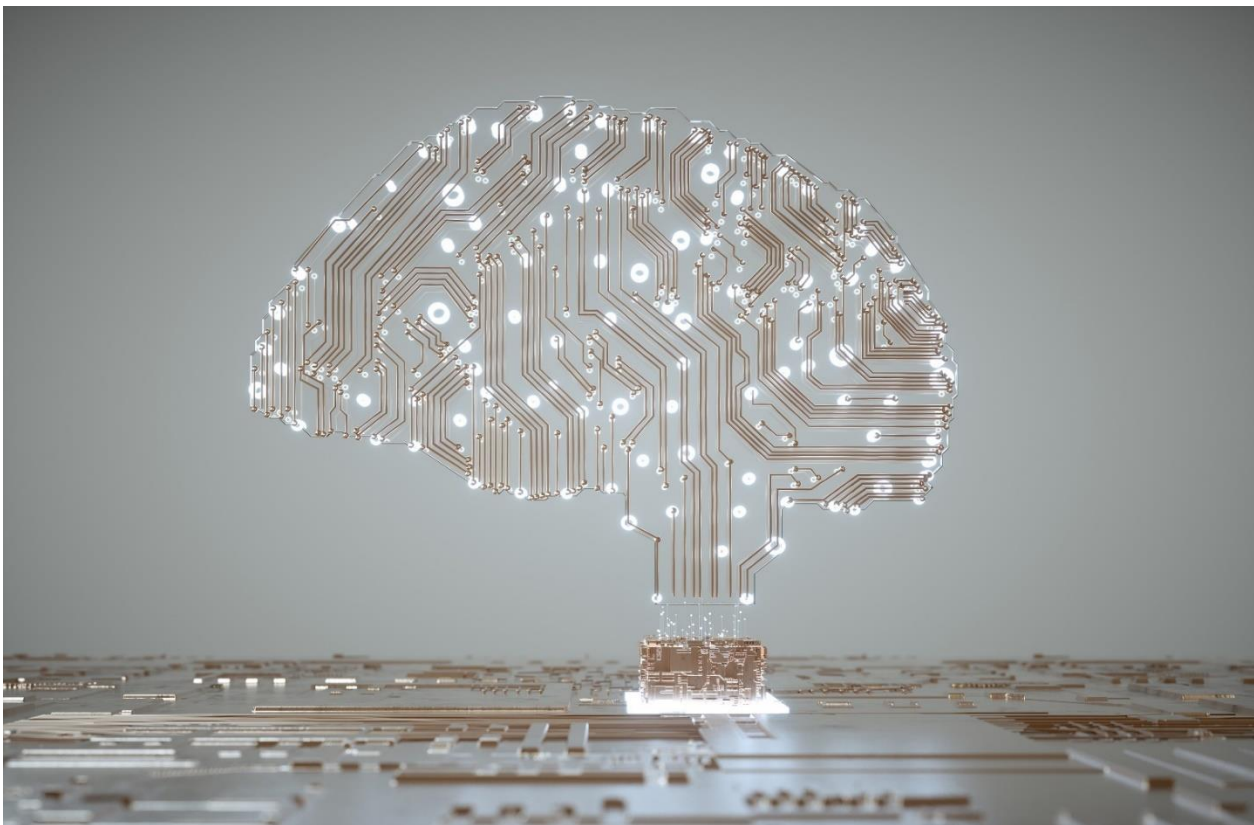


An Evaluation of the Small Business Research Initiative: Appendix E – Government Demand-led & Procurement- driven Innovation: A Review of the Literature



UKRI
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Executive Summary

A review of the literature on the UK Small Business Research Initiative (SBRI) and similar programmes in other countries was carried out at the outset of the SBRI evaluation to inform its design and methods. Other material was uncovered during the course of the evaluation and has been incorporated in this, the final report of the literature review.

There is a substantial body of literature on the UK SBRI and the US Small Business Innovation Research programme (SBIR) from which it was derived and also on procurement-driven innovation policies more generally. We identified over 90 sources of potential relevance from which we generated a short-list of some 40 documents to review.

Key findings

Programmes like SBRI are often referred to as pre-commercial procurement (PCP). They are distinguished from other procurement-driven innovation programmes because of the distinct characteristic that the commissioning authority “*acquires R&D services from a number of providers who develop in competition alternative solution approaches to address one and the same problem of public interest faced by the procurer*” (see European Commission (2015)) with any intellectual property rights shared with the providers.

The main findings from the review of the literature are as follows with regard to the impacts and benefits of PCPs:

- The US SBIR initiative upon which SBRI is based has, from its inception, had a dominating emphasis on maximising the benefits of US Federal Government spending for private sector SME R&D, innovation and new business formation.
- Consequently, the bulk of the evidence currently available on the US (and on the UK too) focuses on these private sector-generated benefits.
- Studies of experience of PCPs in other countries indicate that this dominating focus on private sector benefits holds-up internationally with little effort to assess and quantify the public sector and wider economic and societal benefits.
- Econometric and other studies of impacts on business provide generally robust evidence of significant positive effects of PCPs on sales, employment and investment (both internal and external) for the participating businesses albeit with a significant skew – a high proportion of the gains to date coming from a low proportion of the participating businesses. But there is limited evidence on the scale and persistence of these impacts but evidence from SBRI Healthcare suggests both could be significant.
- Evidence is limited with regard to the public sector benefits of PCPs. What there is by way of quantitative evidence is confined to cost savings. But more qualitative evidence suggests the benefits can be in a variety of forms: improvements in the quality and/or efficiency of public services; reduction of technological lock-in (allowing for higher interoperability across different services); and reduction of the risk of failure and/or cost savings for follow-up procurement.
- There is very little evidence from formal assessments of value for money and public returns on investment through PCPs, reflecting the paucity of quantitative estimates of direct public and private sector costs and benefits. What evidence there is suggests the programmes are likely to provide good value for public money when their private and public sector benefits materialise fully.
- Measurement and evaluation of the outcomes from PCPs are generally not formally instituted or reported although this has begun to change. There are more insights in the

literature on the appropriate designs and methods for evaluating private sector impacts. These confirm that (as has been done in the past for SBRI) analysis of business performance data using econometric methods and comparison groups can be deployed effectively. Insights are less forthcoming with regard to public sector benefits primarily because of the difficulty of establishing a robust counterfactual via comparison groups.

The literature highlights the following factors as being conducive to the implementation of PCPs in ways that are effective in terms of delivery and generating positive outcomes. The PCPs need to be implemented in ways that:

- Foster a more pervasive ‘culture for innovation and evaluation’ in the commissioning authorities’ mainstream procurement practices to foster a stronger learning and adaptation ethos;
- Strengthen independent advisory mechanisms, especially useful for building a ‘culture for innovation and evaluation’ that drives learning and adaptation;
- Preserve continuity in existing programme structures and processes but encourage experimentation and flexibility to better exploit the potential for ‘learning-by-doing’;
- Integrate SBRI and similar programmes into mainstream commissioning but without losing the distinction between PCP and other innovation procurement initiatives; and
- Avoid confining new awards to those businesses that have not previously received them – firms who succeed in past competitions can be building-up useful innovation capability and should not be excluded from participation in future competitions.

The current SBRI evaluation was carried out to test a set of key hypotheses (based on the theory of change underpinning the programme) using a mixed methods approach (as suggested to be appropriate in the literature). The evidence from the literature review can be drawn on to provide reflections on the grouping of these hypotheses as set out below.

Reflections on the hypotheses tested in the SBRI evaluation

Hypotheses relating to PCP design, strategy and governance

The literature review strongly suggests that PCPs can form a critical element in a public procurement strategy designed to stimulate innovation in public and private sectors and the economy more generally. They were most effective in doing this where they fostered a pervasive culture of experimentation, innovation and learning in the commissioning agencies. This required a balance to be struck between maintaining independence and flexibility in the design and governance of PCPs at the same time as ensuring they are seen as an integral part of, and championed within, mainstream commissioning and procurement.

The UK was seen to be at the forefront in the use of PCPs within Europe in the early 2010s and, a decade later with other countries rapidly following suit, was still assessed to be in the group of ‘good performing’ countries with regard to policy measures conducive to mainstreaming innovation procurement.

The UK strengths were assessed to be in its promotion of innovation through procurement, in the support for setting up and disseminating competitions, and in sharing good practices and networking across government departments. Its policy framework was seen as promoting an innovative-friendly public procurement market with a default IPR allocation regime in government contracts that fostered innovation.

However, the UK policy regime was also thought to require strengthening through the development of a dedicated innovation procurement strategy and action plan, promoted more strongly in government and business, integrated more completely within, and 'owned' by, a wider range of departments, and accompanied by more rigorous monitoring, learning and dissemination of potential science and technology solutions.

Hypotheses relating to PCP delivery, implementation and response

The literature review found a strong body of evidence, especially from the SBIR in the US, that PCPs increased business contacts in the public sector and improved their understanding of the procurement process and how they could tap into it. They stimulated scientific and technological advances, supported a wide diversity of small businesses, fostered business formation, helped de-risk innovation and, in some cases, encouraged downstream investment funding.

The evidence was more limited with regard to the extent to which PCPs improved the culture, procedures and skills by which public officials assess the challenges they face and procure/manage business innovation to address them. Reviews of the SBRI suggested that it was not routinely considered by departmental senior staff as a mechanism to be used either for operational or policy purposes. Responsibility for using SBRI was too often located at relatively low levels of seniority in departments and not considered often enough by departments as a policy tool that could be used strategically.

Hypotheses relating to PCP outcomes, impacts and value for money

The literature review found there to be very limited but positive evidence on the extent to which PCPs generated public sector benefits. The largely qualitative and anecdotal evidence suggested they came in the form of cost savings, improvements in the quality and/or efficiency of public services, reduction of technological lock-in (allowing for higher interoperability across different services), and reduction of the risk of failure and/or cost savings for follow-up procurement.

Econometric and other studies of impacts on business provided generally robust evidence of significant positive effects of PCPs on sales, employment and investment (both internal and external) for the participating businesses (albeit with a skewed distribution). But there was limited evidence on the scale and persistence of these impacts.

There is little evidence relevant to the value for public money represented by the funding for PCPs. What little has been done suggested they offer good value for money but only the 2015 SBRI evaluation in Manchester (2015) provided estimates of positive benefit cost ratios.

Source: Steer-ED, 2021

1 Introduction

- 1.1 A review of the literature on the UK Small Business Research Initiative (SBRI) and similar programmes in other countries was carried out at the outset of the SBRI evaluation to inform its design and methods. A wide range of search terms was used to identify sources of evidence relevant to a long list of topics. However, this was not a systematic review of the entire evidence-base that these searches uncovered. Instead, the focus was on the material judged to be most useful at the formative stage of the study in informing the specification of the process and impact aspects of the SBRI and the means by which they could be evaluated.
- 1.2 Other material was uncovered during the course of the evaluation and has been incorporated in this, the final report of the literature review which seeks to:
- Put the UK SBRI in the international context of similar programmes in other countries;
 - Draw out what is known about the outcomes and impacts of such programmes;
 - Consider the methods by which their outcomes and impacts can be assessed;
 - Provide conclusions and reflections on what the evidence from the review says about the key hypotheses being tested in the current evaluation of the SBRI.
- 1.3 There is a substantial body of literature on the UK SBRI and the US Small Business Innovation Research (SBIR) programme from which it was derived and also on procurement-driven innovation policies more generally. There has also been burgeoning interest and activity in the UK and other countries in what has been termed the GovTech sector. This is defined in GDS (2018) as *“a nascent but promising new industry sector where private sector start-ups and technology firms deliver innovative technology-based solutions (often using the latest technologies) to help solve public sector problems”*. However, no literature was found that evaluated the outcomes and impacts of GovTech in a systematic way that could be reviewed.
- 1.4 Over 90 sources of potential relevance were finally identified from which a short-list of some 40 documents was generated for the review. These documents were selected as offering evidence on the outcomes and impacts of SBRI or similar initiatives but without any pre-judgement of the robustness of the methods used to generate the evidence.
- 1.5 This review is structured with the following sections:
- **Section 2: Overview** provides an overview of the UK SBRI, placing it in the context of other procurement-driven innovation programmes and of similar programmes in other countries;
 - **Section 3: Benefits to business and the wider economy** outlines the evidence of private benefits to industry from participation in pre-commercial procurement (PCP) programmes;
 - **Section 4: Benefits to the public sector and the general community** sets out the evidence of public benefits secured by the commissioning authorities and the general community as a result of PCP programmes;

- **Section 5: Process effectiveness and value-for-money** considers the evidence on the process effectiveness of the programmes and their value for money
- **Section 6: Evaluation methods** looks at the methods that have been used to evaluate programmes like SBRI; and
- **Section 7: Conclusions and Reflections** offers conclusions and reflections with regard to the issues considered in the evaluation of the SBRI.

1.6 The specific references cited in the review can be found in the bibliography at Appendix A.

2 Overview

SBRI and other procurement-driven innovation programmes

- 2.1 Programmes like SBRI are often referred to as ‘pre-commercial procurement’ or ‘pre-competitive procurement’ (PCP) initiatives – especially in European Commission documentation. They are distinguished from other procurement-driven innovation programmes because of the distinct characteristic that the commissioning authority “*acquires R&D services from a number of providers who develop in competition alternative solution approaches to address one and the same problem of public interest faced by the procurer*” (Bedin et al (2015)) with any intellectual property rights granted to or shared with the providers.
- 2.2 Semple (2014) provides a flow diagram to determine the appropriate choice of procurement procedure (consistent with an EC procurement directive that was planned for 2015). Depending on whether end-user requirements can be specified and whether R&D services are needed prior to procurement, the appropriate choice could be a PCP or partnership arrangement or a competitive dialogue with or without negotiation.
- 2.3 Bedin et al (2015) distinguish PCP programmes from the following:
- **Public procurement of innovative solutions (PPI)** where commissioning authorities act as lead customer by procuring innovative solutions (not the R&D to develop them) that are newly arriving on the market but not yet available on a large-scale commercial basis;
 - **Exclusive R&D services** procurement by which all benefits accrue exclusively to the commissioning authority and R&D costs are fully remunerated by them;
 - **Innovative partnerships** that combine the purchase of R&D services and the subsequent supply of commercial volumes of the end-products/services into one procurement procedure.
- 2.4 The competitive dialogue approach referred to in the previous paragraph could be added to the Bedin et al list. It is a process in two parts by which the commissioner talks to potential suppliers about the specification and terms and conditions and, after the dialogue closes, a second part when the normal procurement conditions apply with no dialogue between contractor and bidders.
- 2.5 This review only considers what the literature has to say about SBRI and other PCP initiatives.
- 2.6 There is some debate in the literature about whether PCP programmes should be classified, as often claimed, as demand-side procurement initiatives at all or simply recognised as supply-side interventions alongside R&D subsidies. Edquist and Zabala-Iturriagoitia (2015) argue that PCP initiatives are supply-side innovation programmes in all but name. They aim at providing R&D-based solutions to existing challenges but without identifying a buyer for further uptake, articulation and diffusion of any innovation. Commercialisation cannot be regarded as part of the PCP process, they argue, “as none of the procurers funded the

commercialisation of the selected solutions, nor was there any commitment from the funding public agencies to buy the resulting product”.

- 2.7 Putting the semantics to one side, this issue could be important if PCP is seen by those who implement it as primarily a supply side intervention (like R&D subsidies) and not as part of, or integrated systemically into, the mainstream procurement process. The European Commission suggested that PCP can only be integrated into a broader policy instrument mix, shortening time to market and encouraging market acceptance of new solutions if it is seen as part of a coordinated policy and procurement framework (European Commission, 2008).
- 2.8 However, as a literature review by Selviaridis (2016) reports, citing an observation by Georghiou, L., et al (2014), there is an ongoing debate in policy circles as to the potential *“gap between innovation procurement processes, as executed ‘on the ground’ by public procurers and in interaction with suppliers, and relevant policy aspirations.”* He also highlights a point made by Edler and Yeow (2016) over clarity of objectives, that *“a key distinction drawn is between pre-commercial procurement (PCP) which triggers demand for ‘things that do not exist yet’ and public procurement of innovation (PPI) for tried and tested products/services that are procured by public agencies, which may be responding to existing innovations”*.
- 2.9 Selviaridis (2016) highlights the challenges posed by the higher uncertainty and risk associated with PCPs for central finance ministry value-for-money and return-on-investment criteria. The greater the emphasis on cost-savings and the higher the risk-aversion in funding guidelines, the harder it is to support PCP to develop products and services for procurement by, and used in, the public sector when they don’t currently exist.
- 2.10 Even in cases where PCP products and services are developed, Selviaridis shows from the literature that a wide range of operational challenges may have to be overcome before they can be widely adopted. He cites the risk aversion of public procurement agencies, lack of incentives for seeking and purchasing innovative solutions, and supplier risk that the demand for innovative solutions will not materialise. These challenges can be compounded by limited use of innovation-friendly tendering practices (such as outcome-based specifications), difficulties in managing risk and uncertainty, and lack of effective administrative support systems (Edquist et al (2015) and Uyarra et al (2014)).

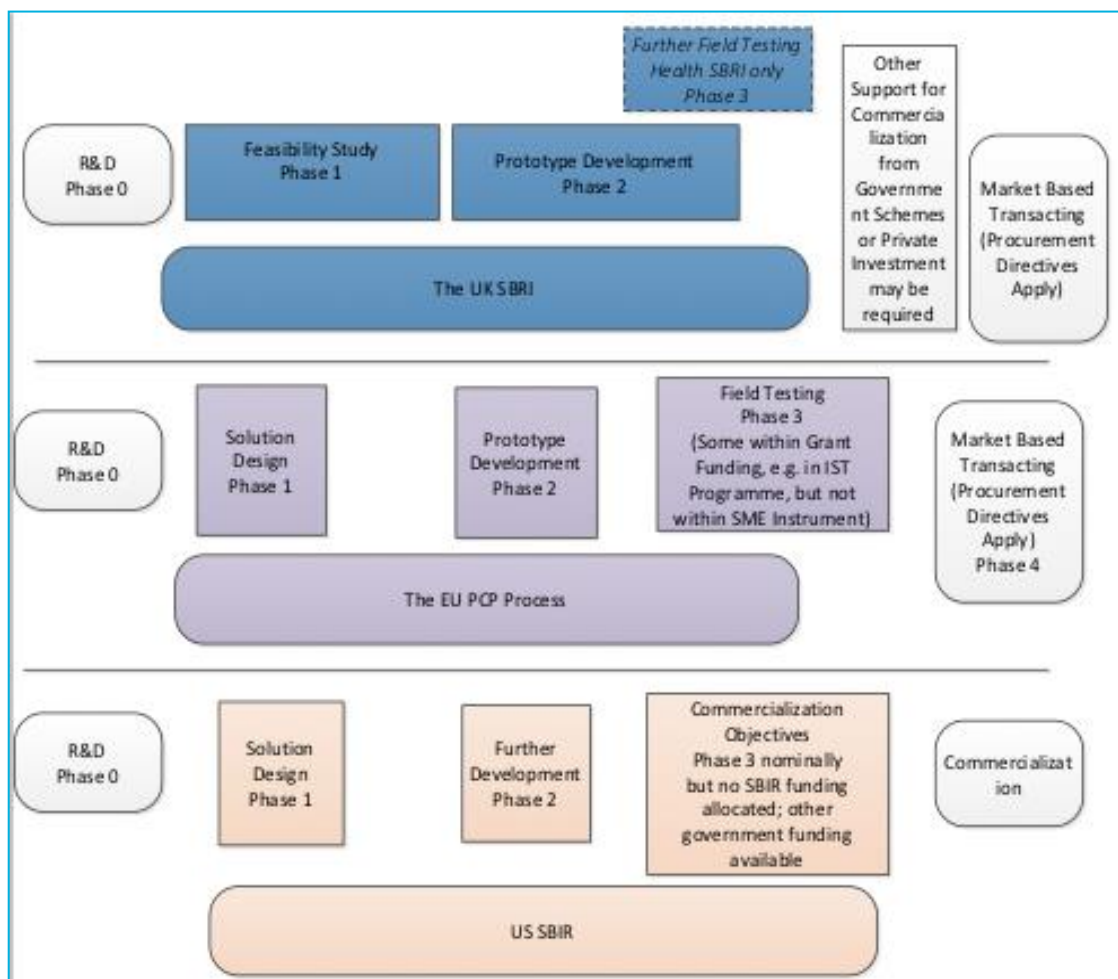
SBRI and similar initiatives in other countries

- 2.11 Over the last 30-40 years governments in an increasing number of countries have sought to use their procurement of R&D, goods and services not only to meet societal needs and challenges but also to promote innovation in business, particularly in SMEs. In doing so they have been following the lead set by the US Government which introduced the Small Business Innovation Research (SBIR) programme in 1982 – *“arguably the hallmark policy initiative in the United States to support technology development and commercialisation in small firms”* - Link and Scott (2017).
- 2.12 The SBIR was clearly seen as an attractive and effective intervention by Congress because it re-authorised the programme on a regular basis (in 1992, 2000, 2011 and 2016). This prompted other governments to follow suit and introduce similar policies. In particular, the UK set up the Small Business Research Initiative (SBRI) in 2001 (re-launched in 2008/09) and, according to Yeow et al (2013), appeared *“to be at the forefront in Europe when it comes to pre-commercial procurement, with other countries following the UK example (Izsak and Edler 2011)”*.

2.13 These various initiatives have the shared purpose to use public procurement to stimulate innovation through R&D and the market uptake of innovative products and services. However, they have not necessarily followed the detail of the US model in its operational mechanisms or even with respect to its primary purposes. They also operate in the different national contexts of general procurement and R&D support policies and methods directed at promoting innovation.

2.14 The following two sub-sections consider, respectively, the differences between the US and UK models and the UK and EU systems. The elements of the US, UK and EU programmes are depicted in Figure 2-1 which has been taken from Manchester (2015).

Figure 2-1: UK SBRI, US SBIR and EU PCP



Source: Manchester (2015)

The UK SBRI compared with the US SBIR

2.15 The objective of the US SBIR is to strengthen the role of innovative small businesses in federally-funded R/R&D to stimulate innovation, engage small businesses to meet federal R&D needs, to encourage innovation in disadvantaged and women owned small businesses, and to increase private sector commercialisation of innovations derived from federal R/R&D to increase competition, productivity and growth. The UK SBRI shares this objective to the extent that it seeks to stimulate innovation in the economy by supporting firms to develop and commercialise new technology-based products and solutions. However, it has the additional

objective to provide government departments and their agencies with new cost-effective, technical and scientific solutions to the challenges they have to meet.

- 2.16 The target businesses of the SBIR are small firms defined as being for-profit companies with 500 employees or less and at least 51% commercially owned by US citizens or permanent residents. The UK SBRI, on the other hand and despite its title, can engage any organisation including businesses of any size, pre-start-ups, universities and charities.
- 2.17 The US SBIR process works through three possible phases: Phase I, concept development/feasibility studies; Phase II, prototype development; Phase III, commercialisation (though these are not funded from the SBIR budget). Some US departments also provide Phase 0 support – very small-scale support for early stage planning and/or SBIR applications. The UK SBRI includes Phases 1 (feasibility) and 2 (prototype development) that are broadly equivalent to Phases I and II. It has a Phase 3 which is not the same as the SBIR Phase III as it is only available in some areas for an extended field trial/research study to robustly evaluate an emerging technological solution.
- 2.18 Management of the programmes is broadly similar – a central body oversees and administers the competition, but each participating public body administers its own programme funds, launches, and manages its own competitions.
- 2.19 The budget for the US SBIR is set by requiring all federal departments and agencies with external R&D budgets that exceed \$100m to allocate a portion of those budgets to SBIR activities. This target portion was set at 3% in 2016. The UK SBRI budget was set at 2.5% of external R&D to be spent with SMEs with an overall target of £50m. The ‘set-aside’ for SBIR is a mandatory requirement – not so for the UK SBRI.
- 2.20 The scale of the SBIR far exceeds that of the SBRI. There were 1190 SBRI contracts worth £99.4m awarded between 2009 and 2012. This compares with the 4000 SBIR contracts awarded a year worth some £1.4bn. According to Audretsch (2001), the SBIR represented about 60 per cent of all public SME finance support and, taken together, public SME finance is about two-thirds as large as private venture capital.

Innovation procurement in the UK compared with EU countries

- 2.21 The European Union PCP arrangement has four phases – Phase 0 (curiosity driven research), Phase 1 (solution design), Phase 2 (prototype development) and Phase 3 (field testing but no financial support other than through the IST programme). There would therefore appear to be broad similarity between the framework structure of the two approaches (and indeed the US approach) especially as Manchester (2015) suggests that the UK aims to do more within its two phases than might be achieved in the three or four phases of the US and EU systems.
- 2.22 There is an ongoing benchmarking study being carried out for the European Commission on public procurement for innovation in the digital economy. The final report is due shortly, but an early version of the UK profile report has been published (European Commission (2016)) and is the source for the comparative observations in this sub-section.
- 2.23 The study concluded that, among the 30 European countries surveyed, the UK was in the group of ‘good performers’ in implementing a set of policy measures conducive to mainstreaming innovation procurement (Finland was the only country assessed to be a ‘strong performer’).

- 2.24 The SBRI was seen to contribute positively to the overall assessment not just in its promotion of procurement of innovation but in the support provided by Innovate UK in the form of setting up and disseminating competitions, the provision of technical assistance, and sharing SBRI practices and networking across government departments. Other positive aspects of the UK policy framework were described as the innovative-friendly public procurement market and a default IPR allocation regime in government contracts that fosters innovation.
- 2.25 The weaknesses of the UK regime were assessed to be in the absence of a dedicated innovation procurement strategy and action plan, the lack of spending targets and a monitoring system for such procurement. It should be emphasised that the assessed strengths and weakness of the UK policy regime relate to the procurement system as a whole and are not specific to the SBRI. They are also assessed on the presence or otherwise of aspects of the policy framework not on observed outputs and outcomes.

Concluding observations

- 2.26 The aims, structure and processes of the UK SBRI appear to be broadly aligned with the US and EU approach although, as Manchester (2015) observed, given the variations in implementation within the US and EU, it is difficult to make simple comparisons between the schemes. One observation that can be drawn from comparing the UK SBRI with other forms of innovation procurement mechanisms and with practices in other countries is that any assessment of its effectiveness needs to take account of the wider procurement regime within which it operates. This is particularly so when evaluating its contribution to stimulating innovation and its commercialisation in the economy and providing the public sector with new solutions.

3 Evidence on benefits to business and the wider economy

Introduction

- 3.1 This section of the review considers the evidence from the literature on the benefits to the private sector businesses engaged directly in SBIR or similar programmes and any indirect benefits in the wider economy. The US SBIR programme has been around for longer than other similar initiatives and therefore is more likely to have been the source of evidence on longer term and wider private sector benefits. This evidence is reported separately from that for other countries.

US experience

- 3.2 There is a substantial body of evidence from reviews and evaluations of the US SBIR programme that it has induced increased scientific and technological advances, business start-ups, survival rates and growth. An early overview of this evidence (Audretsch (2001)) identified the following benefits:

- the survival and growth rates of SBIR recipients exceeded those of firms not receiving SBIR funding (Lerner and Kegler (2001));
- the SBIR induces scientists involved in research to change their career path away from basic research towards entrepreneurship (Audretsch et al. (2002));
- The SBIR awards provide a source of funding for scientists to launch start-up firms that otherwise would not have had access to alternative sources of funding; and
- SBIR awards have a powerful demonstration effect - scientists commercialising research results induce colleagues to consider applications and the commercial potential of their own research.

- 3.3 A later major review (NRC (2008)) reinforced these findings by concluding that the SBIR had the following business benefits:

1. Stimulating scientific and technological advances:

- 1.1. Multiple knowledge outputs as embodied in data, publications, patents and licenses of patents, analytical models, algorithms, new research equipment, reference samples, prototypes products and processes, spin-off companies, and new “human capital” (enhanced know-how, expertise, and sharing of knowledge);
- 1.2. Transfer of research into the marketplace through a wide variety of linking mechanisms - about a third of all NRC Phase II and firm survey respondents indicated that there had been involvement by university faculty, graduate students, and/or a university itself in developed technologies;
- 1.3. High-risk focus. Projects funded by SBIR often involve high technical risk, implying novel and difficult research rather than incremental change;

- 1.4. Indirect path effects. There is strong anecdotal evidence of knowledge generated from SBIR projects becoming relevant in a different technical context later on, and often in another project or even another company;
2. **Providing support for a wide diversity of small business:**
 - 2.1. The NRC Phase II survey and NRC firm survey showed that the programme provided substantial benefits for participating small businesses, at all agencies, in a number of different ways:
 - 2.1.1. **Business formation** - just over 20 per cent of companies indicated that they were founded entirely or partly because of an SBIR award;
 - 2.1.2. **Project additionality** - over two-thirds of SBIR projects reportedly would not have taken place without SBIR funding;
 - 2.1.3. **Alternative development opportunities** - companies often use SBIR to explore different development trajectories through technological options;
 - 2.1.4. **Partnering and networking** - small businesses getting access to outside resources - academic consultants and partners - helping create networks and facilitating the transfer of university knowledge to the private sector;
 - 2.1.5. **Commercialising academic research** - SBIR plays an important role in encouraging academics to found new firms that can commercialize their research; and
 - 2.2. SBIR funding is widely distributed across the small business research community in terms of:
 - 2.2.1. The volume of businesses participating - between 1992 and 2005 more than 14,800 different firms received at least one Phase II award, according to the SBA Tech-Net database;
 - 2.2.2. The extent to which the programme reaches businesses not previously engaged - at least a third of awards at all agencies go to companies that had not previously won awards.
3. **Prompting commercialisation ...**
 - 3.1. **... despite high risk:** Small technology companies use SBIR awards to advance projects, develop firm-specific capabilities, and ultimately create and market new commercial products and services. Although the data vary by agency, responses to the NRC Phase II Survey indicate that just under half of the projects do reach the marketplace:
 - 3.1.1. The full extent of commercialisation needs to be reflected and captured by use of multiple indicators:
 - Sales (using a range of different benchmarks to indicate different degrees of commercial activity);
 - Additional non-SBIR research funding and contracts;
 - Licensing revenues;
 - Third-party investment (including both venture funding and other sources of investment);
 - Additional SBIR awards for related work;
 - 3.2. **... but with a skewed distribution of sales.** SBIR awards result in sales numbers that are highly skewed with a small number of awards accounting for a very large share of the overall sales generated by the programme. For example, just eight of the NSF-supported projects—each of which had \$2.3 million or more in sales—accounted for over half of the total sales dollars reported by respondents;

3.3. ... **and often requiring other funding sources.** SBIR can be a key input but most major commercialisation successes require substantial post-SBIR research and funding from a variety of sources. SBIR awards will have been in many cases a major, even critical input - but only one of many inputs; and

3.4. ... **which they often attract.** SBIR funded research projects enable small businesses to develop the technical know-how needed to attract third-party interest from a variety of public and private sources, including other federal R&D funds, angel investors, and venture funds. The NRC survey revealed that 56 per cent of surveyed projects were successful in attracting additional funding from a variety of sources – including federal and venture capital funding.

3.4 This latter conclusion – the need for other funding sources (and not just venture capital funding) to complement SBIR funding – was confirmed in an analysis of the factors contributing to commercialisation success. Link and Ruhm (2009) found from quantitative modelling that additional developmental funding from non-SBIR federal sources and from own internal sources were important predictors of commercialisation success, relatively more so than additional developmental funding from venture capitalists. They also found that university involvement in the underlying research increased the probability of successful commercialisation.

3.5 More recent studies both confirm and add nuances to these conclusions:

- The BEIS literature review - BEIS (2017) - reported the findings from a number of studies of department specific SBIR programmes in the US (Committee on Capitalizing on Science, Technology and Innovation (2015)) that they had all met three of the four SBIR objectives (with more needing to be done to increase participation of socially and economically disadvantaged small businesses and women-owned businesses). Each of the departmental reports provided evidence confirming the NRC (2008) conclusion of positive post project investments and sales.
- The SBIR programme was found to promote high technology start-ups by Qian and Haynes (2013) who examined whether the local presence of SBIR awards was associated with increased new firm formation rates in the high technology sector. Although the primary objective of SBIR is to facilitate technological commercialisation in small businesses, the analysis based on spatial multivariate methods suggested that the SBIR might also serve as an effective entrepreneurship policy.
- The study by Galope (2016) of the potentially positive effect of an SBIR award on attracting other funding found empirical evidence that the public co-financing of private R&D had a positive effect on the innovation propensity of small high-tech start-ups. But, contrary to expectations, it did not find any significant “*certification effect*” of receiving an SBIR award on attracting follow-on investment. A different certification effect was discovered, namely that SBIR recipient firms were more likely to attract external patents. The author suggested that this confirmed that enterprises need to orchestrate a portfolio of internal and external knowledge assets to produce innovations with unique competitive advantage.
- Link and Scott (2017) confirmed the findings from previous research on the SBIR using more robust quantitative evaluation methods. As they observed, “*while scholars have studied this program in detail, there has yet to be a systematic assessment of how well it is meeting its legislated goals of stimulating technological innovation and increasing private sector commercialization*”. They used a unique set of data on projects funded by the National Institutes of Health (NIH) SBIR to assess the extent to which these goals were

being met. They found that, relative to a counterfactual control group, NIH supported the development of high commercialisation risk technologies and suggested that this finding aligns with the goals of the SBIR and “*may in fact be for the common weal*”.

Experience in the UK

- 3.6 The UK SBRI was introduced in 2001, re-launched in 2009 and evaluated fully by a team led by the Manchester Institute of Innovation and Research in 2015. It was subject to an independent review in 2017 - Connell (2017) – which was supported by an update of the Manchester (2015) work in BEIS (2017).
- 3.7 The Manchester (2015) report found that the SBRI generally worked well both for the firms that applied unsuccessfully and for those who won competitions. It was of benefit to unsuccessful applicants because it challenged their ideas and helped them reformulate their technical objectives or specify them more clearly and precisely.
- 3.8 The econometric analysis of competition winners – matching them with firms in the non-applicant population – estimated positive effects on business innovation on all measures of the latter. The average impact on sales of the participating businesses compared with non-applicants was an increase of 12.4 per cent and an employment increase of 7.3 per cent. In operational terms the scheme was therefore seen to be effective and, moreover, with high levels of additionality.
- 3.9 RAND (2017) also found a high degree of full additionality - among the successful applicants, 52% reported that they probably or definitely would not have undertaken the SBRI Healthcare-funded project if they had not received that funding.
- 3.10 The Connell (2017) review built on the Manchester (2015) work through case studies and confirmed its finding of private sector benefits. It cited the creation of new businesses, the development and launch of new products and applications as well as increased sales. However, the evidence did not provide the basis for generalised quantitative estimates of private sector benefits.
- 3.11 RAND (2017) drew on a survey of firms engaged in SBRI Healthcare projects and an earlier evaluation by OHE (2014) to report measurable outcomes for the companies including job creation and success in obtaining additional funding or investment from other sources.
- Nearly 70 businesses reported that, as a result of the support from SBRI Healthcare, they hired a total of 181 FTE staff (an average of nearly three per company) and had retained a further 237 FTE of existing posts. As shown in the evidence from SBIR, the distribution was highly skewed. One company hired 34 new employees and one other reported they hired 15. No other company reported hiring more than six employees.
 - Just under one third of the organisations that received SBRI Healthcare awards had secured additional co-funding on top of their SBRI Healthcare award.
 - More than one quarter of SBRI Healthcare awardees (13 companies) reported making sales totalling £4m although again with a highly skewed distribution - one company accounting for more than a third of those total sales.
- 3.12 It should be noted that RAND (2017) cautions that the survey results on which the above estimates are based are self-reported outcomes, not based on an observed counterfactual, and should not be generalised beyond the sample.

- 3.13 PA (2018) further reviewed the benefits from SBRI Healthcare and confirmed the earlier findings of significant private sector and wider economic benefits in the form of new jobs valued at £14.6M, sales outside of the NHS of £6.9M as well as the attraction of a further £122M in private investment funding.
- 3.14 Despite these positive outcomes, PA (2018) observed that the pace of adoption and spread by the NHS continued to be an issue. This is reflected in figures which showed that the companies achieved sales outside the NHS over one and a half times the value of sales to the NHS. *“This is despite the fact that the innovations are an industry response to priority needs identified by NHS and endorsed by NHS England”* (PA (2018)).

Experience in the rest of the world

- 3.15 There is a broad and growing evidence-base on other countries’ experiences with SBRI type programmes. As with the US and UK work, however, there is a marked emphasis on examination of private sector rather than public sector benefits.
- 3.16 For example, for Germany, Czarnitzki et al (2020) analysed evidence relating to the impact of legislative reform using econometric methods and concluded that this can boost private sector innovation, but mainly for incremental rather than radical innovations. Aschhoffa and Sofka (2009) compared the efficacy of public technology procurement in Germany relative to other innovation support modalities, namely regulation, provision of infrastructure via universities and research institutions as well as public R&D subsidies. This econometric analysis concluded that a positive impact on private sector innovation can be discerned but is comparable to that of the other major innovation support modalities they assessed.
- 3.17 Loader (2013) provides a useful review of the literature on public procurement in supporting SMEs. This type of study is representative of the general tendency to approach government-led and procurement enabled innovation as a facet of industrial strategy rather than a more balanced set of aims that include benefits in public sector performance.
- 3.18 Crespi and Guarascio (2019) carried out an econometric analysis that indicated that import penetration reduced useful innovation impacts from public procurement. The implication of this could be that an element of home market protectionism helps to maximise the benefits.
- 3.19 Inoue and Yamaguchi (2017) used comprehensive empirical data to examine the performance of firms directly affected by the Japanese SBIR programme and found it to be no better than for a sample of matched firms. This remained the case after controlling for firm sizes, multiple awards, technological levels, the value of venture capital in a region, and population. The authors suggest that this finding could be different from the positive impacts identified for the US programme due to differences in the cultural context and in programme design (e.g. there is no explicit mechanism in the Japanese programme for promoting technology transfer from the higher education sector).
- 3.20 Recent reviews of the private sector benefits from European Union PCPs have been based on small samples because of the limited number of cases that have reached a completed stage where such benefits could expect to be observed. Bedin et al (2015) analysed a set of 8 PCPs and a matching control sample and found that, compared with other procurement approaches, the reviewed PCPs had the following impacts:
- Improved market structures with increased access by SMEs to the procurement market;
 - Increase in the efficiency of R&D expenditures;
 - Speeding up time-to-market; and

- Increased exploitation of IPRs and R&D results.

3.21 However, they did not find any impact on increased attraction of financial investments or on the market shares of ‘awardees’ or sub-contractors. This, they suggested, may be explained by the small sample size of completed PCPs and by the fact that the PCP cases analysed did not include specific interoperability requirements for the solutions to be developed.

3.22 Bos (2020) reviewed progress in 15 completed and 13 ongoing EU PCPs with the winning bids involving a total of 372 businesses and 67 universities or research centres. The review made the following observations on the basis of this sample (i.e. without control groups):

- The PCPs opened a route to market for new players and SMEs with 60% of total contract value going directly to SMEs – double that for procurement more generally across Europe;
- Commercialisation of the PCP products/services had already been achieved by a high proportion of the businesses – 30% of contractors in Phase 1 (solution design), 75% in Phase 2 (prototype development) and 86% in Phase 3 (development and limited testing);
- Half of the contractors had already increased the revenues attributed to the PCP solution; and
- Quarter of the start-ups had secured equity investment since engagement in the PCP.

3.23 Such was the satisfaction with the PCP approach amongst the businesses canvassed in the review that they did not see the need for big changes – just more of the same. In particular, there was strong resistance to any suggestion that purchase of R&D through PCPs should be combined with wide-scale deployment in one procurement package. This was thought likely to have the effect of crowding out start-ups and SMEs from the PCP process.

4 Evidence on benefits to the public sector and the general community

General observations on the literature

- 4.1 There is a striking imbalance observable in the literature between the extensive evidence available on benefits to the private sector (although not necessarily in robust quantitative form) and the limited evidence on benefits to the public sector made possible by the innovation facilitated by SBRI or equivalent programmes. Indeed, there is little material on the form these public sector benefits might take and how they might be evaluated and measured.
- 4.2 It is possible that this is because the US impetus behind the SBIR is predicated on a strong bi-partisan US Congressional interest in maximising the value to the private sector of Federally mandated research and innovation funding. As is frequently the case in the US, targeted support for SMEs provides a rationale for the geographical dispersion of this funding across States and voting districts. It may, therefore, be the case that this politically oriented funding ethos directs attention towards first order private sector impacts in Congressional scrutiny rather than second order public sector benefits.
- 4.3 It is also the case that private sector outcomes and impacts are easier to measure against a counterfactual baseline case because it is possible to create treated and untreated groups with matched business characteristics. In contrast, it is harder to establish a counterfactual for the public sector benefits (what would have happened without an SBRI or equivalent programme). This is evident in the limited number of sources in the literature that address the issue of public sector and wider benefits.
- 4.4 As in the previous section, the evidence from US sources is presented separately from that from other countries.

US experience

- 4.5 The US SBIR does not have a specific primary objective relating to the benefits expected for the departments and agencies that deploy SBIR in terms of generating more effective, higher quality or more cost-effective services and solutions. Consequently, much of the SBIR review and evaluative effort has been focused on the direct and indirect business benefits.
- 4.6 The major review of the SBIR carried out by the National Research Council (NRC (2008)) had this focus but it also considered the extent to which the programme served the objectives of the relevant departments and agencies. It concluded that *“the SBIR program has been adapted effectively by the management of the individual departments, services, and agencies, albeit with significant operational differences, reflecting distinct missions and operational cultures. This flexibility in program management is one of the great strengths of the program”*.

4.7 The bulleted points that follow on departmental experience with SBIR are taken from the NRC (2008) summary:

- **Defence:** At DoD, considerable progress has been made in aligning SBIR-funded research with the strategic objectives of agency research and acquisition. In some parts of DoD, significant success was claimed in inserting SBIR-funded technologies into the acquisition process. The commitment of senior management to the effective operation of the programme and the provision of additional funding appeared to be key elements in success. Teaming among the agency, the SBIR awardees, and the prime contractors was important in the transition of technologies to products to integration in systems.
- **NIH:** NIH and other public health agencies increasingly saw SBIR as an important element in the agency's translational strategy—designed to move technologies from the lab into the marketplace. The NRC's review of the SBIR program at NIH found that SBIR funded projects had significant impact on public health.
- **NASA:** The primary metric for project success is the deployment of SBIR-funded technologies on space missions where the agency pointed to significant impacts.
- **Energy:** As at NASA, SBIR topics and project selection are heavily influenced by the agency research staff's wider R&D responsibilities. At DoE, all technical topics in the SBIR solicitation are constructed to support the overall mission of each of the agency's technical program areas.
- **NSF:** SBIR-funded research meets the agency's primary mission of expanding scientific and technical knowledge. However, it does so by tapping the scientific and engineering capabilities of an important sector—small businesses—that is almost entirely unserved by the remainder of NSF's programs.

4.8 As the above demonstrates, the NRC assessment of the contribution of the SBIR to public benefits was made largely in terms of how it was integrated within the relevant agencies and aligned with their objectives. Based on the NRC evidence, it seems that this was effectively done. But there is little hard evidence on whether the SBIR induced additional benefits to the funding agencies or the public they served.

4.9 Gaster (2017) reported anecdotal evidence that SBIR/STTR had important impacts in saving costs in Federal weapons acquisition programmes – e.g. a report from Lockheed on the F-35 identified \$500 million in savings from that programme alone.

4.10 Only one other study identified from the literature review (Audretsch et al (2002)) assessed the social returns from the SBIR programme but this was not in the form of public sector savings or improved public services but wider external benefits arising from improved business performance. Its conclusion of significant net social benefits was based on a relatively small sample (44 projects) not necessarily representative of all SBIR projects. It also drew on self-reported evidence with regard to the private returns from the projects and the multiplier benefits in the form of profits generated in broader applications and markets. The resultant estimates of social return were very high and far exceeded the opportunity cost of public funds promulgated by the US Office of Management and Budget (OMB).

UK experience

4.11 The Manchester (2015) report concluded that government was likely to benefit from the SBIR programme. It cited the extent of the savings indicated (but not demonstrated) in the review by the Office of Health Economics of the SBIR Healthcare programme. However, it acknowledged that the evidence in this regard was limited and observed that government

departments had not gathered information systematically on the benefits to them and therefore in a way that would support a sound measure of additional benefits (or costs). The report suggested that more work was needed to assess the likely extent of savings. It recommended that this activity should involve comparison of SBRI with alternatives in order to achieve a proper measure of the additionality of the programme.

- 4.12 Neither Connell (2017) nor BEIS (2017) was able to provide evidence on public sector benefits arising from the SBIR. In part this may be because the programme was assessed as not being embedded systematically and fully across government departments and its implementation inadequately accompanied by rigorous management and monitoring information. As Connell (2017) observed, *“the way in which SBRI has been funded and managed varies widely across Government and there is a lack of central, and sometimes departmental, ownership. It is effectively an ‘orphan policy’”*.
- 4.13 RAND (2017) reported that 86% (38 out of 44) of participating businesses claimed that their innovation had generated or would generate net cost savings for the NHS. Fifteen of these respondents provided estimates of expected cost savings per annum as part of the earlier HEE survey. Of those 15, most expected their innovation to generate annual cost savings to the NHS in the tens of millions of pounds.
- 4.14 Data on potential savings for the NHS were also gathered for OHE (2014) which reported that SBRI funded innovations were expected to generate potential savings to the NHS of £7.2-171 million per technology.
- 4.15 PA (2018) estimated the following public sector savings from the sample of eight SBRI Healthcare projects it reviewed:
- Savings to date in the range of £13.1M to £18.6M for the NHS in England and £11.5M to other UK public sector organisations
 - Annual recurring savings currently running at £19.1M per year, including £14.4M for the NHS in England, and this is forecast to increase as adoption spreads.
- 4.16 An assessment of longer-term impacts was made in PA (2018) based on company responses to SBRI Healthcare surveys supplemented by its reports of significant subsequent transactions. It estimated cumulative future savings to the NHS enabled by the SBRI Healthcare portfolio to be of the order of £350M-£480M in 5 years (2022), rising to between £1.2Bn-£1.8Bn in 10 years

Experience elsewhere

- 4.17 Bedin et al (2015) on the basis of a limited sample of PCP cases (and a matched control group) concluded that there had been additional public sector benefits as follows:
- Increases in the quality of public services achieved by deploying the innovative solutions developed as a result of the PCP;
 - Reduced risks of failure in large scale follow-up PPI procurements; and
 - Reduction of supplier lock-in.
- 4.18 However, they did not find that there had been any decrease in prices of products and services arising from the PCPs despite what was seen as a highly competitive, multi-sourcing, phased procurement approach. Nor had there been any increase in inter-operability (although none of the PCPs reviewed had this as one of their objectives).

4.19 In contrast, Bos (2020) from a review of 15 completed and 13 ongoing PCP contracts found that 60% of procurement authorities used PCP to obtain more open, inter-operable solutions. The following additional public sector benefits were identified:

- All completed PCPs delivered solutions that improved quality or efficiency;
- 55% of agencies from completed PCPs had already deployed the solutions; and
- Procurement agencies from 27% of completed FP7 PCPs had prepared additional larger scale procurements with enlarged buyer groups.

5.16 Typical barriers that had to be overcome to scale up the PCP solutions further included: slow standardisation, certification, regulation, unclear health insurance/reimbursement rules and fragmentation in the EU market.

Concluding observations

5.17 Connell (2017) and BEIS (2017) emphasise the potential benefits to the public sector from the UK SBRI but the absence of much by way of evidence on their nature and extent. This was echoed in the literature on the US and wherever the equivalent of the US SBIR had been introduced. Yet, as Connell (2017) argued, the programme offers a ‘win-win’ opportunity for both the public and private sector to “*develop innovative products that address unmet public sector needs*”. For the public sector, it offers a way to gain access to new technologies, products and solutions to improve its cost effectiveness and address policy challenges, whilst supporting a longer term, and more strategic, approach to procurement more generally.

5.18 BEIS (2017) gave further consideration to how, and what, public benefits might be generated from the UK SBRI as set out in the programme logic model they proposed, as follows:

- Activities: Departmental training/learning in the use of procurement for innovation; identifying and defining policy and/or operational needs requiring technological solutions; development of competition briefs to meet those needs;
- Outputs: Improved skills in using procurement for innovation in departments; prototype/new products to meet departmental policy and/or operational needs; improved knowledge of potential solutions and the barriers to overcome;
- Outcomes: Procurement for innovation implemented as standard practice in departments; new products procured and implemented by departments; new products available in the market to address policy challenges; and
- Impacts: Public procurement is a key driver of innovation in the UK; improved quality and efficiency of departmental operations and public services.

4.20 The only evidence found in this review of the above outcomes in the UK was from studies done on SBRI Healthcare where quantified estimates were made of cost savings and where these were assessed to be significant.

5 Evidence from process evaluations on value-for-money

Process evaluations

5.1 The study of the US SBIR that devotes most attention to process issues (NRC (2008)) provides a very detailed review and set of recommendations relating to the management and operational effectiveness of the programme. Its considerations and recommendations are too detailed and specific to include here but fall under the following headings:

- A. **Preserve program flexibility. Agencies, SBA, and the Congress should seek to ensure that any program adjustments made should not reduce the program’s flexibility.**
- B. **Regular evaluations are needed.**
 - 1. The SBIR Program is currently not sufficiently evidence-based
 - a. Limited collection of data and tracking of Outcomes
 - b. Limited analyses and use of metrics
 - c. Inadequate management funding
 - 2. Single benchmarks of achievement are problematic
 - 3. Developing a culture of evaluation
 - 4. Recommendations
 - a. Annual reports
 - b. Internal and external evaluations
 - c. Special topic studies
- C. **Additional management resources are needed.**
- D. **Improve program processes.**
 - 1. The processing periods for awards vary substantially by agency, and appear to have significant effects on recipient companies
 - 2. Agencies should be encouraged to employ a full range of tools to reduce the time between applications and awards
 - a. Monitoring and reporting
 - b. Best practice adoption
- E. **Agencies to take steps to increase participation and success rates of woman- and minority-owned firms.**
- F. **Agencies to have independent advisory boards** that draw together senior agency management, SBIR managers, and other stakeholders and external experts to review current operations and achievements and recommend changes.
- G. **Preserve the basic program structure.**
- H. **Encourage program experimentation.**
 - 1. The Fast Track program
 - 2. Funding beyond Phase II
 - 3. Other improvements
 - 4. Evaluation of change

- I. **Readjust award sizes** to reflect inflation and to allow for continuing flexibility.
- J. **Understanding and managing firms winning multiple awards** is desirable through monitoring but, because there is little evidence to suggest that multiple award winners are, in themselves, a problem, efforts to limit their participation would seem misplaced at this stage.

- 5.2 The Manchester (2015) report on the UK SBRI concluded that the programme largely operated in an effective way with regard to the process by which businesses were engaged. The majority of firms surveyed for the report saw it as offering a unique, flexible mechanism by which highly innovative projects could be supported (with retention of any generated IPR) and a high level of autonomy on how the firms ran the projects. This autonomy was seen to result from the programme being contract rather than grant-based.
- 5.3 However, the report suggested that more might be done to support firms at the pre-challenge phase on partnering and on how best to formulate applications to the programme (as in Phase 0 in the US SBIR). It also considered that, after projects are completed, firms should be signposted to additional sources of support, for example, to support additional development activities, product trialling or market development.
- 5.4 It did not go so far as to recommend the introduction of the equivalent of the Phase III support in the US SBIR. However, the Connell (2017) review concluded that SBRI programme bids should include an element for Phase 3 funding where appropriate. This, it thought, should only be applied very selectively and only when the viability of the technology had already been well demonstrated and there was strong interest in scaling-up by prospective customers.
- 5.5 Government departments and agencies saw the programme as helpful to them in pursuit of their objectives. However, at the time of the Manchester (2015) report, it was found that SBRI was not routinely considered by departmental senior staff as a mechanism that could be used either for operational or policy purposes. Responsibility for using SBRI was generally at relatively low levels of seniority in departments and not generally considered by departments as a policy tool that could be used strategically.
- 5.6 Connell (2017) concluded that a National SBRI Board should be established and should be required to ensure that the SBRI programmes it funds are fully embedded within departments and operated in a systematic manner using best practice innovation programme management processes. They must, it recommended, be directed, managed and supported in a way that maximised the probability of commercial procurement and commercialisation of successful developments.
- 5.7 It also urged that all SBRI programmes receiving central funding should be required to provide details of awards, including recipients, contract amounts and summary project descriptions through a publicly searchable database similar to SBIR's TECH-Net. Future monitoring information obligations should be included in SBRI contracts with companies.
- 5.8 PA (2018) concluded with respect to SBRI Healthcare that "it is clear that diffusion remains problematic". It cited one case as illustrative of the difficulties in securing diffusion – a company with strong prospects for generating positive outcomes reporting slow progress as a result of having to 'make the case to 100 separate buyers, each with its own views'.

Evidence on benefits, costs and overall value for money

- 5.9 For the US case, there is no evidence from the literature review on the overall value for money represented by the SBIR. The Audretsch et al. 2002 study seems to be the only one that

assessed the social returns from the SBIR programme. However, this was calculated as the rate of return that just equates the present value of the expected annual private return to the firm (plus the expected producer surplus in other applications) to the present value of research and post-research commercialisation costs to the firms involved in the absence of SBIR funding. This clearly is a measure of social return, but it is not a cost-benefit or cost-effective measure that relates public and total costs to total benefits.

- 5.10 Manchester (2015) reported an analysis of the impact on UK SBRI supported businesses – matched with firms in the non-applicant population – that suggested they achieved a significant increase in additional turnover likely to persist over 3-5 years. The total turnover increase was then translated into gross value added (GVA) by means of sales/GVA ratios for the sectors on which SBRI had been focussed. This estimate was grossed up from the sample to the population of SBRI winners as a whole and then displacement and multiplier ratios applied using evaluation evidence from other R&D programmes. The resulting total GVA impact was compared with the public sector costs of the SBRI for the relevant period to yield benefit to cost ratio (BCR) estimates of 1.63:1 where effects are self-reported and 2.40:1 on the basis of the econometric estimates. It should be noted that these ratios are derived using a multiplier of 1.56 and, therefore, would be significantly lower without it.
- 5.11 However, the report noted that these BCR calculations reflected purely the impact of SBRI on the sales of competition winners and related spill-over effects. They did not take into account any benefits in terms of departmental cost savings or service improvements which ought to be included in any economic impact assessment of the programme.
- 5.12 The literature review did not identify any sources that provided evidence of quantified benefits across the range suggested as being appropriate in the Manchester (2015) report. This may well be because, as already noted, there is a dominating emphasis on benefits to business that is not matched by studies of the benefits to the public sector attributable to the business innovation that has been catalysed.

6 Evaluation methods

6.1 The major review by the NRC of the US SBIR used a mixed methods approach as set out in its project methodology report (Committee on Capitalizing on Science, Technology and Innovation (2004)). The approach is summarised below.

Table 6-1: Overview of Approach to SBIR Program Assessment

TABLE 1: OVERVIEW OF APPROACH TO SBIR PROGRAM ASSESSMENT				
SBIR Assessment Parameters →	Quality of Research	Commercialization of SBIR Funded Research/ Economic and non-Economic benefits	Small Business Innovation/ Growth	Use of Small Businesses to Advance Agency Missions
Questions	How does the quality of SBIR funded research compare with that of other government funded R&D?	What is the overall economic impact of SBIR funded research? What fraction of that impact is attributable to SBIR funding?	How to broaden participation and replenish contractors? What is the link between SBIR and state/regional programs?	How to increase agency uptake while continuing to support high risk research
Measures	Peer review scores Publication counts Citation analysis	Sales; follow up funding; progress; IPO	Patent counts and other IP / employment growth, number of new technology firms	Agency procurement of products resulting from SBIR work
Tools^o	Case Studies, Agency Program Studies, Study of Repeat Winners, Bibliometric Analysis	Phase II surveys, Program Manager Surveys, Case Studies, Study of Repeat Winners	Phase I and Phase II surveys, Case Studies, Study of Repeat Winners, Bibliometric Analysis	Program Manager Surveys, Case Studies, Agency Program Studies, Study of Repeat Winners
Key Research Challenges	Difficulty of measuring quality and of identifying proper reference group	Skew of returns; Significant interagency and inter-industry differences	Measures of actual success and failure at the project and firm level; Relationship of federal and state programs in this context	Major interagency differences in use of SBIR to meet agency missions

^o Supplementary tools may be developed and used as needed.

Source: Committee on Capitalizing on Science, Technology and Innovation (2004)

Figure 6-1: Multiple Methodologies

Multiple Methodologies

Over the iterative development of the study's methodology, it became clear that no single research methodology would suffice to assess a program as differentiated as SBIR—one with multiple objectives, distinctive agency missions, and varied participants (ranging from small start-ups to relatively large, well-established companies, with product cycles ranging from months to decades). Instead, a complement of methodological tools has been crafted to address different facets of the program's operation.

These tools are firmly grounded in economics and, as noted, draw from the experience of successful approaches pioneered by previous NRC studies of SBIR. They will necessarily have to be implemented in a flexible manner, with additional approaches to be drafted as new research challenges emerge. This document is, in this sense, a *working draft*, reflecting the current state of the Research Team and Committee discussions. It represents the Committee's considered understanding of the tasks at hand, and methodological tools that can be applied to address these tasks. The elaborated methodologies are, thus, not *exclusive*, precluding the adoption of other tools and approaches; nor are they *definitive*, representing a fixed and final statement. Instead, the document provides a summary of current thinking on the project, as it has evolved from the discussions of the Research Team and the Steering Committee, as well as other interested parties. Despite these necessary limitations, this document constitutes a clear statement of the research goals and the tools the Committee plans to use to address them.

Source: Committee on Capitalizing on Science, Technology and Innovation (2004)

- 6.2 As summarised in Figure 6-1, the approach did not seem to include the use of rigorous quantitative evaluation methods involving the use of control groups of businesses matched with those that benefited from SBIR contracts. However, regression methods have been deployed in the literature although use of control groups appears to be a relatively recent development. With the exception of the Japanese study (Inoue and Yamaguchi (2017)), the review confirmed the findings of the NRC study that SBIR and equivalent programmes had positive impacts on the businesses awarded programme contracts.
- 6.3 BEIS (2017) set out the key questions that would need to be addressed in an evaluation of the UK SBRI. These followed from its specification of the programme logic model which included a sequence relating to the possible public sector benefits. As this sequence is largely absent from consideration in the literature, it is worth citing the relevant evaluation questions:
- How have departments benefited from the solutions developed under SBRI – in terms of operational and/or policy goals?
 - How have departments, agencies and firms incurred costs – e.g. administrative costs, opportunity costs, through the SBRI scheme?
 - What are the effects of SBRI terms of improved public services, delivery of public policy, growth of innovative firms and the wider economic effects of this growth (indirect and induced effects on other economic activity, spillovers etc.)?
- 6.4 When considering the appropriate metrics to capture the additional benefits to the public sector, BEIS (2017) suggested that these are likely to have to be captured in a qualitative way:
- qualitative assessment of impacts on departments/ agencies which are not directly financial (quality impact)
 - does the product/process fulfil a need that was previously unfilled, if so, what benefit does it bring?
 - does the product/process fulfil a need in a better way than it was previously fulfilled – and if so, how much better?
 - wider effects on public procurement processes.

- 6.5 As far as evaluation methods are concerned, BEIS (2017) recommended contribution analysis based on a mixed methods approach – much the same as proposed above for the US SBIR. However, methods by which public sector benefits and costs might be captured and assessed were not set out in detail. Therefore, the conclusion of this literature review is that no-one has yet picked up the gauntlet thrown down by Manchester (2015) for more work to be done on public sector benefits by comparing *“SBRI with alternatives in order to achieve a proper measure of the additionality of the programme”*.

7 Conclusions and Reflections

7.1 The main findings from the review of the literature are as follows with regard to the impacts and benefits of PCPs:

- The US SBIR initiative upon which SBRI is based has, from its inception, had a dominating emphasis on maximising the benefits of US Federal Government spending for private sector SME R&D, innovation and new business formation.
- Consequently, the bulk of the evidence currently available on the US (and on the UK too) focuses on these private sector-generated benefits.
- Studies of experience of PCPs in other countries indicate that this dominating focus on private sector benefits holds-up internationally with little effort to assess and quantify the public sector and wider economic and societal benefits.
- Econometric and other studies of impacts on business provide generally robust evidence of significant positive effects of PCPs on sales, employment and investment (both internal and external) for the participating businesses albeit with a significant skew – a high proportion of the gains to date coming from a low proportion of the participating businesses. But there is limited evidence on the scale and persistence of these impacts but evidence from SBRI Healthcare suggests both could be significant.
- Evidence is limited with regard to the public sector benefits of PCPs. What there is by way of quantitative evidence is confined to cost savings. But more qualitative evidence suggests the benefits can be in a variety of forms: improvements in the quality and/or efficiency of public services; reduction of technological lock-in (allowing for higher interoperability across different services); and reduction of the risk of failure and/or cost savings for follow-up procurement.
- There is very little evidence from formal assessments of value for money and public returns on investment through PCPs, reflecting the paucity of quantitative estimates of direct public and private sector costs and benefits. What evidence there is suggests the programmes are likely to provide good value for public money when their private and public sector benefits materialise fully.
- Measurement and evaluation of the outcomes from PCPs are generally not formally instituted or reported although this has begun to change. There are more insights in the literature on the appropriate designs and methods for evaluating private sector impacts. These confirm that (as has been done in the past for SBRI) analysis of business performance data using econometric methods and comparison groups can be deployed effectively. Insights are less forthcoming with regard to public sector benefits primarily because of the difficulty of establishing a robust counterfactual via comparison groups.

7.2 The literature highlights the following factors as being conducive to the implementation of PCPs in ways that are effective in terms of delivery and generating positive outcomes. The PCPs need to be implemented in ways that:

- Foster a more pervasive ‘culture for innovation and evaluation’ in the commissioning authorities’ mainstream procurement practices to foster a stronger learning and adaptation ethos;
- Strengthen independent advisory mechanisms, especially useful for building a ‘culture for innovation and evaluation’ that drives learning and adaptation;
- Preserve continuity in existing programme structures and processes but encourage experimentation and flexibility to better exploit the potential for ‘learning-by-doing’;
- Integrate SBRI and similar programmes into mainstream commissioning but without losing the distinction between PCP and other innovation procurement initiatives; and
- Avoid confining new awards to those businesses that have not previously received them – firms who succeed in past competitions can be building-up useful innovation capability and should not be excluded from participation in future competitions.

7.3 The current SBRI evaluation was carried out to test a set of key hypotheses (based on the theory of change underpinning the programme) using a mixed methods approach (as suggested to be appropriate in the literature). The evidence from the literature review can be drawn on to provide reflections on the grouping of these hypotheses as set out below.

Reflections on the hypotheses tested in the SBRI evaluation
<p>Hypotheses relating to PCP design, strategy and governance</p> <p>The literature review strongly suggests that PCPs can form a critical element in a public procurement strategy designed to stimulate innovation in public and private sectors and the economy more generally. They were most effective in doing this where they fostered a pervasive culture of experimentation, innovation and learning in the commissioning agencies. This required a balance to be struck between maintaining independence and flexibility in the design and governance of PCPs at the same time as ensuring they are seen as an integral part of, and championed within, mainstream commissioning and procurement.</p> <p>The UK was seen to be at the forefront in the use of PCPs within Europe in the early 2010s and, a decade later with other countries rapidly following suit, was still assessed to be in the group of ‘good performing’ countries with regard to policy measures conducive to mainstreaming innovation procurement.</p> <p>The UK strengths were assessed to be in its promotion of innovation through procurement, in the support for setting up and disseminating competitions, and in sharing good practices and networking across government departments. Its policy framework was seen as promoting an innovative-friendly public procurement market with a default IPR allocation regime in government contracts that fostered innovation.</p> <p>However, the UK policy regime was also thought to require strengthening through the development of a dedicated innovation procurement strategy and action plan, promoted more strongly in government and business, integrated more completely within, and ‘owned’ by, a wider range of departments, and accompanied by more rigorous monitoring, learning and dissemination of potential science and technology solutions.</p>
<p>Hypotheses relating to PCP delivery, implementation and response</p> <p>The literature review found a strong body of evidence, especially from the SBIR in the US, that PCPs increased business contacts in the public sector and improved their</p>

understanding of the procurement process and how they could tap into it. They stimulated scientific and technological advances, supported a wide diversity of small businesses, fostered business formation, helped de-risk innovation and, in some cases, encouraged downstream investment funding.

The evidence was more limited with regard to the extent to which PCPs improved the culture, procedures and skills by which public officials assess the challenges they face and procure/manage business innovation to address them. Reviews of the SBRI suggested that it was not routinely considered by departmental senior staff as a mechanism to be used either for operational or policy purposes. Responsibility for using SBRI was too often located at relatively low levels of seniority in departments and not considered often enough by departments as a policy tool that could be used strategically.

Hypotheses relating to PCP outcomes, impacts and value for money

The literature review found there to be very limited but positive evidence on the extent to which PCPs generated public sector benefits. The largely qualitative and anecdotal evidence suggested they came in the form of cost savings, improvements in the quality and/or efficiency of public services, reduction of technological lock-in (allowing for higher interoperability across different services), and reduction of the risk of failure and/or cost savings for follow-up procurement.

Econometric and other studies of impacts on business provided generally robust evidence of significant positive effects of PCPs on sales, employment and investment (both internal and external) for the participating businesses (albeit with a skewed distribution). But there was limited evidence on the scale and persistence of these impacts.

There is little evidence relevant to the value for public money represented by the funding for PCPs. What little has been done suggested they offer good value for money but only the 2015 SBRI evaluation in Manchester (2015) provided estimates of positive benefit cost ratios.

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