms, with the exception that createch firms are significantly less likely to have secured private finance when controlling for demographics.

Table 5.3. Percent of companies using types of finance in previous three years

	Createch	Tech	Overall
Public finance	62%	59%	60%
Private sources of finance	27%	33%	30%
Personal capital of founders	40%	39%	40%
No external funding	22%	22%	22%

Among the sources of public finance (and notwithstanding R&D tax credits as mentioned above), the most commonly cited source of public finance is Innovate UK and UKRI (as would be expected, as these are the source of our sample frame for all of the tech and most of the createch businesses[49]). Beyond these, the most commonly identified sources of support are local and devolved national governments, universities and the European Commission. While the use of several sources differs significantly between createch and tech firms as seen in Table 5.4, these differences are not robust when controlling for demographic variables.

Table 5.4. Sources of finance used by companies indicating receiving public support (bold significant at 0.05 level)

	Createch	Tech	Overall
Innovate UK and other UKRI	**69%**	**82%**	**76%**
UK central government	21%	18%	19%
Local and devolved national governments	**35%**	**23%**	**28%**
Non UK governments	**5%**	**10%**	**8%**
European Commission	18%	25%	22%
Universities	**30%**	**18%**	**23%**
Not for profit organisations	**9%**	**11%**	**10%**
The NHS	6%	3%	4%
None of these/other	0%	3%	1%

Among companies that have received private sector investment, there are a range of types of capital available. The most common is equity, which has been used by 41% of companies, a significantly disproportionate number of which are tech companies (although this effect appears to be driven by the createch firms sourced from AotF/CICP, which are less likely to receive external finance more generally, possibly due to their smaller average size). We also note that companies with R&D budgets are more likely to have received private finance than companies without R&D budgets, and this is particularly the case for equity investment. Table 5.5 also shows that createch firms are more likely to have secured debt finance, but the difference is not statistically significant. Almost one-quarter of companies say they use private capital in the form of self-finance. Interestingly, companies without dedicated R&D workers are less likely to have used personal capital, which potentially indicates a lean, bootstrapping strategy to avoid the need for innovators to rely on personal capital as identified in Di Novo et al (2022). Thirty-three per cent of companies without dedicated R&D workers had injected personal capital into the business, compared to 43% of companies with R&D workers, which was significant to controls.

Among the sources of public finance (and notwithstanding R&D tax credits as mentioned above), the most commonly cited source of public finance is Innovate UK and UKRI (as would be expected, as these are the source of our sample frame for all of the tech and most of the createch businesses). Beyond these, the most commonly identified sources of support are local

and devolved national governments, universities and the European Commission. While the use of several sources differs significantly between createch and tech firms as seen in Table 5.4, these differences are not robust when controlling for demographic variables.

Table 5.5. Types of finance used by companies receiving external finance

	Createch	Tech	Overall
Debt	36%	24%	28%
Peer to peer or crowdfunding	10%	4%	6%
Equity (including VC)	31%	47%	41%
None (self-funding)	17%	26%	23%
Other	19%	21%	20%

Barriers to R&D activities

Finally, we ask companies to rate a number of potential barriers to their R&D activities, which we summarise below in Table 5.6. Respondents rate these on a scale from 1-5, with 1 being 'Not a problem' and 5 being 'A very big problem'

Table 5.6. Participant ratings of barriers to R&D activities

	Createch	Tech	Overall
Costs of R&D is too high	2.5	2.4	2.5
Insufficient availability of finance	3.1	2.8	2.9
Lack of qualified personnel for R&D activity	2.3	2.2	2.3
Market is dominated by established businesses	2.5	2.3	2.4
Insufficient access to R&D infrastructure	1.9	1.8	1.8
Lack of access to research centres, universities or HEIs	1.8	1.6	1.7

It is striking that there are no statistically significant differences in the perceptions of barriers between createch and tech companies. This suggests that the challenges facing the companies are in general common to both groups. Indeed, the rank ordering of the issues in the survey is virtually identical. The only minor difference comes from decomposing the tech sample into IT and other tech companies; here the non-IT tech companies are significantly more likely to view R&D infrastructure as a barrier than either createch or IT/software-only companies. The most highly cited issue is access to finance, followed by costs of doing R&D and dominance of established businesses. Overall, this suggests that the barriers to undertaking more R&D for createch companies are probably best understood as barriers facing all technology companies.

6

Discussion and conclusion

Createch is a relatively recent concept, broadly taken to mean those parts of the creative industries that are particularly technology-intensive. In our report, we set out to propose a clear, practicable definition of createch businesses that researchers and policymakers can use, and apply it in a new firm survey of technology companies to understand the nature of createch R&D, how it is managed and resourced and whether (and how) firms undertaking createch R&D differ from other firms undertaking technology-related R&D.

We define createch businesses as:

> 'Those creative businesses where the development of new technologies or the adaptation of existing technologies in a novel way is a significant part of their business activities, and where creative businesses do not include creative businesses working exclusively in the IT/software sub-sectors.'

Using a survey of 150 createch firms and 203 non-createch tech firms, we reveal the shared features and behaviours of createch and other tech firms which suggest that in many ways both groups of companies can be understood as part of the same phenomenon. However, we also uncover substantial and meaningful differences, which suggest that our definition of createch as a distinct industrial segment of the wider technology sector has merit.

In general, at least in our sample, controlling for size, age, sectoral variation and region, we find that createch and other tech companies have similar profiles in terms of employment, turnover and growth. Furthermore, their levels of investment in R&D (and therefore R&D expressed as a % of sales, or R&D intensity) are also broadly of the same magnitude. We find that on the whole createch businesses are no less likely to be able to access finance than tech companies, and more generally that they perceive the same barriers to R&D (and in order of importance) as perceived by other tech firms.

But we identify substantial differences in the nature and organisation of R&D between createch and other companies. For example, createch firms are much more likely to make use of user-centred design technologies and realtime game engines or virtual production environments in their R&D activities. They are also significantly more likely to invest in R&D via spending on staff and contractor time than investing in physical assets or equipment. Strikingly, they are much less like to rely on specialised R&D departments and manage and account for their R&D using dedicated budgets, but instead are more likely to have R&D roles distributed across individuals within the organisation who do not have R&D roles specified in their job titles. Createch firms also on average employ more freelancers for R&D than tech companies.

Turning to the knowledge domains within which firms undertake R&D, we find as expected that the vast majority of both createch and tech firms draw on Science & Technology (S&T), however createch firms are far more likely to draw on Arts, Humanities and Social Sciences (AHSS) fields (though we note a substantial minority of other tech firms – roughly one-fifth – also draw on AHSS).

In sum, our data paint a nuanced picture of a createch sector which displays many of the characteristics of the wider tech sector but which in the nature and organisation of R&D differs from it in important ways. This potentially has a number of policy implications.

In the first instance, and most obviously, because UK createch firms have a not dissimilar recent growth trajectory to that of other tech firms, their future growth potential should be prioritised, in the same way UK policymakers have prioritised other tech firms in recent years.

A second broad potential policy implication of our work relates to public R&D support. The most common barrier to R&D identified by both createch and other tech firms is in accessing finance for R&D. Policymakers addressing how to design interventions to help createch companies overcome financial market failures will need to pay heed to the differing ways in which they organise their R&D, such as the fact that R&D staff costs account for a greater share of R&D investment and that disproportionate amounts of R&D activity are undertaken by workers who are not traditional R&D specialists (as reflected in the absence of R&D as a term in their job descriptions).

The fact that proportionately larger numbers of createch firms do not set dedicated R&D budgets presents obvious challenges for R&D accounting which are essential to address if createch firms are to benefit from R&D tax relief. Recognition by HMRC and its tax inspectors that createch R&D has these particular features would be a tangible step toward ensuring more createch companies conducting R&D are able to access R&D tax relief. Moreover, our findings suggest that acknowledgement of the importance of AHSS R&D by ending its exclusion from the scope of R&D tax relief would appear to have benefits across the wider tech sector – not just for createch companies.

The distinctive features of R&D in createch businesses also points to the value of targeted createch R&D programmes, building on the experience of the Creative Industries Clusters Programme and Audience of the Future Fund. The AHRC's new Co-STAR research and innovation infrastructure initiative is a further example of how funders can support companies to invest and expand their createch R&D activities.

We hope this report makes for a timely contribution for UK policymakers as they revisit growth priorities, including a Sector Vision for the creative industries.

Appendix: Details of survey sample business characteristics

Creative sub-sectors

Among the creative sub-sectors represented in our createch sample (per the self-reported survey question rather than SIC code extracted from matching the companies to records in the FAME database), there are a range of the nine DCMS sub-sectors represented, as seen below in Table A.1. Companies are allowed to select multiple sub-sectors in which they operate. A majority of the companies in the sample report to have some IT/software activities (though note as before that this is not used for screening into the createch sample). The sub-sectors most widely represented are Product and graphic design, Architecture and Film & TV.

Table A.1. Creative sub-sectors represented in createch sample (n=158)

DCMS Sub-sector	% Createch
Architecture	37%
Advertising and marketing	22%
Product and graphic design	46%
Fashion design	7%
Video games	21%
Film, TV, radio, photography	28%
Publishing	13%
Museums, galleries and libraries	18%
Music, performing and visual arts	18%

Employment

Table A.2 shows that overall, our sample is made up predominantly of companies that would be considered micro- (<10) or small- (<50) sized. Differences in the size of the companies in our sample as measured by employment are not statistically significant between the different groups. While as expected the AotF/CICP createch sample are a little smaller on average, this difference is not statistically significant. On average, past employment growth was zero to negative, depending on company group, no doubt reflecting the wider challenges faced by UK companies in the two years in question (which coincided with the COVID-19 crisis). On average, employment growth is lower for createch companies, but this difference is not statistically significant when we control for differences in age, sectoral characteristics and region between the createch and tech samples.

Table A.2. Employment demographics of sample

	Tech	Createch	Createch GtR	Createch AotF/CICP	Total Sample
Mean employment	17	17	18	12	17
Median employment	8	7	7	6	8
Min/max employment	2/450	2/500	2/500	2/90	2/500
Median 2 year employment growth	0%	-11%	-10%	-15%	-5%

Turnover

As with employment, the reported turnover of companies is not statistically different between the createch and tech samples. While the tech companies again on average have higher turnover, this is not statistically significant once we control for age, sector characteristics and region. As with employment, firms in our sample have experienced zero to negative turnover growth in the recent two-year period, though controlling for employment, age, sectoral characteristics and region the weaker growth in createch firms is not significant.

Table A.3. Turnover of tech and createch samples

	Tech	Createch	Createch GtR	Createch AotF/CICP	Total Sample
Mean turnover	£1.49m	£944k	£976k	£845k	£1.25m
Median turnover	£450k	£335k	£310k	£363k	£375k
Min/max turnover	£0/£80m	£10k/£15m	£10k/£15m	£10k/£8m	£0/£80m
Median 2 year sales growth	0%	-9%	-10%	-7%	0%

It is notable in our sample that while there are a small number of pre-revenue companies or companies with very low levels of turnover, generally speaking the companies in our sample – both createch and tech – are revenue-generating businesses. This is probably a function of the slightly older age of companies in our sample, as well as a potential screening effect associated with the firms having received support from UKRI.

Sales productivity

When we examine sales productivity (sales per employee), we also see no statistically significant difference between the createch and tech samples. As with turnover, createch sales productivity is on average lower, but this is not statistically significant. Notably, while both employment and turnover showed declines over the past two years, the median turnover per employee remained consistent across our sample. These sales productivity figures may appear to be relatively low, but are roughly in line with previous firm survey evidence.[50]

Table A.4. Sales productivity of sample

	Tech	Createch	Createch GtR	Createch AotF/CICP	Total Sample
Mean sales productivity (turnover/ employee)	£90k	£82k	£88k	£67k	£87k
Median sales productivity (turnover/ employee)	£60k	£50k	£44k	£54k	£56k
Median 2 year sales productivity growth	0%	0%	0%	-5%	0%

Age

The distribution of age of the companies in the sample is presented below in Table 2.6. There are a relatively low number of young companies in the survey, with 84% of the companies in the sample being more than six years old, and over one-quarter being more than 20 years old. While this may at first sight appear surprising given the perception of high levels of start-up activity in the tech economy in general, the importance of older firms is partly explained by a substantial share of our respondents having been sourced from GtR, which is likely to have more established firms (insofar as more established firms are likely to have greater capacity to partner on IUK/UKRI-funded R&D collaborations). Notably, the age distribution of our sample is in line with recent telephone surveys of creative industries firms that one of the authors of this report has conducted (Creative Radar[51]) and likely reflects challenges in being able to identify or recruit younger firms into completing surveys. Notwithstanding all of these qualifications, the table below shows that with the exception of GtR, there is broad alignment in the age distribution of different groups in our sample .

Table A.5. Company age of survey respondents

Age	Tech (GTR)	Createch GTR	Createch AoTF	Createch CICP	Createch Crunch base	Total Sample
3 years or less	4%	5%	10%	6%	18%	6%
4-5 years	8%	12%	10%	19%	6%	10%
6-10 years	32%	30%	30%	29%	29%	31%
11-20 years	29%	24%	40%	26%	29%	28%
Over 20 years	27%	29%	10%	19%	18%	26%

Customers

The companies in our sample – whether createch or tech – work with a range of types of client, including other businesses, consumers, the public sector and universities (Table A.6). While virtually all respondents sell to businesses, createch companies are more likely to sell their products or services to consumers and to universities. This is robust to controlling for employment, age, sub-sector and region.

Table A.6. Percent respondents selling products/services to types of customers
(bold differences between createch and tech significant at 0.05 level)

	Createch	Tech	Overall
Consumers	**30%**	**18%**	**23%**
Businesses	96%	92%	93%
Public sector	57%	56%	57%
Universities	**56%**	**45%**	**50%**

Table A.7. Percent respondents selling products/services to types of customers by Tech/CI SIC codes

	Tech SIC (n=175)	Creative Industries SIC (n=175)	Other SIC (n=11)	Total
Consumers	14%	31%	27%	23%
Businesses	91%	95%	100%	93%
Public sector	55%	57%	72%	57%
Universities	48%	50%	72%	50%

Table A.8. Percent respondents selling products/services to types of customers by creative industries sub-sector

	Architecture (n=74)	Advertising (n=67)	Design (n=116)	Fashion (n=14)	Games (n=36)
Consumers	35%	34%	41%	36%	33%
Businesses	100%	96%	97%	100%	97%
Public sector	58%	72%	59%	36%	58%
Universities	58%	57%	63%	64%	67%
	Film & TV (n=53)	**IT & Software (n=201)**	**Publishing (n=27)**	**Museums & Libraries (n=38)**	**Performing Arts (n=33)**
Consumers	38%	19%	37%	37%	42%
Businesses	100%	93%	100%	97%	97%
Public sector	66%	61%	67%	76%	61%
Universities	72%	50%	59%	38%	76%

Revenue sources

We also ask respondents about the sources of their revenues, with figures described below in Table A.9. Companies can choose more than one of these options, and from these we see that the vast majority of both createch and tech companies generate at least some income from sales of business services, with 75% of firms in the sample using these in some way. Createch firms are significantly more likely to generate revenues from selling or licensing software and from putting on live performances and experiences and significantly less likely to sell physical products. These differences are robust to analysis with demographic control variables.

Table A.9. Types of products/services sold by respondents
(bold differences between createch and tech significant at 0.05 level)

	Createch	Tech	Overall
Selling or licensing content	44%	38%	40%
Selling or licensing software	**56%**	**29%**	**41%**
Sales of business services	79%	71%	75%
Sales of physical products	**34%**	**51%**	**44%**
Revenues from live performances, experiences etc.	**18%**	**4%**	**10%**
Sales of physical products	**1%**	**2%**	**2%**

Geography

We do not screen companies on the basis of geography given the limited sample from multiple sources we are using, but in the event all regions and devolved nations are represented (Table A.10). We note that a substantially higher number of companies from our sample – quarter – come from London, compared with 10% for our tech sample, consistent with the finding in Mateos-Garcia (2021a)'s analysis of GtR data.

Table A.10. UK Geographical distribution of sample, by devolved nation and region

Region	Createch	Tech	Overall
East Midlands	3%	4%	4%
East of England	7%	12%	10%
London	25%	10%	16%
North East	1%	4%	3%
North West	13%	10%	11%
Northern Ireland	4%	2%	3%
Scotland	6%	8%	7%
South East	13%	19%	16%
South West	9%	14%	12%
Wales	6%	2%	4%
West Midlands	6%	7%	7%
Yorkshire & Humber	8%	6%	7%

References

Bakhshi, H. (2022) *The Art of R&D*. Creative Industries Policy and Evidence Centre. https://www.pec.ac.uk/research-reports/the-art-of-r-and-d

Bakhshi, H., Breckon, J. and Puttick, R (2021) Business R&D in the arts, humanities and social sciences. London: Creative Industries Policy and Evidence Centre and Nesta. https://pec.ac.uk/policy-briefings/business-r-d-in-the-arts-humanities-and-social-sciences

Bakhshi, H., Djumalieva, J. and Easton, E. (2019) The creative digital skills revolution. London: Creative Industries Policy and Evidence Centre and Nesta. https://www.pec.ac.uk/research-reports/the-creative-digital-skills-revolution

Bakhshi, H. and Mateos Garcia, J. (2013). The Innovation Game. London: Nesta https://www.nesta.org.uk/report/the-innovation-game/

Breschi, S., Lissoni, F., & Malerba, F. (2003). Knowledge-relatedness in firm technological diversification. *Research Policy*, 32(1), 69–87. https://doi.org/10.1016/S0048-7333(02)00004-

Brunow, S., Birkender, A., & Rodriguez-Pose, A. (2018). Creative and science oriented employees and firm-innovation: a key for smarter cities? Cities, 78, 27–38. https://doi.org/10.1016/j.cities.2018.02.002

Caves,R. (2000) *Creative Industries: Contracts between Arts and Commerce*. Cambridge, MA: Harvard University Press.

Charter, M. and Davis, T. (2022) Createch in the UK: Sustainability policy linkage & company activity. London: Centre for Sustainable Design https://cfsd.org.uk/wp-content/uploads/2022/07/CT_Published_July-2022.pdf

Davies, J. and Ward Dyer, G. (2019) 'The relationship between artistic activities and digital technology development', Panel for the Future of Science and Technology, European Parliament https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634440/EPRS_STU(2019)634440_EN.pdf

Di Novo, S., Fazio, G., Sapsed, J. & Siepel, J. (2022) Starving the golden goose? Access to finance for innovators in the creative industries. *Journal of Cultural Economics* 46, pages 345–386 https://doi.org/10.1007/s10824-022-09448-5

Easton, E., Beckett, B. (2021) Freelancers in the Creative Industries. Creative Industries Policy & Evidence Centre, https://pec.ac.uk/policy-briefings/freelancers-in-the-creative-industries

Eisenman, M. (2013): Understanding Aesthetic Innovation in the Context of Technological Evolution. *Academy of Management Review*, 38, 332–351, https://doi.org/10.5465/amr.2011.0262

Hall, B.H. (2002), The Financing of Research and Development, *Oxford Review of Economic Policy*, Volume 18, Issue 1,p. 35–51, https://doi.org/10.1093/oxrep/18.1.35

Hall, B.H. and Lerner, J., (2010), The Financing of R&D and Innovation, in Hall, B. and Rosenberg, N. (eds) *Handbook of the Economics of Innovation*, p. 609-639. https://doi.org/10.1016/S0169-7218(10)01014-2

Jeppeson,L, and Lakhani, K., (2010) Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science* 21(5):1016-1033. https://doi.org/10.1287/orsc.1090.0491

Mateos-Garcia, J. (2021a) Createch Activity in the UK. London: Creative Industries Policy and Evidence Centre and Nesta. https://pec.ac.uk/research-reports/createch-activity-in-the-uk

Mateos-Garcia, J. (2021b) Mapping the R&D landscape for creative technologies. London: Creative Industries Policy and Evidence Centre and Nesta. https://pec.ac.uk/policy-briefings/mapping-the-r-d-landscape-for-creative-technologies

Mateos-Garcia, J., Bakhshi, H., and Lenel, M. (2014) A Map of the UK Games Industry. London: Nesta https://www.nesta.org.uk/report/a-map-of-the-uk-games-industry/

Nesta/Tech UK (2015), A Dynamic Mapping of the Information Economy, London: Nesta/Tech UK https://www.nesta.org.uk/report/dynamic-mapping-of-the-information-economy-industries/

Quintana-García, C., & Benavides-Velasco, C. A. (2008). Innovative competence, exploration and exploitation: the influence of technological diversification. *Research Policy, 37*(3), 492–507. https://doi.org/10.1016/j.respol.2007.12.002

Siepel, J., Camerani, R., Pellegrino, G., & Masucci, M. (2016). *The fusion effect: the economic returns to combining arts and science skills*. London: Nesta. https://www.nesta.org.uk/report/the-fusion-effect-the-economic-returns-to-combining-arts-and-science-skills/

Siepel, J., Camerani, R., Masucci, M., Velez Ospina, J., Casadei, P. and Bloom, M. (2020) Creative Radar: Mapping the UK's creative clusters and microclusters. Multiple: Creative Industries Policy and Evidence Centre and The University of Sussex. https://pec.ac.uk/assets/publications/PEC-Creative-Radar-report-November-2020.pdf

Tether, B. (2002). Who co-operates for innovation, and why: An empirical analysis, *Research Policy, 31*(6),p. 947-967 https://doi.org/10.1016/S0048-7333(01)00172-X

Tether, B. and Tajar, A. (2008); Beyond industry–university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base. Research Policy 37(6-7) 1079-1095 https://doi.org/10.1016/j.respol.2008.04.003

Un, C.A., Cuervo-Cazurra, A. and Asakawa, K. (2010), R&D Collaborations and Product Innovation. *Journal of Product Innovation Management*, 27: 673-689. https://doi.org/10.1111/j.1540-5885.2010.00744.x

Endnotes

1. https://www.gov.uk/government/statistics/dcms-sector-national-economic-estimates-2011-to-2020/dcms-sector-national-economic-estimates-2011-2020
2. https://technation.io/a-decade-of-uk-tech/#introduction
3. Davies and Ward Dyer (2019) 'The relationship between artistic activities and digital technology development', Panel for the Future of Science and Technology, European Parliament https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634440/EPRS_STU(2019)634440_EN.pdf
4. As seen in David Cameron's Blueprint for Technology report in 2010 (https://www.gov.uk/government/publications/blueprint-for-technology) and the Creative Industries Sector Deal in 2018 https://www.gov.uk/government/publications/creative-industries-sector-deal
5. For instance two reports by Tech Nation for the Creative Industries Council: https://technation.io/the-createch-report-2021/ and https://technation.io/the-createch-report-2021-part-2/#jobs-and-skills
6. The Government's 2021 Plan for Growth highlighted the role for technologies to drive growth in the creative industries https://www.gov.uk/government/publications/build-back-better-our-plan-for-growth/build-back-better-our-plan-for-growth-html
7. Bakhshi et al (2019).
8. https://technation.io/the-createch-report-2021/
9. https://technation.io/the-createch-report-2021-part-2/#jobs-and-skills
10. Charter and Davis (2022).
11. We refer to createch as a sector in that, per our definition in Section 2, we consider firms that have createch R&D as a key part of their business. They may have other sectoral characteristics in line with their other activities, but we view them as a 'sector' in this sense.
12. Mateos Garcia (2021a).
13. Of the companies in creative industries sub-sectors, companies in IT and software sub-sectors were most common, representing two-thirds of the companies in the sample.
14. Mateos Garcia (2021b).
15. Mateos-Garcia (2021b) used keywords relating to content and media; data and AI; creative services; computing, and blockchain derived from topic modelling of GtR R&D project descriptions.
16. OECD Frascati Manual 2015 https://www.oecd-ilibrary.org/science-and-technology/frascati-manual-2015_9789264239012-en
17. Currently in the UK there are two surveys that capture R&D-active businesses. The UK Innovation Survey, which is aligned with the EU Community Innovation Survey, randomly samples businesses with more than 10 employees, with sampling focus on sectors known to be more likely to invest in innovation and R&D. The Business Expenditure on R&D (BERD) survey samples a regular pool of business known to invest heavily in R&D alongside a random sample. The methodology behind BERD is currently under review, but an initial response by the ONS highlighted possible undercounting of R&D by small and medium-sized businesses in the current system (https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/articles/comparisonofonsbusinessenterpriseresearchanddevelopmentstatisticswithhmrcresearchanddevelopmenttaxcreditstatistics/2022-09-29).
18. It is for this reason that the ONS's UK Business Expenditure on R&D (BERD) survey currently uses as its sampling strategy the same group of (generally large) firms that are known to be R&D intensive, alongside a rotating sample of other businesses.
19. https://gtr.ukri.org/

20. The GtR data includes the company registration number (CRN) for all companies. With the companies in the sample frame we then matched these against the FAME company database, which provided registration addresses and other Companies House details including SIC code. These addresses were used to telematch against commercial databases of company telephone numbers, allowing us to then identify companies with a known, contactable telephone number.
21. The precise wording used was *"R&D is defined as comprising of creative and systematic work undertaken in order to increase the stock of knowledge and to devise new applications of available knowledge."*
22. These were slightly amended from the DCMS list so respondents were asked yes/no question about whether they had activities in architecture; advertising and marketing (separate from advertising or marketing their own products/services); product and graphic design (for customers, not for their own products); fashion design; video games; film, TV, video, radio and photography; IT, software and computer services (excluding video games); publishing; museums, galleries and libraries; and music, performing and visual arts.
23. For example, Mateos-Garcia, Bakhshi and Lenel (2014) report that the primary activity of only 35% of companies in their mapping of UK video games companies correspond to the dedicated SIC codes for the video games industry.
24. Note from the methodology section that while we do use SIC codes in the initial sample design, we use respondents' reported sub-sectors for sub-sectoral classification.
25. See https://www.gov.uk/government/publications/dcms-sectors-economic-estimates-methodology/dcms-sector-economic-estimates-methodology and https://www.nesta.org.uk/report/dynamic-mapping-of-the-information-economy-industries/ respectively.
26. We are particularly grateful to Andrew Chitty for feedback on the structuring and wording of these questions.
27. Respondents also cite a range of other technologies, such as robotics/automation, 3D technology (printing/scanning), simulations, IoT (internet of things), science based tech (biotech/chemtech), GPS/mapping technologies, etc. but these are in smaller proportions and generally were among companies in the tech sample.
28. Of the remaining sample that don't use these technologies, half use a combination of the other technologies listed, and half used other technologies that are not amongst those listed.
29. While our sample is clearly different in that it is based on companies known to be R&D-active, comparison may be made to the most recent UK Innovation Survey (https://www.gov.uk/government/statistics/uk-innovation-survey-2021-report, where 45% of companies are reported to be innovation active in any way, with 20% of respondents engaging in product innovation and 16% engaging in process innovation.
30. These include research on design innovation (e.g. Thomke (1998); D'Ippollito (2014); Roper et al (2016); aesthetic innovation (e.g. Eisenman 2013; Filitz et al (2015)) and what Stoneman (2011) refers to as 'soft innovation', relating to design or aesthetic innovations, which Stoneman argues are particular characteristics of the creative industries.
31. https://www.gov.uk/government/publications/rd-in-the-creative-industries-survey/rd-in-the-creative-industries-survey
32. R&D departments were themselves organisational innovations pioneered by Thomas Edison, based on the idea that departments with dedicated staff and resource would be allow time to be protected for discovery activities. (We thank Bruce Tether for this point). This model would later be referred to by innovation scholars as Schumpeter mode 2, from the later work of the economist Joseph Schumpeter, who argued later in his career for the importance of R&D labs in larger companies as sources of innovation.
33. See Caves (2000).
34. See also Bakhshi and Mateos Garcia (2013).
35. Bakhshi (2022).
36. See for instance Tether (2002) and Un et al (2010).
37. See Bakhshi (2022) and Bakhshi et al (2021).
38. See https://stats.oecd.org/Index.aspx?DataSetCode=GERD_FORD; only 14 OECD members provide any granular information on this topic, with only five producing estimates for each year in the period 2012-2020.

39. See the OECD Frascati Manual 2015 for FORD categories; we amend ours to provide granularity to our questions.
40. See for instance Breschi et al (2003); Quintana-Garcia and Benavides-Velasco (2008), Jeppeson and Lakhani (2010).
41. See Siepel et al (2016), and Brunow et al (2018).
42. Given space and timing constraints we do not differentiate between registered and unregistered design rights in our questionnaire. We note that the share of respondents citing design rights is higher than figures found in similar surveys: the DCMS R&D survey found 15% of respondents using registered or unregistered design rights, and Creative Radar found 8%.
43. We had not originally anticipated that so many respondents would indicate that their workers doing R&D did not have R&D in their role descriptions, and as such did not ask this question initially. Instead, after fieldwork was completed the survey company re-contacted those respondents who had indicated they had these types of workers and had consented to be contacted again to ask how many such workers they employed. Of the 125 companies who had consented to be contacted, 94 (75%) responded to this further question, of which were 50 createch firms and 44 tech firms. Several interviewees mentioned though that their figures were approximate given the flexible way they staffed their R&D activities.
44. We calculate this by multiplying R&D spend by share of R&D spend on wages, and dividing this by the number of R&D workers.
45. Easton and Beckett (2021).
46. While there is an established academic literature on consultants in R&D (e.g.Tether and Tajar 2008), the distinction between consultancy and freelancing may be thin, particularly in the context of AHSS R&D. This remains an area for further exploration.
47. There are also sub-sectoral differences. Within the createch sample, freelancers working on R&D make a significantly greater share relative to the company workforce in film and TV, games, performing arts and museums and libraries.
48. See for instance Hall (2002) and Hall and Lerner (2010). More specifically in the creative industries, see Di Novo, S. et al (2022).
49. This figure is not 100% because being listed on GtR does not necessarily mean the company received UKRI funding; companies might, for instance, be listed on bids as collaborators and not directly receive any UKRI funding.
50. The Creative Radar surveys (Siepel et al 2020, 2021) (which did not specifically screen for R&D activity, and only consider creative industries businesses) reported a median sales productivity of £62,000 among companies pre-COVID-19, and sales productivity of £35,000 in the pandemic year 2020-2021.
51. In the Creative Radar survey, 9% of respondents were 5 years old or younger.

Creative Industries
Policy & Evidence Centre

Led by **nesta**

Creative Industries Policy and Evidence Centre (PEC)
58 Victoria Embankment
London EC4Y 0DS

+44 (0)20 7438 2500

enquiries@pec.ac.uk

@CreativePEC

www.pec.ac.uk

ISBN: 978-1-913095-75-8