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R&D, Design and Innovation: Examining the links in the Creative Industries.

Insights for Managers and Policymakers from the DCMS's 2020 survey

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Table of Contents

About the Creative Industries Policy and Evidence Centre (PEC) 1
About the author 1
Table of Contents 2
Abstract 3

1. Introduction and Context 4
2. Methods 6
3. Engaging - and not engaging - in R&D, its constituent activities 8
4. Investing in "Other Innovation Activities" 15
5. Introducing Innovations 19
6. The Impact of Innovations on the Creative Industry Organisations 26
7. Discussion and Conclusions 29

Acknowledgements 32
References 32
Appendix: Survey Methodology 34

Abstract

This paper examines the responses from Creative Industries Organisations (CIOs), 89% of which were firms, to the DCMS's 2020 survey on new product and service development activities. The findings show that, perhaps contrary to expectations, many CIOs engage in research and development (R&D), including that which is oriented towards resolving scientific and technological uncertainty. Furthermore, CIOs that engage in R&D, and especially applied research, are more likely to introduce product innovations. Alongside R&D, CIOs also typically engage in several other innovation related activities, such as design, training and the acquisition of advanced machinery and equipment. Furthermore, those that combine these 'other innovation activities' with R&D are more likely to introduce innovations. Combinations of R&D and other inputs are especially strongly associated with the introduction of more novel, 'new to the market' innovations, and with the introduction of more impactful innovations. These analyses suggest: (1) that 'conventional', or 'textbook' approaches to managing innovation can be successfully applied within the creative industries; (2) that CIOs seeking to innovate should not only undertake R&D, but also other activities including design, training and market launch activities. Furthermore, rather than support R&D alone, policies should support 'packages' of innovation related activities, given the extent of research engagement among CIOs, the content of this research needs to be better understood.

This paper includes an analysis of data that is used with permission.
Source: Department for Digital, Culture, Media and Sport
https://www.gov.uk/government/publications/rd-in-the-creative-industries-survey

1. Introduction and Context

For at least a quarter of a century, the 'creative industries' have been attracting interest from policy-makers and academics. In 1997, the newly established Department for Culture, Media and Sport (DCMS) (as it then was) identified the 'creative industries', for which it was responsible, as those: "which have their origin in individual creativity, skill and talent and which have the potential for wealth and job creation through the generation and exploitation of intellectual property." The question of what is, and is not, a 'creative industry' has been debated extensively (see Bakhshi 2020 for a discussion), but need not detain us here. Suffice to say that in the UK at least, and especially among policy-makers, this question was resolved with the adoption of Bakhshi et al.'s (2013) 'dynamic mapping' methodology, which identifies as 'creative industries' those with particularly high shares of people engaged in creative occupations relative to their total workforce. As well as the sector as a whole, the DCMS also recognises nine 'creative industry sub-sectors' (DCMS, 2013).

As a set of industries with a distinctive label or identity, it stands to reason that the creative industries should, in some ways, be different from 'other industries', for example, in their managerial challenges, or opportunities. On the other hand, the businesses within them are still businesses, and therefore face generic 'business challenges', such as the need to at least break-even to survive. Against this backdrop this paper examines the engagement of UK creative industry organisations (CIOs) in research and development (R&D), design and other 'innovation related activities'. The set of activities examined might be regarded as 'conventional' innovation related activities, which are widely associated with innovation in science and engineering-based industries, so the question arises as to what extent these 'conventional innovation activities' are also undertaken by creative industries firms.

By examining the extent to which conventional inputs are used to develop innovations in the creative industries, we do not deny that other forms of innovation, such as aesthetic or 'soft' innovation (Stoneman, 2010), content innovation (Handke, 2004), artistic innovation (Galenson, 2006), 'hidden' (Miles and Green, 2008) and non-technological innovation (Martin-Rios and Parga-Dans, 2016) may also exist and may rely on other inputs. While several studies have identified these forms of innovation and found them to be particularly prominent in the creative industries, there are few studies which examine innovation activities in the creative industries using conventional or standard measures (exceptions include Mueller et al., 2009; Chapain et al., 2010; Protogeou et al., 2017; Gkypali and Roper, 2018).[1] In relying on insights gathered through the use of standard tools for measuring (product) innovation, the approach followed in this paper is very similar to Mueller et al. (2009), who examined innovation and its drivers in Austria's creative industries. We recognise that because we use standard tools our approach highlights the similarities rather than the differences between innovation in the creative industries and other industries. Put differently, our approach essentially examines the extent to which creative industries organisations engage in 'mainstream' approaches to innovation, as opposed to 'maverick' approaches (Jones et al., 2016).

[1] Jones et al (2016, p. 754) also note that: "There is a dearth of systematic understanding of who drives innovation in the creative industries". Similarly, Lassen et al. (2017) observe that to date, "there is little empirical evidence on the specificities and commonalities of entrepreneurship in the creative industries relative to other sectors."

Specifically, the paper provides an analysis of a survey undertaken in 2020 and commissioned by the DCMS on "new product and service development activities undertaken by creative businesses". In seeking respondents, the survey was careful not to mention the word innovation and, although its primary purpose was to explore the extent to which creative industry firms are, or claim to be, engaged in R&D, it did not mention research and development (R&D) either. Responses were gathered from 625 creative industry organisations based in the UK, 89% of which were firms.

The remainder of the paper is structured as follows. Section 2 outlines the methods used. Section 3 assesses the extent to which creative industry organisations (hereafter CIOs) report having engaged in "research and development" (R&D) and its constituent activities. Although engaging in R&D is not necessary for innovation, R&D is widely seen as an investment in knowledge which underpins innovation; the latter involving the application of new ideas. This section also examines the extent to which CIOs engaged in "activities aimed at advancing science and technology by resolving scientific or technological uncertainties", which is a much narrower conceptualisation of R&D taken from the OECD's Frascati Manual (OECD, 2015) and which is used by the HMRC in the UK for defining what R&D qualifies for R&D tax relief. Econometric models, which associate organisational characteristics, such as size, sector and region to engagement in these activities, will be presented. This section also highlights why some CIOs did not engage in R&D.

Section 4 examines the extent to which CIOs engage in 'other' (standard) innovation related activities, such as acquiring computer hardware and software, and other advanced machinery and equipment, acquiring licences and engaging in training, design, market research and/or advertising.

Section 5 relates engaging in R&D and 'other' innovation related activities to the introduction of innovations, including 'product or service innovation' and 'process and organisational innovation'. Through econometric models, this section also reveals the statistical associations between engaging in these various activities and the introduction of innovations. Section 6 then links the use of these different inputs to innovation to the impact of the innovations on the CIOs. Specifically, this analysis seeks to identify the factors associated with introducing innovations that had a relatively high impact on the CIOs and distinguishing these from those associated with relatively little impact.

Section 7 concludes the paper with a discussion of the findings in relation to R&D and innovation management practices as well as policy approaches to support innovation in creative industry organisations.

2. Methods

As mentioned in the introduction, this paper examines the data gathered by a survey commissioned by the Department for Digital, Culture, Media and Sport (DCMS) in 2020. The main objective of the survey was to examine the extent to which Creative Industry Organisations (CIO) engage in research and development (and to a lesser extent innovation) although neither 'R&D' nor 'innovation' were used when introducing the survey to possible respondents.

The survey was based on 'standard measures' of innovation, which are those outlined in the OECD's Oslo Manual (OECD, 2018) and which are implemented in the UK's biannual Innovation Surveys (UKIS) (Gkypali and Roper, 2018). These 'standard measures' of innovation originated in studies of innovation in manufacturing, and there is some controversy as to the extent to which they are appropriate for studying innovation in less 'product-oriented' sectors, such as services (Coombs and Miles, 2000). However, no attempt was made to adapt the survey questions to any supposedly distinctive or peculiar characteristics of the creative industries. Essentially, the DCMS survey adopted an assimilation approach (Coombs and Miles, 2000) which assumes that the methodology originally designed to gather data on product-oriented firms is applicable to creative industry organisations. It is worth noting here that the UKIS also covers most of the creative industries, and also applies an assimilation approach. The DCMS could have relied on the larger UKIS to gain insights into innovation in the creative industries, but chose not to do so for three reasons: First the UKIS's sectoral coverage of the creative industries is incomplete. Second, the UKIS only includes private enterprises with at least 10 employees, whereas about 95% of creative industry organisations are smaller than this. Third, by commissioning their own survey, the DCMS could ask additional questions, including disaggregating research and development (which we discuss below) and ask some more specific questions relevant to the creative industries and policies to support them.

The sampling strategy covered all nine of the officially recognised creative industry sub-sectors. These vary widely in size, and the smaller sub-sectors were deliberately over sampled to achieve valid representation for each in the survey. The survey also covered organisations of all sizes, including one person organisations; larger organisations were deliberately over sampled to ensure these were adequately represented. Further details on the sample and methods are provided in an appendix to this paper.

Data was gathered by CATI – computer assisted telephone interviewing, with respondents informed that they were being contacted by an independent market research company on behalf of the Department for Digital, Culture, Media and Sport and that the purpose of the call was to carry out "a study on new product or service development activities undertaken by creative businesses in the UK … [where this] could include development of physical products, services, content and experiences " (Bird et al., 2020, p. 34). The survey was undertaken in the spring of 2020, with data collection almost completed before the UK went into lock-down for the first time as a result of the Covid-19 pandemic.[2]

[2] This paper complements a report by OMB Research which has also provided an analysis of the data from this survey (Bird et al., 2020). That report is wide-ranging and covers all of the findings of the survey, reporting and discussing the findings only on the basis of descriptive statistics

This was a voluntary survey, and as with any voluntary survey it is not possible to know whether those who chose to participate constitute an unbiased sample of the population. We stress however that neither R&D nor innovation were mentioned by the interviewer in the recruitment of respondents. This was a deliberate choice intended to reduce the potential for bias towards more R&D and/or innovation active organisations that mentioning these terms in the recruitment of respondents may have induced.

3. Engaging - and not engaging - in R&D, its constituent activities

The interviewer asked the respondents if their organisation had undertaken any research and development (R&D) activity in the last twelve months, reading out the following definition of R&D:[3]

'Research and Development' (R&D) covers three types of activity; basic research, applied research and experimental development. It comprises creative and systematic work undertaken in order to increase the stock of knowledge, and in order to devise new applications of available knowledge. R&D does not [emphasised] include routine changes to existing products, services or processes.

Just under half (47%) of the respondents claimed that their CIO had engaged in R&D in the past year. Only six said they "did not know", a remarkably small number. In this paper, we take the answers given by the respondents at face value, even if there may be reasons for doubt (e.g., the high proportion reporting having engaged in "basic research").[4]

Also notable is that the vast majority (93%) of R&D active organisations said they had undertaken R&D within their organisation, although a quarter had bought R&D on a contracted basis.[5] Only a small proportion (8.6%), however, had a specific budget for R&D.

Table 1 reports the simple proportions of organisations that claimed to have engaged in R&D by the creative industry sub-sector. Unsurprisingly, claimed engagement in R&D was most widespread among IT, software and computer services firms, which is the most technologically-oriented of the CI sub-sectors. At least a third of CIOs in all of the sub-sectors claimed to have engaged in R&D.

[3] Derived from the UK Business Expenditure on R&D (BERD) survey, which draws the definition from the OECD's Frascati Manual (OECD, 2015).

[4] To be clear, we are not suggesting the respondents were lying, we are suggesting that they may not have understood what terms such as "basic research" mean, at least according to the OECD's Frascati Manual.

[5] By comparison, only 16% of the firms in all sectors that responded to the UK Innovation Survey (UKIS) of 2019 reported having engaged in internal R&D, with 5% having bought-in R&D services. This may suggest that participation in the DCMS survey was biased towards R&D active CIOs.

Table 1: Overall extent of engaging in R&D and its constituent activities by CI sub-sector

	N.	Engaged in R&D	Basic Research	Applied Research	Experimental Development	Advance S&T
All sectors	**625**	**47%**	**21%**	**36%**	**31%**	**13%**
Advertising & marketing	86	34%	20%	23%	17%	7%
Architecture	93	44%	20%	38%	25%	20%
Crafts	19	53%	32%	47%	47%	n.a.
Design	96	38%	21%	25%	23%	5%
Film, TV, video, radio, etc.	67	49%	22%	30%	30%	6%
IT, software & comp. services	126	70%	26%	61%	55%	26%
Museums, galleries & libraries	41	33%	9%	17%	22%	13%
Music, performing & visual arts	24	45%	19%	33%	27%	8%
Publishing	73	45%	10%	33%	25%	12%

The survey also asked those organisations that had not engaged in R&D why this was the case, and recorded the answers verbatim. Once categorised, the most frequently given reason was that R&D was considered irrelevant to the organisation's activities. Overall, about two-thirds of the R&D non-performers held this view.[6] Table 2 provides some illustrative quotes from organisations in the various CI sub-sectors as to why they did not engage in R&D.

Perceived irrelevance aside, the main reasons for not engaging in R&D included:

- The organisation was too small [58].[7]
- The organisation was too time-pressed [40].[8]
- That the CIO lacked the financial resources to engage in R&D or to buy it in [43].

Other, less commonly identified reasons included: (1) that there was no client demand for it [15][9] and (2) the owners were approaching retirement or in the process of winding-down the business [12]; as these businesses would subsequently close there was "no point" in investing in the future which R&D is understood to be. Meanwhile, a small number (18) declared that they were not engaged in R&D although their answers indicate that they may have been, depending on how R&D is understood.

[6] One, for example, stated: "It is unnecessary as all required tools are already created". Another reported: "We are applying tried and true technologies to reduce the risk to clients".

[7] In most cases these organisations mentioned their absolute (small) size as being a barrier to participating in R&D; a few indicated they had much larger competitors and considered that there was little point in trying to compete through R&D against much better resourced organisations.

[8] These CIOs said they did not engage in R&D because they were fully consumed in undertaking their day-to-day tasks. A few went further, declaring themselves to be in survival mode. This highlights that some slack is required to engage in R&D.

[9] These organisations indicated they only undertake activities for which a client demand exists.

Table 2: Reasons given for not engaging in R&D

Illustrative quotes – Not engaged in R&D due to there being no necessity to do so, or not being appropriate to the businesses' activities
By sector ● **Advertising and Marketing:** We are an advertisement agency, so it is not relevant to the current service provided // We are a creative agency, so research and development is not an inherent part of our field // We work in PR, so it is not necessary. It is more about contacts, knowledge and creativity. ● **Architecture:** We are an architectural design business, not ground-breaking. We must meet the requirements of the local council // I don't need to as an architect. I just build with already existing products. ● **Design:** I do graphic design, unless I develop new software, which I just buy currently, I can't see how R&D activities would apply to my business. ● **Film, etc.:** My industry is film and video production, so R&D is really not applicable to me. // Because it is a photography company and it is not relevant. ● **IT, etc.:** We create web solutions for clients. We use existing technologies and design work around that // We help design websites, where the processes are fairly static, so there is no need for it. ● **Publishing:** We don't really need it. We rely on authors to come to us and we are inundated with manuscripts // We offer translation and that process is rather established. ● **Museums and Galleries:** Because we have one hundred year old steam locomotives so there is not much room for R&D // We are a museum; we don't initiate research. ● **Music, Performing and Visual Arts:** R&D into producing oil painting is not part of [our] agenda // We are a choral society and sing classical songs exclusively with no need to develop new music to sing // We are users of audio equipment, not developers of those.

To examine further engagement (and non-engagement) in R&D among these CIOs we estimated a logistic regression. A logistic regression uses a set of variables to find associations between these and a binary outcome variable; that is whether or not something happened. In our case this 'something' is engaging in R&D, which is coded 1, whereas not engaging is coded 0. The set of predictor variables included in the model were as follows:

- Whether the organisation was **recently established**, defined as established in the last five years (coded 1) or longer established (coded 0). There are no strong grounds for expecting young or established CIOs to differ in their engagement in R&D, and this variable can be considered a "control".

- The **size** of the organisation, in terms of the number of people active in it, including the owners, employees and others. We classified CIOs into six mutually exclusive size-bands, ranging from 1 person to over 30. Larger organisations can be expected to be more likely to engage in R&D, as they are more likely to have the organisational and financial capital to do so and larger volumes of output over which to spread the costs and benefits of R&D. An interesting question is at what point does size not matter with regard to engaging in R&D?

- Whether the organisation was a firm or a **non-firm**, such as a charity or volunteer organisation. As we do not have strong grounds for expecting that firms or non-firms will be more, or less likely to engage in R&D, this can be considered to be a control variable. Almost 90% of the organisations in the analysis were private firms.

- The **sub-sector** of activity. The DCMS recognises nine creative industry sub-sectors, and each organisation was classified to one of these. Some of these sectors are more technologically-oriented than others. For example, 'Software and IT services' is more technologically-oriented than, say, Crafts, and we would anticipate that the more technologically-oriented sectors are more likely to engage in R&D. One sector is used as the reference sector against which the others are compared; we use 'Advertising and Marketing' as the reference sector.

- We also include the government office region (NUTS 1) in which the CIO was (primarily) located. Partly because the number of responses by region varied widely (from 159 in London, and 136 in the South East region, to 13 in Wales and 6 in Northern Ireland), and partly because – with reference to the Government's 'levelling-up' agenda - we were interested in any difference between organisations based in London and the South East on the one side and the rest of the UK on the other, we classified the organisations' locations to one of five **regions**: London; the South East; the Midland plus South West and East of England; the North of England (North West, Yorkshire and the Humber, and North East); and to Scotland, Wales and Northern Ireland. London is used as the reference region against which the others are compared.

The estimated model is reported in Table 3 (All R&D). In summary this found that:

The propensity to engage in R&D increases with organisational size up until around 6 people, after which it does not increase further. Overall, one and two person organisations were less than half as likely as larger CIOs to engage in R&D. This demonstrates that, as anticipated, organisational size matters for engagement in R&D.

Sector also matters. In particular, and as expected, relative to the reference sector of Advertising and Marketing, CIOs engaged in IT, Computer Software and related activities were about four-times as likely to engage in R&D, while CIOs engaged in Film, TV and related activities, and perhaps surprisingly Crafts, were about twice as likely. Architecture CIOs were also somewhat more likely to have engaged in R&D. Organisations engaged in the remaining four sub-sectors (Design, Publishing and Museums, Galleries and Libraries and Music and the Arts) do not differ significantly from those in Advertising and Marketing.

Table 3: Modelling engaging in R&D, its constituent activities, and Market Research

	All R&D	Basic Research	Applied Research	Exp'al Dev't	Advance S&T	Market Research
	Exp(B)	Exp(B)	Exp(B)	Exp(B)	Exp(B)	Exp(B)
Young organisation	0.86	1.55	1.00	0.99	0.69	1.56
One person	0.39**	0.51	0.51*	0.55	0.23***	0.27***
Two people	0.45**	0.39**	0.53	0.51*	0.14***	0.38**
Three to five people	0.63	0.67	0.81	0.67	0.44*	0.55*
Six to ten people	1.08	0.75	1.53	1.68	0.75	0.93
Eleven to thirty people	0.95	0.87	1.31	1.11	1.06	0.85
Over thirty people	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Charity, etc. (not a firm)	0.73	0.43*	0.88	0.84	1.14	1.21
Advertising & Mktg	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Architecture	1.69*	1.04	2.29**	1.82	4.00***	0.48*
Crafts	2.72*	2.14	3.83**	5.43***	Disc.	1.11
Design	1.44	1.21	1.35	1.65	0.95	0.75
Film, TV, etc.	2.22**	1.23	1.62	2.42**	0.97	0.54
IT, Software, etc.	4.48***	1.38	4.88***	5.72***	3.88***	0.94
Publishing	1.63	0.48	1.64	1.74	1.62	1.34
Museums, Galleries, etc.	0.92	0.53	0.62	1.25	0.81	0.83
Music & the Arts	1.62	1.21	1.57	1.87	0.80	0.84
London	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
South East	0.59**	0.91	0.75	0.78	0.85	0.59*
Midlands, SW, EE	0.67*	1.15	0.88	1.03	1.56	0.71
Northern England	0.58**	0.59	0.75	0.74	1.91*	0.66
Scotland, Wales, N.I.	0.58*	0.82	0.59	0.89	0.95	0.70
Constant	1.15	0.42*	0.44*	0.29***	0.14***	0.98
Number of observations	619	613	611	612	618	625
Model Chi-square	66.5***	23.8 (n.s.)	72.7***	69.6***	70.0***	46.5***
-2 Log Likelihood	790.1	604.3	728.1	688.6	406.3	670.9
Nagelkerke R-sq.	0.136	0.059	0.154	0.151	0.199	0.105
Hosemer & Lemeshow	0.878	0.246	0.659	0.997	0.483	0.946

*** = significant at 1%; ** = significant at 5%; * = significant at 10%
Ref. = Reference sector, against which the others are compared
The figures reported are not the coefficients, but the exponents of the coefficients.

This particular model also finds significant regional differences, with the propensity to engage in R&D being about 50% higher among London-based CIOs compared with those located in the rest of the UK, including the South East of England. We will see that in this regard this model is exceptional; other models do not find differences in behaviour between London-based CIOs and those located elsewhere.

Meanwhile, younger CIOs are neither more nor less likely to engage in R&D than their older counterparts, and nor do non-firms (i.e., charities, volunteer organisations, etc.) differ significantly from firms with regard to engaging in R&D.

It is worth noting that the explanatory power of this model is modest, meaning that most of the variation in the data between participation or non-participation in R&D is not captured by the variables included in the model.

An advantage of the DCMS survey over the much larger UK Innovation Survey is that the DCMS survey asked its respondents whether their organisation had engaged in the three constituent activities that comprise R&D, namely 'basic research', 'applied research' and 'experimental development'. The UK Innovation Survey, by contrast, does not ask for this disaggregation.[10] The proportions that claimed to have engaged in each of these activities were high, with two-fifths (43.5%) of those that said they had engaged in R&D claiming to have engaged in 'basic research'; while three-quarters (75.5%) claimed to have undertaken 'applied research'; and two-thirds (65%) 'experimental development'.[11] That engagement in applied research exceeds experimental development is surprising, as the latter is normally understood to be the most widespread component of R&D. Table 1 reports the simple proportions of CIOs in each sub-sector reporting having engaged in each of these activities.

To examine the characteristics of the CIOs reporting having engaged (or not) in each of these R&D activities, we estimated the econometric model outlined above replacing 'All R&D' as the dependent variable with, respectively, 'basic research', 'applied research', and 'experimental development'. The estimated models are reported in Table 3. In summary, they found the following.

The model predicting engagement in '**basic research**' is statistically very weak, and the model as a whole is not statistically significant. The only characteristics that have any (statistical) explanatory power are that two person organisations and non-firms (i.e., charities, volunteer organisations, etc.) are less likely to engage in "basic research". These findings are intuitively understandable. Overall, however, as the model is not statistically significant, this set of independent variables does not explain the propensity to engage in 'basic research'. Engagement in this may instead be associated with other variables not included in this model, or may be very largely idiosyncratic to each CIO.

By contrast, the models for '**applied research**' and '**experimental development**' are both statistically significant (albeit with modest explanatory power) and show similar results. In particular:

- Sector matters. Unsurprisingly organisations engaged in IT, Computer Software and related activities were about five times more likely than firms engaged in most creative industries to engage in both of these activities. Rather more surprisingly, Crafts CIOs were also about 4 or 5 times more likely to engage in these activities. Architecture organisations were about twice as likely to engage in 'applied research', while Film, TV, etc. organisations were about twice as likely to engage in 'experimental development'. CIOs in the other

[10] For the DCMS survey, the interviewer clarified that these were, respectively: "undertaken primarily to acquire new knowledge without a specific application in mind" [basic research]; "work undertaken to acquire new knowledge with a specific application in mind" [applied research], and "work drawing on knowledge gained from research or practical experience, for the purpose of creating new or improved products or processes" [experimental development].

[11] Respondents could also state that they did not know. The "don't know" counts were low, as 6, 8 and 7 respectively for these questions. 77 organisations said they had engaged in all three types of R&D, while 83 had engaged in applied research and experimental development but not basic research.

sectors did not differ significantly from those in the reference sector: 'Advertising and Marketing'.

- There is some rather weak evidence that size matters, with very small one or two person organisations being significantly less likely to engage in these activities. However, given that R&D is generally understood to be an activity that favours larger organisations due to cost and benefit spreading, these size effects were remarkably weak.

- Neither of these models indicate that younger organisations were more or less likely to engage in either applied research or experimental development than their larger counterparts, and nor did 'non-firms' differ from firms. Furthermore, in contrast to the model for R&D as a whole, these models do not find any significant regional differences in the propensities of CIOs to engage in these activities.

Beyond asking about engaging in R&D as a whole, and in its three constituent parts, the DCMS survey also asked its respondents if their organisation had undertaken – during the past year – "any activities which aim to advance science or technology by resolving scientific or technological uncertainties".[12] This question did not refer to R&D explicitly, although resolving scientific and technological uncertainty is considered to be a core purpose of R&D (according to the OECD's Frascati Manual (OECD, 2015), and as determined by HMRC (Bakhshi and Lomas, 2017; Bakhshi et al., 2021)). About one in eight of the respondents (c.13%) claimed that their organisations had done so.[13] This activity was most widespread among IT, Software and Computer Service firms (26%), followed by Architecture firms (20%).

To investigate claimed engagement / non-engagement in this activity further, we re-estimated the same econometric model as above, this time using "engaged in activities which aim to advance science or technology [Advance S&T] by resolving scientific or technological uncertainties" as the binary variable to be predicted. The results from this model are also reported in Table 3.

The main findings of this model are:

- The smallest organisations are, understandably, much less likely to engage in this: one and two people organisations are about a fifth as likely as large CIOs to have done this. However, the propensity to engage flattens out after about 6 people such that six person CIOs are just as likely as much larger organisations to have sought to advance science or technology.

- Architecture and IT, Software, etc. organisations are about four times more likely to have engaged in these activities than CIOs in the other creative industry sub-sectors.

[12] If further clarification was required, the interviewer stated that: "An advance in science or technology means an advance in overall knowledge or capability in a field of science or technology. The purpose of this may be, for example, to introduce a new product, service or process, or to significantly improve an existing product, service or process".

[13] 538 said they had not; 7 indicated that they did not know. Note that while a lot smaller than the proportion indicating that they had engaged in R&D, this proportion is large relative to the 16% of firms responding to the UKIS 2019 that reported that they had engaged in internal R&D.

- There are no other differences (e.g., between younger and older organisations and between firms and non-firms) except the rather surprising (and statistically relatively weak finding) that CIOs in the North of England are more likely to engage in these activities. Quite probably this is a statistical aberration, rather than a true difference. There is no evidence that CIOs based in London and the South East are more likely to have engaged in these activities.

Overall, and in summary, these models find that the smallest (one and two person) organisations are less likely to engage in R&D, whereas after organisations get to around six people the propensity to engage in R&D, or its constituent activities, does not increase further. This suggests there are some scale advantages to engaging in R&D but these are more modest than might have been anticipated. There are also sectoral differences, with the more technologically oriented CIOs in IT, Software and related activities being the most likely to engage in R&D. Meanwhile, only for R&D as a whole is there evidence that London based organisations are more likely to engage in R&D.

4. Investing in "Other Innovation Activities"

While innovation typically involves the application of new ideas, which may be developed through investments in R&D, R&D investments alone may not be sufficient to develop innovations. Therefore, as well as asking about their engagement in R&D, the survey also asked the respondents whether or not their CIO had invested in a set of seven other innovation related activities. The set asked about is those identified by the OECD's 'Oslo Manual' (OECD, 2018) and included in the UK Innovation Survey; they are identified in Table 4 together with their overall frequency and frequency by sub-sector.

The most widely engaged in activity was investing in computer hardware or software, which two-thirds of the CIOs reported having done. The extent of this ranged from three quarters of IT, Software, etc. and Architecture firms, to a third of Crafts organisations. Second most widespread was investing in licences for technology and/or products/services, which half the CIOs claimed to have done. Third was 'any type of design', which two-fifths reported having done.[14]

A third of CIOs said they had invested in changes to marketing methods or product launch advertising, while a quarter had invested in market research and training specifically related to developing new products or services. The least widely undertaken, by a fifth of CIOs, was acquiring advanced machinery and equipment (other than computer hardware or software).[15]

[14] Somewhat surprising here is that the share of 'Design' CIOs investing in 'any type of design' is not considerably higher than across all sectors. Furthermore, at just under 60%, the extent to which Architecture CIOs engaged in design is also somewhat lower than expected

[15] These proportions are high relative to those reported by the UK Innovation Survey of 2019, which found that around 11% of all UK business had invested in design, about 12% in training for innovative activities, while only 2% had engaged in market research. This perhaps suggests that the response to the DCMS's survey was biased towards more dynamic CIOs.

Table 4: Overall extent of engaging in other Innovation Activities by CI sub-sector

	Computer hardware or software	Licenses*	Any type of design	Marketing methods or product launch advertising	Market research	Training to develop products	Advanced machinery or equip ment
All sectors	**66%**	**49%**	**41%**	**34%**	**26%**	**26%**	**21%**
Advertising, mktg	70%	58%	31%	41%	29%	28%	12%
Architecture	75%	53%	58%	18%	16%	29%	22%
Crafts	32%	21%	42%	37%	26%	21%	42%
Design	68%	52%	38%	32%	21%	19%	18%
Film, TV, video.	64%	46%	30%	28%	18%	18%	34%
IT, software, etc.	76%	56%	48%	31%	31%	36%	16%
Museums, etc.	54%	21%	25%	50%	38%	17%	29%
Music & the arts	49%	33%	41%	41%	32%	26%	27%
Publishing	63%	56%	42%	49%	37%	22%	10%

* Licences from third parties for technology or products/services

To examine the statistical associations between engaging in these activities and the characteristics of the CIOs, we estimated a set of logistic regressions using the same specification as used previously with regard to engaging in R&D. The estimates for the model for investing in market research is reported in Table 3 (as this is also a type of research), while the estimates for investing in the other six activities are reported in Table 5.

The model for investing in **market research** shows that the smallest CIOs are much less likely to do this, but that the propensity to engage in market research becomes flat after 6 people such that 30 person CIOs are no more likely to engage in market research than 6 people CIOs. Architecture CIOs, meanwhile, are about half as likely as those in other sectors to engage in market research, which possibly reflects their project-orientation. Overall, this model is statistically weak, meaning the variables included do not explain much of the variation between engaging, or not, in market research.

Design is an activity which is often close to R&D. The model for design shows that Architecture CIOs (3x) and those in IT, Software, etc. (2x) are significantly more likely to engage in design (but, surprisingly, Design sector CIOs are not more likely to have engaged in design). One person firms are about half as likely to have engaged in design, but two to five person CIOs are not significantly less likely to engage in design than much larger CIOs. There are no differences by region, nor between young and older CIOs, or between firms and non-firms.

In relation to the other activities, the following is a summary of the key observations:

- Crafts and Music and the Arts CIOs were less likely than other CIOs to invest in computer hardware and software, but were more likely to acquire other advanced machinery and equipment.

Table 5: Modelling engaging in "Other innovation activities", including design and training

	Computer hardware or software	Licenses	Any type of design	Marketing methods or advertising	Training to develop products	Advanced machinery/ equipment
	Exp(B)	Exp(B)	Exp(B)	Exp(B)	Exp(B)	Exp(B)
Young organisation	1.25	1.15	1.12	2.68***	1.10	1.18
One person	0.55	0.49*	0.47**	0.73	0.30***	0.53
Two people	0.87	0.46**	0.67	0.55	0.26***	0.55
Three to five people	0.78	0.56*	0.85	1.03	0.35***	0.70
Six to ten people	1.37	0.69	1.32	0.89	0.69	1.03
Eleven to thirty people	0.95	1.10	1.16	1.12	0.80	0.88
Over thirty people	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Charity, etc. (not a firm)	0.79	0.87	1.08	1.08	1.11	0.98
Advertising & Mktg	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Architecture	1.35	0.83	3.27***	0.31***	1.17	2.17*
Crafts	0.20***	0.22**	1.95	0.96	0.88	6.20***
Design	0.95	0.87	1.50	0.70	0.69	1.69
Film, TV, etc.	0.80	0.63	0.99	0.54*	0.56	4.07***
IT, Software, etc.	1.23	0.82	1.82**	0.57*	1.20	1.31
Publishing	0.77	0.85	1.52	1.39	0.67	0.89
Museums, Galleries, etc.	0.52	0.14***	0.58	1.18	0.25**	2.47
Music & the Arts	0.41**	0.31***	1.36	0.93	0.69	2.86**
London	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
South East	0.69	0.86	0.97	1.62*	1.14	1.57
Midlands, SW, EE	0.98	0.75	0.86	1.55*	0.95	1.78*
Northern England	1.08	1.12	0.81	1.34	1.38	1.06
Scotland, Wales, N.I.	1.40	0.73	0.85	1.17	1.51	2.49**
Constant	2.95***	2.64**	0.61	0.58	0.80	0.13***
Number of observations	625	625	625	625	625	625
Model Chi-square	43.8***	45.0***	40.6***	45.4***	40.3***	38.1***
-2 Log Likelihood	754.13	821.3.1	807.4	752.6	674.9	598.4
Nagelkerke R-sq.	0.094	0.093	0.085	0.097	0.092	0.092
Hosemer & Lemeshow	0.957	0.875	0.403	0.626	0.334	0.604

*** = significant at 1%; ** = significant at 5%; * = significant at 10%
excl. = excluded; Ref. = reference group among categories
The figures reported are not the coefficients, but the exponents of the coefficients.

- Small CIOs with up to five people were less likely to acquire licences for technology or products/services. This is understandable as the relative cost of licences declines with an increased scale of activity (unless licences are based on output based royalties). Crafts, Museum and Galleries, and Music and the Arts CIOs were all much less likely to have acquired licences than CIOs in the other sub-sectors.

- The smaller CIOs with up to five people, and Museum, Gallery and Library CIOs, were significantly less likely to have engaged in training related to the introduction of product or service innovations. This may be because they were less likely to have introduced product or service innovations.

- Young firms were understandably significantly more likely to have invested in marketing methods and launch advertising than more established CIOs, while, Architecture, 'Film, TV, etc.' and 'IT, Software, etc.' CIOs were less likely to have invested in these activities, possibly because these are more project-oriented and relational, rather than transactional. There is also evidence that CIOs in London were less likely to have invested in these activities.

- CIOs in Scotland, Wales and Northern Ireland were significantly more likely to report having invested in advanced machinery and equipment. The reasons for this are unknown.

- There were no differences between firms and non-firms in their propensities to engage in any of these activities (all else equal).

It is also worth noting that these models are all rather weak statistically, which means that relatively little of the variation in whether or not CIOs engaged in these activities is explained by the characteristics included in the analysis.

5. Introducing Innovations

This section examines the extent to which the CIOs reported having introduced at least one product or service innovation and/or at least one process/organisational innovation in the last three years, and the associations between engaging in R&D (and its constituent activities) and other innovation activities and the introduction of innovations.

Table 6: Overall extent of introducing innovations and by CI sub-sector

	N	Introduced either or both "product" and "process" innovations	Introduced product or service innovations	Introduced 'new to the market' product or service innovations	Introduced process/ organisational innovations
All sectors	**611**	**58%**	**47%**	**24%**	**33%**
Advertising, mktg	83	60%	51%	23%	33%
Architecture	89	36%	25%	10%	21%
Crafts	19	58%	53%	32%	32%
Design	94	47%	36%	13%	27%
Film, TV, video	66	63%	54%	21%	33%
IT, software, etc.	125	71%	64%	42%	37%
Museums, etc.	24	50%	42%	21%	33%
Music & the arts	71	67%	51%	30%	48%
Publishing	40	63%	46%	28%	44%

Overall, almost 60% of the responding CIOs claimed to have introduced either or both a new or significantly improved product or service (hereafter 'product innovation') or a process/organisational innovation[16] (hereafter 'process innovation') in the last three years. Nearly half had introduced a ''product innovation'', of which about half claimed to have introduced a ''new to the market'' innovation (the other half having introduced innovations that are essentially imitative of products and services already available on the market);[17] whilst a third had introduced ''process innovations''.

''Product innovation'' was most widespread in IT, Software and Computer Services, and lowest in Architecture, while 'process innovation' was most widespread in Music and the Arts, and again lowest in Architecture.

Overall, the proportion of CIOs participating in the DCMS survey and reporting having introduced innovation was high relative to the proportion of all Small and Medium Sized Enterprises (SMEs) that reported having introduced innovations in the UK Innovation Survey of 2019. That survey found that just 18% of SMEs had introduced a 'product innovation', while 17% reported having introduced process innovations in the previous three years. This, coupled with the more widespread engagement in R&D (and other innovation related activities) suggests the response to the DCMS survey may be biased to more innovation active organisations.

[16] More specifically "any new or significantly changed form of organisation, business structure, or process in the last three years." Overall, 23% claimed to have introduced both "product" and "process" innovations, and another 23% only product innovations; 10% had only introduced "process innovations".

[17] This distinction between "new to the market" and "new to the firm/organisation" is also standard in the literature. 8 respondents did not know if the innovations were new to the market or not.

To examine further which CIOs introduced innovations, we estimated multinomial logistic regressions with four possible outcomes: 1. The CIO did not introduce either type of innovation. These 'non-innovators' are the reference group. 2. Those that introduced 'product' but not process innovations; 3. Those that introduced 'process' but not product innovations. And 4. those that introduced both types of innovations.

For the first model (Table 7: Model 1), we used the same regressors that were used to 'predict' engaging in R&D and other innovation activities earlier, adding to this a categorical variable distinguishing COIs that (1.) neither engaged in R&D nor invested in any of the other innovation related activities (this is the reference category); (2.) engaged in R&D but did not invest in any of the other activities; (3.) did not engage in R&D but did invest in one or more of the other activities, and (4.) both engaged in R&D and invested in one or more of the other activities.

The results show that CIOs that both engaged in R&D and invested in one or more of the 'other innovation activities' were more likely to have introduced innovations, and were very much more likely to have introduced both types of innovation. In fact, of the CIOs that had engaged in both R&D and other innovation activities, 97 had introduced both types of innovations, while only two that had neither engaged in R&D nor other innovation activities had introduced innovations of both types. Furthermore, CIOs that invested in 'other innovation activities' but did not engage in R&D were more likely to have introduced innovations, and especially both types, than CIOs that engaged in R&D but not 'other innovation activities'.

Beyond this, the model also indicates that:

- Young CIOs were more likely to have introduced both types of innovation than their older counterparts. This is understandable.

- Very small CIOs were much less likely to have introduced innovations, and especially both types, which is understandable, but this size disadvantage soon disappears: CIOs with six or more people were as likely to introduce both types of innovation as the largest CIOs.

- Architecture and Museums & Galleries CIOs were less likely to have introduced innovations, especially Product/Service innovations alone and both types than CIOs in the other sub-sectors. This probably reflects the nature of these activities: architecture in particular is project rather than product based.

- Regional differences are not prominent or systematic. Oddly, CIOs in the Midlands of England were less likely to have reported introducing only Process/Organisational innovations. This may well be a statistical aberration.

Next, we removed the categorical variable for engaging in R&D and/or investing in 'other innovation activities', and instead included a set of indicators (or dummy variables) for engaging in the three constituent R&D activities plus each of the seven other innovation related activities. The results are shown in Table 7 as Model 2. This model shows that engaging in applied research is strongly associated with introducing 'product innovations', both alone and in conjunction with 'process innovations'. It doubles the chances of the former, and triples the chances of the latter. It is not, however, associated with increasing the propensity to introduce 'process innovations'

on their own. By contrast, there is no association between introducing either or both types of innovation and engaging in either basic research or experimental development, meaning that engaging in these activities does not seem to increase the propensity to innovate (all else equal).

Investing in advanced machinery and equipment, in licences, in training, in design, and in marketing methods and launch advertising are all strongly associated with introducing both types of innovation meaning that CIOs that engaged in these activities are much more likely to have introduced both types of innovations. Meanwhile investing in advanced machinery and equipment, in marketing methods and launch advertising and to a lesser extent in licences are associated with introducing 'product innovations' without process innovations. Rather oddly, investing in marketing methods and launch advertising is also associated with introducing 'process innovations' without 'product innovations', and is the only investment associated with this set of innovators. Also notable, and perhaps surprising, is that investing in market research is not associated with a higher propensity to introduce either type of innovation; perhaps this is because market research can also tell organisations when they do not need to innovate, as well as help identify innovation opportunities. Investing in computer equipment is also not significantly associated with introducing either type of innovation.

Table 7: Modelling the introduction of Innovations

	Model 1			Model 2			Model 3		
	Product	Process	Both	Product	Process	Both	Product	Process	Both
Intercept	0.56	0.37	0.15**	0.65	0.32	0.24**	0.65	0.31	0.22**
Young CIOs	1.64	1.43	2.41**	1.53	1.20	2.02#	1.50	1.22	2.09#
One person	0.38*	0.45	0.10***	0.37*	0.37	0.15***	0.40*	0.39	0.16***
Two people	0.42*	0.21**	0.13***	0.46	0.20**	0.18***	0.51	0.21**	0.20***
Three to five	0.57	0.68	0.28**	0.52	0.59	0.34**	0.54	0.62	0.36*
Six to ten	0.82	0.61	0.61	0.89	0.58	0.77	0.86	0.6	0.82
Eleven to thirty	0.54	0.40	1.06	0.40	0.29	0.94	0.37	0.29	0.91
Over thirty	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Non-firms	2.64*	1.55	1.60	2.59*	1.94	1.50	2.62*	1.89	1.49
Adv. & Mktg	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Architecture	0.27***	0.68	0.16***	0.26***	0.68	0.13***	0.21***	0.66	0.12***
Crafts	1.02	0.7	1.23	0.92	0.82	1.26	0.94	0.83	1.35
Design	0.58	1.1	0.48	0.57	1.15	0.53	0.58	1.18	0.55
Film, TV, etc.	1.03	1.14	0.93	1.12	1.21	1.38	1.02	1.24	1.51
IT, Software, etc.	1.13	1.12	0.75	1.26	1.18	0.87	1.12	1.16	0.79
Publishing	0.62	2.45	0.72	0.55	2.20	0.60	0.56	2.24	0.61
Museums, etc.	0.18**	0.44	0.24*	0.20*	0.45	0.42	0.18**	0.46	0.44
Music & the Arts	0.52	1.71	1.06	0.51	1.68	1.13	0.51	1.70	1.19
London	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
South East	1.12	0.55	0.88	0.99	0.53	0.75	0.96	0.53	0.76
Mids, SW, EE	0.87	0.36**	1.00	0.86	0.35**	1.06	0.83	0.35**	1.04
Northern Eng.	1.16	0.62	0.87	1.07	0.62	0.81	0.96	0.59	0.77
Scot., Wales, NI	1.10	0.86	1.49	1.07	0.94	1.44	1.09	0.91	1.40
Neither	Ref.	Ref.	Ref.		excl.			excl.	
R&D only	0.93	0.39	5.66*		excl.			excl.	
Other only	1.80	1.75	8.91***		excl.			excl.	
R&D & Other	5.17***	2.77**	43.36***		excl.			excl.	
Basic Research		excl.		0.87	1.96	0.83	0.83	1.87	0.78
Applied Res.		excl.		2.58***	1.17	3.44***	2.52***	1.14	3.50***
Exp. Devt		excl.		0.88	1.11	0.78	0.83	1.10	0.70
Adv. Sci Tech		excl.			excl.		3.72***	1.79	3.02**
Adv Mach & Eq.		excl.		1.86**	0.97	2.39***	1.85*	0.96	2.25**
Computer Eq.		excl.		0.70	1.43	0.91	0.66	1.42	0.90
Licences		excl.		1.60*	1.32	1.90**	1.54	1.33	1.94**
Training		excl.		1.56	0.71	3.53***	1.56	0.72	3.39***
Design		excl.		1.48	1.69	2.77***	1.45	1.67	2.74***
Market Research		excl.		1.18	0.06	1.48	1.02	0.59	1.41
Mktg/Launch Adv		excl.		2.16***	2.57***	2.71***	2.24***	2.56***	2.64***
Number of COIs	608			598			592		
Model Chi-square	224.5***			301.9***			306.7***		
Final -2LL	1100.9			1209.9			1190.2		
Pseudo R-squares	A 0.31; B 0.34; C 0.15			A 0.40; B 0.43; C 0.20			A 0.40; B 0.44; C 0.20		

*** = sig at 1%; ** = sig at 5%; * = sig at 10%; excl. = excluded; Ref. = reference group
Pseudo R-squares: A – Cox and Snell; B – Nagelkerke, C – McFadden

The figures reported are not the coefficients, but the exponents of the coefficients.

The findings regarding the characteristics of the CIOs (i.e., by age, size, sector, region, etc.) are essentially the same as for Model 1, so the comments above in relation to that model carry over.

Next, for Model 3 we add in an indicator (or dummy) variable to identify those CIOs that said they had engaged in 'any activities which aim to advance science or technology by resolving scientific or technological uncertainties' (Adv. Sci Tech). The findings for all other variables remain unchanged from those in Model 2 (and therefore the comments above apply). The new variable is highly significant, and reveals that engaging in activities to advance scientific and technological knowledge roughly trebles the propensity to introduce 'product innovations', both with and without process innovations; but it is not associated with the introduction of 'process innovations' without 'product innovations'.

Overall, these models indicate that creative industries organisations that engage in both R&D and invest in 'other innovation activities' are more likely to introduce innovations. This suggests strong complementarities between R&D and other innovation activities: in short, if the goal is to introduce innovations, it is better to engage in R&D and other innovation related activities rather than one or other of these. This is particularly true of 'product innovations', with and without 'process innovations'; the factors influencing the latter remain rather opaque.

Also notable is that these models are quite strong statistically, meaning that a substantial part of the variation in whether or not CIOs introduced innovations is 'explained' by the variables in the models, and in particular CIOs' behaviours with regard to engaging in R&D and other innovation related activities contributes to this much more than their structural characteristics, such as organisational age, size and sector.

Next, to explore whether the activities associated with 'new to the market' product innovations differ from those associated with essentially imitative, 'new to the organisation' product innovations, we follow the same approach as above, this time modelling to distinguish between organisations that did not introduce product innovations (the reference category) from those that only introduced imitative innovations, and those that introduced novel, 'new to the market' innovations.[18]

Because the addition of variables between Models 1B, 2B and 3B does not change the results substantially (See Table 8), we focus our discussion on the findings in relation to our preferred model (Model 3B), which, in summary, finds:

[18] Strictly, we might want to correct for how these factors influence "process innovation" out with "product innovation". For econometric simplicity, we do not do this, but: 1 – observe that the factors are generally rather poor at predicting the introduction of that type of innovation (where the associations with "product innovation" are fairly strong), and 2 – for robustness, we have estimated the same models excluding all CIOs that did introduce "process innovations" and the results are very similar to those with "process innovators" included.

Table 8: Modelling "new to the market" and "new to the organisation" product innovation

	Model 1B		Model 2B		Model 3B	
	New to CIO	New to Mkt	New to CIO	New to Mkt	New to CIO	New to Mkt
Intercept	0.55	0.11***	0.65	0.12***	0.63	0.12***
Young CIOs	1.22	2.49**	1.18	2.00	1.10	2.17*
One person	0.26***	0.38*	0.31**	0.44	0.33**	0.51
Two people	0.35**	0.44	0.47	0.48	0.50	0.62
Three to five	0.41**	0.54	0.45*	0.54	0.46*	0.59
Six to ten	0.45	1.53	0.54	1.6	0.57	1.65
Eleven to 30	0.86	1.47	0.83	1.03	0.84	0.94
Over thirty	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Non-firms	1.43	2.52*	1.29	2.3#	1.31	2.42
Adv. & Mktg	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Architecture	0.24***	0.20***	0.24***	0.15***	0.22***	0.10***
Crafts	0.87	1.65	0.92	1.37	1.00	1.35
Design	0.62	0.39**	0.68	0.39*	0.69	0.41*
Film, TV, etc.	1.07	0.77	1.17	1.10	1.13	1.07
IT, Software	0.73	1.19	0.84	1.41	0.81	1.19
Publishing	0.36*	0.91	0.34*	0.71	0.35*	0.70
Museums, etc.	0.25*	0.29	0.32	0.37	0.31	0.36
Music & Arts	0.56	0.73	0.57	0.67	0.58	0.71
Regions	Included		Included		Included	
Neither	Ref.	Ref.	excl.		excl.	
R&D only	1.63	0.75	excl.		excl.	
Other only	2.40**	2.58*	excl.		excl.	
R&D & Other	4.80***	15.09***	excl.		excl.	
Basic Res.	excl.		0.62	0.78	0.61	0.75
Applied Res.	excl.		1.68	4.95***	1.69	5.07***
Exp. Devt	excl.		0.85	0.74	0.81	0.66
Adv. Sci Tech	excl.		excl.		2.07*	4.28***
Adv Mach Eq.	excl.		2.06**	1.94**	2.02**	1.85*
Computer Eq.	excl.		0.63	0.82	0.63*	0.77
Licences	excl.		1.98**	1.18	1.94**	1.13
Training	excl.		2.48***	2.63***	2.47***	2.60***
Design	excl.		1.15	2.81***	1.15	2.84***
Market Res.	excl.		1.52	1.43	1.38	1.30
Mktg/Adv	excl.		1.64*	2.25***	1.69*	2.21***
# of CIOs	605		596		590	
Model Chi^2	196.1***		257.7***		265.1***	
Final -2LL	836.6		940.5		919.0	
Pseudo R^2	A 0.28; B 0.32; C 0.16		A 0.35; B 0.41; C 0.21		A 0.36; B 0.42; C 0.22	

*** = sig at 1%; ** = sig at 5%; * = sig at 10%; excl. = excluded; Ref. = reference group
Regional dummies were included but none are significant.
Pseudo R-squares: A – Cox and Snell; B – Nagelkerke, C – McFadden
The figures reported are the exponents of the coefficients

- Among R&D activities, engaging in 'applied research' is strongly associated with the introduction of new to the market innovations (increasing the propensity by about 5 times), as is engaging in activities to advance science and technology by resolving scientific or technological uncertainties (which increases the propensity by about 4 times). Indeed, the latter is also associated with an enhanced propensity (2x) to introduce imitative, new to the organisation product innovations.

- Engaging in training is strongly associated with introducing both types of product innovation, with a 2.5 times increased propensity. This should not be read to imply that 'training' causes product innovation; it is probably more likely that product innovation requires training as a consequence. Meanwhile, engaging in design is associated with a much higher propensity to introduce new to the market product innovations (approximately 3x), but not imitative innovations. The reverse is true of acquiring licences: organisations that acquire licences are more likely (2x) to introduce imitative but not new to the market product innovations. Meanwhile, investing in marketing methods and/or launch advertising and in advanced machinery and equipment are associated with an increased propensity to introduce both types of product innovation. Again, the suggestion is not that these activities 'cause' product innovations, rather that they are often required for product innovation.

- In relation to the size, sector and location background characteristics there are few significant variations, the most prominent one being that Architecture organisations are much less likely to introduce both types of 'product innovation' which probably reflects their project-based rather than product-based orientation.

- Overall, these the models are statistically quite strong, with the explanatory power is coming from the behavioural variables (i.e. those regarding whether or not the CIO engages in R&D, of different types, and other innovation related activities, also of different types) rather than the CIOs' structural characteristics.

6. The Impact of Innovations on the Creative Industry Organisations

We now turn to the impacts of the innovations on the CIOs that introduced them. To investigate this, the survey asked the respondent to score, between 1 and 5, where 1 is 'no impact' and 5 is 'significant impact', the impact of their innovations on eight items. These questions were not asked of those CIOs that had not introduced either product nor process innovations and/or which had not engaged in R&D. Overall, about 70% of the CIOs surveyed (443/625) answered this question.

Ranked from the highest to the lowest by average impact, "improving the quality of goods or services" was highest, followed by "maintaining market share" and "accessing new customers, users or audiences". "Increasing profitability" and "increasing sales" were in the middle, followed by "increasing the range of goods or services". The two lowest ranked impacts were "starting or increasing exports" and "increasing the number of people employed". A factor analysis of this data finds that all of the items load on to a single 'performance' factor.[19]

Table 9: the Impacts of Innovation Activities on the Creative Industry Organisations

	No impact 1	2	3	4	Significant impact 5	Don't know	Mean Score
Improving the quality of goods or services	27%	10%	21%	20%	19%	3%	2.94
Maintaining your market share	28%	10%	21%	20%	16%	5%	2.85
Access new customers, users, audiences	25%	16%	22%	20%	14%	4%	2.81
Increasing your profitability	30%	12%	21%	17%	17%	4%	2.79
Increasing your sales	26%	16%	23%	17%	19%	3%	2.77
Increasing the range of goods or services	28%	16%	22%	16%	14%	4%	2.71
Increasing number of people employed	51%	14%	16%	7%	9%	4%	2.05
Starting or increasing exports	61%	14%	10%	5%	5%	6%	1.72
All items – Maximum Score (N = 431)	11%	8%	14%	27%	40%	n.a.	
All items – Median Score (N = 431)	25%	15%	30%	20%	10%	n.a.	

For each CIO, we identified the median score and the maximum impact scores[20] and, by estimating ordered logistic regressions, sought to identify the behaviours associated with higher impact scores. We estimated two sets of these, the first for the median impact score, the second for the maximum impact score.

The first pair of models contained the background characteristics of the CIOs (age, size, sector, region), plus the types of innovation they had introduced. The second swapped out the types of innovation introduced and replaced these with whether or not the CIO had engaged in R&D and/or other innovation activities. The third retained these variables while adding back in the types of innovations introduced, plus whether or not the CIO had engaged in activities "which aim to advance science or technology by resolving scientific or technological uncertainties". The results are

[19] Factor analysis can be used to identify one or more groups of variables. For example, there may be a group of variables that relate to growing the business and another related to becoming more efficient. If these orientations are independent, organisations may focus on neither, one or both of these. In this case, all of the variables are found to load onto a single factor, indicating they relate to one orientation: performance.

[20] Where the median is between scores (i.e., 1.5, 2.5, 3.5 or 4.5) they were rounded up.

reported in Table 10. In this set of regressions, a significant negative coefficient indicates an association with a reduced performance impact (i.e., a lower overall impact), while a significant positive coefficient indicates an association with a higher impact on performance.

Table 10: Modelling the Impact of the Innovations / Innovation Activities

	Model 1		Model 2		Model 3	
	Median B	Maximum B	Median B	Maximum B	Median B	Maximum B
Threshold 1-2	-0.25	-1.50***	0.57	-0.43	1.25*	0.19
Threshold 2-3	0.52	-0.79*	1.36**	0.31	2.10***	0.96
Threshold 3-4	1.90***	-0.02	2.78***	1.13**	3.58***	1.83***
Threshold 4-5	3.38***	1.18**	4.28***	2.39***	5.10***	3.13***
Young CIOs	1.38***	0.58	1.66***	0.82**	1.67***	0.84**
One person	-0.43	-0.02	-0.61	-0.20	-0.22	0.13
Two people	-0.53	-0.27	-0.55	-0.26	-0.14	0.11
Three to five	0.23	0.35	0.13	0.31	0.56	0.66*
Six to ten	0.23	0.25	0.19	0.22	0.39	0.38
Eleven to 30	0.41	-0.05	0.69*	0.19	0.61	0.00
Over thirty	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Non-firms	0.38	0.21	0.51	0.45	0.57	0.54
Sub-Sector$	Included	Included	Included	Included	Included	Included
London	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
South East	0.00	0.03	0.21	0.35	0.09	0.23
Mids, SW, EE	0.54**	0.18	0.75***	0.48*	0.58**	0.28
Northern Eng.	0.33	0.03	0.41	0.25	0.34	0.11
Scot., Wal., NI	0.16	0.17	0.35	0.45	0.25	0.33
Neither	Ref.	Ref.	excl.		Ref.	Ref.
"Product" only	0.25	0.16	excl.		0.64**	0.74**
"Process" only	-0.41	-0.81***	excl.		0.06	-0.11
Both types	0.63**	0.31	excl.		0.85***	0.70**
New to Mkt	0.48**	0.73***	excl.		0.11	0.34
Neither	excl.		Ref.	Ref.	Ref.	Ref.
R&D only	excl.		0.34	1.17**	0.39	1.40**
Other only	excl.		0.81*	0.78*	0.54	0.53
R&D & Other	excl.		1.73***	2.02***	1.60***	1.87***
Adv. Sci Tech	excl.		excl.		0.79***	0.85***
# of COIs	428	428	428	428	409	409
Model Chi^2	83.1***	64.8***	97.6***	75.1***	122.2***	112.3***
Final -2LL	1134.4	1069.8	1045	990.1	1114.2	1037.5
Cox & Snell R^2	0.181	0.144	0.204	0.161	0.258	0.240
Nagelkerke R^2	0.189	0.152	0.214	0.170	0.270	0.254
McFadden R^2	0.064	0.054	0.074	0.061	0.096	0.095

As ordered logits, these models report the estimates, not their exponents, as in Tables 1, 2, 3 & 4. Values below zero show a negative association; values above zero show a positive association. $ -sub-sector dummies are included but as none are significant their coefficients are not shown in the table

For brevity, we focus our discussion of the findings on the fullest pair of models, Model 3.

This indicates that:

- The introduction of 'product innovations' by themselves or with 'process innovations' is associated with higher impacts (both median and maximum), while the introduction of 'process innovations' without 'product innovations' does not increase performance (as measured here). Possibly this reflects a 'product innovation' bias among the measures. There are, for example, no items for improved efficiency of operations, making better use of resources or materials, or becoming more sustainable.

- New to the market product innovations are not, perhaps surprisingly, associated with higher impact scores. Two explanations for this are: 1. The innovations have only recently been introduced and may take time to have a more substantial impact; 2. Successful novel innovations are rapidly imitated by rivals, such that the originator does not capture higher performance benefits than the imitators.

- Engaging in both R&D and investing in other innovation related activities is associated with higher impacts (both median and maximum), while engaging only in R&D (which is rare) is also associated with a higher maximum impact. Engaging in 'other innovation activities' without R&D does not significantly increase performance over doing neither R&D nor other activities, although the latter is very rare (c.5% of the sample).

- Also interesting is that engaging in activities 'which aim to advance science or technology by resolving scientific or technological uncertainties' is associated with a higher median and maximum impact scores suggesting the CIOs that pioneer new technologies are able to capture some of the benefits of doing this.

- These behavioural characteristics aside, it is apparent (and understandable that) young CIOs tend to indicate significantly higher impacts of their innovation activities than do longer established CIOs. The other structural variables (i.e., size, sector, firm/non-firm) are generally insignificant. The finding that CIOs based in the Midlands, South West and East of England introduced more impactful innovation seems likely to be a statistical aberration.

- Overall, these models have modest statistical explanatory power. It is again the case that this power derives primarily from the behavioural variables (types of R&D and other innovation activities engaged in, and types of innovations introduced) rather than CIOs structural characteristics. The main message is that introducing 'product innovations', as well as engaging in both R&D and other innovation related activities, are associated with higher impacts on the organisation. Engaging in activities 'which aim to advance science or technology by resolving scientific or technological uncertainties' is also associated with stronger impacts.

7. Discussion and Conclusions

So, what do the results of this analysis tell us about innovation, and innovation management, in the creative industries? It should first be stressed that the survey focused on both conventional 'types' of innovation (i.e., product and process) and conventional inputs to innovation, including R&D and other inputs, such as design, training and marketing. The survey sheds no light on other forms or types of innovation, such as aesthetic or 'soft' innovation (Stoneman, 2010), content innovation (Handke, 2004), artistic innovation (Galenson, 2006) and 'hidden' (Miles and Green, 2008) and non-technological innovation (Martin-Rios and Parga-Dans, 2016) which some argue are particularly significant in the creative industries.

This limitation notwithstanding is it clear that the conventional understanding of innovation has relevance to creative industry organisations, especially for those that seek to innovate through 'mainstream' as opposed to 'maverick' approaches (Jones et al., 2016). Nearly half of the CIOs that responded to this survey claimed to be engaged in R&D and nearly 60% claimed to have introduced at least one product and/or process innovation in the last three years. Also notable is that about one in eight claimed to have engaged in "activities which aim to advance science or technology by resolving scientific or technological uncertainties", which is a narrow concept of R&D. Furthermore, while strictly associative rather than causal, the links between engaging in innovation related activities - including but not confined to R&D - introducing innovations, and achieving performance benefits from innovation, all essentially 'make sense'.

If the aim of policymakers and or managers is to raise the rate and impact of innovations in creative industry organisations, then they could do a lot worse than to encourage the adoption of standard or mainstream approaches to the management of innovation that have been developed primarily in the context of studying innovation in 'non-creative' and product-based organisations. While perhaps not helpful for mavericks and misfits (Jones et al., 2016), the mainstream approach is sufficiently applicable to be useful in the majority of CIOs. Here, I am reminded of the story popularised within management studies by Karl Weick of a group of soldiers who become lost in a snowstorm in the Alps.[21] One of the soldiers finds a map, which calms the group and enables them to discover their bearings, allowing them to navigate to safety. Once back in camp, they show the map to their lieutenant; it turns out not to be a map of the Alps, but of the Pyrenees. The standard or mainstream approach to managing innovation, as laid out in textbooks (e.g., Tidd and Bessant, 2018), may be a sufficiently applicable 'map' to guide innovation, or at least product and process innovation, in the creative industries.

Also notable within this context is that – with the partial exception of architecture, which is very project-oriented - we do not find large difference between the factors associated with innovation in different 'types' of creative industry organisation, where 'type' relates to the organisation's structural characteristics, such as size, sector and

[21] The story was first published by Holub as a poem in the Times Literary Supplement in 1977 (Holub, 1977). It became a central story in Karl Weick's account of "sensemaking in organisations" (Weick, 1995). Thomas Basbøll (2012) provides a full discussion of the origins of the story and its interpretations.

whether or not it is a firm. Generic understanding of how to manage innovation would be valuable throughout most of the creative industries.

This said, there are certain findings that deserve particular attention.

One is the extent to which the organisations responding to this survey claimed to be engaged in R&D, and 'basic research' in particular. The fact that a fifth claimed to be engaged in 'basic research' is frankly surprising, and raises questions about what this is, and whether it is 'basic research' as the Frascati Manual (OECD, 2015) would define it. If not, what do CIOs understand by "basic research"?

A second point is the apparent significance of 'applied research', and the interesting finding that engaging in this, rather than experimental development, is most strongly associated with introducing innovations. Again, this begs the question: what is the content of this applied research?

A third finding is that organisations that combine R&D with other innovation related activities are both much more likely to introduce innovations and are significantly more likely to introduce more impactful innovations. This reinforces the point that R&D is not the be all and end all of innovation (a point that I discuss further below); R&D typically needs to be complemented by other activities, such as design, training and efforts to market and promote innovations. These activities often remain in the shadows, however, while R&D is centre stage, especially among policy-makers.

A fourth set of findings concerns organisational size. Very small organisations involving as few as one or two people are common in the creative industries. The analysis in this paper shows these are generally less likely to engage in R&D as well as other innovation related activities, and are less likely to introduce innovations. All of these findings are understandable because innovation activities typically involve fixed costs and economies of scale. The costs of research, design and development can be the same whether one output is produced or hundreds, and economies of scale also apply in purchasing licences and engaging in training for innovation. It is notable, however, that these disadvantages of smallness appear to apply to only the smallest CIOs; those of a modest size, that is having a workforce of around five or six people, are generally not less likely to engage in innovation activities and introduce innovations than much larger CIOs. With that in mind, one suggestion would be to encourage the very smallest organisations to pool resources, for example when undertaking research, or training. If three or four had similar needs they might pool their resources and undertake or commission these activities collectively rather than going it alone. Another suggestion is that very small creative industry organisations should be encouraged to see the benefits to wider resource pooling, for example by forming partnerships to mitigate the disadvantages of tinyness.[22]

Fifth, in relation to locations, we have only rather crude locational information, but we find almost no evidence of differences in behaviours between CIOs located in different parts of the UK. In particular, while creative industry organisations may be more heavily populated in London and the South East than elsewhere, there is little evidence that those located elsewhere behave differently. This is valuable information in the context of the "levelling up" agenda.

[22] Conventional partnerships aside, other models include co-operatives and the (barristers') "chambers".

Our final remarks concern public support for innovation in the creative industries. Given that engaging in R&D is associated with introducing innovations in the creative industries, can we be sure that firms are not being discouraged from engaging in R&D, or are not investing sub-optimally? R&D is understood to generate spillovers, or externalities, such that others can benefit from the findings of others' R&D without paying for it directly. This means that an R&D performer pays for activities upon which others can freeride. To mitigate this, certain types of R&D are supported by tax credits; specifically, R&D oriented to resolving scientific and technological uncertainty is eligible for tax credits. However, the reasons for singling this component of R&D are unclear, particularly as there is no obligation to make public the scientific and technological uncertainty that has been resolved. If the knowledge is kept secret, or is effectively protected by patents, then this free-riding problem does not arise. Bakhshi and colleagues (Bakhshi and Lomas (2017; Bakhshi et al., 2021) have called for a broadening of the understanding of R&D to increase its relevance to the creative industries, and I would agree with their reasoning.

More generally, the singling out of problems involving scientific and technological uncertainty as problems requiring specific support seems odd when genuinely novel innovations involve multiple uncertainties. There are, for instance, market uncertainties (will it sell?), and production uncertainties (can it be produced economically in volume?). Imitators who benefit from the efforts of the pioneers are not just freeriding on any advances in scientific and technological knowledge, but are also benefiting from reduced market uncertainty and other knowledge, such as whether or not the presentation of the innovation through the originator's design is appealing. Spillovers are therefore not confined to R&D, and especially R&D narrowly defined as advances that resolve scientific and technological uncertainty; they also arise from market research, from design investments, and from training. In light of this, and in light of the fact that successful innovation typically involves a set of activities including, but not confined to R&D, it can be argued that innovation policy should incentivise these packages of activities which confront uncertainty, rather than single out one element. In other words, rather than grant tax relief for some R&D, consideration could be given to granting tax relief for a set of innovation activities that are oriented to developing genuinely novel innovations.

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Appendix: Survey Methodology

The following is a summary of the methods employed by OMB Research to undertake the survey on behalf of the Department for Digital, Culture, Media, and Sport (DCMS); fuller details as well as the full questionnaire can be found in Bird et al. (2020).

The survey was designed by the DCMS with input from OMB Research and its consultants, including Stephen Roper and Jim Love, both leading innovation scholars, and with input from the Policy and Evidence Centre for the Creative Industries, with input from the author of this paper and Hasan Bakhshi, a leading authority on the creative industries. Key questions were subject to cognitive testing, and the whole questionnaire was piloted using Computer Assisted Telephone Interviewing (CATI).

The population of interest was UK businesses operating across the creative industries sectors as defined by the DCMS. Charities and not for profit organisations were eligible, but public sector organisations were not. The sample was sourced from the Dun & Bradstreet's commercial business database.

The creative industries are dominated numerically by the 'IT software and computer services' sub-sector, which accounts for about half of the businesses in the sector. They are also dominated by firms located in London and the South East of England, which combined account for just over half of all creative industry businesses. The creative industries are further dominated by micro-enterprises, with fewer than 10 employees. To ensure the survey included representation of other sub-sectors, regions and of larger organisations, businesses with these characteristics were intentionally over-sampled using a disproportionate stratified random sampling approach which ensured they were adequately represented to allow more robust analysis including sub-types of creative industry organisations. Organisations that declined to take part in the survey were with others replaced in the sampling frame with the same sector, region and size-band characteristics (micro, small, medium, large). The survey asked each respondent to confirm the size of the organisation's workforce as well as its sector of activity. Interviews with organisations not active in any of the creative industry sub-sectors were terminated. (Bird et al., 2020, p. 32).

The target sample was 725, but this was not reached when fieldwork became significantly obstructed following the Covid-19 outbreak and fieldwork stopped at 625 responses. All responses were gathered using CATI between 13th February and 31st March 2020. Interviews lasted 18 minutes on average. As with any voluntary survey, it is not possible to be sure there are no biases in terms of participation or non-participation. The analysis in this paper treats the database as a simple sample; no attempt is made to correct the response through weights to a nationally representative sample. This is for simplicity, but also because the analysis primarily involves multivariate regressions which include the selection variables of size, sector and region.

Appendix: Sample characteristics - Size, Sector, Region, Age, Exporting, Markets

Size	N (%)	Sector	N (%)
One person	122 (19.5%)	Advertising & Marketing	86 (13.8%)
Two people	125 (20.0%)	Architecture	93 (14.9%)
Three to five people	161 (25.8%)	Crafts	19 (3.0%)
Six to ten people	89 (14.2%)	Design	96 (15.4%)
Eleven to thirty people	69 (11.0%)	Film, TV, etc.	67 (10.7%)
Over thirty people	59 (9.4%)	IT, Software, etc.	126 (20.2%)
		Publishing	41 (6.6%)
Private enterprise	559 (89.4%)	Museums, Galleries, etc.	24 (3.8%)
Charity, Not for Profit, etc	66 (10.6%)	Music & the Arts	73 (11.7%)
Total	625 (100%)		625 (100%)

Size	N (%)	Age	N (%)
East of England	28 (4.5%)	Less than 2 years	10 (1.6%)
East Midlands	24 (3.8%)	2 to 5 years	45 (7.2%)
London	159 (25.4%)	6 to 10 years	123 (19.7%)
North East	20 (3.2%)	11 to 20 years	215 (34.4%)
North West	45 (7.2%)	Over 20 years	231 (37.0%)
Northern Ireland	6 (1.0%)	(Don't know)	1 (0.2%)
Scotland	40 (6.4%)		
South East	136 (21.8%)	Is an exporter	266 (42.6%)*
South West	63 (10.1%)		
Wales	13 (2.1%)	Selling to households	268 (42.9%)
West Midlands	42 (6.7%)	Selling to businesses	527 (84.3%)
Yorkshire & the Humber	49 (7.8%)	Selling to public sector	277 (44.3%
Total	625 (100%)	Total	625 (100%)

* Four did not know if the organisation exported in the last year.
Simplified geography – 1. London (159), 2. South East (136), 3. (South West, East Midlands, West Midlands, East of England) (157), 4. (North West, Yorkshire & the Humber, North East) (114), 5. (Scotland, Wales, Northern Ireland) (59)

The following notes compare the realised sample with the population of Creative Industry businesses in the UK by size, sub-sector and age.

- The DCMS estimates there were around 290,000 "creative industries" businesses in the UK in 2018.[31] The vast majority of these were micro businesses (c.95%) , with fewer than 10 employees. This compares with 89% of businesses in the whole of the non-financial business economy. Of the remaining 5%, 83% of creative industry firms had fewer than 50 employees while only 3% were large businesses with 250 or more employees. The size distribution of non-micro firms is similar to that in the non-financial business economy as a whole. Although they still account for over three-quarters (77.6%) of the responses, in the survey micro-businesses are relatively under-represented. The vast majority of the remaining

[31] The Annual Business Survey estimates the following number of enterprises by CI Sub-sector for 2018: Advertising agencies & media representation 24,915; Architectural activities 16,646; Crafts 1,303; Specialised design activities 23,585; Film, TV etc 33,677; IT, software and computer services 148,651; Publishing activities and Translation 13,590; Libraries, archives, museums and other 1,020; Creative, arts and entertainment activities 29,974, providing a total of around 293,000.

responses were from small (93) and medium-sized (39) organisations, with only 8 being from large organisations (250+ employees). Relative to their share of creative industry firms, small, medium and large organisations are all over-represented.

- By region, the DCMS records just over a third of creative industries firms (33.5%) being based in London, and almost a fifth (18.7%) being in the South East of England. London businesses provided a quarter of survey responses, while the South East provided almost 22%. Relative to their populations of businesses, those in the North East of England, Yorkshire and the Humber and to a lesser extent the South West of England and Scotland are over-represented in the survey response, while those in the East of England, and to a lesser extent London and Northern Ireland are under-represented. When combined into larger sets of regions as analysed in this paper, 'Northern England', 'Scotland Wales and Northern Ireland' and the 'South East (of England)' are over-represented relative to their shares of all creative industries firms, while the 'South West, Midlands and East of England' is under-represented, as is London.

- By age, it is not possible to be precise, but it is likely that because it draws from Dun and Bradstreet's business register which is less likely to include new and young businesses, the survey was possibly biased in favour of longer established businesses.

The PEC Consortium

The PEC is led by innovation foundation Nesta and involves a consortium of UK-wide universities, comprising Birmingham; Cardiff; Edinburgh; Glasgow; Work Foundation at Lancaster University; LSE; Manchester; Newcastle; Sussex, and Ulster. The PEC's Director and Principal Investigator is Hasan Bakhshi, who is also Executive Director, Creative Economy and Data Analytics at Nesta.

For more details visit http://www.pec.ac.uk and @CreativePEC


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