technopolis group

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Evaluation of the BBSRC Collaborative Research & Development portfolio

Final report

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List of acronyms and abbreviations

ARC	Animal Health Research Club
BBSRC	Biotechnology and Biological Sciences Research Council
BRIC	Bioprocessing Research Industry Club
BSD	Business Structure Database
CIRC	Crop Improvement Research Club
CoI	Co-Investigators
C&C	Community and Capacity building
CPI	Consumer Price Index
CR&D	Collaborative Research and Development
CRN	Community Research Networks
DRINC	Diet and Health Research Industry Club
FSRD	Food System Resilience
GVA	Gross Value Added
HAPI	Horticulture and Potato Initiative
HEI	Higher Education Institution
IBTI	Integrated Biorefining Research and Technology Club
IP	Intellectual Property
IPA	Industrial Partnership Awards
IRO	Independent Research Organisations
KTP	Knowledge Transfer Partnerships
LENs	Landscape Enterprise Networks
LoLas	Longer and Larger Grants
M&E	Monitoring and Evaluation
NBIC	National Biofilms Innovation Centre
NIBB	Networks in Industrial Biotechnology and Bioenergy
ONS	Office for National Statistics
PI	Principal Investigator
PSM	Propensity Score Matching
R&I	Research and Innovation
RCoI	Researcher Co-Investigators
REF	Research Excellence Framework
ROI	Return on Investment
SAHDE	Sustainable Aquaculture: Health, Disease and the Environment

SARIC	Sustainable Agriculture Research and Innovation Club
SMEs	Small and Medium-sized Enterprises
ToC	Theory of Change
TRL	Technology Readiness Level
UKRI	UK Research and Innovation

Executive summary

This evaluation

The Biotechnology and Biological Sciences Research Council (BBSRC) has commissioned Technopolis to conduct an evaluation of the **impact of its collaborative research & development (CR&D) portfolio in the period from 2011 to 2021.**

The evaluation set out to assess the breadth and extent of impact and wider outcomes relating to investments in the BBSRC CR&D portfolio, providing insight and evidence that will enable BBSRC to further understand its approaches to supporting CR&D between businesses and academic researchers.

The BBSRC CR&D portfolio includes a total investment of **£611 million from BBSRC in addition to cash (£32.8 million) and in-kind (£120.6 million) contributions from industry partners.**

The BBSRC CR&D portfolio has invested in 1,322 projects through 1,805 individual awards where project Principal Investigators (PIs) have collaborated with a diverse group of 1,753 different partners. These include 1,282 private sector businesses, 283 academic organisations, and 188 non-profit organisations.

The evaluation has considered the portfolio as a whole as well as its **five constituent investment categories**:

Responsive Mode grant awards with industry partners

Industrial Partnership Awards (IPA) and LINK awards

Community & Capacity Building Investments

BBSRC-led Strategic CR&D investments

Strategic Co-Funding (across UKRI)

Evaluation questions and methodology

The study covers five questions:

1. At a CR&D **portfolio level**, what are the outputs, outcomes, and wider impacts of BBSRC investments?
2. How have **each of the portfolio investment categories** differentially contributed to the overall outcomes and impacts?
3. To what extent has the BBSRC CR&D portfolio delivered **value for money**?
4. What is the breadth and **diversity of businesses supported** across the BBSRC CR&D portfolio?
5. To what extent has BBSRC CR&D support helped academic researchers and businesses access and use **research and innovation infrastructure**?

To address these questions, the evaluation team has adopted a **Theory-Based approach**, using Contribution Analysis as an overarching analytical framework combined with **Econometric**

Analysis to quantify the impact on businesses and estimate the Return on Investment (ROI). The evaluation combines qualitative and quantitative methods and makes use of available evidence from both primary and secondary sources to provide robust and transparent evaluation findings. There is a strong participatory element to the evaluation, which sought engagement from a wide variety of stakeholders through surveys and interviews. Primary data collection has included:

- Online surveys of 409 academic leads and 37 partners
- Qualitative interviews with research participants and PIs (12) to gather insights and evidence on the pathways that facilitated the realisation of project benefits
- Qualitative interviews with industry participants (six) to also gather further insights and evidence on the pathways that facilitated the realisation of project benefits
- Qualitative interviews with other stakeholders (eight) to gather insights into the BBSRC CR&D portfolio and its significance in the wider environment

The portfolio-level Theory of Change (ToC) identifies four ***impact domains*** each of which represents a path to impact, but also mutually support each other:

- **Capacity building:** Development of new knowledge and skills leading to enhanced capacity in pre-competitive and business-led bioscience and critical mass of expertise in strategic areas of national importance
- **Partnerships:** Collaboration and knowledge sharing, leading to an improved understanding of commercial bioscience and enhances long-term partnerships which help leverage additional investments in research and innovation (R&I) beyond the projects
- **Technological and commercial development**: Early product development and creation of intellectual property (IP) enabling increased technological maturity, removal of barriers to innovation and business development, eventually leading to improved business performance and the introduction of new products and services to market
- **Business engagement and policy impacts:** Engagement with bioscience businesses and the creation of "thought leadership" in strategic areas which enable informed policy making and the development of standards which help emerging industries and markets as well as contributing to addressing societal and policy challenges

Main findings

The table below presents a succinct overview of the benefits accrued across the different investment categories.

It also shows the estimates of the ROI for each investment category. This ROI provides only a partial analysis of value for money since it only captures the effects on business performance and should be read in conjunction with the assessment provided across impact domains. Caution is also advised when interpreting the results for investment categories as the sample sizes are significantly smaller than the aggregate sample for the CR&D portfolio.

The econometric analysis indicates that the net cumulative GVA growth achieved to date is £140 million for the full sample of businesses in our analysis, representing £646,000 per company. This GVA figure is available for the 217 matched companies in our analysis, after removing

outliers[1]. We anticipate that the portfolio will continue to generate impacts in the future. This is because some companies included in the analysis have only recently started their projects and the difference with the comparator group becomes more apparent over time.

We estimate that the overall ROI for the CR&D portfolio is 1:7, meaning that each £1 invested by BBSRC has generated a net impact of £7, even after accounting for deadweight and the counterfactual. When private sector leverage is taken into account (cash and in-kind contributions from industry which were included within the application at the outset), we find that each £1 invested by BBSRC and industry partners has generated £5 in economic return after accounting for the counterfactual[2]. This is in line with findings for other comparable initiatives, however the outcome for the BBSRC CR&D portfolio is particularly strong considering the majority of the portfolio investment is in pre-competitive CR&D and the impact period measured is limited to the scope of the evaluation.

Investment category *	Key outcomes and impacts	ROI for BBSRC funding**	ROI for BBSRC and private sector
Responsive mode with industry	• Evidence of significant contributions to the body of knowledge and adoption of new knowledge and tools developed through CR&D • Provided a route to involve businesses in discovery-led projects • New partnerships were established, and some were strengthened but the intensity of interaction and the benefit drawn from the collaboration varied between projects • Individual examples of significant commercial impact, but most projects have modest innovation outputs e.g., IP and no significant effect on business performance	**1:3**	**1:2.5**
IPA & LINK	• Enabled businesses to tap into the expertise within the UK academic base and enabled the training of post-doctoral researchers in industry-relevant skills where some went on to be employed by industry • Strengthened and/or deepened existing partnerships • Provided the financial incentive for industry to collaboratively conduct fundamental progressing to more applied research with leading UK academics due to the co-investment mechanism	**1:25**	**1:13**

[1] The sample size includes businesses who were successfully identified in The Business Structure Database (BSD), have a suitable match after performing propensity score matching (PSM), and have values that fall within the interquartile range (IQR). We have excluded extreme values that fall outside of the IQR.

[2] The value of subsequent private sector investments from industry after the application form was not available.

	• Resulted in significant improvements in turnover and employment for participating businesses • Generated the highest ROI. From all investment categories, IPA and LINK have the highest marginal effects on Gross Value Added (GVA) growth which may be partly explained by greater industry co-investment and projects being more tailored to specific needs of industry partners		
 **Community & capacity building**	• Strengthened the understanding and ability to work with businesses and provided access to training in IP • Supported the creation of new partnerships and networking opportunities as well as primed future collaborative R&D areas • Supported early-stage Technology Readiness Level (TRL) progression contributing to de-risking investments through Proof of Concept (PoC) and other activities • Wider policy influence and "thought leadership" through national networks	**1:8**	**1:6**
 **Strategic BBSRC-led**	• Contributed to overcoming market failures and shared barriers to innovation through enabling pre-competitive R&D and developing a critical mass of skills in strategic fields • Strengthened and deepened existing partnerships within and across industries • Strong uptake of findings by businesses which then supported onward commercialisation through overcoming shared barriers to innovation • Nationally important programmes which bring businesses together pre-competitively to help coordinate R&D and skills development in a way which also helps to advance policy, standards, and regulation to deliver a wide array of impacts	**1:9**	**1:7**
 **Strategic co-funding**	• Contributed to the progression from pre-competitive R&D and publications to onward commercialisation • Building on existing partnerships and previous BBSRC-led investments contributed significantly to knowledge sharing and common understanding • Supported technological development with high TRL progression from 3 to 6 on average • Provided significant benefits to business turnover and employment across diverse sectors and industries	**1:9**	**1:7**

Notes: * The five investment categories are described in more detail in section 1.2
** The ROI figures exclude outliers defined as three standard deviations above the mean. See details in section 4.1.5

In addition to the outcomes and impacts highlighted above, it was found that BBSRC's CR&D investment categories are helping academic researchers and businesses use a wide range of research and innovation infrastructures in the UK and internationally, promoting collaboration

and accelerating discoveries. Around one third of researchers and businesses, whose project required the use of research infrastructures, were able to use infrastructures that would have been otherwise difficult to access as a result of BBSRC CR&D funded projects.

Overall, we find that:

- The CR&D portfolio has made significant contributions to the body of bioscience and industry-relevant research
- Investments have contributed to the training of R&I talent and have often provided recruitment opportunities for industry partners
- CR&D investments have enabled new and enhanced partnerships within projects and widened networks providing a route for business of all sizes to access relevant expertise within the academic research base
- There is evidence of contributions to technical and commercial progress across the low and middle range of the TRL scale and that the continuum from pre-competitive to commercial scale work has been strategically supported
- It has delivered a 1:7 ROI and supported a median increase of two jobs per company per year compared to non-beneficiaries
- Finally, we find contributions to societal policy and standards through large investment with significant national and international footprints, especially in the agrifood, animal health, and human health fields

Across all parts of the portfolio, BBSRC's investments in CR&D are highly valued by participating researchers and businesses and has delivered significant benefits for the bioscience sector in the UK.

1 Introduction

1.1 This report

This report presents the findings from the evaluation of the BBSRC CR&D portfolio. **It is structured as follows**:

- Section 1 provides an introduction to the BBSRC CR&D portfolio, the evaluation, and the methodological approach
- Section 2 provides an overview of the BBSRC CR&D portfolio
- Section 3 presents the outputs, outcomes, and impacts across the four impact domains
- Section 4 presents portfolio level impacts
- Section 5 presents reflections from conducting the evaluation and some recommendations to support future activities of the BBSRC CR&D portfolio

A series of appendices then provide further details to the methodology and findings for each element of the study.

1.2 BBSRC Collaborative Research & Development portfolio

The BBSRC, as part of UK Research and Innovation (UKRI), plays an important role in supporting academic researchers and businesses engage in bioscience and biotechnology through CR&D. This is an important objective within BBSRC's Strategic Delivery Plan[3] where BBSRC support for CR&D has the following objectives:

- Working with businesses and the bioscience research base to design and invest in strategic, collaborative R&D innovation programmes that are pre-competitive
- Connecting businesses to world-leading bioscience expertise and facilities across the UK through business partnering
- Enabling businesses to nurture talent and meet diverse skills needs
- Partnering with Innovate UK to accelerate and maximise the impact of bioscience through business-led innovation

The BBSRC supports CR&D through different types of investments and mechanisms which vary in terms of purpose, the value of individual investments, and mode of implementation. These are collectively referred to as the **"BBSRC Collaborative R&D Portfolio."**

The current evaluation primarily covers the period from 2011 to 2021, where the BBSRC has invested a total of £611 million in CR&D across the portfolio. The evaluation also includes

[3] BBSRC Strategic Delivery Plan 2022–2025, September 2022, p. 20, available at: https://www.ukri.org/publications/bbsrc-strategic-delivery-plan/

investments in the Diet and Health Research Industry (DRINC) Research Club, which was initiated in 2006 but has continued during the period covered. The investments within the portfolio fall within five broad categories of investment as described in Table 1.

Table 1 Investment categories in the BBSRC CR&D portfolio

Responsive Mode grant awards with industry partners: Researchers can submit research grant applications at any time for consideration by one of the Research Committees under the BBSRC "Responsive Mode" competition and these can involve private sector businesses as research partners. This provides a flexible route for involving businesses at the earliest stages in discovery-led research in relevant R&D activities within the research base.

Industrial Partnership Awards (IPA) and LINK awards: These programmes support collaboration across all bioscience and biotechnology sectors supported by BBSRC. The programmes aim to enable businesses to collaborate with the bioscience academic research base, helping to deliver societal and economic impact. Contributions from businesses are mandatory under these programmes. To be eligible under the IPA programme, industry partners must make a cash contribution that is at least equivalent to 10% of the balance of the project costs (excluding the industry contribution). In order for an application to be eligible under a LINK programme, at least 50% of the full project cost must come from industry (either cash or in-kind).

Community & Capacity Building Investments: The purpose of these investments is to prime academic-industry collaborations as well as build early-stage capacity and capability in strategic areas, including internationally. This is done through a variety of investment types, such as networks with proof-of-concept funding, pump-priming programmes, and business interaction vouchers. This category has also involved investments in skills and talent development in relevant industrially-focused areas such as through BBSRC investment in supporting the Innovate UK-led Knowledge Transfer Partnerships (KTPs).

BBSRC-led Strategic CR&D investments: These pre-competitive investments are typically large-scale flagship programmes for bioscience and biotechnology, led by BBSRC and involve multiple academic and industry stakeholders. They aim to address market failures by reducing shared barriers to innovation across industries and sectors, whilst also being aligned to national strategy and policy areas.

Strategic Co-Funding (across UKRI): The BBSRC also provides strategic innovation co-funding to collaborative R&D investments led by other areas of UKRI. This includes a long-standing strategic partnership with Innovate UK. The aim is to ensure that, where necessary and appropriate, bioscience and biotechnology are strategically supported within these investments, and through partnering with Innovate UK, business-led innovation is also supported.

Source: Based on input from the BBSRC

1.3 About the evaluation

The BBSRC has commissioned Technopolis to conduct an evaluation of the impact of its CR&D portfolio in the period from 2011 to 2021. The evaluation has considered the portfolio as a whole as well as its five constituent investment categories in addressing the evaluation questions listed in Table 2.

Table 2 Evaluation questions

1. At a CR&D **portfolio level**, what are the outputs, outcomes, and wider impacts of BBSRC investments?
2. How have **each of the portfolio investment categories** differentially contributed to the overall outcomes and impacts?
3. To what extent has the BBSRC CR&D portfolio delivered **value for money**?
4. What is the breadth and **diversity of businesses supported** across the BBSRC CR&D portfolio?
5. To what extent has BBSRC CR&D support helped academic researchers and businesses access and use **research and innovation infrastructure**?

1.4 Methodological approach

1.4.1 Methodological approach and tools

The evaluation set out to assess the extent to which the BBSRC CR&D portfolio has met or is expected to meet its objectives, providing insight and evidence that will enable BBSRC to further understand its approaches to and investments in CR&D.

To address the evaluation questions, the evaluation team has adopted a **Theory-Based approach**, combining several methodological tools as summarised in Table 3**.** A Contribution Analysis was used as an overarching analytical framework and combined with an **Econometric Analysis** to quantify the impact on businesses and estimate the ROI within the period of the evaluation.

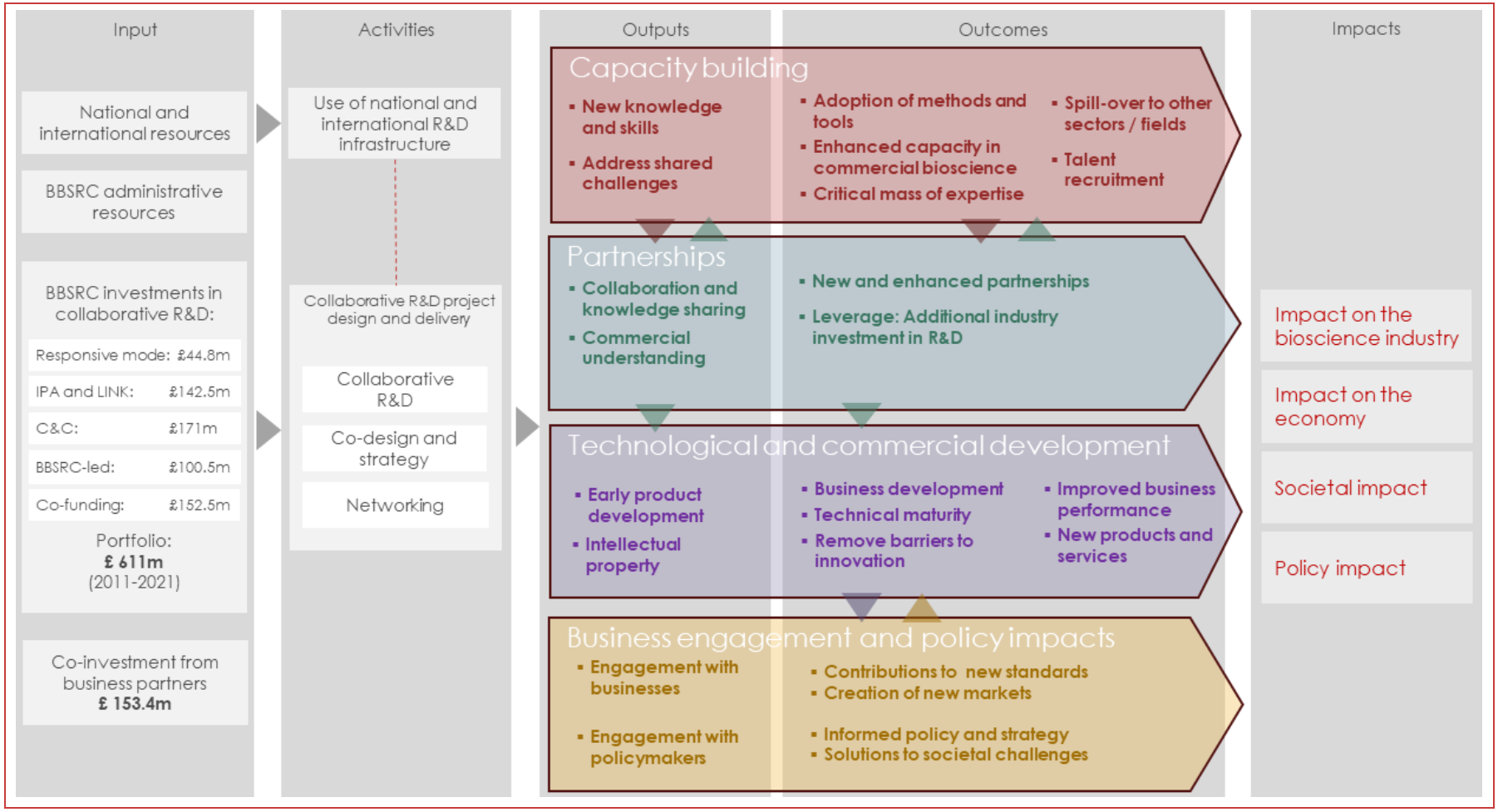
The evaluation combines qualitative and quantitative methods and makes use of available evidence from both primary and secondary sources to provide robust and transparent evaluation findings. There is a strong participatory element to the evaluation which sought engagement from a wide variety of stakeholders through surveys and interviews.

Table 3 Methodological tools

Tools	Description
Review and analysis of secondary sources	
Portfolio analysis and desk research	Portfolio data provided by the BBSRC and outcomes data from Researchfish were reviewed and analysed in detail from relevant grants. The team reviewed an array of policy documents, programme and project level documentation, past evaluations including those for the LINK and IPA programmes, and relevant Research Excellence Framework (REF) impact case studies.
Theory of Change	We developed an "embedded" set of theories of change (ToC). A theory of change was developed for each of the five main categories as well as an aggregated version. Each ToC outlined how each strand "maps onto" the overall aggregated ToC. This is presented in Appendix E.
Primary data collection	
Online surveys	The team designed and implemented an online survey to be completed by academic leads. The survey was disseminated via email in September 2023 with a subsequent follow-up during Winter 2023. The survey was completed by 409 academic leads. A breakdown of respondents can be found in Appendix H. An additional survey of project partners from industry and other non-academic institutions was distributed via the academic PI. This part of the survey received 37 responses which have primarily served as qualitative input into the analysis.
Qualitative interviews project participants	We conducted in-depth semi-structured interviews with participants in projects from the BBSRC's CR&D portfolio, including 12 PIs and six industry partners. The interviews provided further insights and evidence on the pathways that facilitated the realisation of project benefits, thereby enhancing and completing responses to closed survey questions. Appendix G contains a list of those consulted in the interview programme.
Qualitative interviews with other stakeholders	We conducted interviews with eight stakeholders, including UKRI staff members and prominent representatives from the UK bioscience ecosystem. The interviews provided insights into the BBSRC's investment portfolio and its significance in the wider environment. Appendix G contains a list of those consulted in the interview programme.
Analysis and synthesis	
Contribution Analysis	Contribution Analysis is used to synthesise and assess a range of different types of qualitative and quantitative evidence of outcomes and impacts against the programme's objectives and ToC and provide a contribution narrative describing how the BBSRC CR&D portfolio investments have contributed to these.
Econometric Analysis	Econometric Analysis is used to estimate the effect of participation in BBSRC CR&D projects on industry partners. The analysis is based on BBSRC monitoring data matched with the Office for National Statistics (ONS) Business Structure Database (BSD). A Propensity Score Matching (PSM) approach was used to identify a control group, and a Difference-in-Difference model was implemented to estimate effects on turnover, employment, and labour productivity i.e., turnover per employee. The ROI figures are estimated for each investment category and for the portfolio as a whole. These figures reflect the net cumulative GVA estimates for industry partners relative to the cost of investment. See details in Appendix D.

1.4.2 BBSRC CR&D portfolio Theory of Change

Figure 1 Theory of change: BBSRC CR&D Portfolio



Source: Technopolis

The portfolio-level ToC was developed in consultation with the BBSRC. With a set of diverse interventions that make up the BBSRC CR&D portfolio, the objectives are necessarily defined in broad terms and there are multiple pathways to achieving impact. The ToC identifies four main ***impact domains***, each of which represents a path to impact but also mutually support each other:

- **Capacity building:** Development of new knowledge and skills leading to enhanced capacity in pre-competitive and business-led bioscience and critical mass of expertise in strategic areas of national importance
- **Partnerships:** Collaboration and knowledge sharing, leading to an improved understanding of commercial bioscience and enhances long-term partnerships which help leverage additional investments in research and innovation (R&I) beyond the projects
- **Technological and commercial development**: Early product development and creation of intellectual property (IP) enabling increased technological maturity, removal of barriers to innovation and business development, eventually leading to improved business performance and the introduction of new products and services to market
- **Business engagement and policy impacts:** Engagement with bioscience businesses and the creation of "thought leadership" in strategic areas which enable informed policy making and the development of standards which help emerging industries and markets as well as contributing to addressing societal and policy challenges

The ToC forms the basis for the contribution analysis and the analytical framework used for this analysis.

1.4.3 Challenges and limitations

The evaluation faced a number of challenges:

- **Portfolio data:** The evaluation covers a period of 11 years during which time BBSRC CR&D investments have been implemented under a large number of different programmes and funding instruments, often with different rules of participation, reporting requirements, formats, and IT systems.
- **Time lag:** Many of the activities described in the portfolio were undertaken a number of years ago, and many project PIs and participants have since moved on or retired. The ability of participants to recall outcomes and distinguish BBSRC-funded CR&D projects from other activities diminished over time. The qualitative evidence obtained therefore reflect the more recently implemented part of the portfolio better than older parts.
- **Evidence from industry partners:** The evaluation team were unable to identify and contact industry partners directly and therefore relied on an indirect mode of distribution of the participant survey via the academic PIs. The response to the partner survey limited the ability to allow for a quantitative analysis of these responses. Survey and interview evidence therefore represent the perspective of academic PIs better than the perspective of industry partners.

2 The BBSRC Collaborative Research & Development portfolio

Analysis of the monitoring data allowed us to examine the scale and nature of funded projects, the characteristics of participating organisations and project partners, as well as the progress made in the delivery of outputs, outcomes, and impacts. This section presents our analysis of BBSRC grant data recorded at the stage of application.

2.1 Project Characteristics

The BBSRC has invested in and supported 1,322 projects as part of its CR&D portfolio through a total of 1,805 individual awards during the period covered in this evaluation. This primarily includes grants awarded between 2011and 2021,[4] but also includes initial investments in the DRINC programme, which was initiated in 2006 and continued through the evaluation period covered.

The count of projects refers to the specific R&D activities that are being conducted using the funds provided by one or multiple awards per project:

- **Projects** are led by a Principal Investigator (PI) from an eligible research organisation, which include academic organisations, research council institutes, public sector research organisations, and other approved independent research organisations. Additionally, projects may also involve Co-Investigators (CoI) who meet the necessary requirements or Researcher Co-Investigators (RCoI) who have made or are expected to make significant intellectual contributions to the project.[5]
- The portfolio includes 1,805 individual **awards**. These are within funded projects and account for cases where multiple unique award-holders are involved per project. The number of awards represents the total count of unique grant reference numbers, whilst the number of projects denotes the total count of distinct project names, which may involve one or multiple award-holders collaborating on a single project.

Table 4 below provides insights into the distribution of funded projects between the five investment categories. Approximately 38% of all funded projects are in the Community and Capacity Building category which represents a variety of investment types aimed at supporting early-stage academic-industry collaborations. The portfolio also includes projects that support investigator-led research which provides an opportunity to align academic research expertise with innovation and translation opportunities for businesses including IPA & LINK (20%) and Responsive Mode with Industry (7%). A further 13% of projects fall into the BBSRC-led Strategic CR&D category, which aims to address market failures in a pre-competitive context. The portfolio also includes investments of innovative CR&D projects co-funded with UKRI or other research funders and represents 22% of all projects.

[4] This includes the calls or "sessions" (as described in portfolio data set provided) ascribed to these years. In a small number of instances, the final award and project start took place the following year.

[5] Examples of RCoI include post-doctoral research assistants, technology specialists and clinical fellows.

*Table 4 BBSRC investment per category, 2011–2021**

Category	Number of awards	Percentage of awards	Number of projects	Percentage of projects
Responsive Mode grant awards with industry partners	93	5%	88	7%
IPA and LINK awards	379	21%	268	20%
Community and Capacity Building	531	29%	501	38%
BBSRC-led Strategic CR&D investments	280	16%	170	13%
Strategic co-funding	522	29%	295	22%
Overall	1,805	100%	1,322	100%

Source: Technopolis data analysis of BBSRC Grant database. Note (*) includes the DRINC research club starting in 2006

The BBSRC CR&D portfolio spans multiple funding programmes which cover research activities at different stages of the innovation life cycle, including discovery research, technology development, the use of equipment, research networks, and skills development. Appendix A includes further details on the different types of funding programmes under each investment category as well as a breakdown by type of initiative which provides further insight into the type of investments grouped under the "Other" category.

2.2 Value of award funding and industry contributions

The cumulative expenditure for the entire BBSRC CR&D portfolio amounts to over £611 million primarily covering the period from 2011 to 2021. It is also inclusive of the DRINC investment which started in 2006 (see Table 5) as the programme was ongoing during the evaluation period. Approximately 28% of the total funding is allocated to projects in the Community and Capacity Building category, 23% of the total funding is for the IPA and LINK category, with a further 7% of funding for awards in the Responsive Mode with Industry category (£45 million). 25% of the funding resides within the Strategic Co-funding category and 17% for BBSRC-led Strategic CR&D investments.

Overall, projects funded in the entire BBSRC CR&D portfolio have secured £32.8 million in cash and £120.3 million from in-kind contributions from project partners at the outset of the award. The IPA & LINK category, which has specified industry contribution requirements had the largest amount of industry contributions (£24.6 million cash and £54 million in-kind) and represents 51% of the total contributions.

Table 5 shows the breakdown for different funding programmes in each investment category.

*Table 5 BBSRC investment and value of industry contributions, per investment category, 2011-2021**

Category	Value of BBSRC funding	Funding in each category as a % of total	Total value of cash contributions	Total value of in-kind contributions	Average BBSRC funding per project
Responsive Mode grant awards with industry partners	£44.8m	7%	£0.797m	£10.8m	£509k
IPA and LINK awards	£142.5m	23%	£24.6m	£54.0m	£532k
Community and Capacity Building	£171m	28%	£4.1m	£24.5m	£399k
BBSRC-led Strategic CR&D investments	£100.5m	17%	£2.6m	£5.2m	£408k
Strategic co-funding	£152.5m	25%	£0.738m	£26.1m	£520k
Overall	**£611m**	**100%**	**£32.8m**	**£120.6m**	**£461k**

Source: Technopolis data analysis of BBSRC Grant database. Note (*) includes the DRINC research club starting in 2006

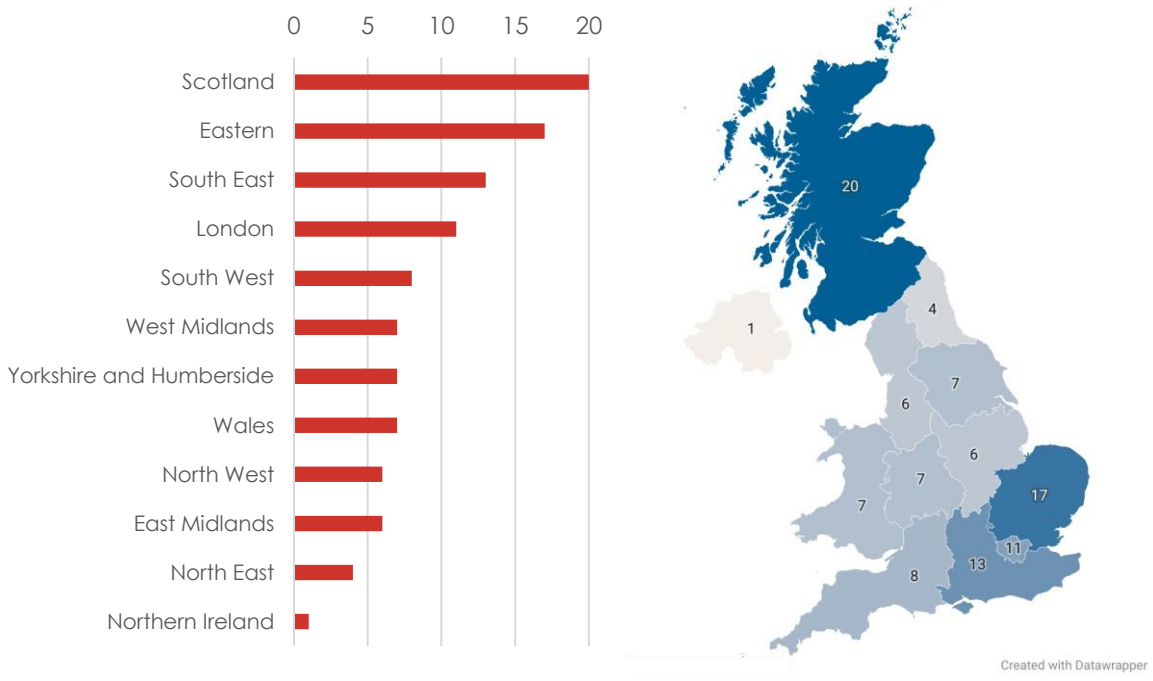
2.3 Characteristics of project leads and industry partners

2.3.1 Project leads

Between 2011 and 2021, the BBSRC CR&D portfolio has funded 107 unique organisations as project leads,[6] of which 99 were either Higher Education Institutions (HEI) or eligible Independent Research Organisations (IRO), with a further eight being BBSRC's strategically supported institutes. Of the 107 organisations, approximately 21% won just one award, 24% won between two and five awards, and 55% won more than five. The average (mean) number of awards per research organisation is 15. In terms of the location of awarded organisations, it was identified that the majority were in England (73%), followed by Scotland (17%), Wales (6%), and Northern Ireland (1%) (see Figure 2).

[6] The figure includes a count of unique lead organisations (excluding organisations of co-investigators) based in the UK. The analysis includes BBSRC NIBB main awards only. There are 22 additional organisations that are associated with sub-NIBB awards. When these additional awards are included, the total number of organisations increases to 129.

Figure 2 Number of supported organisations as project leads, by UK region and country



Source: Technopolis data analysis of BBSRC Grant database

2.3.2 *Project partners*

Project PIs have collaborated with a diverse group of 1,753 different partners.[7] These include 1,282 private sector businesses, 283 academic organisations, and 188 non-profit organisations (see Table 6).

Table 6 Number and type of project partners

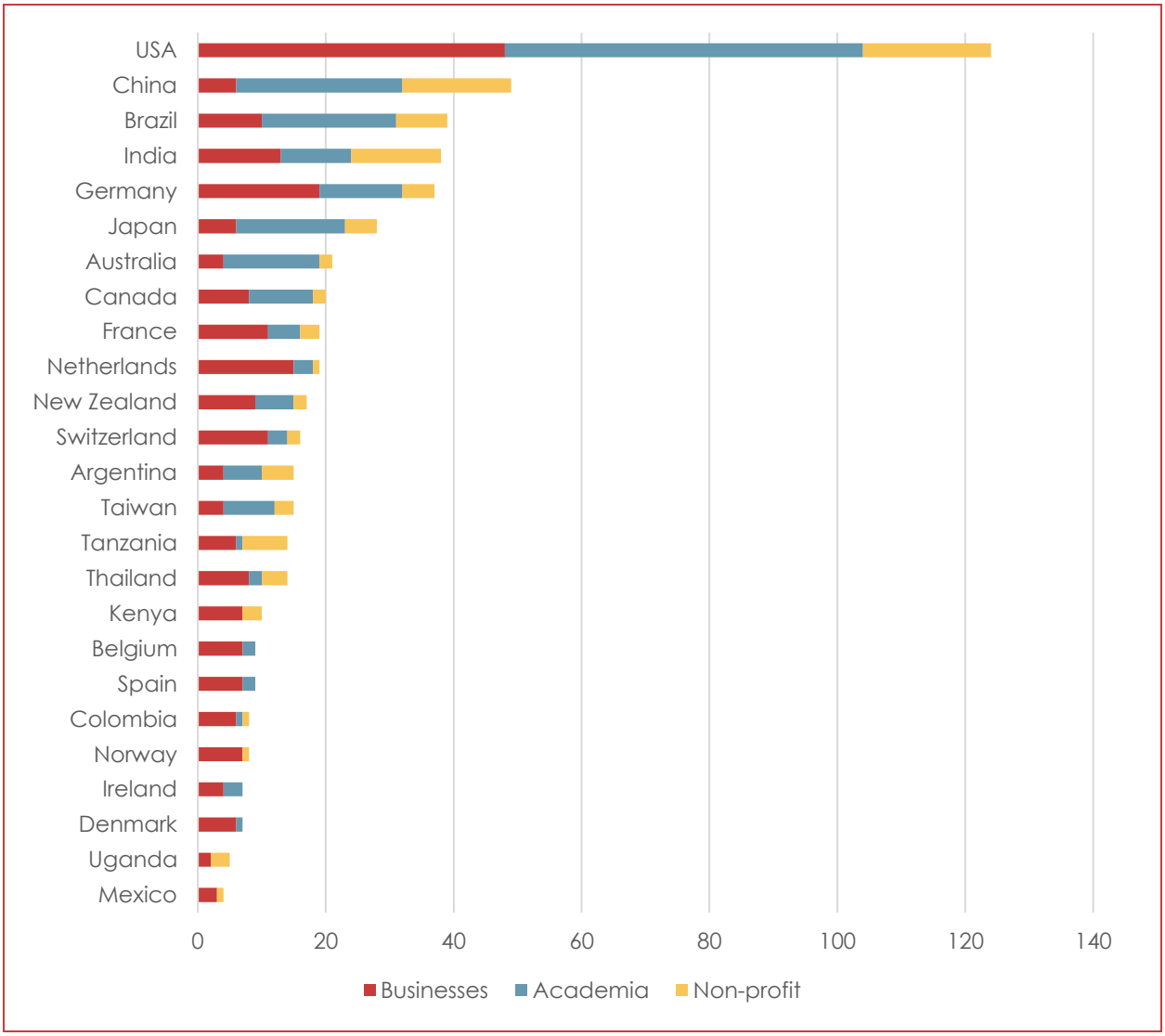
	No. of project partners	**% of project partners**	**No. of project partners based in the UK**	**% of project partners based in the UK**	**No. of project partners based outside the UK**	**% of project partners based outside the UK**
Businesses	1,282	73%	1,025	80%	257	20%
Academia	283	16%	43	15%	240	85%
Non-profit	188	11%	52	28%	136	72%
Total	**1,753**	**100%**	**1,120**	**64%**	**633**	**36%**

Source: Technopolis data analysis of BBSRC Grant database

[7] The figures refer to the number of project partners included on the application at the outset, rather than including any new collaborations that may have developed during the course of the project.

Overall, 64% of project partners are based in the UK, whilst the remaining 36% are located internationally. Notably, the share of international partners is significantly higher among academic and non-profit organisations, whereas industry partners are predominantly UK-based. Figure 3 shows the top 25 international partner locations, split by partner type.

Figure 3 Number of international project partners, by type and country (top 25 countries)

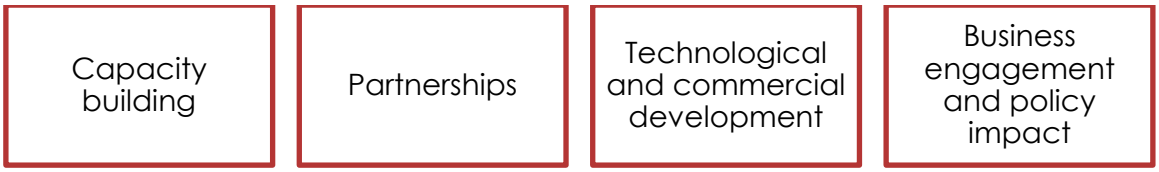


Source: Technopolis data analysis of BBSRC Grant database

3 Outcomes and impacts by domain

3.1 Introduction and summary

This section sets out the findings from the four impact domains and their contributions to the following:



Each section draws on the evidence from all of the various data collection strands. This includes interviews, surveys, portfolio analysis, secondary evidence from Researchfish outcomes data, and REF impact case studies. A detailed analysis of survey results is provided in Appendix G.

Summary

There is robust evidence which links BBSRC investments to improvements in capacity building (knowledge and skills) and that the investments have been essential in fostering partnerships and networks across the sector. Similarly, developments in technology and the creation of intellectual property can often be traced directly to CR&D investments.

Investment category	Key outcomes and impacts
 **Responsive Mode with industry**	• Evidence of significant contributions to the body of knowledge and adoption of new knowledge and tools developed through CR&D • Provided a route to involve businesses in discovery-led projects • New partnerships were established, and some were strengthened but the intensity of interaction and the benefit drawn from the collaboration varied between projects • Individual examples of significant commercial impact but most projects have modest innovation outputs e.g., IP and no significant effect on business performance
 **IPA & LINK**	• Enabled businesses to tap into the expertise within the UK academic base and enabled the training of post-doctoral researchers in industry-relevant skills where some went on to be employed by industry • Strengthened and/or deepened existing partnerships • Provided the financial incentive for industry to collaboratively conduct fundamental progressing to more applied research with leading UK academics due to the co-investment mechanism • Resulted in significant improvements in turnover and employment for participating businesses • Generated the highest ROI. From all investment categories, IPA and LINK have the highest marginal effects on Gross Value Added (GVA) growth which may be partly explained by greater industry co-investment and projects being more tailored to specific needs of industry partners

Community & capacity building	• Strengthened the understanding and ability to work with businesses and provided access to training in IP • Supported the creation of new partnerships and networking opportunities as well as primed future collaborative R&D areas • Supported early-stage Technology Readiness Level (TRL) progression contributing to de-risking investments through PoC and other activities • Wider policy influence and "thought leadership" through national networks
Strategic BBSRC-led	• Contributed to overcoming market failures and shared barriers to innovation through enabling pre-competitive R&D and developing a critical mass of skills in strategic fields • Strengthened and deepened existing partnerships within and across industries • Strong uptake of findings by businesses which then supported onward commercialisation through overcoming shared barriers to innovation • Nationally important programmes which bring businesses together pre-competitively to help coordinate R&D and skills development in a way which also helps to advance policy, standards, and regulation to deliver a wide array of impacts.
Strategic co-funding	• Contributed to the progression from pre-competitive R&D and publications to onward commercialisation • Building on existing partnerships and previous BBSRC-led investments contributed significantly to knowledge sharing and common understanding • Supported technological development with high TRL progression from 3 to 6 on average • Provided significant benefits to business turnover and employment across diverse sectors and industries

3.2 Contribution to capacity building

Capacity building: Development of new knowledge and skills leading to enhanced capacity in pre-competitive and business-led bioscience and critical mass of expertise in strategic areas of national importance.

3.2.1 New knowledge

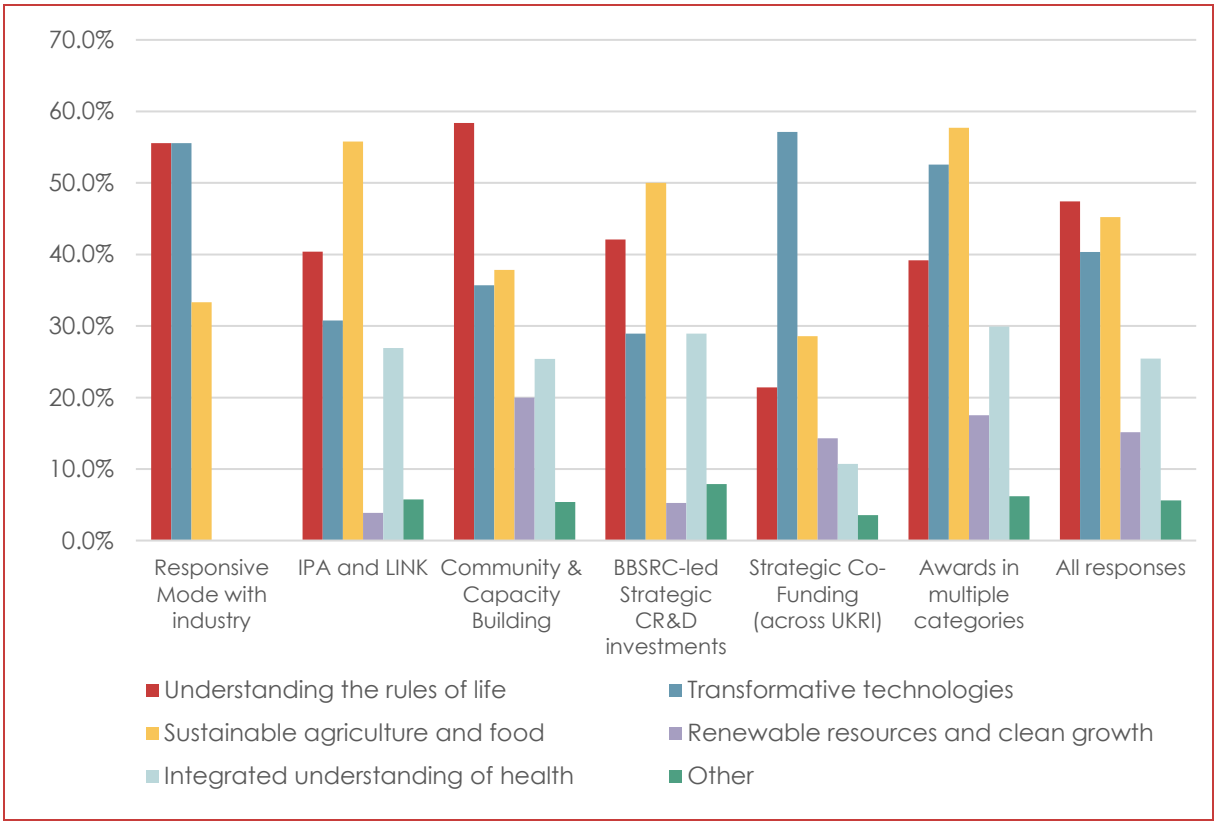
The projects funded by BBSRC investments in CR&D contributed directly to the creation of new knowledge with different parts of the portfolio focusing on different types of knowledge outputs.

PIs were asked to identify which of the BBSRC's broad research and innovation priorities8 their research profile was best aligned with through the survey. PIs in receipt of Responsive Mode

[8] These are the priorities defined the BBSRC's Delivery Plan from 2019, available at: BBSRC-250920-DeliveryPlan2019.pdf (ukri.org). This differs in part from the most recent strategic delivery plan for 2022-2025.

with Industry grants were focussed on three main objectives: basic research questions in the biological sciences ("Understanding the rules of Life"), developing transformative technologies, and less commonly sustainable agriculture and food. In comparison, PIs of grants in other categories reported a broader set of objectives and addressed challenges related to renewable resources and health. Non-BBSRC-led grants were most likely to focus on transformative technologies.

Figure 4 PI research profile (BBSRC priority area) by investment category



Source: Survey of BBSRC PIs, n = 407

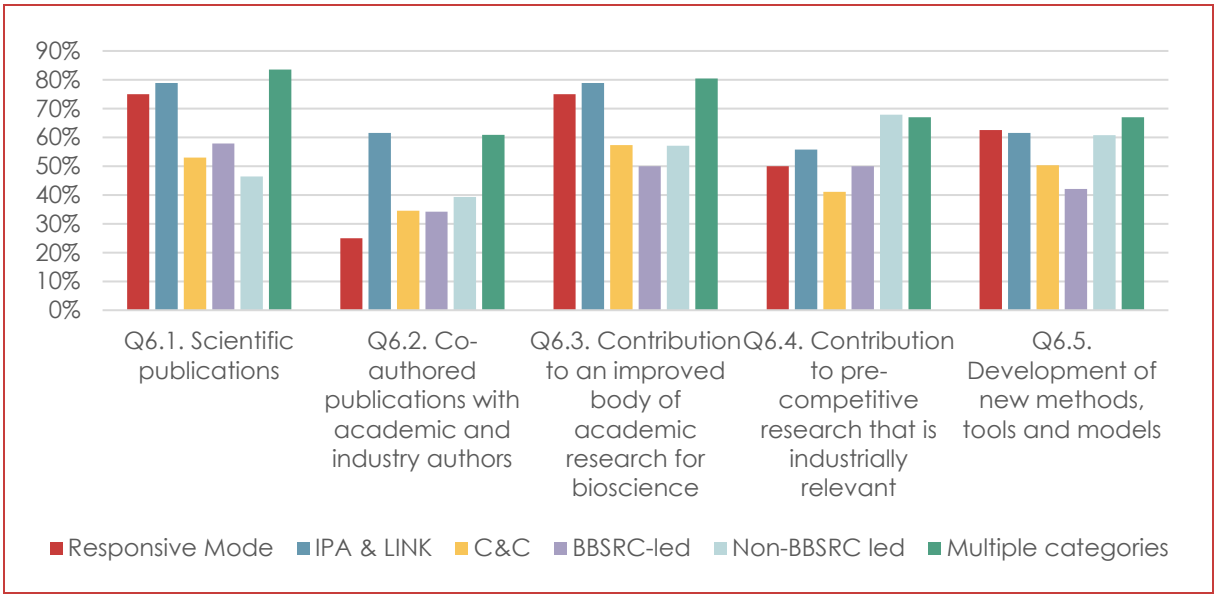
The majority of **PIs reported contributing to an improved body of academic research for bioscience, industry-relevant pre-competitive research, and the development of new methods and tools** (see Figure 5).

Different parts of the portfolio also differed in the types of scientific outputs. Most PIs highlighted that the research within their BBSRC CR&D projects have formed the basis for scientific publications, especially within Responsive Mode grants. Many have also co-authored papers with industry, including more than 60% of IPA and LINK projects.

Academic publications are not developed to the exclusion of commercially relevant knowledge or to other types of outputs. Many of the same projects which highlight publications also report the creation of spinouts and IP (see section 3.3 below), and some also find BBSRC CR&D projects have improved their ability to bring relevant research findings to the attention of industry:

"Working closely with collaborative partners has ensured that fundamental research is highly relevant to the industrial community. This has led to changes in the way publications are written to ensure readability by wider audiences."[9]

Figure 5 Scientific outputs



Source: Survey of BBSRC PIs, n = 373

BBSRC CR&D projects have also contributed to the generation of new knowledge among participant businesses. It has enabled companies to undertake a range of activities, including research that could improve existing, as well as develop new products and processes, develop new test procedures and methodologies, and understand research that could be important for the business. More than 60% of businesses responding to the evaluation survey see BBSRC CR&D projects as 'critically important' or 'very important' for them to be able to undertake these activities. Several businesses further point to ways in which participation in BBSRC CR&D projects have provided them with a new understanding of pathways to impact and deployment of technology to markets. For some businesses, this has meant establishing new areas of development, whereas for others, it has led them to understand better how their existing products could contribute to new developments. [10]

3.2.2 *Skills and capacity in pre-competitive and business-led bioscience*

BBSRC CR&D projects have had a positive impact on technical and non-technical skills and has helped developed capacity to undertake pre-competitive bioscience research for both academic and industry partners.

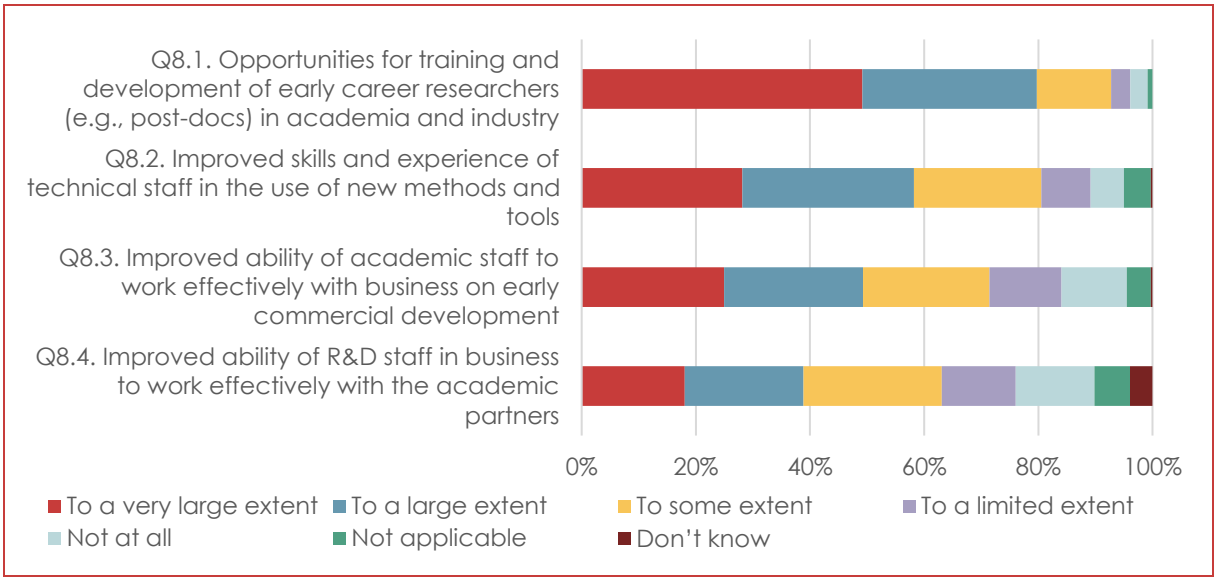
Most academic PIs reported significant skills-related benefits including the improved ability among academics and businesses to collaborate. Furthermore, members of academic

[9] Project PI of multiple CR&D grants

[10] See Appendix H

research teams reported building experience from business interaction and gaining a better understanding of what is required when reaching agreements on IP and licencing (Figure 6).

Figure 6 Skills-related benefits enabled by BBSRC CR&D projects



Source: Survey of BBSRC PIs, n = 360

BBSRC CR&D projects have been particularly instrumental in providing opportunities for developing skills of early-career researchers and innovation talent, with 80% of academic PIs reporting this to be the case across the portfolio to a "large" or "very large" extent. As a result, the development of early career researchers has contributed to the availability of research and innovation talent in the bioscience sector. 35% of academic PIs reported talent being recruited by industry – including in pharmaceutical and agricultural companies – especially from the IPA & LINK programmes as well as through projects funded with co-investment from Innovate UK.[11]

> "The postdoctoral researcher on the project learnt about how academia and industry work. He is now working in the pharmaceutical industry for a contract research organisation."

In several instances, early career researchers have also become entrepreneurs, developing their own spinout companies based on their experience in BBSRC CR&D projects.

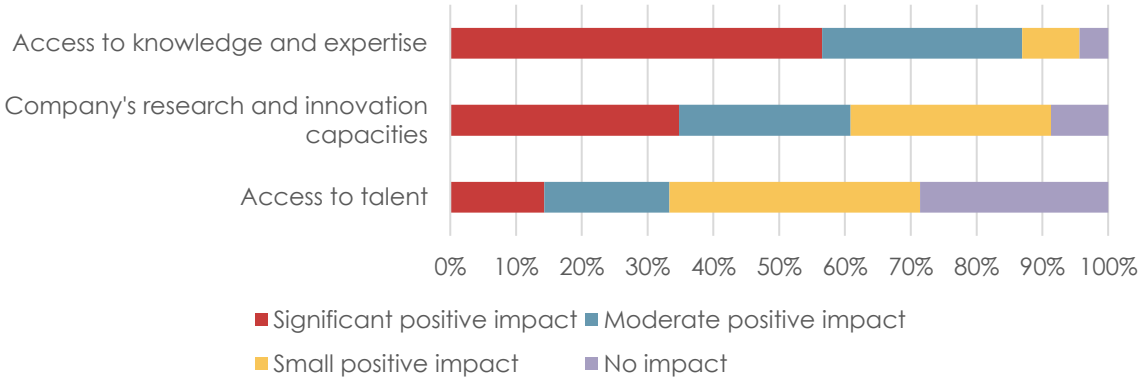
For businesses, BBSRC CR&D projects have been particularly important for accessing existing knowledge and expertise as well as strengthening the internal research and innovation capabilities of the company, as evidenced by survey responses from businesses participation in BBSRC CR&D projects (Figure 7).

[11] Survey of Academic PIs, Question 9, see Appendix H.

"The project has enabled us to gain knowledge in new biomanufacturing technologies and how our current processes compare to them."[12]

This ranges from getting up to speed on the current state of knowledge, to developing and adopting new tools and processes, and adapting internal management processes as a result of new knowledge.

Figure 7 Impact of BBSRC CR&D projects on knowledge and R&I capacity in business



Source: Survey of business partners, n =23

3.2.3 *Adoption of methods and tools*

CR&D projects have resulted in the development of specific tools, databases, and/or methodologies. More than half of academic PIs reported that such tools had been taken up and used by others within the field as well as 22% in other fields. Multiple industry partners also reported developing and adopting new methods and tools as a result of their involvement in BBSRC CR&D projects, as illustrated below.

[12] Survey response from Business PI.

Examples of methods and databases developed and adopted

Academic partners:

- A universal set of markers for testing whether salmon are of farm, wild, or hybrid farm/wild origin
- The UK Anaerobic Digestion Microbiome Project collected weekly microbiome data from industrial-scale digestion plants across the UK to further understanding of anaerobic digestion. This project helped to better control its process and efficiency

Industry partners:

- Reactive fragment screening approaches to advance and accelerate drug discovery
- A predictive tool to better understand the efficacy of pesticides
- Ability to clone, express, and assay new enzymes for advanced bioengineering with potential applications across a number of sectors
- In-house insect screening capabilities for germplasm evaluation and understanding
- An embryo-biopsy technique to allow DNA sampling for genomic and genetic analysis to improve animal breeding
- Internal management processes

Source: Researchfish, survey of academic and industry partners, company websites

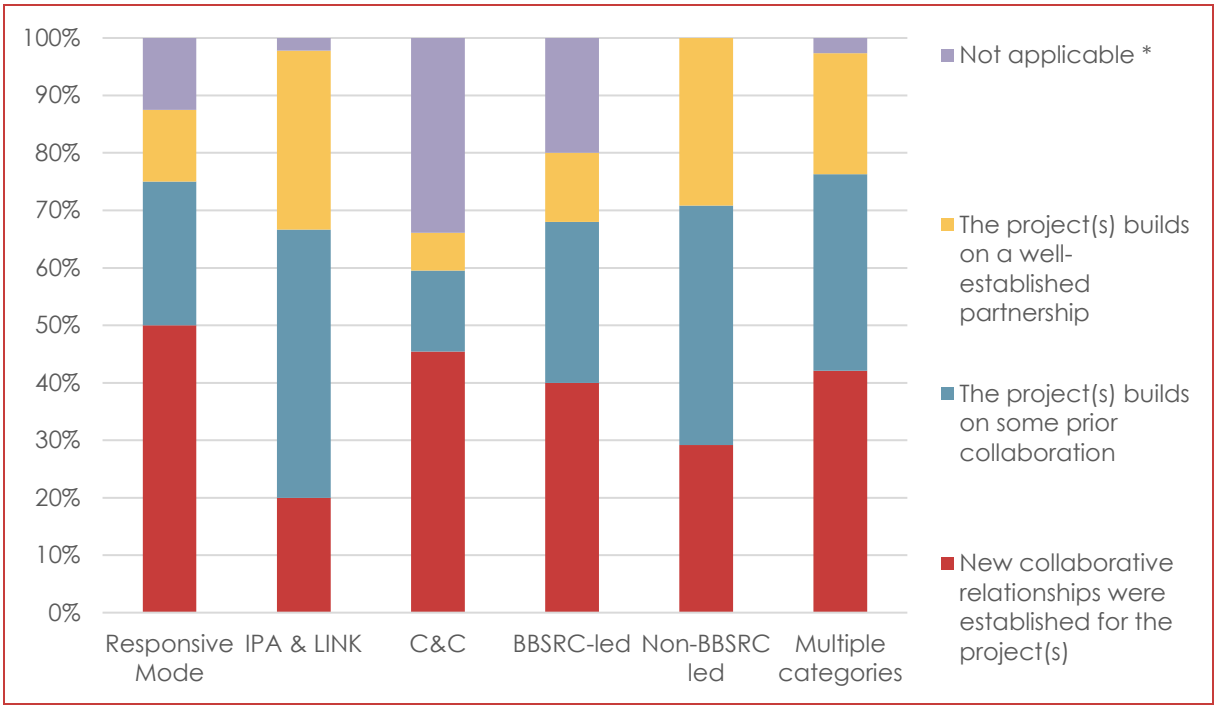
3.3 Contribution to partnerships

Partnerships: Collaboration and knowledge sharing, leading to an improved understanding of commercial bioscience and enhances long-term partnerships which help leverage additional investments in research and innovation (R&I) beyond the projects

3.3.1 New and enhanced partnerships

BBSRC CR&D investments have enabled the development of new as well as enhanced research partnerships within projects and wider networks. According to the survey of academic PIs, 39% of projects across the portfolio involved partnerships with industry partners that the academic PI had not collaborated with previously. Furthermore, data from the survey displayed in Figure 8, show that Responsive Mode with Industry and Community and Capacity building grants were most likely to provide opportunities to work with new industry partners, providing an entry point for new relationships, whereas IPA & LINK grants were more likely to build on prior collaboration.

Figure 8 Academic collaboration with industry partners



Source: Survey of BBSRC PIs, n = 236. Note: * Some academic selected "not applicable" as they were unable to comment on industry partners

The variety of mechanisms which BBSRC implements across the CR&D portfolio provides different entry points for companies and academics to conduct collaborative research. Investments in the Community and Capacity building category were highlighted by companies consulted for the study as relatively low-risk ways of trying things out whereas IPA & LINK provide more focused projects with a larger degree of commitment on the part of industry partners.

> "This project has given us a much deeper knowledge and appreciation of the challenges that our industry faces. Also, a clearer understanding of the use of academia to develop practical but science-based interventions." [13]

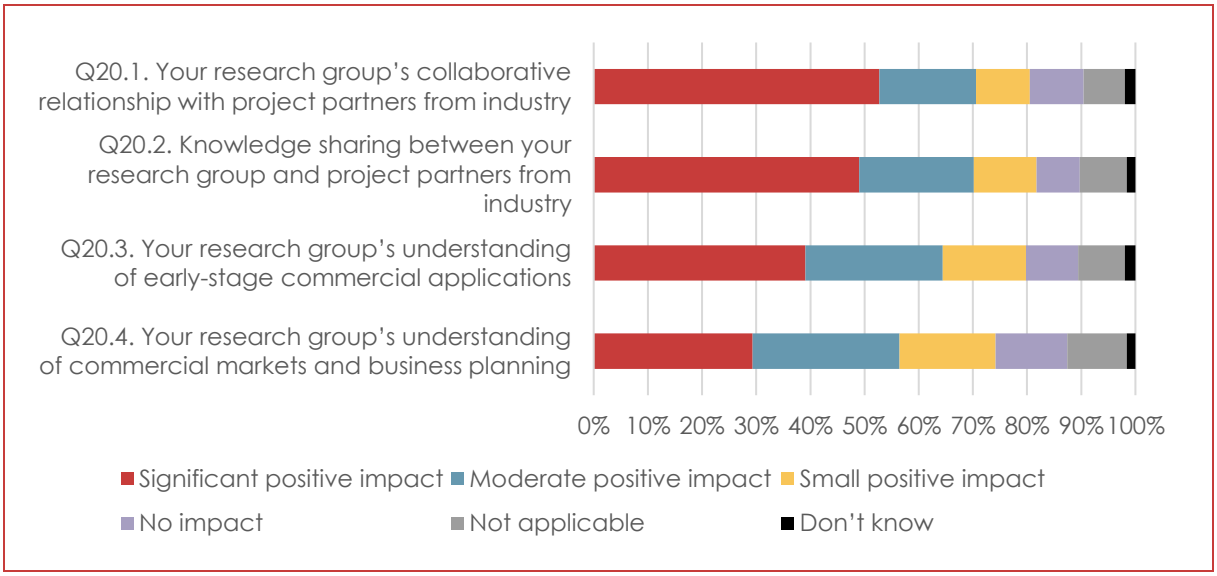
Large investments which bring industry partners across sectors and industries together provide an opportunity for businesses to help inform the scope and strategy of the overall investment. For example, the Research Clubs have had the further benefit of building communities within national strategic areas of bioscience research and orienting research towards industry-relevant areas. For businesses not directly involved in these types of investments, activities which facilitate wider access to the investments and associated communities of practice have been an efficient way for businesses to gain access to relevant academic expertise.

[13] Survey of industry partners

3.3.2 *Collaboration and knowledge sharing*

Participants in BBSRC CR&D projects derived significant benefits from the collaboration, especially with regards to improving relationships and knowledge sharing with partners. This was seen across the portfolio as shown in Figure 9, but particularly in IPA and LINK projects where 76% of academic PIs saw this as a significant benefit, as compared to less than 50% of PIs of projects in other categories, and 55% of companies responding to the survey (see details in Appendix H).

Figure 9 Impact of BBSRC CR&D projects on academics collaborating with industry



Source: Survey of BBSRC PIs, n = 313

In general, BBSRC CR&D projects were viewed in a very positive manner and were described as "exemplary at building mutual understanding." With regards to businesses, collaboration was perceived positively, for example it has enabled businesses to be become more innovative:

> "We are not a research institute but want to want to be innovative and forward thinking, collaborating in this way helps us achieve this"

From these initial interactions, it was identified that partnerships and collaborations between industry and academia and the knowledge base extend beyond just BBSRC-funded projects through various forms of collaboration as described in the following section.

Example: The National Biofilms Innovation Centre

The National Biofilms Innovation Centre (NBIC) is a key Innovation Knowledge Centre (IKC) in the UK funded by both BBSRC and Innovate UK. Borne out of a series of projects initially funded through BBSRC CR&D funding, NBIC aims to drive innovation in biofilm control and exploitation through collaborations between new companies and research institutions.

The NBIC has deepened long-term partnerships between new companies including small and medium-sized enterprises (SMEs), where funding is made available for academics to conduct industrially relevant research into biofilms. The centre is a strategic partnership with

four core universities (Edinburgh, Liverpool, Nottingham, and Southampton) and has attracted investment from regional clusters. This has since expanded to include a total of 59 research institutions and over 260 companies, including those from outside the UK.[14] The added value of the National Hub and the BBSRC funding of NBIC is to provide the sector with a single point of contact for research and innovation into biofilms, where provisions can be made regarding the access to key resources, guidance and expertise, as well as reducing the administrative burden for the sector.

BBSRC funding of the NBIC has catalysed industry engagement in the biofilms sector where one example of this success was indicated in the survey. Respondents reported that two fellowships are now funded by industrial partners at the Universities of Nottingham and Birmingham. As Birmingham is not one of the four core partners, this demonstrates the significant reach and impact that NBIC has had on the sector.

Furthermore, BBSRC CR&D funding has led to the de-risking and advancement of key technologies with the potential for impact across a variety of sectors. It is expected that biofilms will have an impact across a wide array of industries including health, food, and manufacturing. The economic significance of biofilms is estimated to be $4tn globally.[15]

An independent review[16] found that NBIC had generated a total economic impact of £204 million since its founding and has created 50 jobs. Across four key project areas funded by BBSRC – microbial diagnostics, microbially induced corrosion, and AI systems for engineering microbial communities in wastewater treatment – the technologies developed from TRL 1 to TRL 5 on average (technology basic validation in a relevant environment), formed the basis for new patents, new trademarks, as well as spin-out companies based on project findings.

In 2022, BBSRC and Innovate UK invested £7.5 million into a second phase for the centre.[17]

3.3.3 Continued collaboration

The majority of BBSRC CR&D projects led to continued collaboration after the end of the grant period. Over 50% of academic PIs indicate that they have continued their collaboration with their industry partner and a further 18% have plans for future collaboration activity.[18] The most common example of continued collaboration took the form of co-developing products and services which were developed during the BBSRC CR&D projects (36%) as well as the development of grant proposals (31%) as shown in Figure 10 below.

Furthermore, results from the survey suggest that IPA & LINK projects are particularly likely to lead to further collaboration with more than 75% having continued their collaboration or are planning to do so, as compared with 58% for Community and Capacity building grants. It was

[14] "NBIC's Mission," available at: lhttps://biofilms.ac.uk/mission/

[15] Economic significance of biofilms: a multidisciplinary and cross-sectoral challenge, Cámara *et al.*, npj Biofilms and Microbiomes, 2022, available at: https://www.nature.com/articles/s41522-022-00306-y

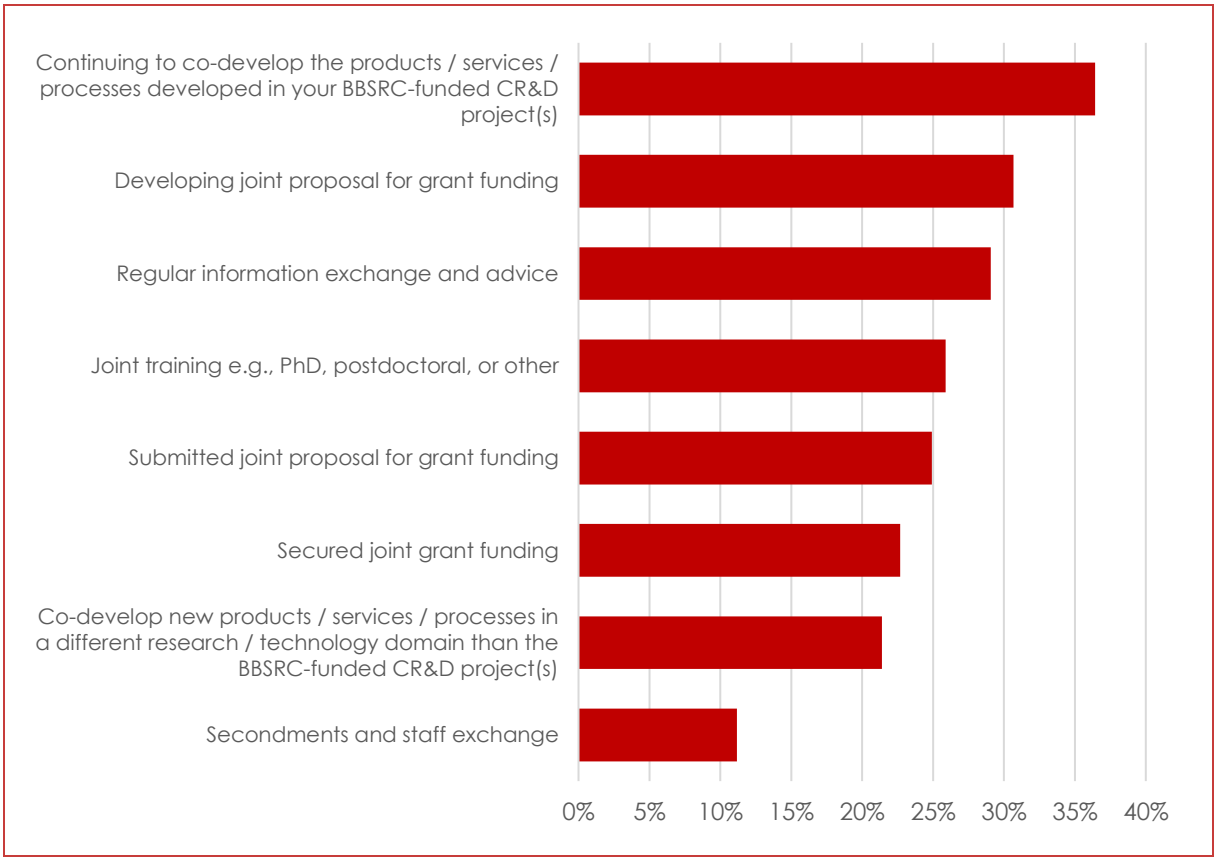
[16] https://www.ukri.org/news/national-biofilms-innovation-centre-drives-economic-growth/

[17] "UK biofilm capability boosted by new funding", available at: https://www.ukri.org/news/uk-biofilm-capability-boosted-by-new-funding/

[18] Survey of BBSRC CR&D PIs, see Appendix H

found that IPA & LINK and Strategic Co-Funding grants were more likely to continue the development of projects and services, and IPA & LINK projects were particularly likely to also lead to continued information exchange, joint training activities, and secondments in comparison to other funding categories.

Figure 10 Type of continued collaboration after BBSRC CR&D projects



Source: Survey of BBSRC PIs, n = 313

In addition to continued collaboration with project partners, our consultation with participants suggests that participation in BBSRC CR&D projects often lead to collaboration with other organisations (not their original project partners) and that this was facilitated by networking as well as gaining a better understanding of collaborative opportunities.

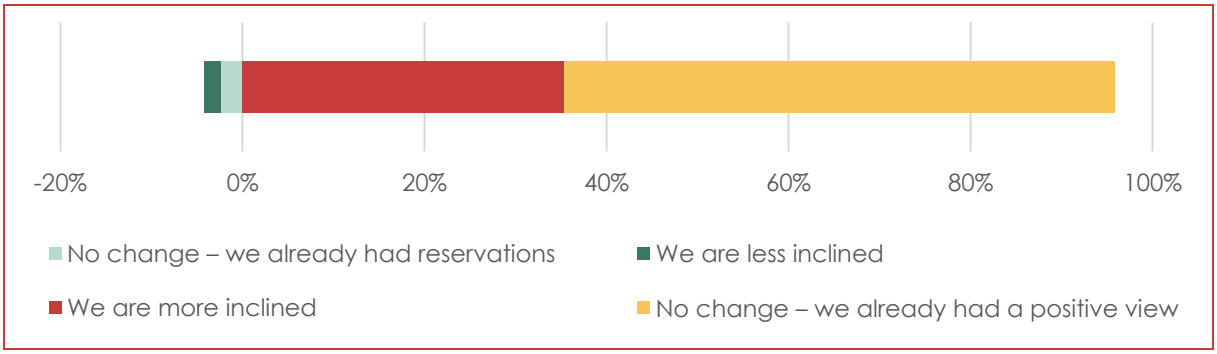
Survey responses, summarised in Figure 11, further confirm that a large majority of academic PIs have a positive attitude towards collaboration with industry and that many have a more favourable view of collaboration with industry after a BBSRC CR&D project in comparison to before.

> "With my background in fundamental science, I was rather ignorant of the opportunities and benefits. This BBSRC funding opened my eyes to the immense benefits and potential for collaborating outside the academy."[19]

[19] Response to survey of Academic PIs

A small minority of PIs did not report similar benefits, and these were largely due to difficult experiences or a realisation that their skillset and interests were better suited towards fundamental research. This was most prevalent for Community and Capacity building grant holders which provided the opportunity to, sometimes unsuccessfully, collaborate with businesses.

Figure 11 Impact of BBSRC CR&D projects on attitudes towards collaboration with industry partners



Source: Survey of BBSRC PIs, n = 286

Overall, this suggests that BBSRC CR&D grants have led to both a greater awareness of and a greater inclination to engage in academic-industry collaboration. The fact that IPA & LINK grants are more likely to lead to continued collaboration with the same project partners, and that Community and Capacity building grants are less likely to do so, can be explained by the rationale of the funding opportunities where the former offers support for more targeted collaboration and the latter mechanisms are geared towards building broader interactions between academia and industry.

3.3.4 Leverage of additional investment

As described in the previous section, BBSRC CR&D projects often lead to continued collaboration, and thereby further investment in R&D which goes beyond the co-investment required for the BBSRC CR&D projects themselves.

Evidence from Researchfish suggests that 655 projects (58% of projects for which data is available) have obtained further funding, totalling £1.15bn by 2023.[20] This is the value of further funding reported by BBSRC awardees in their Researchfish submissions, after deduplicating the data to remove repeated grants associated with multiple BBSRC awards.

This is 1.9 times the original amount invested by the BBSRC in the CR&D portfolio. The data suggests that a large majority (82%) of this funding stems from public sources (e.g., new research grants), whereas 8% has been obtained from industry and 10% from other sources (such as academia and charity). [21]

[20] In cases where further funding is awarded to a consortium, the estimated figure presented includes only the value allocated to individual researchers.

[21] See Appendix B1.2

The share of further funding from industry is likely to be heavily underestimated as these have been derived based on reporting from academic PIs to Researchfish. The figures also do not capture any wider positive effect on the propensity of the company to invest in R&D.

3.4 Contribution to technological and commercial development

Technological and commercial development: Early product development and creation of intellectual property (IP) enabling increased technological maturity, removal of barriers to innovation and business development, eventually leading to improved business performance and the introduction of new products and services to market

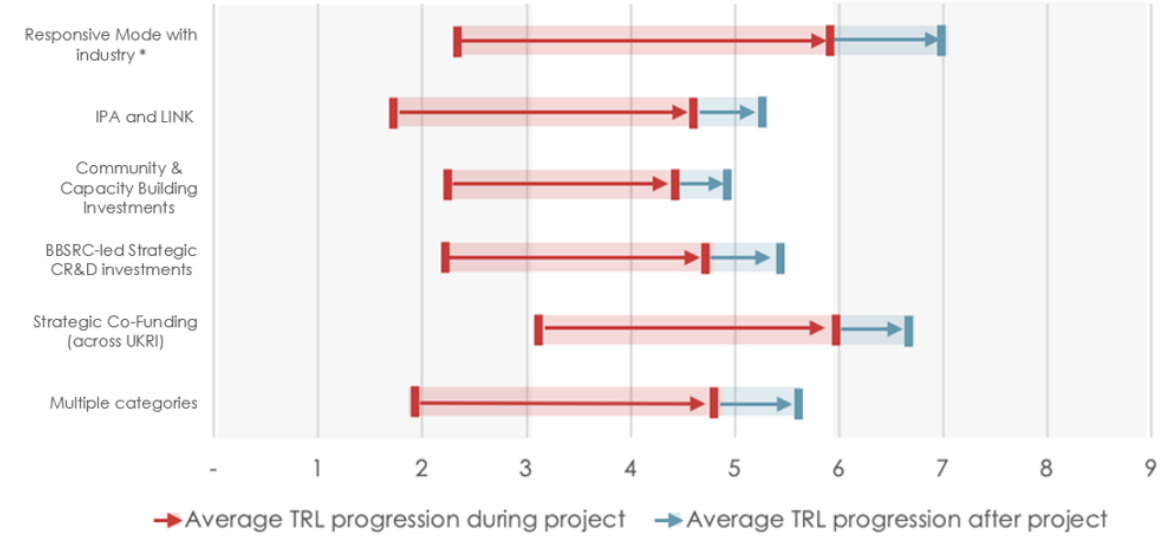
3.4.1 Early product development and de-risking

CR&D projects across the portfolio have contributed significantly to the technological development and creation of IP as well as the formation of spinouts. The innovation outputs and outcomes identified are concentrated within certain investment categories where the majority have been identified in BBSRC investments with Innovate UK.

Based on self-reported assessments from the academic PIs the average Technology Readiness Level (TRL) of technologies developed in BBSRC CR&D projects was 2.1 at the start of the project and 4.8 at the end of the project.

Moreover, where technologies were developed further after the end of the BBSRC CR&D project they had reached an average TRL of 5.5. Figure 12 shows that the TRL start and end point are generally lower for the four investment categories led by BBSRC and higher for Strategic Co-Funding investments which include co-investment across UKRI but most typically with Innovate UK. This suggests that the different categories each play a different role in the development of new technologies.

Figure 12 Average self-reported TRL progression during and after BBSRC CR&D projects



Source: Survey of BBSRC PIs, n = 358 (respondents) reporting on 688 technologies
Note: The figures for the 'Responsive mode' category are based on a small number of responses

Qualitative evidence suggests that earlier developments, e.g., as part of Community and Capacity building projects contribute to de-risking and prepare the foundations for further investments. For example, academics noted that SMEs benefitted from a de-risked technology which enabled them to approach investors with further research opportunities.

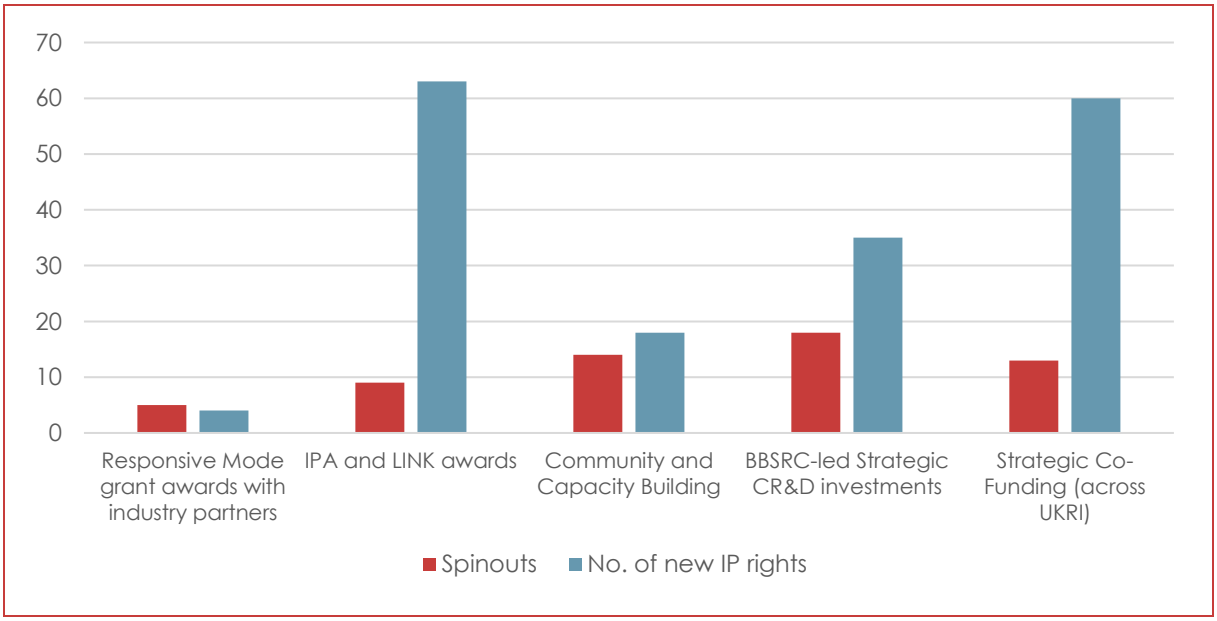
> *"The relationships developed are durable and will hopefully offer projects delivered in collaboration with the SMEs in the future, and therefore we are including them as partners on larger grant applications to de-risk some of our technology."*[22]

The businesses consulted in the evaluation also described how BBSRC CR&D projects have supported technology development through de-risking the academic-industry partnership and outsourcing long-term and higher risk R&D work to the academic partner.[23]

3.4.2 *Innovation outputs: intellectual property and spinouts*

BBSRC's CR&D projects from across all investment categories have resulted in new IP and spinout companies. According to data from Researchfish, 11% of all BBSRC CR&D projects have led to new IP, with a total of 180 new IP rights being protected as a result. As shown in Figure 13, IPA & LINK awards and Strategic Co-Funding projects, in particular with Innovate UK, have been more likely to produce new IP.

Figure 13 Spinouts and new IP rights resulting from CR&D Projects, by investment category



Source: Researchfish (see Appendix B 1.6)

Further to generating IP, CR&D projects also resulted in the creation of at least 53 new spinout companies, including 18 from the category of BBSRC-led strategic CR&D investments. It is known that the total number of spinouts is likely underestimated, as evidence from the survey

[22] BBSRC Academic Researchers Survey, Technopolis

[23] BBSRC Partner survey, Technopolis

of academic PIs has identified several additional spinouts which have not been reported in Researchfish. A recent evaluation focussed on 471 BBSRC attributable spinouts incorporated over a 40-year period and the survey evidence from this study shows that BBSRC funding has been essential to the formation of many of these spinouts. [24]

Furthermore, academic PIs reported that the reason for selecting to form a spinout company over other exploitation routes was due to the desire to attract new investment and bring new technologies to market. A more critical view, expressed by one survey respondent, reported that spinout companies are prestigious but are often unhelpful as industry partners see them as part of an attempt by academics to monopolise IP rather than enable industry partners to benefit from it.

3.4.3 Removing barriers to innovation

In addition to specific innovation outputs and technological developments, **CR&D projects have also had the effect of reducing barriers to innovation for the participating industry partners.** 76% of companies responding to the survey confirm that this has been the case, citing a combination of contributing factors including the following:[25]

- access to knowledge and expertise
- access to experts and relationships
- understanding of testing methods
- funding for research that would not otherwise have been possible within the company, helping to overcome financial barriers to innovation
- access to materials and IP otherwise not available
- access to new markets

This suggests that the reduction of barriers to innovation through CR&D projects is achieved as a result of the combined effect of various benefits to the participants and wider sector described elsewhere in this section.

This evaluation has identified that the Research Clubs have provided a particularly effective mechanism for removing barriers to innovation. They have provided companies with the ability to access knowledge and expertise, identify strategic research needs, and overcome financial barriers to pursuing research at a stage when it would not have been viable to do so on a commercial basis. According to one interviewee, who was involved in the Crop Improvement Research Club (CIRC) and Integrated Biorefining Research and Technology Club (IBTI):

> *"The industry clubs have been very good from the BBSRC side. They were cost-effective… The focus on community building made a huge impact and used money effectively."*

[24] CPC (2024) "Economic impact assessment of BBSRC attributable spin-outs", available at: https://www.ukri.org/publications/economic-impact-assessment-of-bbsrc-attributable-spin-outs/

[25] This is based on responses to the industry survey conducted for this evaluation. Due to the relatively low number of responses (see Appendix H) this should be seen as illustrative.

Another feature of the Research Clubs, which was highlighted in the interviews, was the duration of the initiatives which were often across multiple funding rounds and provided the necessary time for technologies to evolve and mature. It was reported that this supported the bridging of basic and applied research and enabled the translation of scientific research into applied technological development.

Example: Research Clubs

Research and Innovation Clubs were an essential part of the CR&D portfolio and represent 83% or £82.6m of the BBSRC-led strategic investments. These included the:

- Animal Health Research Club (ARC)
- Bioprocessing Research Industry Club (BRIC)
- Crop Improvement Research Club (CIRC)
- Diet and Health Research Industry Club (DRINC)
- Horticulture and Potato Initiative (HAPI)
- Integrated Biorefining Research and Technology Club (IBTI)
- Sustainable Agriculture Research and Innovation Club (SARIC)

The Clubs were funded under a membership model, in which industry stakeholders came together to define a series of research challenges of shared interest that would benefit the whole industry or help members advance strategic priorities. With this, members configured a research agenda to develop over several years through research projects and PhD studentships. Alongside research, there was also a dissemination component fulfilled by networking activities whereby members shared the knowledge being generated by the project and updated the research agenda to align with the findings. For this reason, most of the Clubs involved sectoral Knowledge Transfer Networks to support this activity and assisted with the management of the club.

In terms of the mechanism, BBSRC provided between 85% and 90% of the necessary funding for developing the agreed research agenda. Industry stakeholders paid a membership fee of around 10% of the total funding. There was also additional government funding provided for two clubs, the ARC and CIRC, where the Scottish Government contributed approximately 10% of the research budget.

In some cases, the research agenda of the club aligned with the remit of other Research Councils. BBSRC brought the relevant Councils together to co-invest in the research agenda and cross-funding was observed in four out of the six clubs. For example, in the BRIC, BBSRC co-invested alongside the EPSRC and MRC on a project-by-project basis over five years.

The number of industry stakeholders varied across the Clubs, from nine to 20 company members, and often included business competitors, mostly big corporations with significant market share, which helped to strengthen the impact of the research.

The Research Clubs as a mechanism to fund CR&D was found to have multiple benefits. They:

- F**unctioned as** a bridge between Responsive Mode funding and CR&D funding by combining the requirements for academic rigour with strategic research direction

- Provided a critical mass of research, people, and facilities within their given fields and strengthened their visibility to the wider sector
- Enabled an efficient use of resources by expanding the number and variety of projects undertaken in comparison to what could have been funded with the same budget through a Responsive Mode mechanism
- Led to the formation of specialist networks, for example collaboration within IBTI led to the formation of three "NIBBS" networks on Lignocellulosic Biorefinery, Food Waste, and Plant in Products[26]

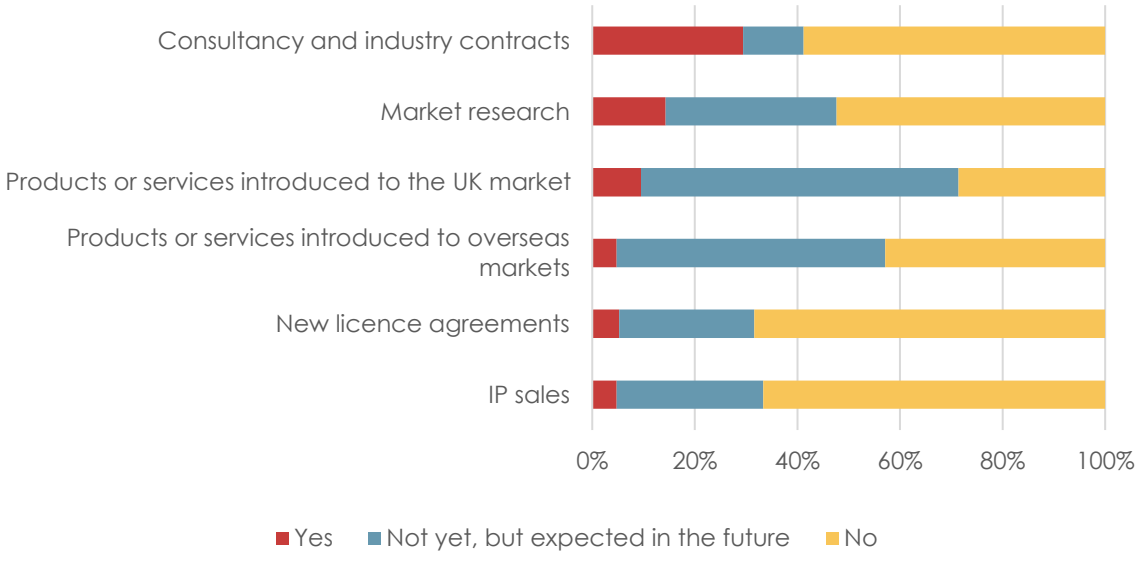
3.4.4 *New products and services*

BBSRC CR&D investment is targeted at pre-competitive and pre-commercial R&D and the introduction of new products and services is not a common outcome from CR&D projects.

> "It is still in the new product development phase but learnings from the project…could potentially open up a whole new class of products for the…market" (Industry partner)

There were few reports from businesses, in the evaluation survey, regarding the introduction of new products or services to the market, but more than half expected this to happen in the future (see Figure 14). Regardless, the consultation period confirmed that the technology developed in CR&D projects often enable or contribute to future product development.

Figure 14 Commercial benefits from CR&D projects as reported by industry partners



Source: Survey of industry partners (n=21)

[26] A review of the Integrated Biorefining Research and Technology Club (IBTI Club), December 2017, available at: https://www.ukri.org/publications/review-of-the-integrated-biorefining-research-and-technology-club/

In addition, the consultation with businesses found that there are a set of wider, commercially relevant benefits arising from participation in CR&D projects such as improving their understanding of their position in the market, improved customer confidence, as well as being viewed as an innovative company.

> "The side benefit however was being able to demonstrate to customers our engagement/forward thinking approach." (Industry partner)

This is often only apparent in retrospect and can be illustrated by impact case studies submitted to the REF. 62 projects from the CR&D portfolio were cited a total of 67 times in 55 separate REF2021 impact case studies. These case studies cited at least one CR&D project as one of several sources of new knowledge contributing to impact, including some commercial impact (see Appendix C).

Example: Impact case study (REF2021) – Guiding nanoscopic probe design and developing methods to benchmark AFM performance using double helix DNA imaging

"Prof. Hoogenboom's research on DNA imaging at University College London has provided Bruker, the global market leader in this area, with new methods and a benchmark to test and improve the performance of their atomic force microscopic (AFM) instruments and probes. This has resulted in increased expertise now benefiting staff in a global company and in benchmarking a new microscopy model that is now the most successful of Bruker atomic force microscopes. This research has led to the development of new probes targeted at delivering the highest resolution images in PeakForce Tapping mode, which are now part of a more lucrative range of AFM probes sold by Bruker, contributing to the $2,100,000,000 revenue generated by the company in 2019."

Source: REF2021 Impact case study database[27]

3.4.5 Business development and performance

The evidence collected for the evaluation was insufficient to measure the effect of individual CR&D projects on business development and performance, but some companies consulted identified the commercial benefits derived directly from their involvement, for example:

> "This project has supported the development and improvement of existing technical skills within our company. Commercially, to be a partner in CR&D projects…gives our customers confidence that we sell and provide them with far more than just our products. We are benefitting all involved in this supply chain."

The findings from the econometric analysis demonstrate significant benefits to revenue and employment, with a ROI ratio of eight or above for all investment categories except for Responsive Mode with Industry (see Section 4). In addition to the benefits resulting directly from project innovation outputs during the grant period, it was also reported that businesses derived significant long-term benefits from being involved in BBSRC CR&D projects when compared to the comparator group over time. Further to employment and revenue, these include broader

[27] , Available at https://results2021.ref.ac.uk/impact/0E71F442-3234-4EAA-B41D-9907CEFD4B9C?page=1

benefits such as contacts, access to networks and expertise, as well as the ability to take part in the strategic direction associated with publicly funded research.

3.5 Business engagement and policy impacts

Business engagement and policy impacts: Engagement with bioscience businesses and the creation of "'thought leadership"' in strategic areas enables informed policy making and the development of standards which help emerging industries and markets as well as contributing to addressing societal and policy challenges.

3.5.1 Business engagement

Across all of the categories, the CR&D portfolio has enabled engagement between the research base and businesses in a variety of ways as described in the previous sections. Mechanisms such as the Research Clubs and BBSRC NIBB were highlighted in our consultations as particularly useful, cost-effective ways for businesses to engage with the science-base. These mechanisms were also highlighted as effective means to engage directly with BBSRC, where businesses could gain an awareness of ongoing research and, in some cases, help shape research priorities.

In terms of the wider effort to engage with businesses, an important element has been the coordination of investments between the team at BBSRC and across UKRI, most notably with Innovate UK. Through consultation with stakeholders, it was identified that the coordination of research-led investments by the BBSRC and business-led investments at Innovate UK has improved markedly over the period covered in the evaluation. This has enabled a clearer path from successful CR&D in strategic areas to additional investment which supports businesses progress towards commercialisation. Furthermore, through these coordinated activities, BBSRC investments have been successfully deployed to the relevant business networks organised by Innovate UK, increasing the profile of BBSRC with the industrial community.

As previously described, the CR&D portfolio offers a range of entry points for businesses to undertake CR&D projects with academic leads. These include smaller programmes and networking opportunities which have comparatively lower barriers to entry for the business under the Community and Capacity building investment category. Despite this, an analysis of the profile of industry partners in the CR&D portfolio (see section 2.3) demonstrates that businesses participating in BBSRC CR&D projects tend to be more established than the wider-UK business population across all sectors.

To further understand this observation, stakeholders were consulted and several barriers to greater involvement of SMEs and newly established companies were identified. First, industry partners require a clear business rationale for getting involved in CR&D and often these projects are deemed to be more speculative and long-term. Second, that smaller companies are less able to cope with uncertainty, and the risk of investing time and resource into an activity which might not yield a return in the short or medium term is too high. Third, that although this may reflect the nature of CR&D, it was suggested that the previous step could be mitigated if academic PIs were able to design projects with this in mind and communicate the business case more clearly to would-be partners.

3.5.2 *Contribution to standards and supporting new markets*

The development and commercialisation of new technologies are often reliant on the development of new standards to enable emerging industries and markets to flourish. Standards are necessary to enable innovative companies to make claims about the performance or the innovative features of products which include claims about contributions to societal challenges such as climate change.

Example: Ecosystem markets

Investments in the Community and Capacity building category have led to the development of **high-integrity ecosystem markets which are now generating new income streams** from nature-based solutions to climate change. A project supported by BBSRC explored ecosystem services, specifically the selling of land management measures that deliver functions such as water quality management or flood risk management to generate revenue for landowners and managers.

The Landscape Enterprise Networks (LENs) were founded as a spin-out of this project and the funding has extended operations in the UK and Europe. By 2020, the LENs had generated **more than £5 million in income.** LENs have since worked to support the development of Defra's policy framework with a UK government target of £1 billion per year by 2030 for a market in ecosystem services to develop standards for soil carbon. Academic researchers and policymakers anticipate that the long-term outcomes include new income streams for farmers, improved water quality, and the stability of agricultural supplies.

Through the CR&D portfolio's larger investments, the BBSRC has helped ensure that bioscience and biotechnology businesses across a myriad of industries and sectors are able to shape these new developments which require a sustained effort over a long period of time. A primary example of this includes the BBSRC and Innovate UK investment in NBIC (see profile above), which has identified standardisation as an important unmet need that is acting as a barrier for further innovation and commercialisation.[28] The CR&D investment has positioned the NBIC, as well as the wider UK biofilm ecosystem, to play an important role in shaping standards across the sector through membership of the International Biofilm Standards Task Group as well as through the largest biofilms centres located in the US, Singapore, and Europe. [29]

3.5.3 *Contribution to addressing societal and policy challenges*

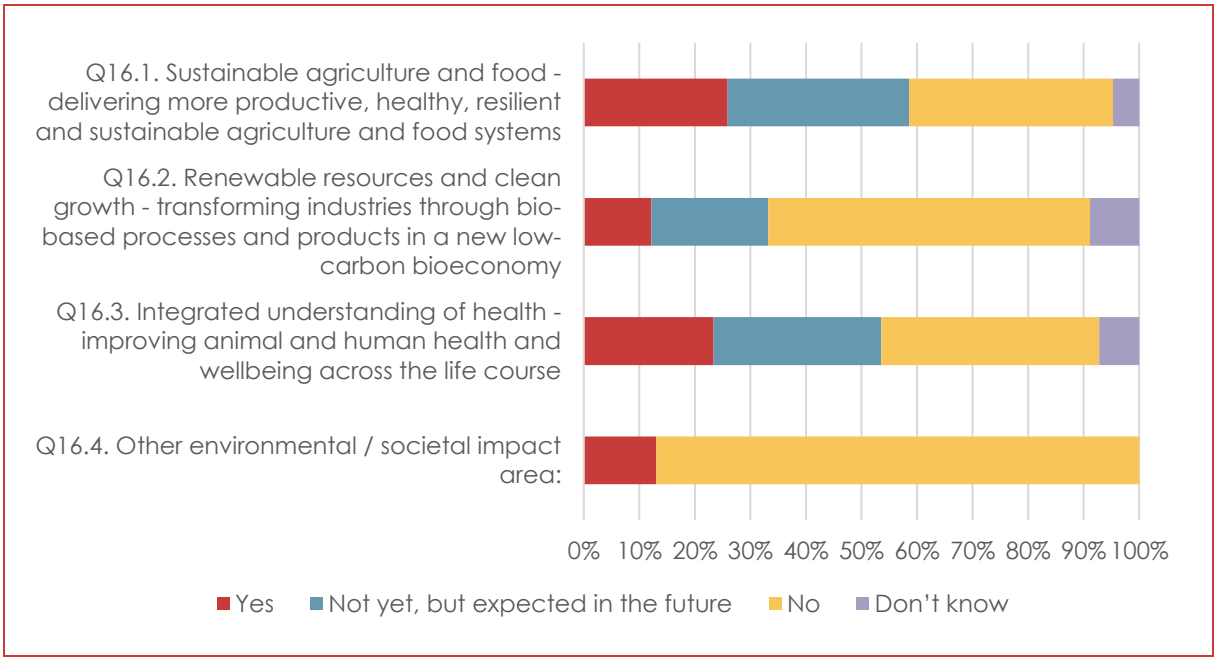
BBSRC CR&D projects have contributed to addressing societal challenges and policies in a number of areas, especially within the agriculture, food, animal, and human health fields. This includes examples where research findings have contributed directly to new products, processes, and services such as novel foods with improved nutritional and health properties, contributions to the development of new drugs and treatments, as well as the improved

[28] "Biofilms Standards and Regulations" available at: https://biofilms.ac.uk/standards-and-regulations/

[29] Members are NBIC, the Centre for Biofilm Engineering (US), the Singapore Centre for Environmental and Life Science Engineering, and the European Cooperation in Science and Technology (COST) Anti-Microbial Coating Innovations to prevent infectious diseases (AMICI) Team.
(see: https://biofilm.montana.edu/international-standards-task-group/position-statement.html)

efficiency and reduction in resource use, for example through reduced water usage in food production. Through consultation with academic stakeholders, PIs also indicated that their work had the potential to deliver wider societal impacts and benefits in the future (see Figure 15).

Figure 15 Environmental and societal impacts of BBSRC CR&D projects



Source: Survey of BBSRC PIs, n = 294[30]

BBSRC CR&D projects have contributed to the development of policy through thought leadership in a range of policy-relevant areas. This has primarily taken the form of award holder engagement with policymakers, responses to specific inquiries, and setting agendas for wider policy discussions.

In a similar manner to the development of new standards, BBSRC's larger CR&D investments have been particularly instrumental in enabling impacts relevant to policy. These investments have brought together stakeholders, including societal groups, policymakers, as well as academic and industry partners. This has helped to consolidate relevant knowledge and ensure that it can be mobilised when the need arises.

[30] Survey Q16. "Please indicate whether you believe your BBSRC-funded CR&D project has helped to deliver environmental and societal impacts in any of the following areas?"

Example: IKnowFood: Integrating Knowledge for Food Systems Resilience

The IKnowFood project was supported by three BBSRC CR&D grants under the Food System Resilience (FSRD) initiative from 2016 to 2021. Through consolidating the previous knowledge generated, the aim of the project was to bring together actors in the global food system which included farmers, food processors, retailers, policymakers, and consumers to enhance the overall resilience of the food system.[31] As a result, the IKnowFood project provided a platform for policy work to be undertaken with government and industry, as well as in tertiary sectors at the local, regional, national, and international scales.

The outcomes of the project include the production of several publications, datasets, and information resources[32] as well as, in several key instances, providing key inputs into the development of UK policy. Examples of this include:

- Evidence which informed the **National Food Strategy**[33]
- Informing the work of the **Food Systems team in the Defra Chief Scientists Office**
- Evidence submitted to the **UK Parliamentary enquiry into soil health**, with recommendations for a simple soil health measure.[34]
- Contributions to the **Co-op Future of Food vision**[35]

In addition, IKnowFood has engaged in a number of forums in the UK and internationally, including UK parliamentary committees (International Trade and Environment Food and Rural Affairs) as well as European policy workshops. [36]

3.6 Other portfolio-level findings – access to R&I infrastructure

The ability of the bioscience community to perform research, advance scientific knowledge, and develop new technologies is enhanced by providing access to advanced technologies, facilities, and equipment. These can range from basic experimental equipment to state-of-the-art instrumentation which include high-throughput omics platforms, farm scale/in-field infrastructures, as well as advanced bioimaging technologies. BBSRC investments in CR&D aim to support academic researchers and businesses access the wide range of research and innovation infrastructures, in the UK and internationally, to promote collaboration, accelerate discoveries, and ultimately contribute to advancements across the remit of BBSRC including in healthcare, agriculture, and environmental sustainability.

Through the CR&D portfolio more than two thirds of project PIs reported using some form of infrastructure as part of their CR&D project(s). In terms of the facilities used, the most common

[31] IKnowFood - School for Business and Society, University of York

[32] Gateway to Research: https://gtr.ukri.org/projects?ref=BB%2FN02060X%2F1

[33] National food strategy for England - GOV.UK (www.gov.uk)

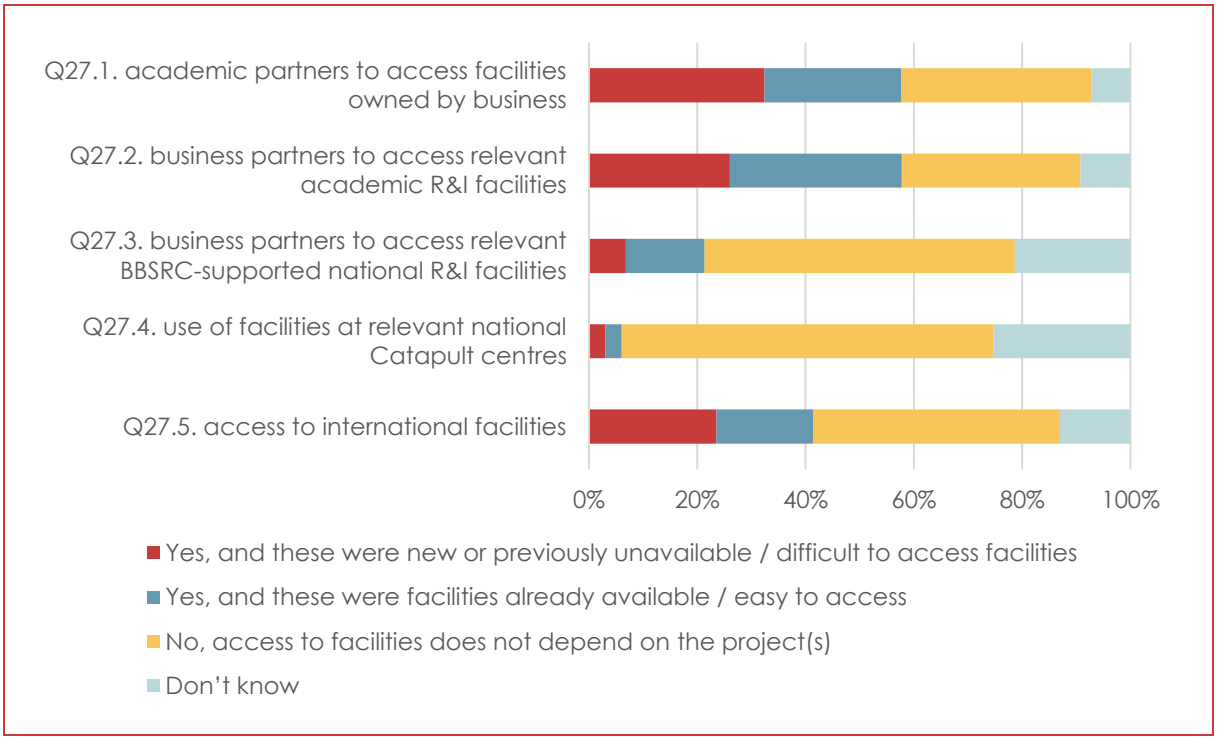
[34] Soil Health - Committees - UK Parliament

[35] https://www.coop.co.uk/sustainability

[36] Gateway to Research: https://gtr.ukri.org/projects?ref=BB%2FN02060X%2F1

were those hosted by the academic or industry project partners in comparison to accessing national or international facilities. As shown in Figure 16, 58% of academic PIs indicated that CR&D projects had enabled access to facilities owned by a business where 32% reported that these were previously difficult to access facilities (see Appendix H). A similar percentage of respondents indicated that the same was true for businesses accessing relevant academic facilities.

Figure 16 BBSRC CR&D projects and access to R&I facilities where some form of infrastructure was used as part of the CR&D project(s))



Source: Survey of BBSRC PIs, Q27, n = 182

IPA and LINK grants were particularly instrumental in supporting academic researchers access business-owned facilities with 57% of PIs reporting that their CR&D projects have enabled access and a further 35% of these reporting that this was for previously inaccessible facilities. Throughout the consultation, there were many instances where these facilities were seen as critical to the success of a project, for example where businesses were able to offer facilities more advanced or more relevant to commercial-scale testing. In a similar manner, industry partners were able to access facilities hosted by academic institutions. This was also seen as critical, especially for smaller companies with limited in-house resources or highly specialised equipment.

The survey also sought to understand the extent to which academic leads of CR&D project(s) encountered significant barriers to accessing R&I infrastructure and it was found that just under a quarter (23%) of PIs reported these as significant. The barriers most commonly cited included a lack of funding and a lack of awareness regarding the availability of R&I facilities both nationally and internationally. This helps explain why infrastructure hosted by the businesses and higher education institutions participating in the programme were much more likely to be used than national and international facilities beyond the project consortium. Further barriers

identified by academics included the lack of technical expertise available at R&I facilities in conducting specific research experiments. For international facilities, researchers pointed to additional barriers related to the geographical location, cost of travel, and ability to transport samples overseas. One specific example highlighted by an academic lead was the lack of biorefinery facilities in the UK to perform industrial testing at scale for bio-based products.[37]

A number of ideas were suggested from the interviews to help improve access to R&I facilities. Several participants and stakeholders consulted for the study suggested initiatives to raise the awareness of R&I facilities available, including the awareness among businesses of facilities hosted at universities. Although many participants had received BBSRC-funding to cover the cost of accessing R&I infrastructure, some also suggested that additional small grant funding for this purpose could be useful or more flexibility to use grant funding for these purposes could be helpful.

[37] This was also an observation in the evaluation of BBSRC investments in industrial biotechnology research published in September 2024, available here: https://www.ukri.org/publications/evaluating-bbsrc-investments-in-industrial-biotechnology-research/

4 Impact of the BBSRC CR&D portfolio

4.1 Economic impact and Return on Investment (ROI)

In this section we assess the impacts of the CR&D portfolio on turnover, employment, and turnover per employee by observing changes in business performance over time and drawing comparisons between beneficiaries and a suitable control group of non-beneficiaries. The control group in this study was selected from the wider business population via a method of Propensity Score Matching (PSM). The PSM was conducted once for the whole portfolio and then separately for the five investment categories using the same modelling specifications i.e., the same matching criteria. See Appendix D1 for further details on the methodology. This section presents the results for the BBSRC CR&D portfolio as a whole. The results for the five separate investment categories are only available in Appendix D1.

For this analysis, beneficiaries are defined as industry partners who have collaborated with project leads as part of a BBSRC-funded CR&D project whilst non-beneficiaries are businesses in the wider population that have not participated in the CR&D portfolio but are similar in terms of their observable business characteristics.[38] The analysis presented below is based on a small sub-sample of non-beneficiary companies identified from the wider business population via PSM. From the total business population of two million businesses, the control group consists of 475 businesses with similar characteristics to those of beneficiaries. Hence, the analysis controls for differences in business characteristics between the two groups prior to the intervention.

The baseline (marked as "B") is defined as the two-year average before the first project start date. We assume that the funding will have no measurable impact during the first year of implementation (marked as t+0) as this period will primarily be dedicated to setting up project activities. The analysis traces the median business performance up to ten years after this point, from t+1 to t+10.

Due to the staggered nature of the interventions, the sample size varies depending on how many years have passed since the first year of treatment. The estimates presented for t+1 include all project partners whilst those for t+10 only reflect the impacts on businesses first treated in 2011 or before.[39] As such, the changes in the outcome variables observed in each period are influenced by the compositional changes in the sample. Only those industry partners who are associated with the IPA and LINK investment category are represented beyond period t+7. The tables in Appendix D1 provides further details on the sample sizes in each period for each category.

[38] The model controls for observable differences available in secondary datasets, including the location, age, industry, baseline employment, and baseline turnover values. As such, one key limitation is that the model does not control for differences in the quality of leadership teams in each business and their overall propensity to innovate prior to the intervention.

[39] Business who become inactive (e.g., dissolved or liquidated) are included in the analysis and their employment and turnover figures are recorded as zeros. As such, any differences in the survival rates between beneficiaries and non-beneficiaries are already reflected in the median impact estimates.

The analysis below illustrates the change in business performance outcomes relative to the baseline. If a business has participated in multiple projects, we used the earliest project start date from all their projects to estimate the baseline. For the category-specific results, we used the earliest project start date from all projects in that specific category to estimate the baseline (see Appendix D1). Each business has the same weight in the analysis, regardless of the number of projects.

For each outcome indicator, we present the median increase from the baseline in absolute terms (in panel a) and the percentage terms (in panel b). The median estimates are relatively more representative of the business population in each group and less likely to be skewed by extreme values compared to the mean. The analysis also excludes extreme values which has an impact on the sample sizes presented in the tables.[40]

To display the impacts attributable to the CR&D portfolio, the analysis also includes tables that illustrate the median difference-in-difference estimates between beneficiaries and non-beneficiaries in each period and the median annual changes across the entire treatment period. The tables include absolute differences and parentage points differences i.e., the absolute differences between two percentages, marked as percentage points.

The analysis presented below is based on the full sample of beneficiaries in the entire BBSRC CR&D portfolio. Appendix D4 includes the results for each one of the five investment categories.

4.1.1 Employment impacts

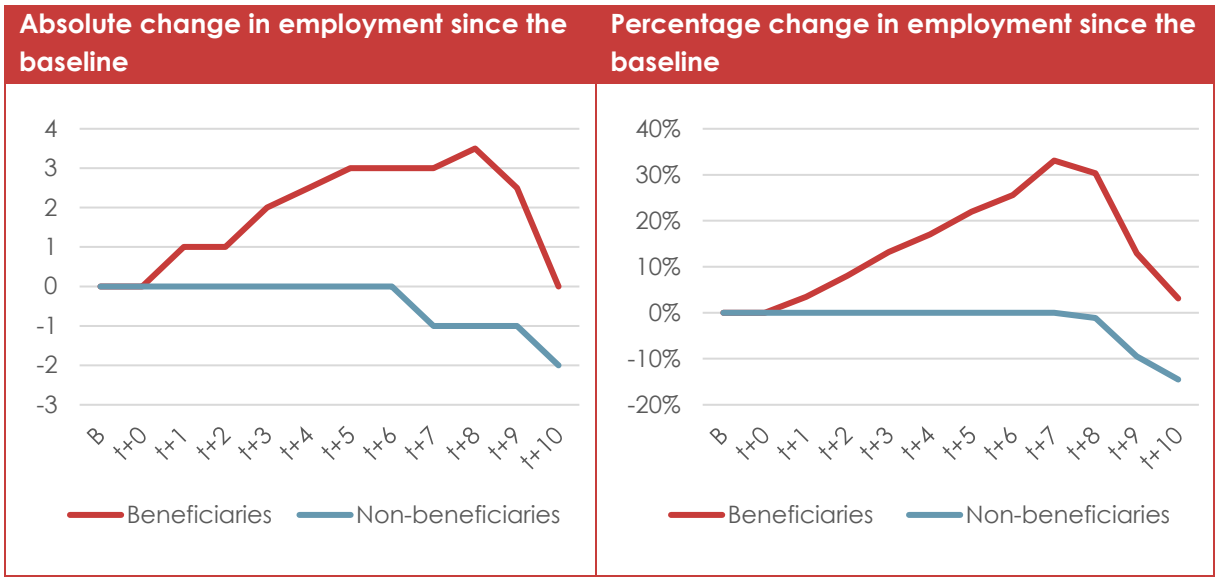
Overall, the results from the econometric analysis indicate that industry project partners have experienced a steady growth in employment with a median increase of two employees per company per year, over and above the increase for non-beneficiaries (see Figure 17 and Table 7). When changes in performance are observed over time, it was identified that beneficiaries added one new employee one year after the project start date, peaking at four new employees eight years after the project start. In contrast, non-beneficiaries have not experienced any significant growth from the baseline.

The results presented here incorporate the sample of matched beneficiaries in the BBSRC CR&D portfolio. However, it is worth noting that a share of businesses were treated more recently and have data only five years after the first treatment. Only businesses in the IPA and LINK category are reflected beyond period t+7. As shown in Appendix D4, whilst businesses associated with this investment category experienced a steady growth in employment in the first six years after the first treatment, this is followed by a decline in subsequent years. As expected, the same trend is visible here as this is the only group of businesses that influence the portfolio-level results beyond t+7.

As such, the results presented here likely reflect changes in the sample composition and the fact that different investment categories are reflected over time. This observation holds true for all other outcome variables presented below.

[40] Extreme values are defined as values that are three standard deviations below or above the mean.

Figure 17 Median change in employment since the baseline for beneficiaries and non-beneficiaries



Source: Business Structure Database

Table 7 Employment: difference-in-difference estimates between beneficiaries and non-beneficiaries

	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	Median
Absolute	1	1	2	3	3	3	4	5	4	2	2
Percentage points	3	8	13	17	22	26	33	31	22	18	14
Sample size	896	858	806	703	624	449	291	155	98	62	896

Source: Business Structure Database. Note: the sample size is split roughly evenly between beneficiaries and non-beneficiaries. The sample excludes outliers defined as three standard deviations above or below the mean.

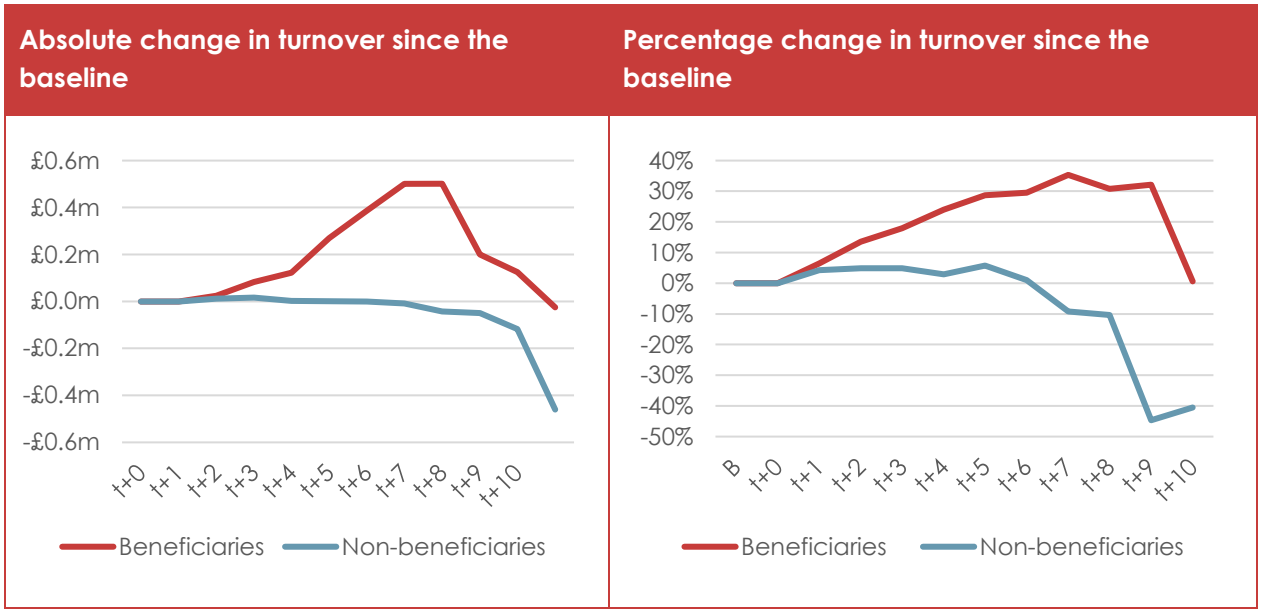
4.1.2 Turnover impacts

The analysis shown in Figure 18 and Table 8 indicates a positive turnover impact for businesses participating in BBSRC CR&D projects. In the year after the project start date, beneficiaries experienced a median increase in turnover of £24,000 (six percentage points median increase), whilst non-beneficiaries experienced a more modest median growth of £12,000 (four percentage points median increase). The gap between the two groups increased in each subsequent years, peaking at £543,000 in favour of beneficiaries seven years after the project start. The decline after t+7 is influenced by the compositional changes in the sample size as only those industry partners associated with the IPA and LINK investment category are reflected after this period.

Defining the turnover growth benefits of the CR&D portfolio as the median increase in turnover by which beneficiaries outperform non-beneficiaries over the entire treatment period (from t+1- to t+10), it was found that the median annual benefit is £145,000 per company. This means that, according to our econometric analysis, beneficiaries have outperformed a similar group of non-beneficiaries over the period under assessment. The difference in performance in favour

of beneficiaries is visible after controlling for observable differences in business characteristics and time trends that may have impacted the outcomes.

Figure 18 Median change in turnover since the baseline for beneficiaries and non-beneficiaries



Source: Business Structure Database. Note: the sample size is split roughly evenly between beneficiaries and non-beneficiaries

Table 8 Turnover: difference-in-difference estimates between beneficiaries and non-beneficiaries

	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	Median
Absolute(£k)	12	67	121	268	387	509	543	250	243	435	145
Percentage points	2	9	13	21	23	29	45	41	77	41	13
Sample size	895	860	808	705	628	453	291	152	97	61	895

Source: Business Structure Database. Note: the sample size is split roughly evenly between beneficiaries and non-beneficiaries. The sample excludes outliers defined as three standard deviations above or below the mean

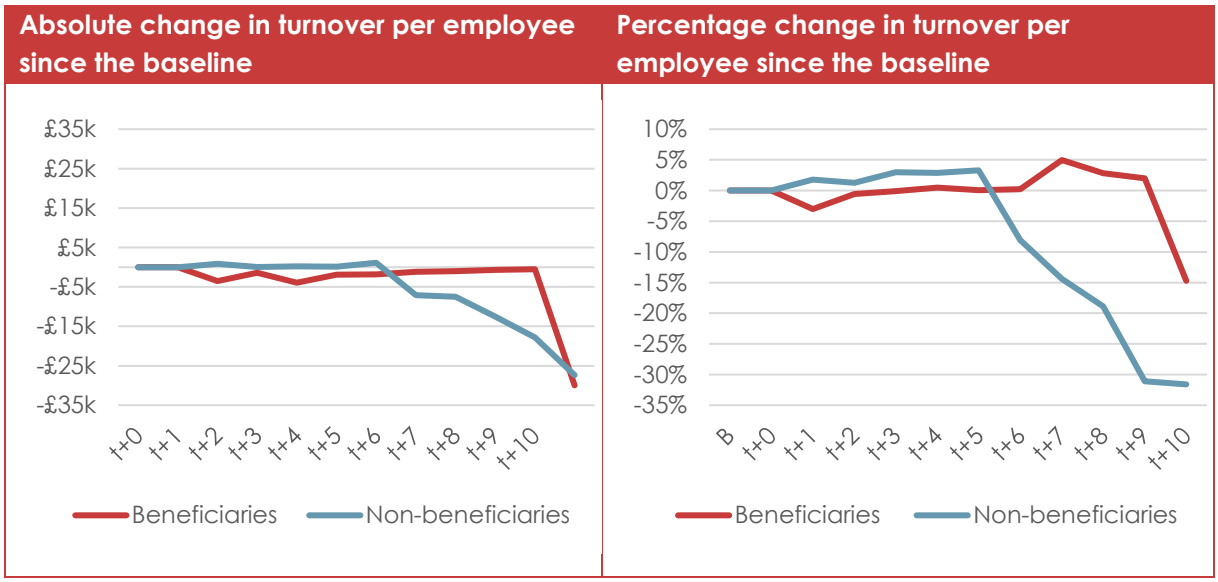
4.1.3 Turnover per employee impacts

The econometric analysis indicates that beneficiaries have experienced a steady growth in turnover and employment but the results for labour productivity i.e., turnover per employees are mixed. Figure 19 indicates that beneficiaries experienced a lower median productivity performance compared to non-beneficiaries in the first five years after the project start date but outperformed them in subsequent years. Over the ten-year treatment period, we find that the annual change in the median turnover per employee is £2,400 lower for beneficiaries compared to matched non-beneficiaries (see Table 9).

It is difficult to determine the precise reasons behind these findings but one explanation, based on the prior employment and turnover findings for beneficiaries, is that the rate of employment

growth has outpaced the rate of turnover growth, leading to lower median values of turnover per employee. As noted previously, due to the staggered implementation of the funding, the number of years that have passed since the initial treatment is different for businesses in the sample. The only businesses that are represented beyond t+7 are those associated with the IPA and LINK category. Hence, the dip in the data after this period is explained by this compositional change in the sample of businesses.

Figure 19 Turnover per employee: median absolute and percentage change from the baseline for beneficiaries and non-beneficiaries



Source: Business Structure Database. Note: the sample size is split roughly evenly between beneficiaries and non-beneficiaries

Table 9 Turnover per employee: difference-in-difference estimates between beneficiaries and non-beneficiaries

	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	Median
Absolute(£k)	-4.4	-1.4	-4.2	-2.0	-3.0	7.5	10.0	15.6	18.6	1.1	-2.4
Percentage points	-5	-2	-3	-2	-3	8	19	22	33	17	-4
Sample size	891	851	800	699	618	448	288	151	96	60	891

Source: Business Structure Database. Note: the sample size is split roughly evenly between beneficiaries and non-beneficiaries. The sample excludes outliers defined as three standard deviations above or below the mean

4.1.4 Single versus multiple investment

The following section explores the difference in economic performance between beneficiaries who participate in a single project compared to those who participate in multiple projects funded from the same BBSRC investment category or from different categories. The analysis relies on the original matching between beneficiaries and non-beneficiaries without any

additional matching between different beneficiary groups. For each business in the analysis, the earliest project start date was used to establish the baseline.

Appendix D3 includes descriptive statistics on the characteristics of companies involved in a single project versus multiple projects. From the analysis, it was identified that beneficiaries associated with more than one project were more likely to be large businesses (i.e., with 250 or more employees) compared to beneficiaries with a single project.

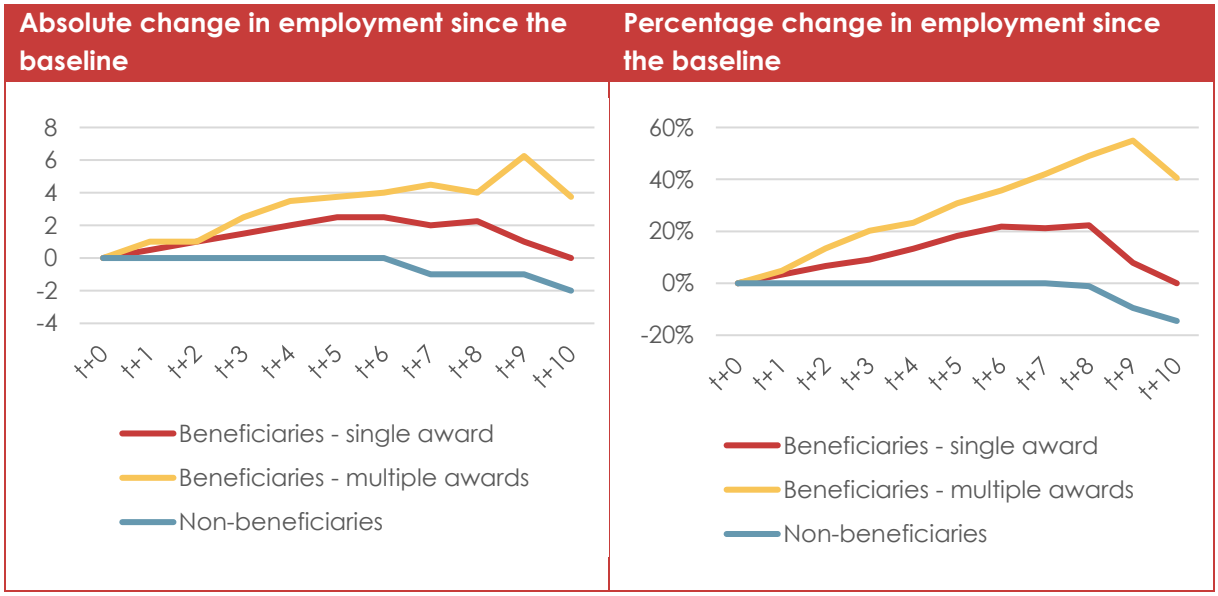
The analysis presented below is for the BBSRC CR&D portfolio. The equivalent analysis is not available for each investment category due to the small sample sizes.

4.1.4.1 Employment impacts

Table 10 shows the extent to which beneficiaries associated with multiple projects experienced stronger employment growth than those associated with a single project or none. The analysis indicates that beneficiaries with multiple BBSRC projects have experienced a larger increase in employment (28 percentage points) compared to those with only a single project (nine percentage points). These values represent the increase over and above that for non-beneficiaries.

When the absolute changes in performance over time are observed, it is noted that both beneficiary groups had a median increase of one employee two years after the project start date (see Figure 20). However, over time, beneficiaries with multiple projects experienced a stronger growth in employment, peaking at six new employees after six years (compared to just one new employee for beneficiaries with a single project). The decline after t+7 is influenced by the compositional changes in the sample size as only those industry partners associated with the IPA and LINK investment category are reflected after this period.

Figure 20 Median change in employment since the baseline for beneficiaries (single vs multiple awards) and non-beneficiaries



Source: Business Structure Database

Table 10 Employment: difference-in-difference estimates between beneficiaries (single vs multiple awards) and non-beneficiaries

	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	Median
Percentage points (single projects)	3	7	9	13	18	22	21	23	17	15	9
Percentage points (multiple projects)	5	13	20	23	31	36	42	50	64	55	28
Sample (beneficiaries with single project)	280	263	243	203	176	118	75	40	26	17	280
Sample (beneficiaries with multiple projects)	133	129	127	122	113	95	60	32	19	13	133
Sample (non-beneficiaries)	475	455	425	369	327	235	152	80	50	31	475

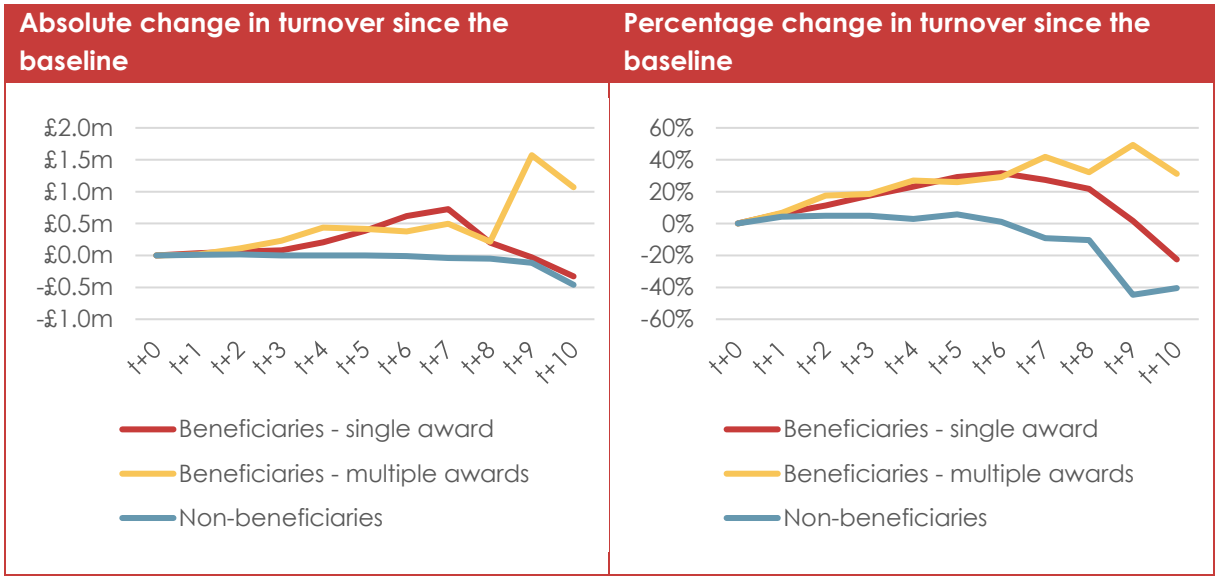
Source: Business Structure Database

4.1.4.2 Turnover impacts

Table 11 shows the difference-in-difference coefficients which measure the median percentage points increase in turnover by which beneficiaries with either a single project or multiple projects outperform non-beneficiaries. Across the entire treatment period, both beneficiaries with a single or multiple projects have experienced a growth in turnover compared to non-beneficiaries, with the difference being even more pronounced for the group of beneficiaries who have engaged in more than one BBSRC project (19 vs 10 percentage points).

When the absolute changes in turnover performance over time are observed, it was identified that both beneficiary groups experienced an increase in turnover from their baseline up to t+8 (see Figure 21). After this point, the turnover trends of the two groups diverge. Multi-project beneficiaries experience an increase in turnover, while single-project beneficiaries experience a decrease in turnover from their baseline. These trends are influenced by the compositional changes in the sample size as only those industry partners associated with the IPA and LINK investment category are reflected after period t+7.

Figure 21 Median change in turnover since the baseline for beneficiaries (single vs multiple awards) and non-beneficiaries



Source: Business Structure Database

Table 11 Turnover: difference-in-difference estimates between beneficiaries (single vs multiple awards) and non-beneficiaries

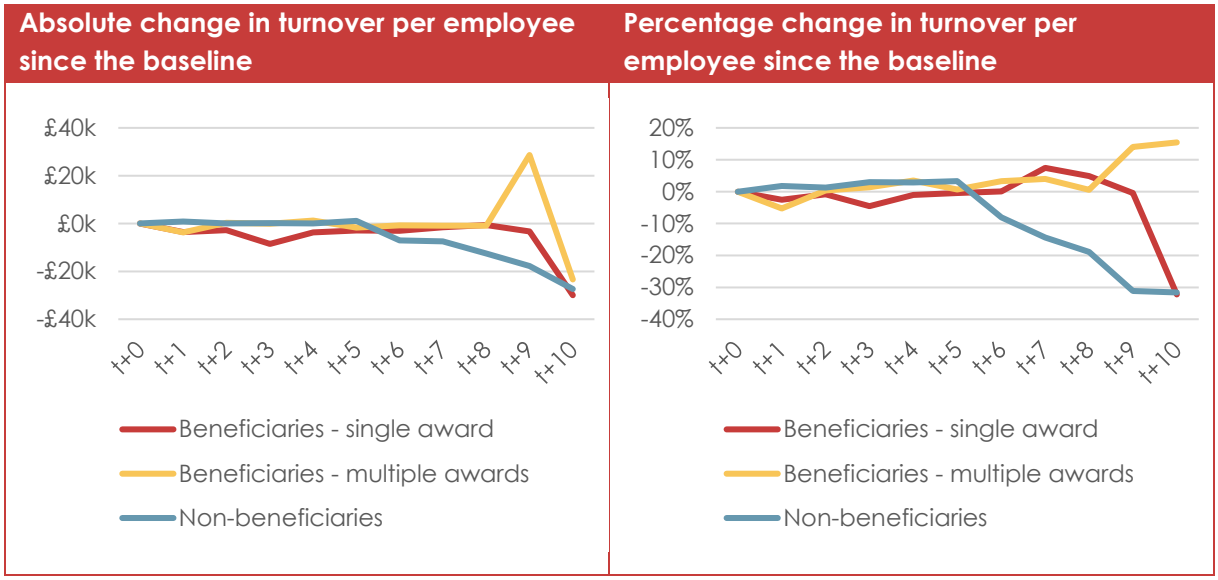
	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	Median
Percentage points (single project)	2	6	13	20	23	31	37	32	46	18	10
Percentage points (multiple project)	3	13	14	24	20	28	51	43	94	72	19
Sample (beneficiaries with single projects)	276	260	241	203	175	118	76	41	27	17	276
Sample (beneficiaries with multiple projects)	133	129	130	121	112	95	59	31	18	13	133
Sample (non-beneficiaries)	475	456	428	372	330	235	152	79	50	30	475

Source: Business Structure Database

4.1.4.3 Turnover per employee impacts

Figure 22 shows that that beneficiaries with either a single or multiple awards experienced a lower median labour productivity performance compared to non-beneficiaries in the first five years after the project start date but outperformed them in subsequent years. The decline after t+7 is influenced by the compositional changes in the sample size as only those industry partners associated with the IPA and LINK investment category are reflected after this period.

Figure 22 Median change in turnover per employee since the baseline for beneficiaries (single vs multiple awards) and non-beneficiaries



Source: Business Structure Database

Table 12 shows the difference-in-difference coefficients for the turnover per employee indicator. The figures compare the percentage points change between beneficiaries, with either a single project or multiple projects, and non-beneficiaries. It was identified that beneficiaries involved in multiple projects performed slightly better than those who have only received a single award.

As shown in Table 12, beneficiaries with multiple projects have experienced an improvement in labour productivity (one percentage point) compared to the decline for beneficiaries with a single project (negative seven percentage points). These are the difference-in-difference coefficients which represent the change over and above that for non-beneficiaries.

Table 12 Turnover per employee: difference-in-difference estimates between beneficiaries (single vs multiple awards) and non-beneficiaries

	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	Median
Percentage points (single projects)	-4	-2	-8	-4	-4	8	22	24	31	-1	-7
Percentage points (multiple projects)	-7	-1	-2	1	-3	11	18	19	45	47	1
Sample (beneficiaries with single project)	276	259	240	200	175	119	75	41	27	17	276
Sample (beneficiaries with multiple project	132	131	130	123	113	96	61	32	19	13	132
Sample (non-beneficiaries)	472	452	422	369	327	235	153	80	50	31	472

Source: Business Structure Database

4.1.5 Gross Value Added (GVA) and Return on Investment (ROI)

The economic impact of the CR&D portfolio was estimated by multiplying the turnover figures by an estimate of the GVA/turnover ratio for the relevant sector, region, and year. The GVA conversion factors, which represent the ratio of GVA for £1 of turnover, was sourced from the ONS, Annual Business Survey, 2021. These GVA estimates represent the proportion of economic activity beneficiaries have added through their production process i.e., the output minus the cost of goods and services used in production. The GVA figures were adjusted for inflation using the Consumer Price Index (CPI) and presented in 2020 prices.

The cumulative figures represent the growth of GVA from the baseline for beneficiaries. The net effect attributed to BBSRC's funding is determined by estimating the cumulative rise in GVA for the beneficiary group over and above that for the non-beneficiary group. The change in GVA from the baseline for non-beneficiaries represents the likely trajectory in GVA in the absence of the funding. As such, the value is subtracted from the increase of beneficiaries in order to measure the impact attributed specifically to BBSRC's funding. The net cumulative increase in GVA is the value that we can reasonably attribute to BBSRC funding, after accounting for what would have happened anyway.

To remove the impact of large outliers in the dataset, which significantly skew the final estimates, the analysis is based on the group of companies that fall within the interquartile range, IQR i.e., companies that have a cumulative GVA that falls within the middle half of the data. The net increase in GVA accumulated over the entire treatment period was compared with the cost of funding for matched companies included in the analysis to present a ROI figure.

As noted previously, some companies in the analysis have had only a limited amount of time since their first year of treatment and we expect that the CR&D portfolio will continue to generate impacts in the future. The ROI results presented here are based on data of realised GVA growth to date and without incorporating projected increases in future years. The findings present the direct impacts for beneficiaries and exclude any indirect impacts resulting from a change in the supply chain. As such, Type I and Type II multipliers were not used.

The results shown in Table 13 indicate that, based on the data for matched companies that fall within the interquartile range, the impact of BBSRC funding on industrial partners includes £140 million in net cumulative GVA compared to the initial BBSRC investment of £20 million as well as a further £8 million in private sector co-investment (£1.4 million in cash and £6.6 million in-kind contributions). Hence, the analysis demonstrates that:

- For every £1 invested by BBSRC, the funding has generated £7 in economic benefits
- For every £1 invested by BBSRC in conjunction with the industry partners, the funding has generated £5 in economic benefits

Appendix D.4 includes the ROI results for each one of the five investment categories.

Table 13 Return on investment from BBSRC funding

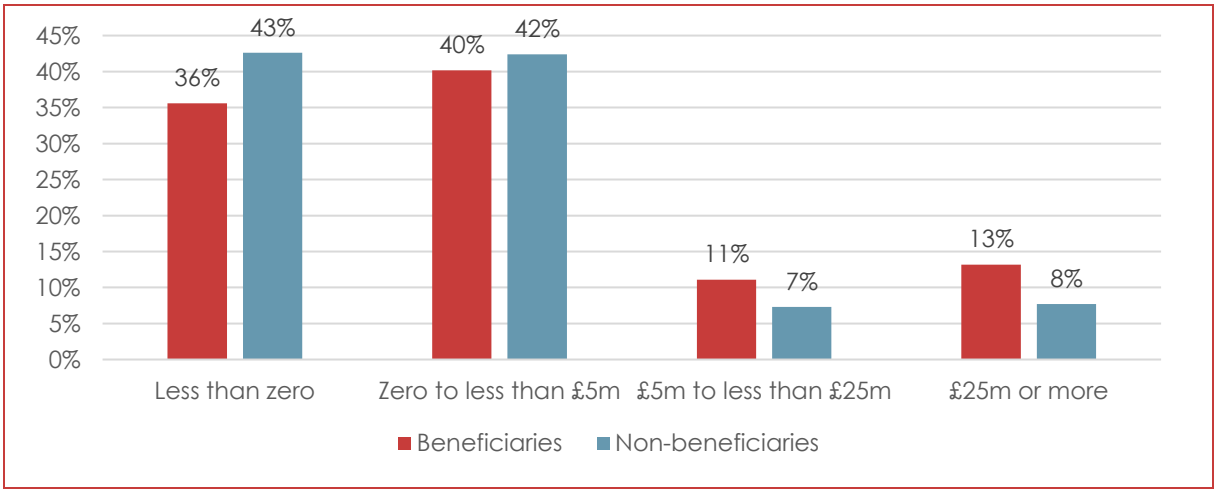
	BBSRC CR&D portfolio
Cumulative change in GVA for beneficiaries *	£184m
Net cumulative GVA *	£140m
Net cumulative GVA per company *	£0.646m
Value of BBSRC investment *	£20m
Value of cash contributions *	£1.4m
Value of in-kind contributions *	£6.6m
Return on investment ratio for BBSRC funding	1:7
Return on investment ratio for BBSRC and private sector leverage cash and in-kind contributions	1:5
Sample size of beneficiaries *	217

Source: Business Structure Database. Note: *The table includes businesses who were successfully identified in BSD and fall within the interquartile range. The lower sample size reflects the exclusion of extreme values that fall outside of the IQR

Figure 23 shows the distribution of cumulative GVA since the baseline for both beneficiaries and matched non-beneficiaries. The analysis captures all companies, including large outliers who fall outside of the interquartile range. 64% of beneficiaries have experienced an increase

in their cumulative GVA since the baseline compared to a slightly smaller share of non-beneficiaries (57%).

Figure 23 Distribution of cumulative GVA since the baseline for beneficiaries and matched non-beneficiaries



Source: Business Structure Database. Note: The sample size is 433 for beneficiaries and 483 for non-beneficiaries. This does not exclude outliers

5 Summary and conclusions

This section contains a summary of the findings of the evaluation and a set of recommendations for future monitoring and evaluation of the BBSRC CR&D portfolio.

5.1 Conclusions

Overall, we find that:

- The BBSRC CR&D portfolio has made significant contributions to the body of bioscience and industry-relevant research
- Investments have furthered contributed to the training of R&I talent and have often provided recruitment opportunities for industry partners
- CR&D investments have enabled new and enhanced partnerships within projects and wider networks providing a route for businesses to access relevant expertise within the science base
- There is evidence of contributions to technical and commercial progress across the low and middle range of the TRL scale
- The BBSRC CR&D portfolio has delivered a 1:7 ROI (in terms of net GVA) and supported a median increase of two jobs per company per year in comparison to similar non-beneficiary companies
- Finally, there are examples of contributions to societal policy and standards through large investments which have had a significant national and international footprint, especially in the agrifood, animal health, and human health fields

The following subsections describe the evaluation findings as they relate to each of the evaluation questions.

5.1.1 Portfolio-level outputs, outcomes, and impacts

Evaluation question 1: At a CR&D portfolio level, what are the outputs, outcomes and wider impacts of BBSRC investments?

The BBSRC CR&D portfolio has had a significant impact across the four impact domains identified in the TOC.

- **Capacity building:** Significant contributions have been made to the body of bioscience and industry-relevant research. Investments have further contributed to the training of R&I talent and have often provide recruitment opportunities for industry partners.
- **Partnerships:** CR&D projects have created new and enhanced collaborative research partnerships as well as created networks and communities across important scientific and industrially-relevant areas. The CR&D portfolio has delivered a variety of funding mechanisms which has provided multiple entry points for businesses and researchers to engage with CR&D and this has contributed significantly to creating more positive attitude towards collaboration. In addition, the majority of collaborative projects have led to continued collaboration where £1.90 in further funding has been raised for every £1 of BBSRC CR&D project funding.
- **Technological and commercial development:** CR&D projects have enabled the development of technologies from TRL 2 to TRL 5 on average and have helped de-risk these for further investment. The portfolio has resulted in at least 53 spinouts, the creation of new IP, as well as further examples of direct contributions to new products and services. It was found that not every project resulted in an innovation output of this kind but, where industry partners did achieve new innovation outputs, this was often a result of the combined outputs of multiple projects which is to be expected. Although not all individual projects resulted in an innovation output, the econometric analysis shows that there are clear benefits to industry partners in terms of employment and turnover.
- **Business engagement and policy impacts:** There are multiple examples where BBSRC CR&D projects have contributed to addressing societal and environmental challenges through enabling new products and services with improved health and environmental characteristics. Larger CR&D investments have been particularly impactful in creating national coordinated networks and centres in areas of strategic importance. These investments are uniquely positioned to engage with policymakers and drive the development of standards and new markets at national and international levels.

Furthermore, through BBSRC initiating coordination activities and aligning the priorities of CR&D investments with other areas of UKRI, especially Innovate UK, this has enabled successful pre-competitive, collaborative research in strategic areas to progress through to commercial scale and business-led innovation. This has provided a critical pipeline as well as a wider ecosystem of support for important national priorities.

5.1.2 *Contribution of individual portfolio investment categories*

Evaluation question 2: How have each of the portfolio investment categories differentially contributed to the overall outcomes and impacts?

The evaluation has assessed in detail each one of the five investment categories defined by the Business Interaction team at the BBSRC. The outputs and outcomes both overlap and vary, in some cases significantly, between the investment categories as summarised above.

It is worth noting that the economic impact estimates are based on the benefits to the project partner companies and do not include wider benefits to the sector or society. It is to be expected that targeted collaboration in IPA and LINK projects achieve a higher direct return to the participants whereas larger strategic investments provide a value add to a much wider group of constituents that is harder to capture in a single figure.

We find a clear division of labour between investment categories:

- **Responsive Mode grant awards with industry partners** have made contributions to the development of knowledge and have provided flexible ways of including businesses in academic research. In isolation, this investment category has the smallest effect on the overall aims of the CR&D portfolio and often experiences improved impact when combined with other grants.
- **IPA and LINK** awards have provided opportunities for more focused collaboration, knowledge sharing, and the co-production of outputs including co-authored papers and intellectual property. This investment category is instrumental in strengthening existing partnerships and knowledge sharing and has provided significant benefits to participating companies with regards to increasing employment and turnover.
- **Community & Capacity Building Investments** have provided a series of entry points for businesses where there are low barriers to entry. Through the provision of small grants and networking opportunities this has helped to improve the understanding of and attitude towards CR&D. This investment category has been particularly instrumental in creating new partnerships and enabling successful experiences to progress to other CR&D initiatives.
- **BBSRC-led strategic CR&D Investments** have provided support at a scale that has enabled the creation of national focal points for academic and industry stakeholders to coordinate pre-competitive research in their given field with significant knowledge and innovation impacts. Of particular note, the investment in the NBIC has led to the centre playing a proactive role in working at national and international levels to enable new markets and standards.
- **Strategic Co-Funding (across UKRI)** have supported the generation of new knowledge and the development of technologies across the TRL 3 to 6 range. This investment category, which is well aligned to BBSRC-led investments, has provided a route for innovation where there has been a need to build upon previous successful CR&D projects as well as provide access to business-led innovation support for later stage commercialisation typically provided by Innovate UK.

Conceptually, the structure of the investment categories might suggest that these represent progressive steps towards innovation, but in practice we observe a much less linear process. The added value of the CR&D portfolio consists of the ability to move between science or innovation-led as well as small- and large-scale initiatives, depending on the requirements and

opportunities for the research partnership. This includes instances where Innovate-UK led projects have prompted new questions to be investigated through BBSRC-led CR&D projects or where unexpected findings have led to opportunities for applications that are distinct from the ones originally envisaged.

5.1.3 Delivering value for money

Evaluation question 3: To what extent has the BBSRC CR&D portfolio delivered value for money?

The evaluation has identified a number of benefits arising from the BBSRC investment in CR&D where there is a mixture of evidence for quantifiable as well as qualitative benefits.

The Return on Investment is estimated at £7 for every £1 invested. This is an important metric but only measures one component of the value added, the private returns (GVA) to the specific firms involved as project partners in CR&D grants. Pre-competitive, CR&D funding by the BBSRC has benefited a much wider group of companies beyond the official project partners and research organisations. Despite this, the value of these additional benefits cannot be calculated based on the available evidence.

This metric constitutes good value for money compared to other investments in R&D support. As the BBSRC CR&D portfolio contains a complex set of investments, it is difficult to identify specific benchmarks against which to assess the relative merits of alternative investment strategies.[41]

Table 14 Summary of value for money assessment by element

Dimension of VfM	Comments	Assessment
Value to participating firms	The ROI of the BBSRC CR&D portfolio on business GVA is at 7:1	High
Value to the bioscience sector	The evaluation has found evidence of sector-wide benefits to the bioscience sector in the UK through: • Increased knowledge • Increased pool of talent • Lowered barriers to innovation and critical mass in strategic sectors	High
Value to society	Whilst there have been contributions to addressing societal and policy challenges, notably food security and environmental protection, there may be more direct ways of achieving such outcomes	Fair

Source: Technopolis

[41] For a recent study on R&D returns, see: Dimos and Vorley (2023): Innovate UK Grants and R&D returns: Impact on business and economy, Innovation Caucus, November 2023, available at: https://ircaucus.ac.uk/publications/innovate-uk-grants-rd-returns/

All investment categories have contributed differentially to outcomes. The analysis has revealed different rates of economic return across the portfolio as well as different types of benefits to the wider community, sectors, and society. Some consultees suggested that greater value is derived from prioritising business-led investments, such as co-funding with Innovate UK, but the evaluation findings suggest that a mixture of investments provide differential benefits. More broadly, the five investment categories are not independent from each other and combinations of different types of CR&D awards tend to provide additional benefits. It was identified that the variety of the CR&D portfolio was critical to stakeholders, and that investments could be used at different stages in an often-non-linear way when progressing towards technological maturity and potential commercial applications.

5.1.4 Breadth and diversity of businesses supported

Evaluation question 4: What is the breadth and diversity of businesses supported across the BBSRC CR&D portfolio

The BBSRC's CR&D portfolio supported a total of more than 1,200 different business as industry project partners who have collaborated with academic recipients of BBSRC funding. In addition, a large group of businesses in the wider sector benefited from other forms of involvement in terms of aligned activities and from accessing talent, expertise, and knowledge which has been developed through CR&D projects.

Although the majority of industry partners were identified as micro- and small-sized businesses (up to 50 employees), large businesses and relatively long-lived businesses are significantly overrepresented as compared to the general business population in the UK. The BBSRC CR&D portfolio offers a range of entry points for businesses to be involved in CR&D and it may be the case that smaller and more recently established businesses are involved more frequently in less formal roles not accounted for in these statistics or benefit from the portfolio's contributions to knowledge, talent, and the networks available in the sector. In some cases, consultees identified specific issues, such as the lack of financial support for businesses in BBSRC-led programmes and that the value proposition for businesses to get involved in programmes is not as clear as it could be. Furthermore, the uncertainty which is inherent in pre-competitive R&D can also function as a deterrent for smaller and more recently established businesses which have to focus on short and medium-term targets.

5.1.5 Enabling access and use of research and innovation infrastructure

Evaluation question 5: To what extent has BBSRC CR&D support helped academic researchers and businesses access and utilise research and innovation infrastructure?

In the majority of cases, access to the relevant infrastructure were critical to CR&D projects and the CR&D awards were often instrumental in enabling access. More than two thirds of project PIs reported using some form of R&I infrastructure as part of their CR&D project(s) where nearly half described access as essential. Furthermore, one in five indicated that BBSRC CR&D grants were instrumental in providing access to facilities that were previously inaccessible and IPA and LINK grants, in particular, were an important mechanism in allowing academic researchers to access business-owned facilities.

PIs described that facilities were often seen as critical to the success of projects, for example due to being able to access equipment more advanced or more relevant to commercial-scale testing but industry partners also indicated that the reverse was also true. For businesses,

especially smaller companies, it was critical for them to access facilities hosted by academic institutions due to limited in-house resources or needing to access highly specialised equipment.

Nearly a quarter of PIs reported that there were significant barriers to accessing relevant R&I facilities and common barriers cited included the lack of funding, including travel to international facilities, the lack of awareness of facilities, as well as the lack of access to technical expertise needed to operate the equipment. It also became apparent that infrastructure needs varied greatly between different thematic areas of the portfolio, for example the need to access farms and animals for certain types of agricultural and food R&I to highly specialised equipment used in many pharma- and health-related fields.

5.1.6 Monitoring and evaluation

The process of conducting the evaluation has highlighted a number of challenges inherent in managing data for a large and complex portfolio where much is a consequence of how the different investments have been implemented and recorded.

Recommendation 1: Build on scope and portfolio work through this evaluation

This evaluation has defined the scale and scope of the CR&D portfolio in the context of ROI and wider impact. In the future, the BBSRC should continue to use the scope and definitions developed in this evaluation for the collection of future monitoring and impact data. In a similar manner, the ToC developed for this evaluation should be revisited regularly to ensure that it is up to date and reflects BBSRC's current strategy. The priority given to business and innovation is reflected in the BBSRC's most recent strategic plans.

Recommendation 2: Improve evidence base on business participation

For this evaluation, there was a limited ability to identify and contact business partners within the portfolio. To improve this, we recommend collecting business registration numbers to improve the ability of matching data with external and secondary data sources. Furthermore, in preparation for future evaluations, we also recommend exploring options to include provisions in grant conditions to contact business partners directly.

5.1.7 Annual performance tracking

The BBSRC can derive significant benefit and strategic intelligence from an annual internal exercise to collate existing evidence from across the portfolio. By performing this exercise annually, the BBSRC would receive additional benefit by being able monitor movements and trends across the portfolio over time. The focus of these would be on the near-term outcomes and any analysis of longer-term outcomes and ROI is likely to require a more resource-intensive evaluation exercise for which the BBSRC would be better prepared.

In addition, an annual exercise could contribute to more effective communication to internal and external stakeholders about the portfolio's achievements and possibly inspire would-be participants to engage.

Recommendation 3: Update indicators on investments and outcomes

We suggest developing a list of indicators for continuous monitoring using the table below as a starting point.

Table 15 Overview of M&E indicators and sources by impact domain

Domain	Indicator	Source of evidence
Investments	BBSRC-investment in CR&D	Grant data
	Co-investment by project partners	Grant data
Outcomes – Capacity building	Co-authored publications with industry	Researchfish
Outcomes – Partnerships	Academic partners involved in CR&D projects	Grant data
	Industry partners involved in CR&D projects (incl. characteristics: size, age, sector)	Grant data (possible match with third party data)
	Further investment in R&D by industry partners	Researchfish
Outcomes – Technological and commercial development	IP rights obtained Spinouts	Researchfish
	Notable outcomes	Researchfish CR&D case studies
Outcomes – Business engagement and policy impact	Businesses engaged by the BBSRC in events	BBSRC team
	Examples of engagement of BBSRC-supported initiatives with policymakers	Researchfish CR&D case studies

Source: Technopolis

5.1.8 Future evaluations

There is good reason to periodically commission external evaluations of the portfolio as this will provide an external perspective as well as an independent review of the CR&D portfolio. An external evaluation would also facilitate a more detailed review of investments as well as questions or attribution of outcomes to the portfolio and quantification of impacts to be identified.

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