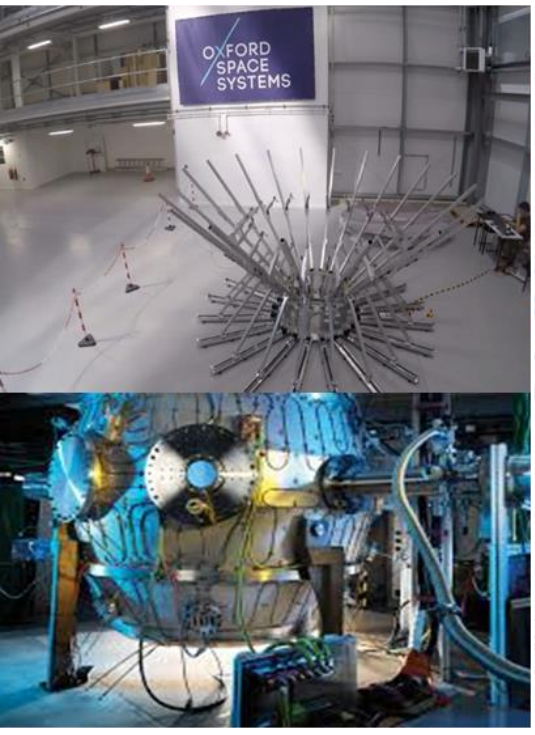
UK INNOVATION & SCIENCE SEED FUND

Assessment of the economic and wider benefits of the UK Innovation and Science Seed Fund

Final Report to Midven Ltd on behalf of the UKI2S partners

March 2020



SQW

In 2012/13, the **UK Innovation and Science Seed Fund (UKI2S)** partners commissioned **SQW** to carry out a review of the economic impact of the Fund. The principal aim of the study was to estimate the contribution of UKI2S to the UK economy through its investments in early-stage companies, specifically in terms of the effects on co-investment, employment creation, exports and Gross Value Added (GVA). In addition, the study aimed to assess the wider benefits of UKI2S through application of new technologies developed by portfolio companies, and the development of new knowledge and skills (both within the companies and among the research base). In total, 25 portfolio companies were assessed.

At the time, it was envisaged that there should be further periodic reviews. In 2019, SQW was commissioned to provide an update assessment of the Core Fund using a similar methodology and measures as those used in 2013 (based on company data available up to around September 2019), and undertake a first assessment of the SynBio Fund created in 2013. This report presents the findings from this study.

The update assessment has examined in detail a cohort of 37 companies that have been supported by UKI2S. This represents approximately two thirds of the total portfolio of companies invested in to date, excluding those companies where there was insufficient data and those that were invested in less than 12 months ago.

The study has drawn on a range of company information (including financial performance and investment histories) and in-depth consultations with Fund Managers and portfolio company representatives. The study has also drawn on the Fund Manager's files containing companies' management accounts, employment records, grant applications and tax records, over and above publicly available sources such as the statutory accounts. The data covers the period from foundation to the most recently available full financial year for each company (for most this was up to a point between September 2018 and September 2019).

The assessment was not designed to be a full evaluation of the Fund and its set-up and operation, nor was the study required to make formal recommendations going forward. The study records the headline financial performance of the Fund but does not analyse this in detail.

More information on the UK Innovation and Science Seed Fund is available from the Fund's website: https://ukinnovationscienceseedfund.co.uk/

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Executive Summary

The UK Innovation and Science Seed Fund (UKI2S) is a Seed capital fund investing across the UK in early-stage companies in a range of technology areas. The Fund is closely aligned with the activities and aims of its seven partners, led by UK Research and Innovation (UKRI) and the Defence Science and Technology Laboratory (Dstl). UKI2S includes a specialised sub-fund focused on the emerging field of synthetic, or "engineered", biology (SynBio), accounting for around one-third of the total Fund.

UKI2S was set up in 2002/03 with £4m funding from UK government to help Public Sector Research Establishments (PSREs) exploit the commercial value of their research by filling a perceived gap in the provision of early-stage risk capital. Since its inception, UKI2S has grown in scope and remit with additional partners and capital being added over the years. All funding has been provided from public sources and all the Fund's partners are publicly funded bodies. Since its first investments in 2002/03, the Fund has invested at a steady rate, providing nearly £15m of equity funding to 57 start-up companies. UKI2S is managed by a private sector fund manager, Midven, with an advisory committee consisting of the Fund's core partners[1] and external members with backgrounds in finance and technology.

The Fund has a dual mandate: to generate a positive economic impact from commercialisation of technologies, and to make itself sustainable in the long term by achieving sufficient financial return from realisation of its investments (all of which is retained and recycled into future start-ups).

This study has evaluated the performance of the Fund in meeting the first of these aims: generating positive economic impact. It analysed a cohort comprising 65% of the portfolio[2], and concludes that the Fund is making a strong economic contribution and plays a key supporting role over and above the investment provided. The table below outlines the key investment indicators, and the additional direct impact in terms of GVA and R&D investment attributed to UKI2S.

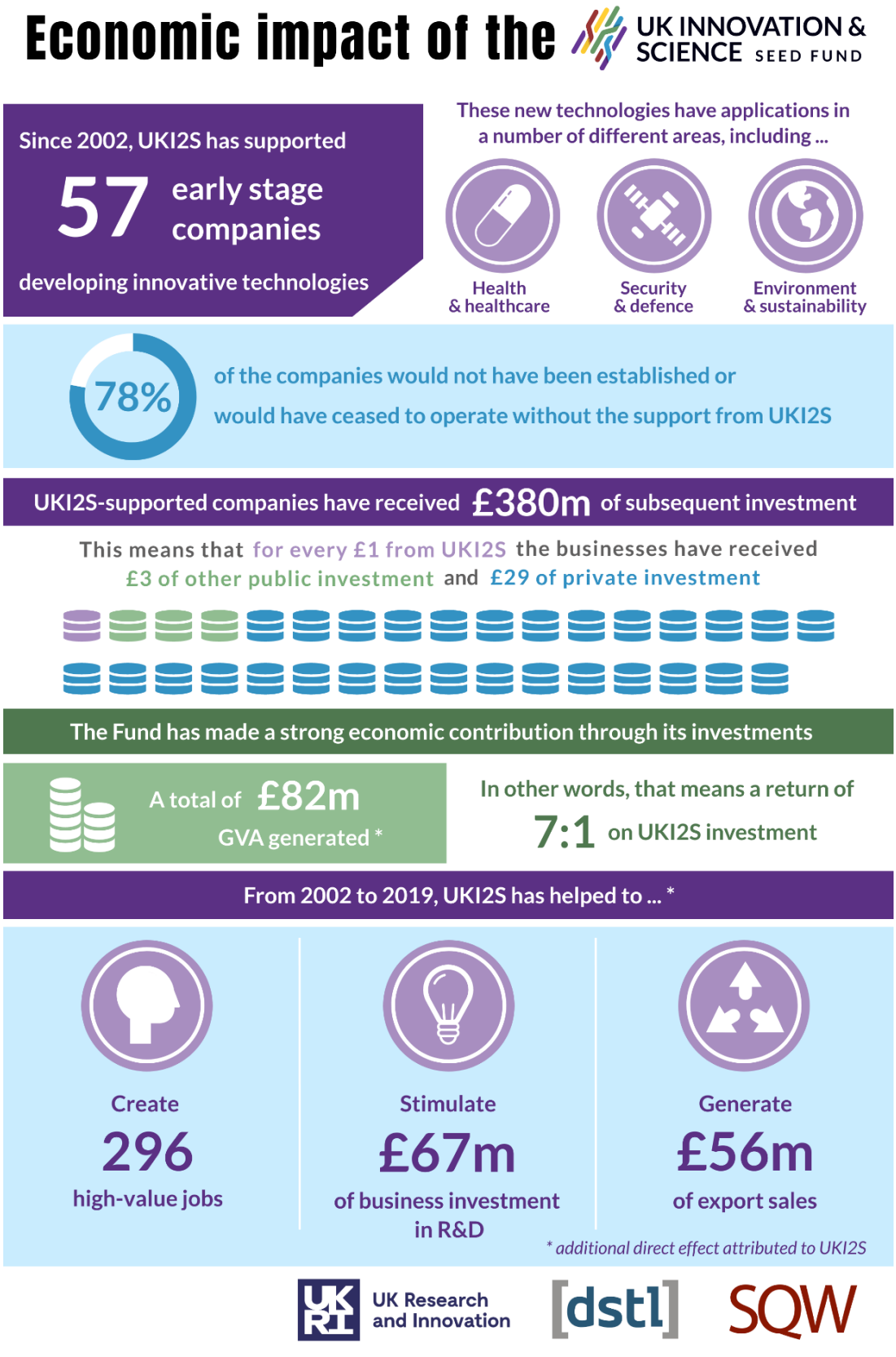
Investment indicators (gross figures)	**2002-2019**
UKI2S investment	£11,643,000
Co-investment – total public and private	£379,843,000
Additional direct impact attributed to UKI2S[3]	
GVA[4]	£82,350,000
GVA per £ invested	7:1
R&D expenditure by the companies	£67,080,000
Ratio of attributable R&D expenditure to UKI2S investment	6:1

[1] STFC, BBSRC, NERC and Dstl. All apart from Dstl now form part of UKRI.
[2] 37 out of the 57 companies that the Fund has invested in to date.
[3] The overall direct effect that would not have happened without the Fund's input and is attributed to UKI2S (i.e. by taking account of UKI2S's role versus other government inputs, including investments, grants, soft loans and tax/ investment reliefs).
[4] As measured by the value of employment over time.

The key findings of the study include the following:

- The Fund is positioned at the very earliest Pre-Seed and Seed stages of the finance escalator, earlier than venture capital funds and right at the start of what is known as the 'Valley of Death' – the gap between start-up and the point at which a company can sustain itself through sales of products and services.
- The Fund has invested in companies that are often involved in Deep Technology (i.e. complex science and engineering-based entities), which has particularly long timescales to market. In this sense, UKI2S is providing "ultra-patient" capital.
- UKI2S demonstrated high additionality, playing a key role in creating and supporting new businesses: over 75% of investee companies would not have been created or would have ceased to operate without investment from the Fund. This highlights the Fund's role in helping businesses overcome the 'Valley of Death'.
- The companies have gone on to raise substantial amounts of later stage investment with the Fund often playing a key role in introducing investors. Whilst not all related to the introductions of the Fund, the scale of co-investment is substantial – companies have raised around £380m in total from other investors.
- According to the Fund Managers' information on the location of investors, it is estimated that around half (47%) of total co-investment has come from overseas, representing foreign investment into the UK.
- The companies are highly R&D intensive with around half of the total investment raised being deployed on research and development of novel technologies.
- The jobs created are highly skilled, high-wage jobs with an average annual salary of £47,000; the UKI2S cost per additional job created was under £40,000.
- Return on Investment is high – for every £1 of investment from UKI2S there has been a return of £7 of GVA and £6 of R&D spend attributable to UKI2S.
- There have been some encouraging results from investee companies, including three sales of portfolio companies to major international buyers since 2017 that have returned nearly £9m to the Fund; this includes an early success for the SynBio Fund, with its first exit in 2018. As an "evergreen" fund, these proceeds can be recycled into further investments, demonstrating the Fund's Value for Money.
- Exiting an investment does not lead to the gains being lost overseas as is often assumed. For example, the acquirers of two companies sold in the past three years have used the acquisition in the UK as the worldwide base for new operations due to the acquired company's distinctive skills in the UK.
- The Fund's mandate is to accept the high levels of risk inherent in complex and ambitious technology-based companies, and 20 companies to date have been written off or are expected to fail (amounting to around one third of the portfolio).
- The types of technologies developed by the portfolio companies evidence their importance more widely to society, with benefits resulting from application of new technologies particularly identified in three key areas: health and healthcare, security and defence, and energy and the environment.

Figure 1: Headline economic impact estimates



Source: SQW

1. Introduction

1.1 The UK Innovation and Science Seed Fund (UKI2S or 'the Fund', and previously known as the Rainbow Seed Fund, RSF), is a specialist fund that invests in very early stage technology-based companies.

1.2 SQW Ltd (SQW) was commissioned by the Fund Manager on behalf of the investors and partners in UKI2S to conduct a study on the economic and wider benefits of the Fund, covering both the core part of the Fund set up in 2002/03 (referred to herein as the Core Fund) and the synthetic biology sub-fund (SynBio Fund) established in 2013. The study was an update to a previous assessment conducted in 2013[5].

1.3 The principal aim of the study was to estimate the economic contribution of UKI2S through its investments in early stage companies, specifically in terms of the effects on co-investment, employment creation, R&D expenditure, exports and Gross Value Added (GVA). In addition, the study aimed to assess the wider benefits of UKI2S through application of new technologies developed by portfolio companies, and the development of new knowledge and skills (both within the companies and among the research base).

1.4 The assessment was not designed to be a full evaluation of the Fund and its set-up and operation, and was not required to make formal recommendations going forward. Nor was the study intended to analyse the financial performance of the Fund.

1.5 In the previous study, SQW assessed the economic and wider benefits of RSF (as it was then called) based on its portfolio of 25 companies. The box below presents the headline findings from this earlier assessment.

Headline findings from the 2013 study

Our previous assessment found that, from £6.4m invested in companies, there had been an estimated £21m contribution to GVA through the value of the jobs that had been created in companies. The Fund was associated with high levels of additionality, with many of the companies unlikely to exist without the investment provided, reflecting the important gap that it filled in the provision of early stage capital for innovative companies.

The Fund had contributed to the creation of over 100 jobs, and to leveraging significant amounts of other public and private investment. Companies that had reached sales stages were making significant contributions to trade: a high proportion of sales were exports.

Wider benefits were also identified through case studies on individual companies, with technologies contributing to healthcare, the environment, security, and international development.

[5] SQW (2013) Assessing the economic and wider benefits of the Rainbow Seed Fund, Final Report to Midven Ltd on behalf of the Rainbow Seed Fund partners. Available here.

1.6 It was noted at the time of the 2013 study that many of the benefits were still expected, which reflected the early stages of development for the companies in the portfolio. Now over six years further down the line, the original portfolio has matured with some new entrants, exits, business closures and companies that are dormant.

1.7 Against this background, this study had two key objectives, namely to:

- provide an updated assessment of the Core Fund and a first assessment of SynBio Fund companies using a similar methodology and measures as those used in 2013 (based on company data available up to around September 2019)
- provide an insight into the different roles played by the Fund through case studies of portfolio companies.

Approach to the study

Assessing the economic contribution

1.8 The broad approach to analysing the economic contribution of the Fund followed established HM Treasury Green Book guidance. However, the use of GVA does present certain challenges when looking at early stage businesses, and this study sought to provide a broader picture of the contribution of the Fund by looking at other indicators. In particular, it has drawn on wider guidance (e.g. BEIS evaluation guidance[6] and Scottish Enterprise guidance on economic impact assessment[7]) to tackle specific challenges in estimating the impact of early-stage companies. More detail on the economic assessment is provided in Annex A, with the remainder of this sub-section setting out a brief summary of the approach.

1.9 The approach to the assessment of the economic contribution has been to adopt a basket of key indicators. For each of these, we have estimated the benefits to date. The analysis covered the following indicators:

- co-investment
- R&D expenditure
- employment created
- value of exports
- GVA (using the value of employment as a proxy).

1.10 The principal approach to estimating GVA to date has been through the use of employee costs as a component of GVA. The focus on employee costs follows Scottish Enterprise guidance, which indicates that this is an appropriate approach given the pre-sales nature of many of the businesses. Effectively, this is measuring the value of a portion of R&D activities, thereby estimating the investment of resources now for commercial returns later. Note that in assessing GVA, the standard income-based approach is to combine employee costs with surpluses/losses. However, the types of companies invested in by UKI2S typically reinvest in their technologies, reflecting their core purpose of building value in technology rather than

[6] Department for Business, Energy and Industrial Strategy (2019) Business support evaluation framework. Full version available here.
[7] Scottish Enterprise (2008), Additionality and Economic Impact Assessment Guidance Note, Scottish Enterprise, Glasgow

generating surpluses, especially in the early years. Therefore, the standard approach is not a good reflection of the economic value, and surpluses/losses have been excluded.

1.11 The main steps in the process of estimating the economic contribution have been as follows:

- First, financial and other performance data for the individual companies supported by UKI2S was collated, in particular details of investments (including co-investment), other government inputs (notably EIS, SEIS, VCT and R&D tax relief), employment, wages, R&D expenditure, sales, and level of exports.
- This information was drawn by the Fund Manager from a combination of statutory accounts, management accounts, board reports and other available sources. For some businesses we have also drawn on consultations with company executives to fill gaps in the data. This produced "gross" estimates of the key metrics.
- Next, the degree of "additionality" of the investments was assessed, comprising the following key elements:
  - judgements on the degree of additionality of the companies supported, i.e. the extent to which they would have been created and survived without support from UKI2S
  - other additionality factors for "leakage" (based on whether employment, research or purchasing activity is located overseas) and "displacement" (based on known/ anticipated competitors and markets).
- This was followed by an assessment of the attribution of the impacts to UKI2S, i.e. the relative importance of the role played by the Fund in establishing or keeping the company going. Reflecting the critical importance of the earliest stage of investment to create companies, the attribution is based on the first round of investment (the proportion of UKI2S investment versus other government-backed investment and other public inputs, including tax reliefs through schemes such as EIS and VCT relief), and adjusted if there have been any rescue or pivot rounds or other significant input made by the Fund.[8]
- Attribution and additionality factors were then applied to 'gross' estimates to provide 'net' attributable estimates of the direct economic contribution of UKI2S (excluding multiplier effects)[9].
- Outputs from the analysis were presented primarily as a snapshot of the whole Fund up to 2019. To examine the evolution of certain indicators over the early years of a start-up, some elements of the data were presented as a time-series.

Assessing the wider benefits

1.12 The assessment of wider benefits has focussed on the following two areas:

[8] If UKI2S has played a significant role, then attribution has been increased by 10 percentage points.
[9] Note that this is the direct effect of the Fund. Indirect supply chain effects and induced income effects, estimated through multipliers, have not been assessed. Some contractor employment is included as these are similar to the direct employees of firms.

- the contribution that companies have made, or might make, more widely to society through commercialisation of research and application of new technologies
- the contribution to the development of new knowledge and skills, both within the businesses and across the wider research base.

Gathering the evidence

1.13 As stated above, a significant amount of company-level data has been gathered and analysed to inform the economic assessment. This has been complemented with consultations with Fund Managers and companies themselves (a full list of consultees is provided in Annex C). In total, 14 portfolio businesses were consulted. Three of these interviews were undertaken as case studies and allowed us to explore the topics in greater depth (included in Chapter 3).

1.14 These consultations have enabled us to probe on issues around additionality and attribution, as well as to capture evidence on the wider benefits of UKI2S. The assessment of additionality is based on perceptions of consultees, rather than by using a comparison group of companies. As is explained in Annex A, a comparison group could not be meaningfully established given the nature and number of the companies in the portfolio.

Structure of the remainder of this report

1.15 The rest of this report is structured as follows:

- Chapter 2 provides the context and background to UKI2S (including an overview of its portfolio).
- Chapter 3 discusses the fit of UKI2S within the wider policy and finance landscape. It then moves on to identify the Fund's three key roles in the commercialisation of research and development of early stage technology companies.
- Chapter 4 provides an assessment of the economic contribution of UKI2S, including the key indicators of R&D expenditure, employment, exports and GVA.
- Chapter 5 sets out the evidence on the wider benefits of UKI2S, in particular relating to contribution to society through commercialisation of new technologies, and the development and sharing of new knowledge and skills.
- Finally, Chapter 6 summarises the main findings and conclusions from the study.

1.16 A series of Annexes provide supporting information covering: the method for estimating the economic contributions (Annex A); a list of the companies supported by UKI2S (Annex B); a list of those consulted as part of the study (Annex C); a set of data tables complementing the calculations of the economic contribution (Annex D); and the Fund's investment policy (Annex E).

2. Background to the study

Chapter purpose

This chapter sets out the background to UKI2S and the context within which the study has been undertaken. Specifically, it provides an overview of the history of the Fund, its partners, its rationale and objectives, modus operandi, and fit within the wider policy and finance landscape. The chapter also reviews the Fund's portfolio, including headline figures on its financial performance.

Key headlines

- UKI2S has seven Limited Partners in the Fund, all of which are public bodies actively engaged in research. This includes two core partners: the Defence Science and Technology Laboratory (Dstl) and UK Research and Innovation (UKRI).
- The Fund's investment remit means it is closely aligned with the strategic interests of its partners, for which UKI2S represents one part of a range of commercialisation activities funded or delivered by them.
- The Fund is structured and operates the same way as private sector venture capital. However, UKI2S is distinctive in its willingness to invest at much earlier stages, when there is little certainty surrounding the applications of technology, lack of experienced management involved, and a substantial amount of further development and funding required.
- UKI2S has grown from an initial £4m to £27m of committed capital from its partners; this includes a specialist £10m sub-fund focused on the emerging field of synthetic biology.
- To date, the Fund has invested in 57 companies.
- UKI2S's investments are capped at a level that constrains its ability to make returns comparable to normal venture capital funds and may impact on the Fund's ability to maximise Value for Money. Nevertheless, the Fund has achieved some notable financial returns with close to £9m (yielding a profit of £7m) having been realised through the sale of three companies in the past three years.
- The Fund is an "evergreen" structure, so these returns are recycled into future new investments, boosting the Fund's capital from £27m to 34m.

What is UKI2S?

Background and history

2.1 UKI2S is a specialist early stage venture capital fund focused on investing at the very early stages (Pre-Seed, Seed and Series A) in technology companies emerging from a number of publicly funded laboratories and campuses in the UK, and in the specific field of synthetic biology. The Fund was originally established in 2002/03 as the Rainbow Seed Fund (RSF) following the 1999 Baker Report, *'Realising the Economic Potential of Public Sector Research Establishments'*, which recommended for a source of funding to be established to provide early stage risk capital to remedy a perceived market failure in funding very early-stage technology-based start-up companies emerging from the science base. UKI2S was therefore created to focus on the laboratories within the large publicly funded research organisations that lie outside the universities in what are known as Public Sector Research Establishments (PSREs).

2.2 The objectives of UKI2S are to:

- fill a gap (or "market failure") at the very earliest stage of spinning out a company, by providing a source of early stage investment capital for technologies emerging from the R&D activities of the Fund's partners, based at relevant partner sites or campuses, or within the synthetic biology field
- where relevant, support the development of commercialisation activities within the partners and their campuses, building long term relationships with the technology transfer offices (TTOs) of the partners and helping to build a more entrepreneurial element within the PSRE culture
- make itself sustainable over the long term by realising its investments and recycling the proceeds into new investment (i.e. an "evergreen" fund).

2.3 The Fund was initially established with four partners – the Science and Technology Facilities Council (STFC), the Defence Science and Technology Laboratory (Dstl), the Natural Environment Research Council (NERC), and the UK Atomic Energy Authority (UKAEA) – with £4m funding from the then Department for Trade and Industry's[10] (DTI) PSRE Fund.

2.4 Over the years, UKI2S has grown in scope and remit with additional capital and partners added. The Fund was expanded in 2006 to bring in the Biotechnology and Biological Sciences Research Council (BBSRC), and again in subsequent years to include further partners (see next sub-section).

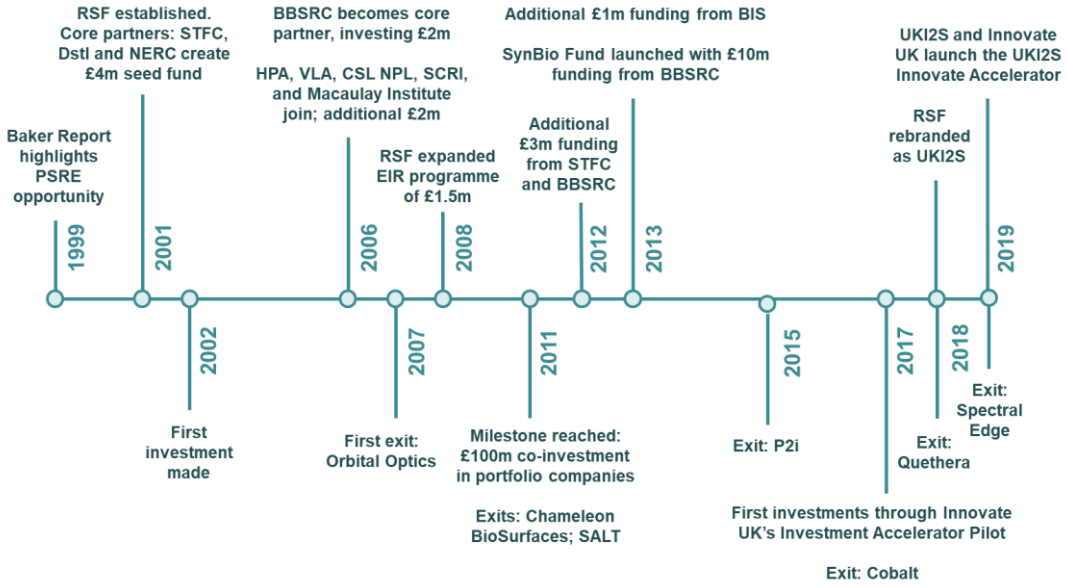
2.5 UKI2S's investment remit has historically been largely defined through its relationship with the partners. The Fund's initial investment mandate was limited to funding technologies that were directly derived from work done at its partner institutes. In 2012, alongside funding provided directly by BBSRC and STFC, this was broadened to allow investment in early stage companies based at BBSRC and STFC associated sites, principally the major campuses at Harwell, Daresbury, the Babraham Research Campus, Rothamsted and Norwich Research Park, all centred on major national research centres with strategic investment from BBSRC or run by STFC. At the same time, the investment mandate was also widened to cover NERC's National Oceanography Centre in Southampton.

[10] Predecessor of the Department for Business, Energy & Industrial Strategy (BEIS)

2.6 In 2013, BBSRC provided UKI2S with further funding of £10m to set up a separate sub-fund focused on synthetic biology (referred to herein as the SynBio Fund). Specifically targeting early stage SynBio companies, this fund is narrower in scope than the Core Fund but it is not limited in geographical scope, being able to invest anywhere in the UK.

2.7 In 2018, the Fund changed its name from RSF to UKI2S to reflect the Fund's growing remit. Figure 2-1 highlights the key events for the Fund since its inception.

Figure 2-1: Timeline of UKI2S



Source: SQW

2.8 The initial funding of £4m has led to several injections of additional capital over the following decades, and the Fund now has total subscribed capital of £27m from its partners. All funding has come from the public sector, initially from DTI (and its successors) through further rounds of the PSRE Fund. The Fund's capital base has been expanded over the years as the number of partners has grown and the remit expanded. The largest single addition to the Fund came in 2013 when BBSRC committed £10m to establish a ring-fenced facility focused on SynBio technologies (more information is provided in the box below) within the Fund. There are therefore now effectively two parallel funds within UKI2S: the original Core Fund to which £17m has been committed, and the SynBio Fund of £10m.

The rapidly developing field of Synthetic Biology

Synthetic Biology (SynBio) is an emerging, trans-disciplinary field at the intersection between engineering and biology. As such, it has the potential to deliver new applications and processes across the bioeconomy, benefitting a range of sectors including health, energy and advanced materials. Although growing rapidly, SynBio as a field of research is still at an early stage, and the full range of applications is yet to be identified. Given the infancy of SynBio research, companies operating within this field may struggle to define the precise value proposition or business model for their technologies, making it difficult to attract investment.

In 2012, the Synthetic Biology Roadmap for the UK was published by an industry-led working group of stakeholders. In setting out a strategic plan for SynBio in the UK, it called for further investment to help accelerate this technology (and its

potential applications) to market. The Roadmap drew attention to this emerging field, leading to a £50m capital investment in synthetic biology announced in the 2012 Autumn Statement. In 2016, the UK Synthetic Biology Strategic Plan was published, further emphasising the strategic importance of the field in the UK.

Partners

2.11 There are currently seven Limited Partners in the Fund. All of these are public bodies that are actively engaged in research. This includes two core partners: Defence Science and Technology Laboratory (Dstl) and UK Research and Innovation (UKRI). UKRI is a public organisation bringing together Innovate UK, Research England and the seven Research Councils, including the Science and Technology Facilities Council (STFC), the Biotechnology and Biological Sciences Research Council (BBSRC), and the Natural Environment Research Council (NERC) – all of which were previously core partners in the Fund.

Figure 2-2: Core partners of UKI2S

2.12 The five other partners are the National Physical Laboratory (NPL), the James Hutton Institute, Culham Centre for Fusion Energy (CCFE), Public Health England (PHE), and the Animal and Plant Health Agency (APHA). The total number of research locations within the UKI2S partner network exceeds 100, but the distribution of research is not uniform across all sites. The map in Figure 2-3 shows the principal campuses of the Core Partners, which are associated with the majority of investments from the Fund.

Figure 2-3: Principal partner sites

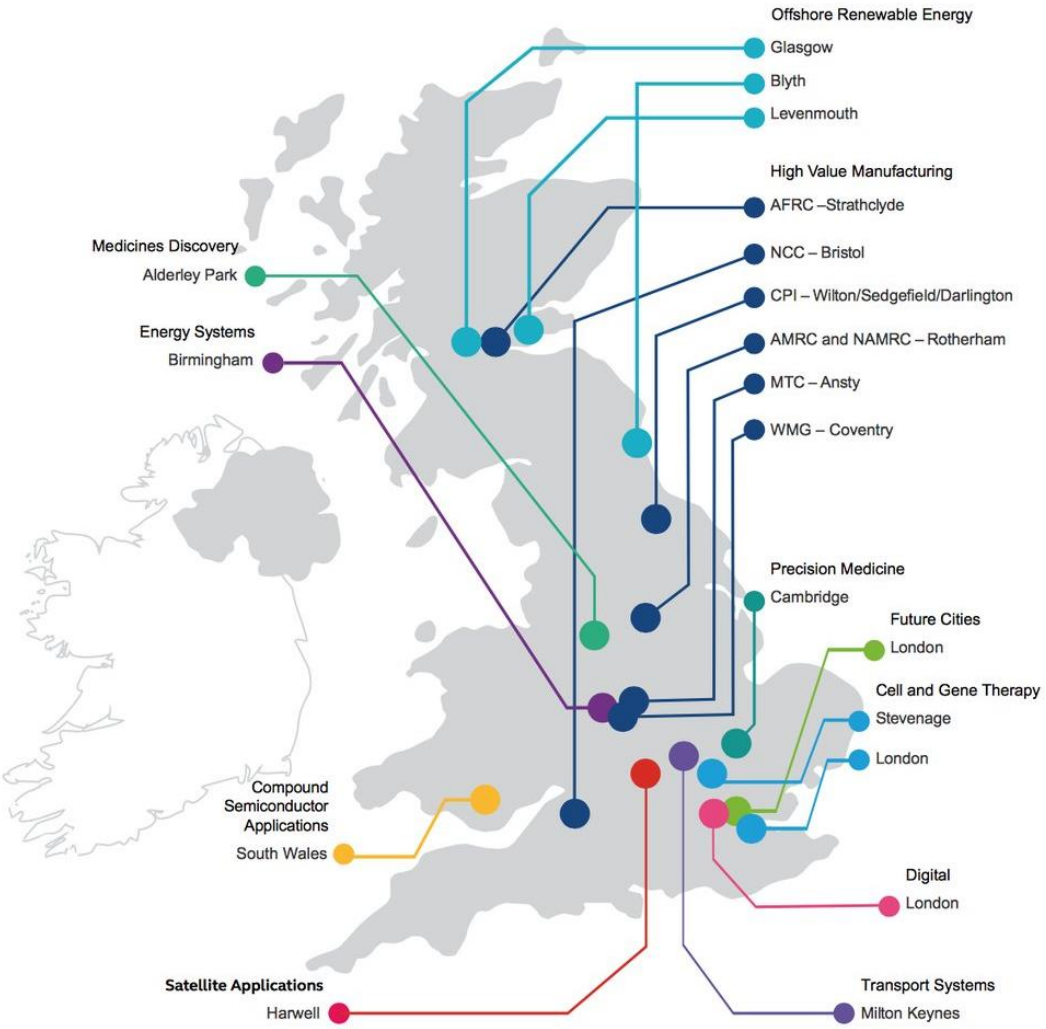
Source: UKI2S

2.13 The Fund's investment remit is aligned with the strategic interests of its partners. For the partners, UKI2S represents one part of a range of commercialisation activities funded or delivered by them, with others including funds such as proof of concept grants. The fit of UKI2S in this wider finance landscape is described later in this chapter.

2.14 The Fund has partnered with Innovate UK in two programmes which combine equity from UKI2S and Innovate UK grants to accelerate the growth of companies in the UKI2S portfolio. Most recently, Innovate UK provided a grant facility of £10m that has been allocated across over 25 companies. The grants are made alongside investment from UKI2S or – more frequently – a wider syndicate of investors assembled with the assistance of the Fund. More information on these linkages is provided in Chapter 3.

2.15 UKI2S has also recently partnered with the national Catapult Network of world-leading technology centres (see Figure 2-4) and is able to invest in SMEs working with a Catapult.

Figure 2-4: Catapult network



Source: UKI2S

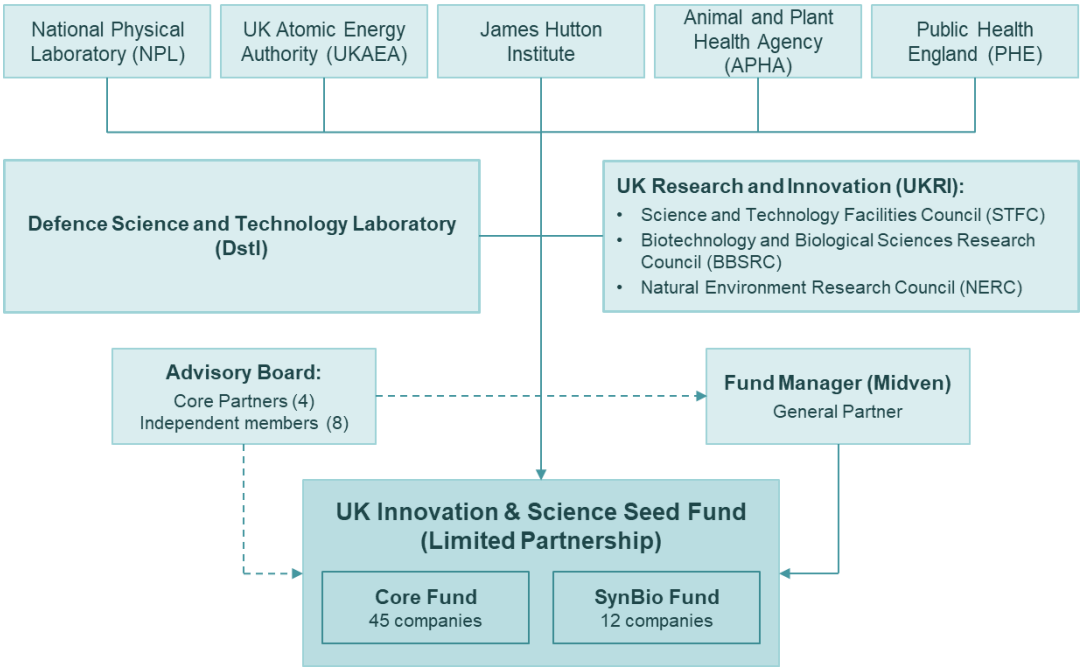
Modus operandi of the Fund

Structure

2.16 The fund is structured as a conventional Limited Partnership, similar to the majority of venture capital (VC) funds, with the seven Fund partners[11] being Limited Partners (i.e. investors). The laws governing Limited Partnerships specifically limit the ability of investors to involve themselves in investment decisions, and all day-to-day investment operations are carried out by the Fund's manager, Midven Ltd, a specialist SME fund management company. The core Limited Partners are represented on an advisory committee, which also includes a number of independent members drawn from industry and finance, with the independent members always in a majority. Figure 2-5 depicts the structure of UKI2S, showing the relationship between the partners, the Advisory Committee and the Fund Manager.

[11] UKRI, Dstl, NPL, the James Hutton Institute, CCFE, PHE and APHA

Figure 2-5: Structure of UKI2S



Source: UKI2S

Investment focus and criteria

2.17 As would be expected from the depth of science represented in the Fund's partners, the companies are usually highly research intensive and there is a common theme of "Deep Tech", defined by the European Investment Bank as "*unique, differentiating, hard to reproduce technological or scientific advances that require a thorough understanding of the technology and market to understand their potential.*"[12] However, the Core Fund has no specific sector focus and investments have been made in fields ranging from fusion energy to materials and optics.

2.18 The Core Fund invests in companies or projects arising from three sources: R&D from the partners' own laboratories, companies based at the national campuses managed by the partners, and companies working with the nationwide network of Catapult centres. The SynBio Fund, by contrast, is focused on companies working in the field of synthetic biology, a core area for BBSRC, but otherwise is free to invest across the UK. The Fund's full investment policy is included in Annex E.

Investment approach and positioning of the Fund

2.19 UKI2S invests between £25,000 and £1m[13] in a company over several years and several funding rounds as the company grows, though, in line with its mandate, the bulk of its capital is deployed in the earliest years of a company's life. The Fund has invested in 57 companies to date and is currently investing in around nine new investments per annum together with a number of follow-on investments into existing holdings.

[12] European Investment Bank (2018) Financing the Deep Tech revolution: How investors assess risks in Key Enabling Technologies (KETs). See full report here.
[13] The Core Fund is capped at investing £500,000 per company (initially set at £250,000 but raised in 2009). The SynBio Fund is able to invest up to £1m. The largest investment in any single company to date is £830,000.

2.20 UKI2S is not permitted to invest more than £500k per company in the Core Fund and £1m per SynBio Fund company. This means that the Fund is not able to "follow its money" by investing in companies that have genuine potential to generate returns, as a normal VC fund would do. As a result, the proportions of equity held by UKI2S become diluted and quite small by the time of exit, thereby limiting the returns.

2.21 The Fund invests in the same way as private sector venture capital, taking minority equity stakes, and uses the same instruments (typically Ordinary and Preferred shares). In any prospective business, UKI2S looks for the same identifying characteristics a VC fund would, including disruptive technology, applications in broad and deep markets, and novel and defensible intellectual property (usually in the form of patents). UKI2S is, however, distinctive in being willing to invest at much earlier stages than most private sector investors, when there is little certainty surrounding the applications of technology, lack of experienced management involved, and a substantial amount of further development and funding required. Figure 2-6 outlines the risks typically present in the types of companies that UKI2S invests in.

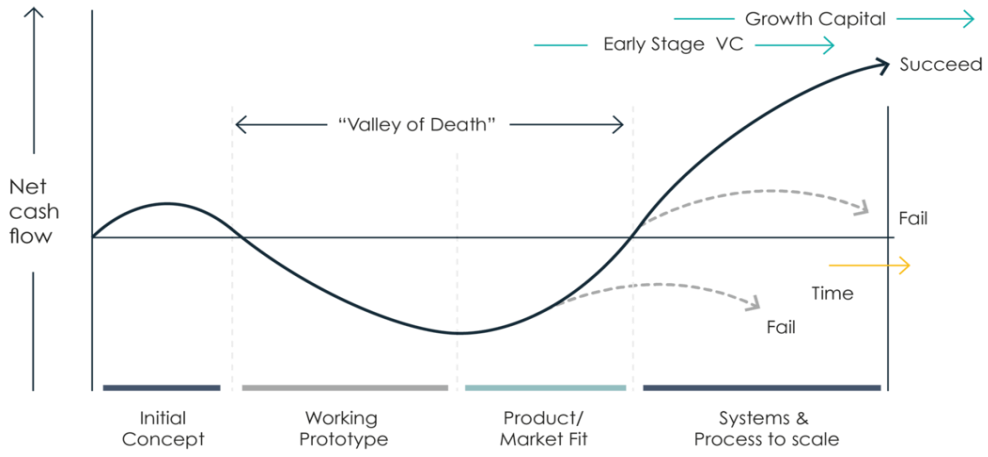
Figure 2-6: Key risks in UKI2S portfolio companies

Source: UKI2S

2.22 In terms of the stage of investment, the Fund is positioned quite clearly at the Seed stage[14] of the finance escalator, and right at the start of what has become known as the 'Valley of Death', the gap between start-up and the point at which a company can sustain itself through the sales of products and services (Figure 2-7).

[14] Seed capital is defined by the British Venture Capital Association in its 'Guide to Private Equity' as: "*To allow a business concept to be developed, perhaps involving the production of a business plan, prototypes and additional research, prior to bringing a product to market and commencing large-scale manufacturing*". The guide goes on to say: "[Generally] *seed financings are too small and require too much hands-on support from the* [venture capital] *firm to make them economically viable as investments*."

Figure 2-7: Finance escalator



Source: UKI2S

2.23 During this period, a company is dependent on investors and grants for support and is always vulnerable to setbacks:

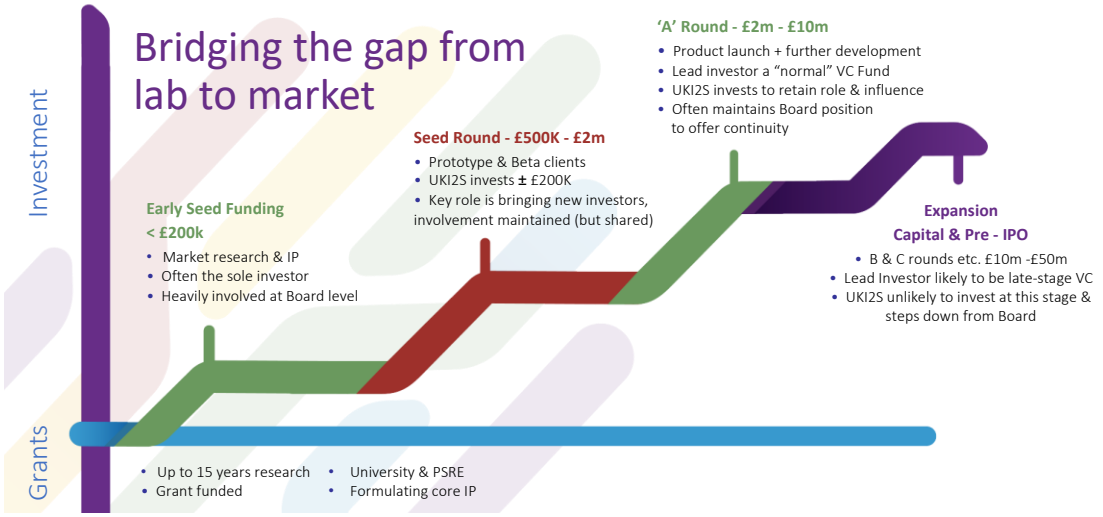
> *"The valley of death can be encountered at various stages of the commercialisation process, but is most often acutely felt in pre and early stage company formations where there are gaps between the early stage/proof of concept nature of the technology and the beginning of increased production and generation of significant revenues"*[15]

2.24 The investee businesses are heavily R&D intensive with around 50% of funding typically going into research activities. At these early stages, the companies are engaged in product development, with a view to generating sales at later stages and eventually exiting by way of trade sale.

2.25 The schematic in Figure 2-8 describes a typical funding cycle for a technology start-up. It illustrates the critical importance of UKI2S at the very earliest stages, and how this reduces markedly as the new investors are brought in, the funding rounds increase in size, and the company gets closer to the market.

[15] House of Commons Science and Technology Committee (2013) Bridging the valley of death: improving the commercialisation of research. See full version here.

Figure 2-8: Funding cycle for technology start-ups showing UKI2S positioning



Source: UKI2S

Fit within the wider landscape

Policy landscape

2.26 UKI2S aligns with the wider policy landscape in the UK, supporting the key strategic policy objectives. At a high level, the launch of the Industrial Strategy[16] in 2016 was intended to significantly reshape the UK innovation landscape including associated funding, infrastructure and policy. The strategy placed a more explicit focus on science, innovation and R&D, in particular highlighting the need to connect world-leading research with industry, and set an ambitious objective to raise total investment in R&D to 2.4% of GDP by 2027. It identified four 'Grand Challenges': Artificial Intelligence and data; ageing society; clean growth; and future of mobility. To address these challenges, and support a competitive UK economy, the Industrial Strategy Challenge Fund (ISCF) was launched. By investing in both the research base and innovative businesses, ISCF is central to the efforts to maximise the value of new ideas being developed. The Industrial Strategy also included a government measure to increase the rate of R&D tax credit to 12%. This policy emphasis is important to UKI2S in contextual terms, given that the businesses supported by the Fund are all R&D intensive.

2.27 For the partners of UKI2S, a key part of their organisations' wider objectives is that research achieves impact and supports UK prosperity. Through improving the foundations and environment for research and innovation, UKRI seeks to deliver economic, knowledge and societal/cultural impacts. It has therefore set a key focus on supporting universities and other research organisations with their knowledge exchange and commercialisation activities. UKI2S supports this objective by providing a vehicle to investing in spin-outs and early stage companies that are engaging and collaborating with the knowledge base.

2.28 For the core partners, UKI2S complements other provision that is available, in particular proof of concept funding which could lead on to investment from the Fund. Examples of this alignment include the following:

[16] HM Government (2016) Industrial strategy. Building a Britain fit for the future. Full version available here.

- For BBSRC, UKI2S aligns with Enterprise Fellowships and the Follow-on Funding that cover the proof of concept stage, as well as the research, translation and commercialisation across campuses and institutes.

- For NERC, UKI2S is potentially a next step in the provision of support for spinouts from its Centres (including the British Geological Survey, the British Antarctic Survey, the National Oceanography Centre and the Centre for Ecology and Hydrology (now UKCEH)), complementing other knowledge exchange and innovation funding and paths to commercialisation.

- For STFC, UKI2S again aligns with its own funding to support the proof of concept stage (including Challenge Led Applied Systems Programme (CLASP) and internal proof of concept funding) and adds to its campus incubation activities for SMEs by providing access to finance for the community of SMEs in its Business Incubation Centres and clustered on its campuses at Sci-Tech Daresbury, Harwell, and the Royal Observatory Edinburgh.

- For Dstl, UKI2S complements the Defence and Security Accelerator (DASA, replacing the former Centre for Defence Enterprise), which funds exploitable innovations for defence and security. The programme provides an entry point for those new to the sector/supply chain, for which barriers can exist for SMEs. It also provides a vehicle to achieve other objectives in relation to national security through bolstering UK-based supply chains in the defence sector.

2.29 The complementarity of UKI2S with Innovate UK initiatives was identified in the 2013 report, with investee companies also taking advantage of grant programmes such as Smart. The Fund continues to be well-aligned with Innovate UK's activities and, in addition to the ongoing relevance of the various grant programmes offered by Innovate UK, the links have become more explicit in recent years:

- The Fund has partnered with Innovate UK in two programmes which combine equity from UKI2S and Innovate UK grants to accelerate the growth of science-based companies. The Investment Accelerator Pilot programme combines grant funding with matching investment from VC funds. UKI2S has accounted for a significant proportion of investment provided under this scheme. Building on this successful collaboration, in May 2019 the UKI2S Innovate Accelerator was launched with £10m of Innovate UK funding to be combined with equity investment from UKI2S.

- The network of Catapult Centres, set up to close the gap between concept and commercialisation, is also important to UKI2S. By providing expertise and facilities to innovative companies in specific technology areas, these Centres seek to accelerate the development of early-stage technologies. UKI2S is collaborating with the Catapult network and invests in companies working with Catapults, including the Satellite Applications and High Value Manufacturing Catapults.

Finance landscape

2.30 On the face of it, the UK's venture capital sector is thriving. The overall quantum of venture investment has been growing strongly in recent years. According to Beauhurst, the leading data provider on venture funding, a record-breaking £12bn was invested in 2019,

outstripping the previous record of £9.1bn in 2017.[17] This funding came from a wide range of sources, from angels under the EIS scheme and VCT funds to overseas venture funds. There has been substantial growth in web-enabled platforms for crowd-sourcing investment at the smaller end of the spectrum of investment, and in new corporate venture funding at the larger end.

2.31 The venture capital sector also receives a good deal of support from across the political spectrum. Early stage investment and innovative start-ups are areas of great interest to most governments looking to foster new industries, create high-value jobs and boost productivity, and the UK is no exception. In the UK, there is the additional driver to prove that the output of the country's highly rated science base can be translated into lasting economic benefit – an aspiration to which UKI2S can partly trace its origin. This political commitment has produced substantial levels of support including from the British Business Bank for VC funds, and through tax reliefs for private individuals investing through EIS and VCT schemes.

2.32 The industry-led Patient Capital Review[18] in 2017 explored barriers to finance faced by innovative companies, identifying significant opportunity in the provision of large-scale patient investment to highly ambitious but capital-intensive businesses (such as university spin-outs). In response to the Patient Capital Review, additional resources have been allocated to support the provision of patient capital (primarily through programmes managed by the British Business Bank).

2.33 However, for the types of Deep Tech companies that UKI2S focusses on, the picture at the early stages is not as encouraging as the above would suggest. This was highlighted in the recent Beauhurst report[19] showing that investment into university spin-outs fell in 2019 in spite of total funding for early stage investment doubling. The sector faces some critical structural issues, including the fallout from the collapse of Neil Woodford's fund management company and the poor performance of the Patient Capital Trust, his vehicle for early stage investments. The headline numbers above mask two important elements highly relevant to the areas in which UKI2S operates, namely the stage and sector of the businesses invested in. The striking growth in recent years has been driven almost entirely by later stage companies raising substantially larger rounds than previously seen, with financings of over £50m becoming commonplace. Early stage activity, however, contracted back to levels not seen for five years. In its 2018 summary report, Beauhurst noted that *"a worrying fall in deals at the seed stage will need to be corrected if the UK is to hold on to its place as a leading startup economy"*[20]. The sectoral distribution also looks very different from a decade ago, with more funding in sectors where the science base is not well represented. In 2018, Beauhurst identified Fintech as the most active sector, followed by AI, Proptech, Edtech and Blockchain, which were all ahead of Life Sciences, the only traditional Deep Tech sector to make the top seven.

2.34 A particular feature of the UK's early stage technology investment is the funds created around university spin-outs, a model arguably pioneered by the Government at the turn of the century with a cluster of University Challenge Seed Funds (UCSFs) being established. UKI2S itself was, in effect, the UCSF for the public research base outside the universities. These funds prompted a small wave of private sector activity in the 2000s led by IP Group, a listed company that

[17] Beauhurst (2020) The Deal. Equity investment in the UK 2019. Available here.
[18] Patient Capital Review Industry Panel (2017) Patient capital review. Industry Panel response. Full version available here.
[19] Beauhurst (2019) Equity investment into UK spinouts. Available here.
[20] Beauhurst (2019) The Deal – Equity investment in the UK 2018. Available here.

struck deals with nearly 20 universities. However, the field is now dominated by funds focused on the 'Golden Triangle', namely Oxford Sciences Innovation (£630m), Cambridge Innovation Capital (£300m) and Albion's UCL Technology Fund (£50m). With the exceptions of Mercia and Edinburgh's Old College Capital, there are no other university-focused funds of any scale currently operating outside the Golden Triangle.

2.35 At present, the sector is somewhat overshadowed by the high-profile failure of Woodford Investment Management, at least partly caused by the (over)exposure of its funds to early stage and therefore illiquid investments. This may have increased external perceptions of early stage investment as being excessively risky. However, Woodford's positioning within the VC landscape was also structurally important. Alongside the direct investments into technology companies, Woodford was an anchor investor in other technology funds including IP Group, Mercia and CIC. Hence, the fall-out from Woodford's failure may have an effect on funds' ability to raise capital in future.

2.36 With a few notable exceptions, business angel investment is less of a feature in Deep Tech than in other sectors, with many angels deterred by the length of time to market, unfamiliarity with the science, and the high risk of future dilution by later stage investment. A recent report for Research England by Mike Rees[21] highlighted that the sector is not a major recipient of angel investment, with only 6% of EIS funds raised going into university spin-outs. The proposed introduction of the Knowledge Intensive EIS scheme may improve this.

2.37 The backdrop also includes the widely recognised need to replace the role of the European Investment Fund (EIF) post-Brexit. EIF has historically supplied around a third of capital for the venture sector. The government intends to fill some of this gap with the British Patient Capital (BPC) initiative, managed by the British Business Bank. In the past, the Bank has provided limited support to Seed funds, focusing more on Series A and later stages; it remains to be seen whether this will change with the introduction of BPC.

2.38 The UK government is working to persuade UK institutional investors such as pension funds to allocate capital to venture funds but there is limited evidence that these efforts have had an effect to date, and progress in some areas is hindered by the government's own legislation on cost structures, as highlighted in a recent report from the British Business Bank and Oliver Wyman[22].

2.39 Against this backdrop, it appears that the early-stage Deep Tech sector served by UKI2S needs to be seen through a slightly different lens. The Rees report summed up the landscape by concluding that *"access to capital is improving, but there are very real structural issues related to its source, amount and concentration."*[23]

[21] Mike Rees (2019) Advice on university-investor links. Available here.
[22] British Business Bank & Oliver Wyman (2019) The future of defined contribution pensions. Available here.
[23] Mike Rees (2019) Advice on university-investor links, p. 3. Available here.

Portfolio overview

Headlines on investment performance

2.40 Since its first investments in 2002/03, UKI2S has provided a total of £14.78m funding to 57 early-stage technology companies. In addition, the Fund has provided 38 companies with just over £905k in early stage pump-priming "pathfinder" investments to fund exploratory work on commercial viability (up to £50k each).

2.41 The Fund has seen five profitable sales to date, realising a total of £8.7m (as against the investment of £1.7m from UKI2S). Because UKI2S is structured as an "evergreen" fund, all of these proceeds are retained in the Fund for future investment.

2.42 Alongside investment from UKI2S, the 57 portfolio companies have received £505m in co-investment from private investors (from £14.8m of UKI2S investment to date). This shows that the amounts invested by UKI2S are modest compared to others, with multiples of over 34 for the Fund's investment. The Fund's role in helping to bring this co-investment on board is explored in Chapter 3.

2.43 Although an analysis of the financial performance of the Fund is not within the scope of this report, we have set out the key indicators of the Fund's performance to date in Table 2-1.

Table 2-1: Investment performance of UKI2S

Number and size of investments	
Investments made (excluding pathfinders)	57
Total invested to date	£14,780,000
Average investment (across 57 companies)	£260,000
Range of investment	£25,000 – £830,000
Status of investments	
Active companies	32 (56%)
Failures (written off) plus "inactive"	20 (35%)
Exited companies	5 (9%)
Co-investment	
Private sector co-investment (across 57 companies)	£505,000,000
Average private sector co-investment (across 57 companies)	£8,810,000
Ratio of co-investment to UKI2S investment	34:1
Value of and profits from investments	
Valuation of current portfolio	£19,900,000
Proceeds of realisations to date (from five company exits)	£8,700,000
Profit on realisations to date (from five company exits)	£7,000,000
Total value of investments (realised & unrealised)	£28,600,000
Multiple of investment (whole fund)	1.9 x

Source: UKI2S

Risk appetite

2.44 Given the risks associated with early stage investments, it is inevitable that some have not worked as planned. UKI2S investments inherently carry a good deal of risk, and failure to make the grade is regarded as a necessary part of the process. Reflecting the willingness of the Fund to take on high levels of early stage risk, 15 of the 57 investments have been written off, and a further five are regarded as close to failing.

2.45 Similarly, around 25 of the 38 pathfinder investments have been written off. This is again reflective of the Fund's risk profile, exacerbated by the fact that pathfinder investments are made at the earliest, most risky stages with an even higher level of uncertainty than for a typical UKI2S investment.

2.46 Failure to make the grade is therefore regarded as an inevitable part of investing in early-stage technologies. In some cases, failure is due to a combination of factors and not necessarily reflective of the technology's potential (see case study box below). It is also important to note that whilst some investments have not worked from UKI2S's perspective, the basis of the technology supported may still go on to have economic benefit. For example, UKI2S wrote off its investment in Thruvision in 2007 but the company was later acquired for its technology, merged with another business and listed on the AIM market.[24]

Case example: Microbial Solutions

Microbial Solutions was part of the UKI2S portfolio from 2007 to 2015. Spun out of the Centre for Ecology & Hydrology, part of the Natural Environment Research Council, the firm developed a patented combination of microbes that had the capacity to break down recalcitrant sludges from engineering processes, specifically the lubricants used in drilling and cutting into solid metal (e.g. engine blocks). These fluids have an intrinsically high chemical content in order to maintain their efficiency as lubricants, which makes them some of the most difficult fluids in the world to dispose of safely. Large oil companies were therefore actively looking for better disposal solutions. UKI2S invested initially with an early £25k "pathfinder" funding, and then joined with Oxford Capital Partners in a Seed round of just over £1m to take the technology out of the lab and get it first into a pilot to see if it would work at industrial scale. The company hired a new CEO, though only part time, and a Chairman who was the former MD of a major oil company.

There were some initial successes, including an increasing level of interest from potential users and a strong relationship with a likely lead partner, a UK-based leader in the worldwide lubricant market. However, the potential partner was taken over by a private equity concern with no interest in expanding their range, resulting in the relationship being cut overnight. Microbial Solutions worked hard to bring a major oil company on board as a replacement industrial partner and in 2013, they committed a substantial sum to a pilot at their Bridgend engine plant and started internal discussions on a possible worldwide roll-out. However, the company insisted on exclusivity, which was to prove a problem.

The pilot plant was, as is so often the case, only partially successful. Meanwhile, the oil company's projection of potential target sites produced a lower number than originally thought, and the machining industry started to adopt techniques that

[24] The company is no longer quoted having de-listed and restructured itself; the Thruvision technology remains a core part of what is now a stable company with sales of around £25m.

required less lubricant. The Bridgend plant was, therefore, getting more nervous about its future (eventually leading to an announcement about its closure in 2019).

In late 2014, UKI2S and other investors faced a choice about further investment. Microbial Solutions' technology still held enough promise to suggest that a market might exist, but the oil company's insistence on exclusivity meant the company had no clear picture of it. Discussions amongst investors were protracted and the eventual outcome was, in hindsight, a poor compromise – it included enough money for six months but not enough to resource a proper business development effort. Microbial Solutions effectively remained dependent on the major oil company and although they did make a conditional offer for the business, negotiations broke down and the business was forced to close in 2015.

For the fund manager, **the key lessons learned relate to a combination of "obvious" and "less obvious" factors**. Top of the "obvious" list is the exclusivity requirement, which was always understood to be high risk but regarded as inevitable given that they were funding 100% of the business during the pilot. A second key factor was the market's shift towards dry machining, effectively serving notice on the need for large scale lubricant solutions, albeit not immediately. There were also some less obvious factors, which were seen as equally critical. These related principally to changes of investment personnel and strategy at the other fund investors, which removed the sense of continuity and ownership that is often instrumental in make or break discussions.

Stage of companies

2.47 Unlike other technologies such as software and mobile applications which can be built and launched rapidly, the development pathway for most of the technologies emerging from research, and supported by UKI2S, is a lengthier one. Deep Tech is also characterised by a high level of uncertainty around business models and potential applications (particularly in emerging research fields such as SynBio). In these areas, the combination of large and often long-term programmes with slow-moving customers creates a slow adoption cycle and a difficult environment for SMEs that are seeking to develop new technologies.

2.48 The development of novel drugs and treatments is well-known as being a lengthy process. Indeed, the Wellcome Trust has estimated the average time lag between expenditure in cancer research and impact on patients to be close to 15 years[25]. The cycle of development and adoption is also long in other areas where UKI2S invests, including security and defence, and the energy market. This lengthy route to impact can be illustrated in the case of one of the portfolio firms, Tokamak Energy, which aims to build the world's first fully functioning fusion reactor to provide the world with a cheaper, more sustainable source of energy. UKI2S has been involved in the business from the outset, starting with initial pathfinder funding in 2010. Although the company is on track and has delivered against all milestones to date, the development process is time-consuming, and commercialisation is not expected until 2030 at the earliest.

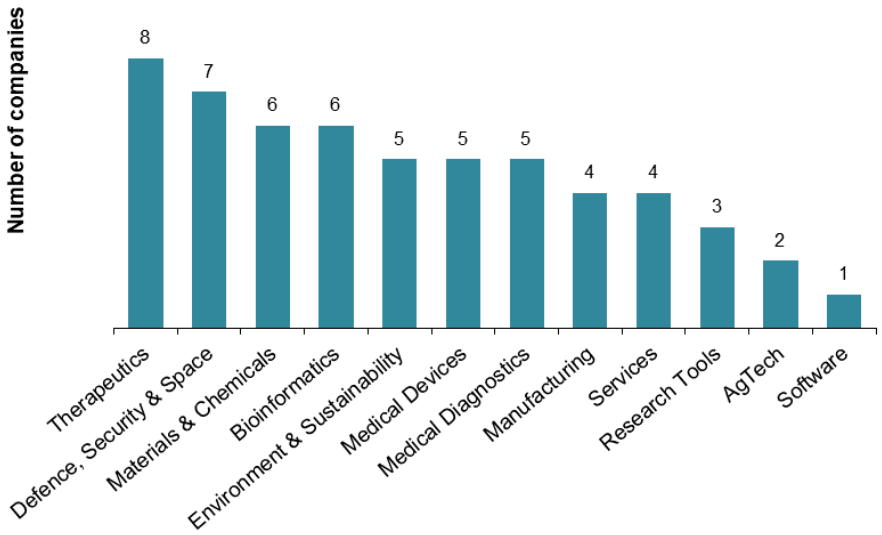
[25] The Wellcome Trust (2014) Medical research: What's it worth? Full report available here.

2.49 The average investment holding period for VC firms is of the order of eight years[26]. UKI2S tends to invest at least 2-3 years before a typical VC fund would get involved, suggesting that UKI2S will have to hold its investments for an average of close to a decade before seeing returns. Given the diversified nature of its portfolio, the Fund may achieve stellar returns from one or two companies, allowing proceeds to be recycled (contributing to UKI2S's "evergreen" objective). However, the financial return is of secondary importance to the partners, and so this study fulfils a key purpose by assessing the economic and wider contribution of the Fund.

Sector distribution

2.50 As might be expected from the breadth of activities within its partners, UKI2S has invested across a range of areas (see Figure 2-9). Across all portfolio companies, the key areas of application for technologies include therapeutics (8 businesses), defence, security and space (7), materials and chemicals (6) and bioinformatics (6). As is demonstrated in Chapter 5, many of the technologies developed by the businesses have (potential) applications spanning several different areas.

Figure 2-9: Distribution of technologies by key area of application



Source: SQW based on UKI2S data

2.51 It should be noted that the addition of the Synthetic Biology sub-fund in 2013 has resulted in an increased concentration in the biotechnology field, which has somewhat skewed the overall distribution, with all 13 companies in the SynBio portfolio having applications in the medical and biotechnology fields. In the Core Fund, there is a near 50/50 split between medical and non-medical technologies.

[26] European Investment Fund (2017) The European venture capital landscape: and EIF perspective. Working paper no 41. Available here. The report found that the average holding period for VC in 2017 was 8.3 years for companies securing an exit; data was not available for companies remaining in VC portfolios.

3. Role of UKI2S

Chapter purpose

This chapter describes the role played by UKI2S in supporting the commercialisation of ideas from the research base and the development of early-stage technology-rich companies. In doing so, we draw on evidence from consultations with the Fund Managers and the businesses invested in. Finally, we present the evidence on the extent of additionality of the investments in portfolio companies.

Summary of key findings

Drawing on the evidence, and the roles played by UKI2S, we have found very high levels of additionality, i.e. it is unlikely that many of the companies supported would have been started or developed without the Fund's involvement.

This reflects the very early stage at which UKI2S becomes involved, when there are very few other alternatives, and the ongoing roles played by the Fund. However, the Fund remains heavily involved for several years beyond the initial investment and continues to support the growth of the businesses.

We identified three ways in which UKI2S provides support to its portfolio companies across the various stages of development. In broad terms, these relate to:

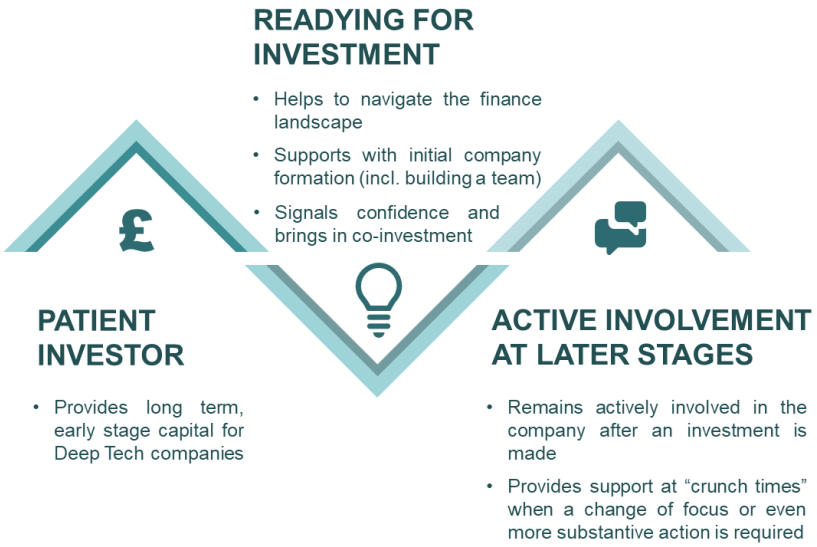
- the Fund's role as a lead or co-lead investor in the very early stages
- the mentoring role in readying businesses for further investment
- supporting subsequent company development through its role at board level in every business.

Helping to establish early stage businesses

Three key roles

3.1 The 2013 study identified three key roles of UKI2S in how it supports companies, namely: as an investor; through readying businesses for further investment; and in terms of the support for company development beyond funding (see Figure 3-1). These roles remain highly relevant, and the second role has broadened to reflect the broader group of companies worked with, which includes early-stage companies that already existed and require guidance and support so that they are ready to access equity investment. This chapter summarises the evidence gained from this 2019 study.

Figure 3-1: Key roles of UKI2S



Source: SQW

UKI2S as an investor

3.2 The most obvious role of UKI2S relates to its investment in businesses at the earliest stages of their development and its willingness to take risks that others will not. As explained in Chapter 2, the Fund's focus on Deep Tech means that it is often dealing with technologies that are characterised not only by high levels of risk due to the many uncertainties involved, but also a lengthy route to value (and eventual return on investment). To maximise the potential of these new technologies, a long-term approach to investment is required. The importance of the Fund's role as a "patient" investor[27] has been demonstrated in the case of Cobalt Light Systems (see box below).

Case examples: importance of long-term perspective

For **Cobalt Light Systems** (**£432,000 invested from Core Fund**), a company developing instruments for non-invasive analysis of materials, the key markets are highly regulated. With various compliance standards and approvals required, these markets have high barriers to entry. When Cobalt Light Systems was formulating its business plan, UKI2S was active in steering the firm in the direction of these hard-to-access markets – supporting the choice of a longer and more complex, but also more secure route to value. The business benefitted from the Fund being able to see the long-term value in this approach, and the continued support in successive investment rounds. The Fund, in turn, benefited when the business was bought by Agilent, which has expanded Cobalt's Harwell operation since acquisition.

[27] Patient capital does not have a fixed definition, but generally refers to investment that is prepared to wait a considerable time (i.e. five years or more) before seeing returns.

3.3 Whilst UKI2S does aim to generate a return on investment to contribute to its "evergreen" objective, the Fund's primary interests are in helping to support the commercialisation and development of research and early-stage technologies. This means that UKI2S is willing to take a risk when it sees sufficient potential in a company and gets involved at much earlier stages than most VC funds. As was described in Chapter 2, UKI2S sometimes invests even before the Seed round through its pathfinder funding. In a number of cases, these small amounts of investment – provided at the earliest, most risky stages – have been critical to progressing technologies up to a point where the company is able to demonstrate its value. For instance, Atelerix used £25,000 funding to complete proof of concept work, which was *"crucial for making the case [to early clients and other investors]",* whilst Cobalt used it to explore the viability of applications in healthcare – work that underpinned the raising of the first full Seed round.

> *"Without UKI2S seeing the value in what I was describing, we would never have got the Seed round underway, and would never have progressed this far."*
>
> Quethera (SynBio Fund)

3.4 UKI2S's role in bridging the Valley of Death extends beyond its own investment to helping companies leverage further funding, both directly and indirectly. As one consultee recognised, the Fund is *"always championing the next investment",* using its influence at board level to ensure that the company understands the likely expectations of future investors, setting targets and allocating resources to maximise the chances of raising money at the next funding round.

3.5 By using its networks to identify relevant investors and make connections, the Fund makes a direct contribution to bringing in co-investment. For example, Cobalt Light Systems, CytoSeek, Quethera, Synthace and Atelerix have all received investment from funds identified as likely investors and introduced by UKI2S. Co-investment data is set out in Chapter 4.

3.6 More broadly, an investment from UKI2S signals credibility to other investors who will almost always consult with the Fund Managers at the early stage of their investigation to get an informed view of the company and its performance to date. This boost in investor confidence is particularly important for early-stage, high-risk businesses, as noted by one consultee: *"When you are creating a business, your most important asset is credibility. UKI2S backing added strongly to it."*

Readying companies for investment

3.7 A second key role of UKI2S relates to helping companies navigate the finance landscape. This is particularly pertinent given the Fund's primary focus on technologies emerging from research. Scientists and other research staff are used to operating on long-term timescales with technologies typically looking ahead ten or more years. They often have little experience or knowledge of the VC landscape, including the options available and the key issues around it. By working closely with businesses during the early stages of development, UKI2S helps the teams to navigate this area. This help includes ensuring that investment propositions seek the right amount in future investment rounds and establishing appropriate milestones for the

> *"Forming a relationship with an investment fund at such an early stage forces you to get moving in terms of company formation and structure."*
>
> CytoSeek (SynBio Fund)

business. For CytoSeek, a spin-out from the University of Bristol, the experience of engaging with UKI2S was valuable in preparing the company for future private investment: *"You start to understand the machine: how they are likely to invest, the terms that you are likely to get, and what the expected timelines are."*

3.8 UKI2S also contributes to readying companies for further investment by helping them become more sustainable. Building the management team and board is a key element in growing companies, and the Fund has been key to building experienced teams in a number of cases across the portfolio. Using its existing network of recruiters and professionals, the Fund has contributed to bringing in staff from engineers to senior executives and board members. Some examples of companies that have benefitted from this support include Cobalt Light Systems, Quethera, Pireta, Synthace, Tokamak Energy, CytoSeek, and Tropic Biosciences.

3.9 Similarly, UKI2S has been able to draw on its connections to help with other aspects of business. For instance, one recent addition to the portfolio has greatly expanded its assessment of potential addressable markets following high level introductions to two companies that quickly became clients, and also to key intermediaries including the High Value Manufacturing Catapult. Another company received tips for marketing with limited resources from the Fund's Marketing Manager.

> *"They have the experience of seeing lots of companies go through the same thing so if there is anything that we are dealing with, they are able to say: "We have seen this a hundred times.""*
>
> Core Fund company

3.10 More generally, UKI2S as an experienced investor provides a good *"sounding board"* for the companies. As identified in the 2013 study, the Fund's positioning between researchers and TTOs on the one hand, and private investors on the other hand, means that it is able to understand and *"speak the language"* of both sides. Because UKI2S understands the detail of the research as well as its commercial potential, the Fund is trusted by both sides. In a number of cases, the advice provided by UKI2S has been instrumental in devising and refining business plans. Examples of other support – spanning a range of issues and areas – include the following:

- During the early years, one of the portfolio companies struggled with *"getting the balance right"* on its board. The power dynamic between different investors was perceived as difficult and at times counterproductive. By bringing in a new perspective and in some ways coordinating the board, UKI2S helped to resolve this.
- UKI2S was able to advise one of the companies when it was struggling to attract talent. In this case, the Fund's greater visibility of pay scales was instrumental in ensuring that the business was offering a competitive salary. Alongside this, the Fund will often take a role in advising on the introduction of share option schemes to incentivise key employees.
- The Fund has also been able to advise businesses on issues regarding policy/regulations and intellectual property (IP). In one case, UKI2S made the recommendation to include additional IP in the portfolio – something which the company would not have done otherwise, but proved valuable at a later stage.
- One consultee was invited to provide evidence at a Parliamentary Committee hearing on a topic related to the firm's area of business. A representative from UKI2S attended

this meeting to provide support and strengthen the argument by providing an investor's perspective on the matter.

Supporting subsequent company development

3.11 A third key role is that UKI2S continues to take an active interest in supporting its portfolio companies after an investment is made. In every business it has a seat or observer status on the board in the initial period following investment, and often thereafter. In a number of cases, and particularly during the early stages, the Fund has been the single or one of only a small number of other investors represented on the board. In that sense, one of the businesses described UKI2S as *"part of the company"*, demonstrating the active involvement. This allows the Fund to be in the position to provide continued and effective support. The importance of this early support was illustrated by a consultee who joined a business three years after it had been established with initial pathfinder investment from UKI2S. Given that the firm was still very early stage at that point, he was surprised at the progress that had been made in only a few years: *"It had been nurtured to a point where there was a clear understanding of both the technology and the potential markets – it was obvious that there was a road ahead to follow."*

> *"Some VC funds just give you money and leave you to get on with it. Others are the complete opposite and are trying to micromanage you. We never got any of that from UKI2S – it was always constructive and helpful."*
>
> Synthace (SynBio Fund)

3.12 In some cases, the strategic advice from UKI2S has led to a change in direction or focus. For instance, the Fund was key to the change in direction by MIRICO (broadening its technology), The Electrospinning Company (change of business model from a product to a more service-oriented business), and Atelerix (focusing on a business-to-business rather than a business-to-consumer model). In the case of Synthace, UKI2S invested at a time when the company had decided to change from a service provider to a software company, and the Fund was heavily involved in seeing this through.

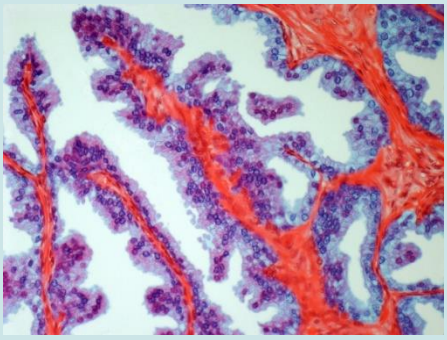
3.13 The Fund's continued involvement means that it is also able to support businesses at crunch times when a change of focus or even more substantive action is required. This includes coordinating and backing rescue rounds[28] when progress has stopped, or pivot rounds[29] when a change in strategy requires further funding. In these cases, further investment from UKI2S, where it considers that there is still potential, is intended to give other investors confidence.

3.14 The Fund's ongoing involvement is representative of its long-term perspective. The case of CellCentric illustrates the often complicated route to impact for innovative companies, and the importance of patient capital in realising the potential value.

[28] Investment at a later stage when progress has faltered and/or other investors are hesitant.
[29] A further investment in the company to fund a change in direction. This includes shifts in technology, market focus, service-to-product (or vice versa), etc.

Case example: importance of patient capital

CellCentric (£460,000 invested from Core Fund) is a clinical-stage biotechnology company focussed on using epigenetics to develop new drugs for prostate and other cancers. Prior to UKI2S's initial £250,000 investment in 2006 (not long after the addition of BBSRC as a partner opened up the Fund to the organisation's biotech research base), the company had closed a £580,000 seed round from private investors. Although the Fund had no role in the business being established, it was instrumental in seeing the business switch focus and move into drug target identification. During the early years, the business struggled to find traction, ahead of epigenetics becoming mainstream. The consultee considered that given the very risky and long route to market, *"a more short-term focussed investor would have given up on the business."* It was felt that UKI2S recognised the potential even when it was difficult for the firm itself to prove value. Having been advised by UKI2S to *"give it one more go*", CellCentric evolved again in 2013 to concentrate on drug discovery and development. This was pivotal, with the company ultimately going on to raise £19m in 2018 to advance its first of its kind cancer drug into clinical trials for multiple indications.



3.15 UKI2S retains an active role throughout the life of its portfolio companies, until the eventual exit. This has been visible in the cases of Quethera and Cobalt Light Systems, where the Fund had a central role in exit negotiations. The support included informing the negotiations by advising on realistic valuations on the business, help in choosing between different offers, as well as a general desire to keep up the momentum and *"get it over the line."* Equally, at least one firm has rejected less than optimal acquisition offers based on the advice received from the Fund.

3.16 The next three pages include case study summaries for three companies supported by UKI2S – Cobalt Light Systems, Tokamak Energy and Quethera – exploring the role that the Fund has played in greater depth. For two of these companies, Cobalt Light Systems and Quethera, UKI2S was involved from the initial pathfinder investments until the eventual exits (in 2017 and 2018, respectively).

COBALT LIGHT SYSTEMS

FUND	Core Fund
TOTAL INVESTED	£432,000
TECHNOLOGY	Non-invasive analysis of materials
LOCATION	Harwell, Oxford

Cobalt Light Systems was established in 2006 as a spin-out from STFC's Central Laser Facility at the Rutherford Appleton Laboratory (RAL) in Harwell. Based on Raman spectroscopy, the firm's innovative technology is able to measure concentrations of materials and substances inside containers with a high degree of accuracy. The business has developed a portfolio of four benchtop and handheld instruments.

A key application for this non-invasive, through-barrier chemical analysis is in security: Cobalt's scanners are widely deployed at EU airports, providing screening of liquids, aerosols and gels. The handheld portable unit can, for instance, be used by first responders at crime scenes or environmental incidents to detect hazardous chemicals, explosives and narcotics. Outside security, the technology is widely deployed in quality control for pharmaceutical research and production, helping to produce cheaper and more reliable drugs.

UKI2S was involved in Cobalt Light Systems from the start, and retained an active role until 2017 when Cobalt was acquired by Agilent Technologies and became the global base for its Raman spectroscopy business. The Fund was the first investor, providing £25,000 of pathfinder funding in 2006 to help refine the technical detail and develop a commercial proposition. This early investment from UKI2S, complemented by strategic advice, was recognised as critical to *"nurturing"* the business to a point where it had a clear understanding of both the technology and the potential markets. The Fund was therefore instrumental in readying the business for further investment, and it was considered that some of the early co-investors would not have invested without its involvement. Following the initial pathfinder funding, UKI2S invested over £400,000 in the company. UKI2S has played a number of other roles in helping to develop the business, including:

- **assisting with building an experienced team** from the outset, e.g. help with attracting talent and achieving balance in the Board's composition
- **providing ongoing strategic advice** through its position on the Board, e.g. actively steering the business in the direction of highly regulated markets, recognising the long-term value of these markets despite the considerably larger sums of investment required in the short term
- **making connections** to networks to explore different options, e.g. food sciences groups
- **supporting exit negotiations** by advising on offers and helping to maintain momentum.

It is very unlikely that the business would have been established without the initial pathfinder funding from UKI2S. The investment from the Fund was complemented with advice and support which, over time, became relatively more important than the financial contribution (given that the Fund's investments are capped at £500,000). UKI2S was therefore instrumental in steering the business through the earliest stages of spinning out: *"there are a lot of technologies that do not make it out of the lab because they do not have that help with direction."*

TOKAMAK ENERGY

FUND	Core Fund
TOTAL INVESTED	£400,000
TECHNOLOGY	Fusion energy
LOCATION	Milton Park, Oxford

Tokamak Energy is a spin-out from Culham Centre for Fusion Energy. It is developing commercial fusion power, based on the reaction that powers the sun and the stars. By combining spherical tokamaks with the latest generation of high temperature superconducting magnets, the firm is seeking to build a device capable of replicating the sun's processes on Earth.

Fusion is an alternative to fission, the form of energy creation currently used by all nuclear power plants. Compared with fission, fusion is safer (with no risk of meltdown and no by-product of radioactive waste), has extremely high energy density, and the fuel is abundant. It therefore presents the potential to be a cheaper and more sustainable long-term source of energy. The company forecasts that by 2050, fusion energy could account for a fifth of total energy production, resulting in the equivalent of a 25% reduction in current CO2 emissions globally. The high temperature superconducting magnet technology – where tokamak energy has world-beating technology - has a range of potential applications outside tokamak fusion including proton beam therapy, particle accelerators, scientific research magnets, energy storage, and energy efficient industrial processes.

Tokamak Energy illustrates that the time to commercialisation for Deep Tech companies can be very long. Although the business has delivered against all of its milestones to date, the development process is time-consuming and commercialisation of the spherical tokamak power plant technology is not expected until 2030 at the earliest. In 2017, the company unveiled its ST40 spherical tokamak (see photo) which aims to be the world's first device to achieve the plasma temperature required for fusion processes. In 2018, ST40 reached 15m degrees – a vital milestone, but still some distance from the required 100m degrees, a target for 2020.

Tokamak Energy has now raised £117m in investment and employs 80 full time staff, a journey which started in 2010, with UKI2S making a £25,000 pathfinder investment to develop a business plan. Since then, the Fund has invested over £370,000 over several rounds of funding. UKI2S has been instrumental in bringing in co-investment by adding credibility to the business – in particular, other investors would not have invested in the seed round without the Fund's involvement. It has also assisted Tokamak Energy with finding other public funding, including from Innovate UK, and has supported the firm in other ways, through:

- **providing long-term support and advice** at Board level for over a decade
- **helping to build an experienced team**; both the Chairman and the senior Board Observer were introduced by UKI2S
- **links to other networks**, including introductions to National Grid, Centre for Process Industries and potential key suppliers.

Without the initial pathfinder investment from UKI2S, Tokamak Energy would not have been established. As an early stage company developing a very deep technology, there were no other funding options available for the business and therefore *"no alternative way forward."*

QUETHERA

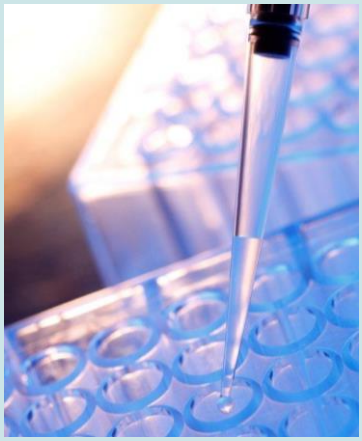
FUND	Synbio Fund
TOTAL INVESTED	£237,000
TECHNOLOGY	Gene therapy for eye disorders
LOCATION	Babraham Research Campus, Cambridge

Established in 2013, **Quethera** used gene therapy to develop novel treatments for common eye disorders. The company's initial focus was on normal tension glaucoma, a leading cause of irreversible blindness. At the time of this case study, there were no treatments available for glaucoma – existing approaches only treat the risk factors, rather than the condition itself. Quethera's proprietary gene therapy technology, still being developed, involves inserting therapeutic genes directly into target retinal cells. If successful, the treatment would be simple and inexpensive to administer, requiring only a single injection.

UKI2S was the founding and lead investor in Quethera, providing seed funding of over £150,000 from its SynBio Fund in 2015 to support the firm's initial set up and early experiments. UKI2S led the early investment syndicate. Prior to this first investment from the Fund, Quethera had been developing its therapeutic modality and had not begun laboratory work. The initial UKI2S investment was followed with another £85,000 from the Fund in the form of convertible loans, which enabled the business to demonstrate strong results with key in vitro and in vivo studies. In 2018, Quethera exited the UKI2S portfolio after it was acquired by Astellas, a Japanese multinational pharmaceutical company, in a £85m deal that includes several further milestone payments as the therapy meets development targets on the path to market (expected around 2025). Astellas continues to fund a post-doctoral researcher at the University of Cambridge who was working on the project prior to acquisition.

UKI2S remained active on the Board until the firm's exit. Over the three years of its involvement, the Fund supported Quethera in various ways, including through:

- **bringing in other investors** by making introductions and adding credibility; it was believed that co-investors would have been unlikely to invest without UKI2S
- **providing strategic advice** on business proposition
- **helping to build an experienced team**, e.g. bringing in a Board Member and recommending other candidates
- **supporting exit negotiations** by advising on offers and providing financial advice.



UKI2S was therefore instrumental in guiding Quethera through the early stages of development, and it is unlikely to have made progress otherwise*: "without UKI2S seeing the value in what we were describing, we would never have got the seed round underway and never have progressed this far."*

Quethera illustrates how UKI2S-supported companies can contribute to the development and sharing of new knowledge. Since the firm's exit, one of its two co-founders has set up another company, Ikarovec, to use the same technology platform for treating other common eye diseases, initially targeting diabetic macular oedema. As part of this research, he is working with a PhD student on the technology. The experience of building a company to a successful acquisition helped the team to develop commercialisation skills and establish a network of contacts. In June 2019, Quethera's management team was recognised with the British Venture Capital Association Management Team Award.

Assessment of additionality

Deadweight

3.17 Reflecting the role that UKI2S plays as an early stage investor, we have assessed additionality[30] as being high (i.e. deadweight is low), consistent with the Fund's investment mandate which results in supporting those companies that are unlikely to have been established or have progressed otherwise. Fundamentally, there is a strong underpinning rationale for UKI2S itself, as set out in Chapter 2 with reference to the 'Valley of Death', and the early stage funding landscape where few alternative options exist. This is reinforced by the Fund's role in subsequent development, ensuring that the businesses become sustainable.

3.18 We have made four judgments on the levels of additionality based on the consultations, as set out in Table 3-1[31]. This approach aligns with the 2013 study, though the bands have been expanded to reflect the Fund's role in both establishing new businesses and ensuring the survival and development of existing early-stage businesses.

Table 3-1: Summary of additionality judgements

Judgement on additionality (non-deadweight)	No. of companies	Commentary
Full	17	Very unlikely that the company would have been established, or it would have closed in the absence of support that UKI2S provided (including further investment through rescue/pivot rounds)
High, i.e. c. 75% additional	5	Company unlikely to have been established or continued to operate, though small chance it would have done
Medium, i.e. c. 50% additional	11	Company may well have been established and continued to operate, though this is likely to have taken longer, had a different focus, or the business would have operated at reduced scale for longer
Low, i.e. 0-25% additional	1	Likely that the company would have been established and continued to operate, much to the same degree of scale, focus and timing.

Source: SQW

3.19 There are three key arguments that have underpinned the assessment of additionality, which have applied in various ways across the portfolio, discussed as follows.

3.20 **First**, in some cases other investors would not have invested at all, or UKI2S has been instrumental as an initial co-investor:

- In the case of the former, the stage of the development (being some distance from market) or the nature of the technology presents too high a risk for private funds to invest. As explained previously, this is frequently the case for companies in the portfolio.
- In the case of the 38 pathfinder investments, 13 of these have graduated to become full investments. The purpose of these small investments is to fund exploratory work on commercial viability, often alongside technical proof of concept grants from other

[30] i.e. the extent to which companies would not have been established at all, would not have continued to exist, or would not have developed as quickly or in the same way in the absence of UKI2S.
[31] This covers the 34 companies for which both benefits and costs have been considered. It excludes the three companies where costs have been incorporated but not the benefits.

sources. This usually takes place even before the company has been incorporated and is extremely high risk. Given this, consultations suggest that these are very unlikely to have made any progress without UKI2S's pathfinder funding.

- As an initial co-investor, UKI2S is typically one of two or three within a consortium that has invested at the outset. It is difficult to be certain on the counterfactual in these cases, but consultation evidence suggests the input of UKI2S has provided confidence for other investors to go ahead. In the absence of UKI2S, companies may have been able to source other investment, for example from business angels, though this is likely to have taken longer, or may have resulted in progress stalling.

3.21 The **second aspect of additionality** is that without UKI2S's input as an active investor, businesses are unlikely to have been able to progress beyond initial rounds. As we have illustrated earlier in this chapter, the Fund's contribution to readying businesses for further investment comes in different forms, such as supporting companies with business planning and investment proposals, and using its extensive networks to identify potentially useful connections. As one consultee recognised, UKI2S was instrumental in *"nucleating the development".*

3.22 The **third aspect of additionality** is that without UKI2S's support at later stages, some businesses may have collapsed or lost focus. As illustrated earlier, there have been some examples where UKI2S's ongoing support has saved and/or helped businesses. This relates to both strategic advice, as well as the funding provided in pivot or rescue rounds. In cases where the business would not have continued to operate without UKI2S's involvement, we have assumed full additionality. In two cases, additionality judgements from the 2013 study have been revised to reflect the Fund's subsequent role in avoiding business closure.

3.23 In many cases, the arguments above are combined to provide a strong case for high levels of additionality associated with UKI2S's investment and wider support.

3.24 We note that some companies go to UKI2S as a first choice investor on the grounds that they know that other VCs will not invest at such early stages. This is distinct from the traditional view that publicly-backed funds should be the funder of last resort. In the environment in which companies are operating this may be understandable, and in almost all cases, there have been grounds for UKI2S to be involved, based on the arguments set out above. We would highlight that it is important to continue to ensure high levels of additionality by considering alternatives to the publicly-backed UKI2S.

Leakage and displacement

3.25 Leakage and displacement have been assessed as low for most of the companies. This is based on two key factors:

- For most companies, the employment and research activity is taking place in the UK, and so there is no leakage. There have been some exceptions, and in some cases the impacts have ceased to exist in the UK where activity has moved overseas. Although we note that some of the exited firms that have been bought by overseas companies have continued to operate in the UK, allaying fears that technology-based companies leave the UK upon acquisition.

- The competition for companies is often outside of the UK, because many of the companies supported operate in global markets. Moreover, in many cases companies are developing genuinely novel products for which there are no clear competitors, or are part of a small group of similar businesses developing new markets (and so not directly competing with one another).

Overall additionality

3.26 The upshot of the assessment of deadweight, leakage and displacement is that average levels of additionality are estimated at 0.7832. Put another way, 78% of the businesses would not have been established or continued to operate in the absence of UKI2S, which in simple terms means that 29 out of the 37 businesses assessed are 'net additional'[33].

[32] This covers the 34 companies for which both benefits and costs have been considered. It excludes the three companies where costs have been incorporated but not the benefits.
[33] If grossed up to the portfolio of 57 companies, this results in 44 net additional businesses created.

4. Estimates of the economic contribution

Chapter purpose

This chapter sets out our estimates of the economic contribution of UKI2S. In doing so, we follow the underlying logic of the scheme (and HM Treasury Green Book logic) starting with investment inputs (including co-investment) followed by the immediate results in terms of employment effects and R&D expenditure. The chapter then turns to consider resulting business performance in terms of export sales. The last step in quantifying the benefits of UKI2S is set out in terms of estimates of GVA based on the value of employment.

The analysis excludes multipliers. The estimates are based on historic data, and so the study does not assess any likely future economic contributions.

Summary of key findings

Based on the assessment of 37 companies, we found that the Fund has made a strong contribution to the economy through its investments. The table below sets out the economic contribution made by the portfolio companies from 2002 to 2019, including both the gross effect[34] and the additional direct impact attributable to UKI2S[35].

	Gross effect	Additional direct impact attributed to UKI2S
Co-investment leveraged	£380m	-
R&D investment by businesses	£156m	£67m
Ratio of R&D investment to UKI2S investment	-	6:1
Jobs created (based on maximum employment of each portfolio company)	772	296
Export sales generated	£169m	£56m
GVA generated	£220m	£82m
Ratio of GVA generated to UKI2S investment	-	7:1

Overview of companies covered

4.2 In total, 37 of the 57 portfolio companies have been examined as part of the study[36]. This includes three businesses for which costs have been incorporated but not the benefits due to data gaps[37]. Of these 37 companies, 31 have been invested in from the Core Fund, four from the SynBio Fund, and two from both funds (Core Fund followed by SynBio Fund in both cases).

[34] The overall direct effect made by the firms supported, before any account is made of the influence of contribution made by UKI2S.
[35] This is the combined direct effect of portfolio firms that would not have happened without UKI2S input, takes account of potential displacement and leakage, and is attributable to input from UKI2S.
[36] Investments made in the past 12 months are too young to have had an impact, and so are excluded.
[37] The levels of benefit would not have a significant effect on our estimates.

For the purpose of this assessment, we have treated the two companies that had received investment from both funds as part of the SynBio portfolio, given that the most recent investments have been from this fund. The 37 companies assessed reflect the more mature part of the portfolio, and so the assessment of impacts is fairly comprehensive of the economic contribution of UKI2S to date.

4.3 In this chapter, the estimates of the economic contribution include companies within both the Core and SynBio Funds. The corresponding figures for each of the two funds are provided in Annex D.

Key terms

4.4 Several technical terms are used in this chapter, and their meanings are presented in Table 4-1. Within this, it is important to note the values for these terms have been calculated on an individual company basis. Further detail on the data supporting this chapter's analysis is provided in Annex D of this report.

Table 4-1: A note on key terms

Term	Meaning	Simplified worked example based on employment benefits
Gross (as in 'gross' effect)	Overall direct effect, e.g. in terms of employment, made by a firm(s) supported, before any account is made of the influence of contribution made by UKI2S	= 100 employees
Additional 'direct' effect[38]	The direct effect of a firm(s), e.g. in terms of employment or GVA, that would not have happened without UKI2S input, and that takes account of potential displacement* and leakage**	= 100*(1-Dw)*(1-D)*(1-L) where: Dw = deadweight (say, 0.25 or 25%) D = displacement (say, 0.1 or 10%) L= Leakage (say, zero) e.g. 100*(0.75)*(0.9)*(1) = 67.5 employees
Additional 'direct' effect attributed to UKI2S	The effect above that is attributed to UKI2S's input (i.e. by taking account of UKI2S's role versus the inputs of other government inputs, including investments, grants, soft loans and tax/ investment reliefs)	= 100*(1-Dw)*(1-D)*(1-L)*(1-NA) where NA = non attributable (say, 0.4 or 40%) e.g. 67.5*0.60 = 40.5 employees

Source: SQW

* *in the case of UKI2S, displacement occurs when a company's activities/market share brought about through public sector support are offset (partially or fully) by a resulting reduction in the activities/market share of other UK-based companies*

** *in the case of UKI2S, leakage occurs when a company's employment, research or purchasing activities take place outside the UK*

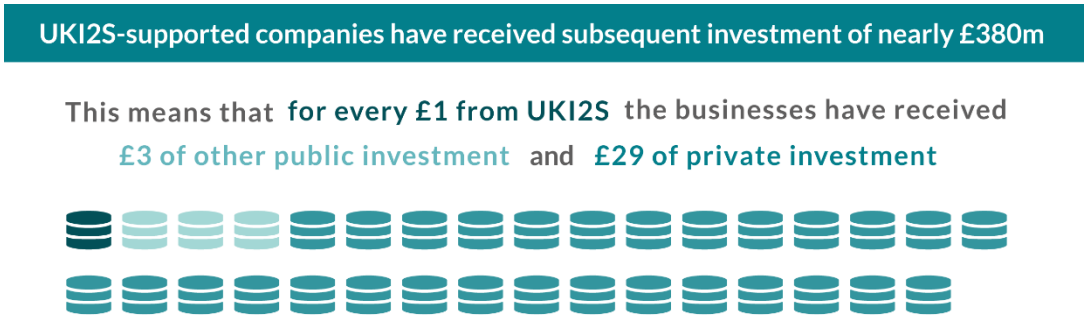
[38] It is important to note that the average additionality level of 0.78 is an arithmetic average across the portfolio of companies assessed. It is not possible to simply use this coefficient to move from 'gross' to 'additional' effect, because additionality varies across the companies and the calculation of the additional effect is affected by the relative significance of each company.

Economic contribution of the Fund

Investment

4.5 In the period of 2002 to 2019, UKI2S has invested a total of £11.6m in the 37 portfolio companies analysed as part of this study. This accounts for 3% of the total investment[39] received by those firms during this period, highlighting the significant scale of further investment in UKI2S-supported companies (see Figure 4-1).

Figure 4-1: Further investment received by portfolio companies



Source: SQW

4.6 Table 4-2 shows the balance of investment in portfolio companies, i.e. the level of investment from UKI2S compared with funding from other sources. Whilst the figures are 'gross effects' (i.e. not accounting for attribution and additionality), the data provide an indicative scale of investment that UKI2S helps to leverage in early stage innovative companies.

Table 4-2: Balance of investment (2002-19)

	Total	Average
UKI2S investment – total	£11,643,000	£315,000
UKI2S investment – start-up funding	£3,677,000	£99,000
Co-investment – total	£379,843,000	£10,266,000
Co-investment – public	£39,737,000	£2,074,000
Co-investment – private	£340,106,000	£9,192,000
UKI2S investment as a % of total investment	3%	

Source: SQW analysis of UKI2S data

4.7 According to the Fund Managers' records on the location of investors, it is estimated that around half (47%) of total private co-investment has come from overseas, representing foreign investment into the UK. In addition, the most recent major investment into one of the companies, £67m into Tokamak Energy (not included in the model's assessment as it occurred following the end point for data collection), included £50m from overseas.

4.8 The investment from other sources, along with R&D tax credits, has resulted in other public inputs into the companies. Table 4-3 presents other government inputs through R&D tax credits, and EIS, SEIS and VCT tax relief on eligible private sector investment.

[39] This includes both other public investment (equity, loans or grants) and private investment.

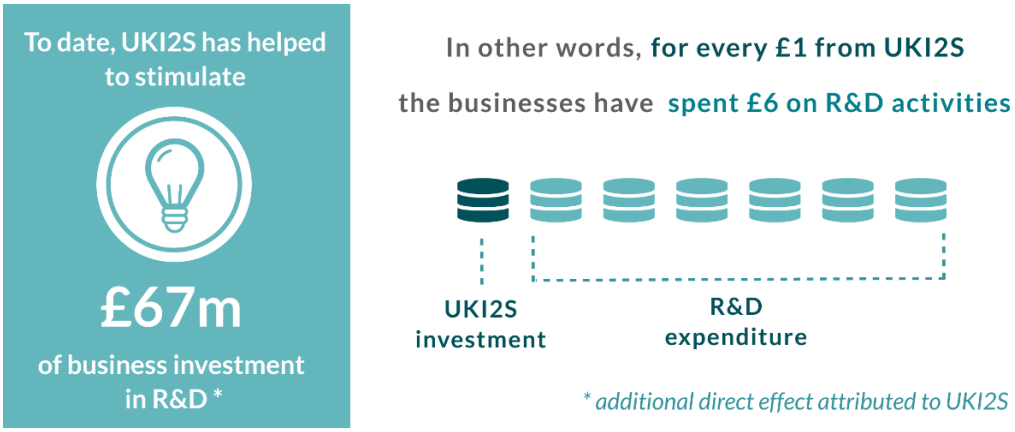
Table 4-3: EIS, SEIS and VCT eligible investment and tax relief (2002-19)

	Total	Average
Total EIS / SEIS / VCT-related investment	£67,300,000	£1,819,000
Total public subsidies through investment reliefs and R&D tax credits	£58,769,000	£1,588,000

Source: SQW analysis of UKI2S data

R&D expenditure

Figure 4-2: R&D expenditure by portfolio companies



Source: SQW

4.9 As the work of the Partners and the Fund's investment focus would suggest, all companies supported by UKI2S are heavily R&D intensive. Data of sufficient quality were available for 21 of the 37 companies (i.e. just over half of the cohort, though this includes the larger contributors to R&D expenditure). To date, these 21 portfolio companies have collectively invested, in gross terms, over £156m in R&D. This means that around half (46%) of the total cash injection in these companies[40] has been spent on R&D activities. It should be noted that there is a temporal distortion that reduces the real percentage since the denominator (i.e. funds raised) includes substantial sums raised more recently (£60m in 2018/19) and budgeted for R&D expenditure that has yet to take place and show in the R&D figures.

4.10 Of the £156m recorded as spent on R&D in these companies, £67m is estimated to be attributable to UKI2S and would not have happened without the Fund – that is an average contribution of £1.8m per company (see Table 4-4). This average is skewed by some particularly large contributors: of the 37 companies assessed, nine had additional direct impact on R&D expenditure attributable to UKI2S of over £1m (including one case where this figure was over £30m).

Table 4-4: Additional direct impact on R&D expenditure attributed to UKI2S (2002-19)

	Total	Average
R&D expenditure to date (2002-19)	£67,078,000	£1,813,000

Source: SQW Analysis of UKI2S Data

4.11 In other words, the portfolio companies have spent around £6 on R&D for every £1 invested by UKI2S. This represents a significant contribution to developing research and knowledge,

[40] Including UKI2S investment, other public investment, and private investment.

which is very relevant to the Industrial Strategy objective of raising R&D expenditure to 2.4% of GDP by 2027.

Employment

Figure 4-3: Employment created by portfolio companies

Source: SQW

4.12 We have assessed the employment associated with UKI2S firms through two key metrics: (i) maximum employment, i.e. the sum of the maximum level achieved by each company in the 2002-19 period, and ii) current employment in 2019[41]. The 'direct'[42] additional impact on employment that is attributed to the Fund is presented in Table 4-5.

4.13 Maximum employment has nearly doubled since the last assessment in 2013: from 153 to 296. This change reflects the growth in some companies, including some significant increases (e.g. Tokamak Energy), and new businesses being added to the portfolio with their associated employment. This 296 is the attributable impact to UKI2S, with a total "gross" maximum employment across the portfolio of companies of 772.

4.14 The current level of additional employment attributable to UKI2S is 213. This lower number reflects the subsequent development of companies from their peak employment, and in particular the fact that some companies (e.g. Microbial Solutions) have since been liquidated and that others have exited with associated declines in employment (e.g. Microvisk). As reported at the end of this chapter in the context of value for money, we would highlight that exited companies do not necessarily mean falls in employment, as some exited companies have retained activities in the UK and indeed expanded (e.g. Cobalt Light Systems).

Table 4-5: Additional direct impact on employment attributed to UKI2S (2002-19)

	Total	Average
Maximum employment to date (2002-19)	296 attributable to UKI2S (out of 772 max combined employment to date)	8
Current employment (2019)	213 attributable to UKI2S (out of a total of 651 jobs in 2019)	6

Source: SQW analysis of UKI2S data

[41] In current employment calculations, we have assumed that employment and salary figures have stayed the same as last year before exit (with the exception of cases where the level of employment post exit is known to be zero). This approach reflects the fact that some firms have retained a base in the UK following exit, and therefore continue to have an impact on the economy. However, in the cases where companies have expanded post-exit, this impact may be underestimated.
[42] 'Direct' impacts result from the expenditure and operation of the investee firm.

4.15 As can be expected given the technological nature of the portfolio companies, the jobs created are of high value. Over the period of 2002 to 2019, the average salary was £47,000 for staff[43] on payroll (see Table 4-6). The average annual employment cost for contract staff was £57,000 (note that this is the cost to employer and not the salary received by the contractor[44]).

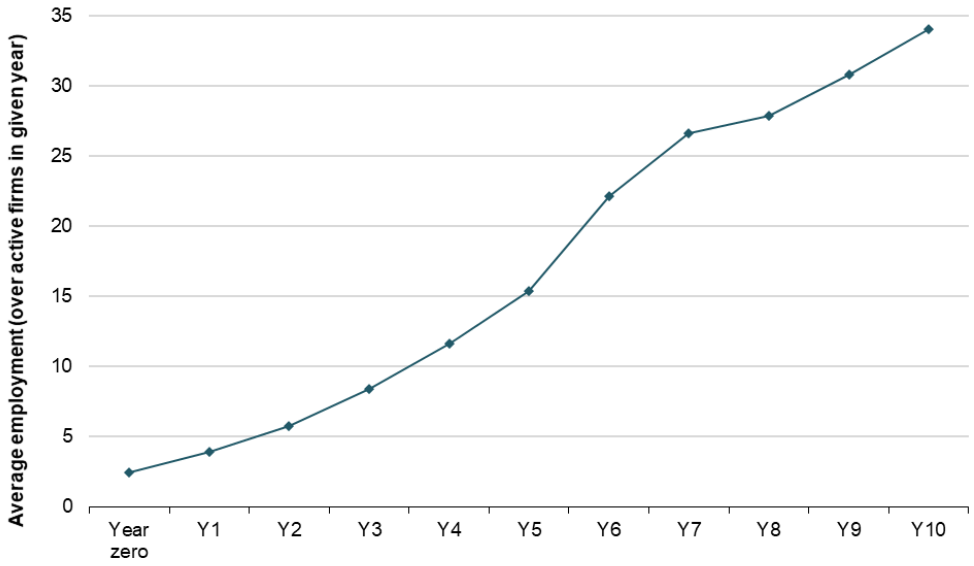
Table 4-6: Average salary (2002-19)

	Average annual salary
Average annual salary – payroll staff (2002-19)	£47,000

Source: SQW Analysis of UKI2S Data

4.16 Figure 4-4 below shows the trajectory of employment growth by plotting average gross employment figures[45] against the number of years a business has been operating. During the early years, employment tends to be low as development activity is usually undertaken by a small group of scientists. Once firms mature and near commercialisation, job numbers start increasing as additional capacity is required in-house. There is significant variation at company level, and it is important to note that the data in Figure 4-4 are for live companies reaching the relevant age along the horizontal axis. Nevertheless, the chart provides an indicative trajectory for employment of companies that reach certain levels of maturity.

Figure 4-4: Time series analysis of average employment growth across the first ten years of operating

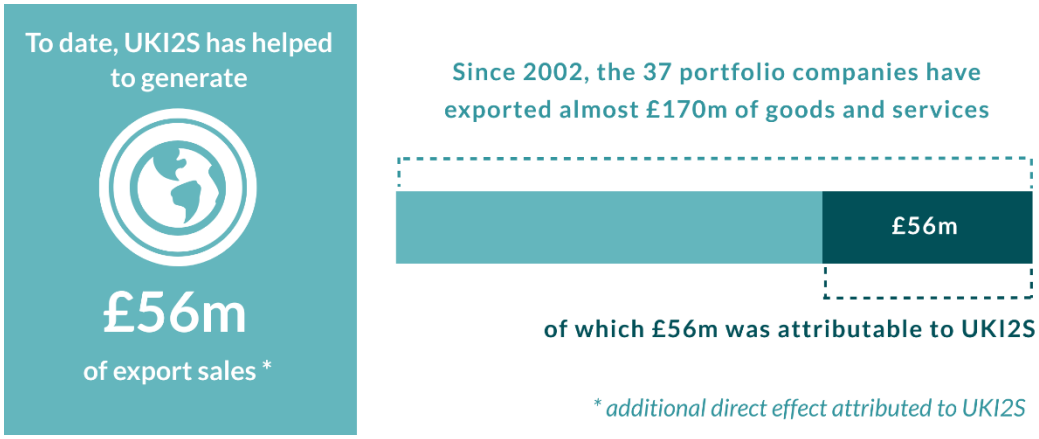


Source: SQW analysis of UKI2S data

[43] Average salary has been calculated using total employment costs (i.e. cost of employing staff to employer), which include National Insurance (NI) contributions, pensions, bonuses, and other benefits. As a proxy, we have assumed that employment costs account for 120% of salaries.
[44] Contract staff typically charge a premium of 15-25% above salary to cover NI contributions, pension and other expenses, but this depends on a number of factors including the location, sector and level of staff. It is therefore not possible to provide a meaningful salary estimate for contract staff, so we have reported on the average annual employment cost instead.
[45] The average was calculated across all active firms in any given year. Note that this includes all 37 companies in year zero, but is reduced to eight companies by year 10.

Contribution to export sales

Figure 4-5: Export sales by portfolio companies



Source: SQW

4.17 Since 2002, the portfolio companies have, in gross terms, exported just under £170m of goods and services. Of all export sales, £56m is attributable to UKI2S (see Table 4-7) – over five times higher than the contribution of £10.4m reported in the last assessment. This growth in volume of exports is reflective of companies becoming more mature and reaching sales stages.

4.18 The average direct effect attributed to the Fund stands at £1.5m, but this is skewed by some particularly large exporters (including two cases where the direct additional impact stands at over £10m).

4.19 It is important to note that a large percentage of the portfolio companies are within the biotech field, and almost all of these are entirely focused on development of novel therapies. These companies expect to be bought at some point along the research and development journey and would never expect to make sales.

Table 4-7: Additional direct impact on exports attributed to UKI2S (2002-19)

	Total	Average
Exports to date (2002-19)	£55,869,789	£1,510,000

Source: SQW analysis of UKI2S data

GVA contribution

4.20 Between 2002 and 2019, the 37 firms contributed over £220m in GVA (gross) to the economy. The direct additional impact on GVA that is attributed to UKI2S is estimated to be £82m to date (see Table 4-8), which is an increase from the £21m reported in 2013.

Table 4-8: Additional direct impact on GVA attributed to UKI2S (2002-19)

	Total	Average
GVA to date (2002-19)	£82,351,000	£2,226,000

Source: SQW analysis of UKI2S data

4.21 Note that the estimate of GVA is based on the value of additional direct employment that is attributed to UKI2S over time as a proxy. This covers part of the income approach, though excludes profits/losses. Given the nature of the companies the broad intent is to create value in technology and so continually invest in R&D, rather than generate surpluses. Therefore, reflecting surpluses/losses is potentially misleading of the value generated.

4.22 A further dimension that is excluded is the potential future value. It is difficult to estimate this given the uncertainties associated with companies and their technologies. Nevertheless, one component of this reflects the exit values for companies that have exited the UKI2S portfolio. In essence, these are proxies for the value or returns that those acquiring the companies expect to generate – and so a surplus component of GVA. Adopting the same impact methodology, the additional direct impact on GVA attributed to UKI2S through exit values is £34m (from five company exits[46]).

Regional distribution

4.23 As discussed in Chapter 2, much of UKI2S's investment is restricted to the location of its key sites and partners. The spatial pattern of the Fund's investments to date reflects its investment criteria, with a skew towards the South East and the East of England, each accounting for 13 of the 37 investments assessed in this study. Similarly, the majority of the Fund's investments (23 of the 37) have been within the "Golden Triangle" of Cambridge, Oxford and London. For comparison, Beauhurst has estimated that the Golden Triangle attracted 75% of all equity investment into spinouts in 2019.[47]

4.24 Table 4-9 presents the regional distribution of UKI2S's portfolio in terms of the number, cost and estimated GVA impact of the 37 investments reviewed as part of this study.

Table 4-9: Geographical distribution of UKI2S investment to date (2002-19)

	Number of investments		Cost of Investment		GVA impact of investment[48]	
	n	%	£	%	£	%
Regions						
South East	13	35%	£4,657,000	40%	£58,443,000	71%
East of England	13	35%	£4,336,000	37%	£12,309,000	15%
Greater London	3	8%	£1,107,000	10%	£750,000	1%
Other regions / devolved nations	11	30%	£2,650,000	23%	£11,600,000	14%
Golden Triangle vs other						
Golden Triangle	23	62%	£8,088,000	69%	£68,362,000	83%
Other	14	38%	£3,555,000	31%	£13,989,000	17%
Total	37	100%	£11,643,000	100%	£82,351,000	100%

Source: SQW analysis of UKI2S data

4.25 The creation of the SynBio sub-fund in 2013 has given UKI2S more opportunities to invest in other parts of the country because it is not tied to specific partners or sites. This is evident in the data covering the wider set of 57 companies that UKI2S has invested in to date (i.e. not just the 37 reviewed in this study), which shows that 11 of the 17 investments through the SynBio Fund – accounting for two thirds of the total amount invested from this fund – have been made outside the Golden Triangle. Table 4-10 presents the full breakdown of investment data for all 57 companies from the two funds.

[46] Cobalt Light Systems, Orbital Optics, P2i, SALT and Quethera.
[47] Beauhurst (2020) Equity investment into UK spinouts. Available here.
[48] Direct additional impact attributed to UKI2S

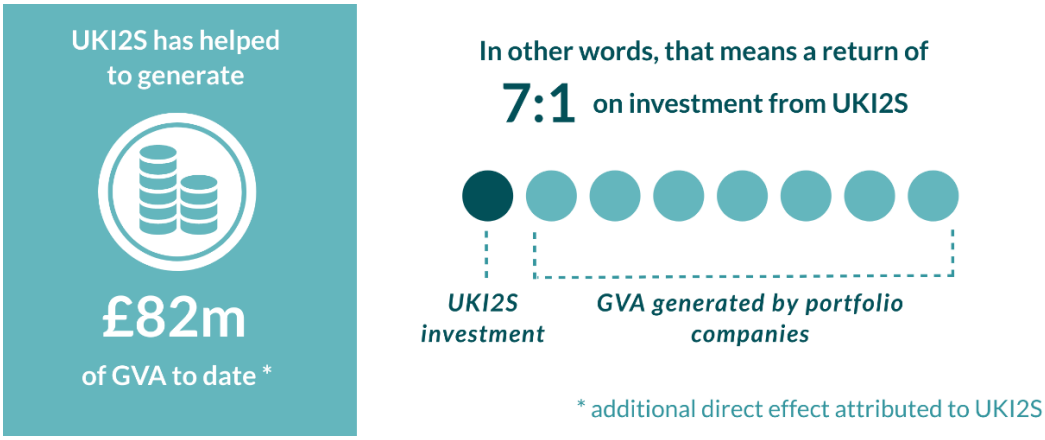
Table 4-10: Geographical distribution of all UKI2S investment to date by fund (2002-19)

	Number of investments (n)		Cost of investment (£)	
	Core Fund	SynBio Fund	Core Fund	SynBio Fund
Regions				
Greater South East [49]	27	11	£8,388,000	£2,860,000
Other regions	13	6	£2,342,000	£1,102,000
Golden Triangle vs other				
Golden Triangle	22	6	£7,289,000	£1,289,000
Other	18	11	£3,440,000	£2,673,000
Total	40	17	£10,730,000	£3,962,000

Source: SQW analysis of UKI2S data

Value for Money

Figure 4-6: Value for Money



Source: SQW

4.26 Based on the GVA to date estimate of £82m, and the investment inputs into the companies[50], the Fund has generated a return of £7 per every £1 invested in the period of 2002 to 2019 (see Table 4-11). Reflecting the growth in impacts to date since the previous assessment in 2013, the return on investment figure has improved from 3:1.

Table 4-11: Return on Investment (2002-19)

	Based on additional direct impact attributed to UKI2S to date
Return on Investment (2002-19)	7:1

Source: SQW Analysis of UKI2S Data

4.27 The analysis of value for money can also be viewed through an assessment of the cost per job that is additional and attributed to UKI2S (see Table 4-12). This is based on the level of current and maximum employment, and so represents a measure of the cost per job that has been

[49] Covering South East, East of England, and Greater London
[50] Due to gaps in data, the total benefits across the 34 firms have been set against the investment costs for the set of 37 companies supporters. Investment figures include inputs made through investments but exclude the fund management costs.

sustained or created to date. In interpreting these figures, it is important to note that the value of jobs being created is clearly high given the technological nature of the employment.

Table 4-12: Cost per job – additional and attributed to UKI2S

Indicator	Cost per job
Cost per current job (2019)	£55,000
Cost per maximum job (2002-19)	£39,000

Source: SQW analysis of UKI2S data

4.28 Two further aspects are important in highlighting the value for money of the Fund:

- UKI2S is intended to be an "evergreen" fund, designed to be at least partially self-renewing. As an investment fund it holds assets (i.e. stakes in companies) that should be realisable in future years, and the proceeds can be recycled into further investments. Therefore, in favour of value for money is that returns on investment can be put to work again. Exits from the fund have generated £8.7m of returns to the Fund for reinvestment.

- There is evidence of some exited firms retaining a base, or indeed expanding, in the UK and therefore continuing to have an impact on the economy. For example, after Cobalt was acquired by Agilent, the multinational life sciences company chose Harwell as the base for its flagship Raman spectroscopy site. Since the close of the period covered by this report, the Fund has also sold its stake in Spectral Edge to Apple. Terms of the deal are undisclosed but the Fund principals are satisfied that the aims of the Fund have been satisfactorily met and are particularly pleased to note that the purchaser is maintaining and is likely to expand the current base of operations in Cambridge.

Progress of the economic contribution since 2013

4.29 UKI2S has therefore made a strong economic contribution through its investments. Table 4-13 summarises the headline findings on the economic contribution to date, providing a comparison with the corresponding figures from the 2013 study to illustrate the progress in contribution in the last six years.

Table 4-13: Summary of key indicators on current economic contribution (2002-19)

Investment indicators	**2002-13**	**2002-19**
UKI2S investment	£6,369,000	£11,643,000
Co-investment – total	£126,791,000	£379,843,000
Co-investment – other public	*Data not available*	£39,737,000
Co-investment – private	*Data not available*	£340,106,000
Impact and value for money indicators	**Additional direct impact attributed to UKI2S**	
	2002-13	**2002-19**
GVA[51]	£21,022,000	£82,351,000
GVA per £ of UKI2S invested	3:1	7:1
R&D expenditure	-	£67,078,000
Combined max employment of firms	153	296
Cost per maximum job	£42,000	£39,000
Current employment (2013 / 2019)	142	213[52]
Cost per current job (2013 / 2019)	£45,000	£55,000
Exports to date	£10,370,000	£55,870,000

Source: SQW analysis of UKI2S data
Base: 2013 = 25; 2019 = 37

[51] As measured by the value of employment over time.
[52] Note that for exited companies, we have assumed that the employment and salary figures have stayed the same as last year before exit (with the exception of cases where the level of employment post exit is known to be zero).

5. Wider benefits of UKI2S

Chapter purpose

This chapter sets out the evidence on the wider benefits of UKI2S, based on consultations with company representatives. This is focused on two key aspects relating to the role of UKI2S in contributing to the objectives of the key partners, in particular: commercialising the technologies to contribute to society, and the development and sharing of new knowledge and skills. The analysis looks at the combined effects of both the Core and SynBio Funds.

Summary of key findings

A review of the types of technologies developed by the portfolio companies has evidenced their importance more widely to society. In this chapter, we present a series of examples to illustrate where benefits from commercialisation have or are expected to occur. These identify different types of wider benefits resulting from application of new technologies across a broad range of sectors, ranging from drug development and advanced medical diagnostics through to security and space applications to technologies highly relevant to climate change (including fusion energy and plant science).

A second set of wider benefits relates to the Fund's role in contributing to the development and sharing of new knowledge. More specifically, we have identified two areas where these impacts have occurred: developing and sharing new knowledge through collaborative activity, and developing innovation and commercialisation skills.

Contributing to wider societal outcomes through application of research

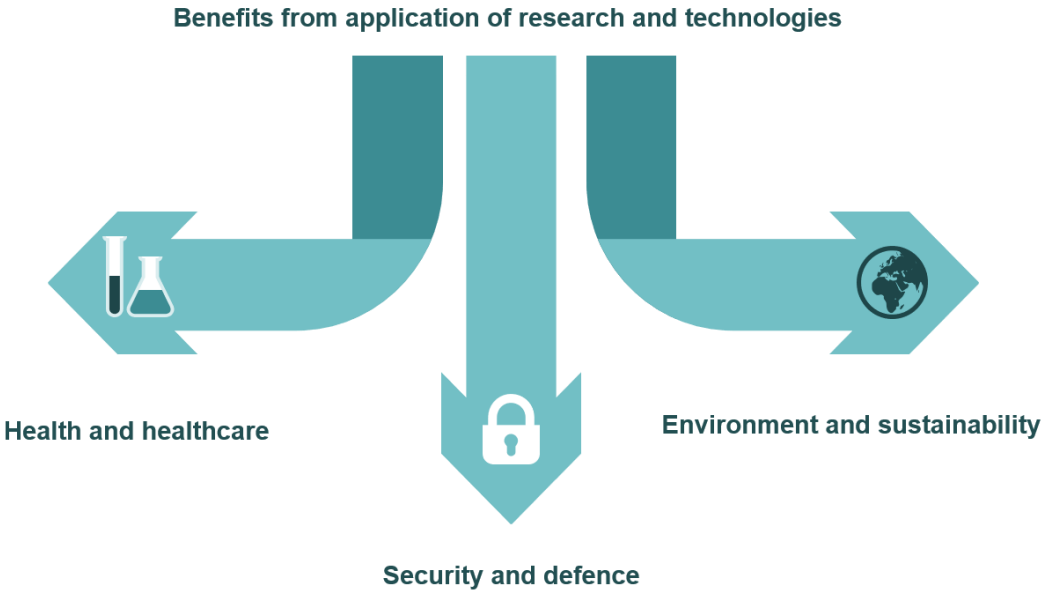
5.4 As part of their organisational objectives, the partners of UKI2S have a remit to ensure that the science and research that they fund contributes to the society through the application of new technologies and ideas. The formation and development of spin-outs that apply technologies in ways that contribute to societal outcomes represents one way to do this.

5.5 Another key objective for the partners is to ensure the competitiveness of the UK in the relevant areas. This is particularly pertinent for Dstl, which has a core objective of helping to maintain the UK's advantage on the global stage in defence and security. Fulfilling this goal is critical for national security, and important for ensuring value for money for the taxpayer through Ministry of Defence spending.

5.6 As was identified in Chapter 2, UKI2S has invested in a wide variety of technologies with a range of potential applications. This is also the case for the SynBio Fund: although there is a specific focus on companies working in the field of synthetic biology, this technology can be translated into applications across various sectors.

5.7 We have grouped the investments from the two UKI2S funds into three very broad areas where (potential) benefits occur have been identified: health and healthcare; security and defence; and environment and sustainability. There are many interesting examples of new technologies that can lead to wider benefits, but these are difficult to quantify at this stage. The following sub-sections include examples from case studies to demonstrate the benefits or potential benefits in these three areas. In several cases the technologies have a wide range of possible applications.

Figure 5-1: Wider benefits of UKI2S



Source: SQW

Health and healthcare

5.8 In health and healthcare, a key area of work relates to drug discovery – a field characterised by a lengthy development process. For companies operating in this field, the length of time to market is a barrier to attracting investment (exacerbated further by the typically high amounts required), and so UKI2S has played a key role in establishing the businesses or accelerating their development.

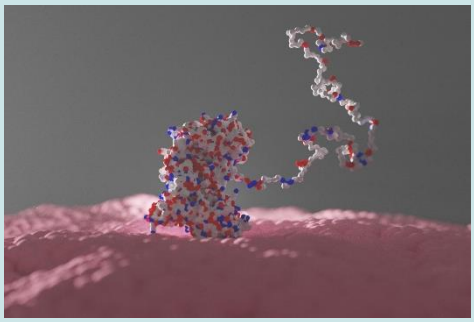
5.9 Key potential benefits in this area relate to improving treatment of diseases (including glaucoma and various types of cancers), and addressing growing concerns around drug resistance[53]. The four case examples below illustrate the impact of these technologies.

Case examples: improving treatment of diseases

Quethera (£237,000 invested from SynBio Fund) is using gene therapy to develop novel treatments for common eye disorders. The company's initial focus was on glaucoma, the leading cause of irreversible blindness for which there are currently no treatments available – existing approaches only treat the risk factors, rather than the condition itself. Quethera's gene therapy approach allows the use of therapeutic

[53] We note that the firms do not see the NHS as a prime market for their discoveries given the inherent difficulties in selling novel interventions to the NHS.

genes directly into target retinal cells. With only a single injection required, it would be easy and cheap to administer. The therapy is currently six years away from commercialisation[54]. In 2018, Quethera was acquired by a multinational pharmaceutical company in a deal which enables further development of the treatment.



CytoSeek (**£410,000 invested from SynBio Fund**), a spin-out from the University of Bristol, is developing the next generation of cell therapies. Using cell membrane augmentation technology, the business seeks to address conditions which small molecule drugs are currently unable to tackle. So far, it has undertaken several proof-of-concept projects, identifying three key areas of application: immuno-oncology (key focus), cardiovascular heart therapy, and cartilage repair.

Case examples: developing novel drugs to address resistance

Originally a spin-out from the Gurdon Institute at the University of Cambridge, **CellCentric** (**£460,000 invested from Core Fund**) is a biotechnology company focussed on epigenetics – an emerging field in drug discovery and development. The firm's key area of work is in developing a new drug for late-stage prostate cancer patients whose tumours are unresponsive to existing drugs. Pre-clinical data has verified in vivo efficacy of the drug, and clinical trials are currently ongoing. This technology is also expected to have potential applications for other types of cancer that do not respond to current treatments, including haematological malignancies, lung and bladder cancers.

Another company, **Nemesis** (**SynBio Fund**), is developing Transmids, therapeutic agents that can eliminate antibiotic resistance genes. Crucially, the company's therapy does not directly kill the bacteria that are causing the infection, but instead removes the bacteria's ability to resist treatment with antibiotics. This allows existing antibiotics to remain effective and provides a way to protect against the risk of resistance when administered alongside novel antibiotics. Avoiding killing bacteria directly helps reduce selection for resistance to Nemesis' drugs and, hopefully, will prolong their effectiveness. At the time of this study, Nemesis had generated in vivo data demonstrating that the approach is effective and is in the midst of its series A raise.

5.10 In addition to those companies directly involved in drug discovery, there are others developing applications to service and supply the sector. For instance, Atelerix has developed

[54] It is noted that the treatment is unlikely to be available through the NHS.

an innovative technology which allows the storage and transportation of cells at room temperature (see example box below). Other examples include the following:

- **Eagle Genomics** (**£375,000 invested from Core Fund**) is developing a software platform to help pharmaceutical and biotech companies understand the notoriously complex genomic and microbiomic datasets.
- **Perfectus Biomed** (**£150,000 invested from Core Fund**) provides microbiological testing services relating to microbiology research, biofilm testing, cell culture testing and viral testing.
- **Synthace** (**£550,000 invested from SynBio Fund**) has developed a software platform for biological research.

Case example: improving cell storage and transport

Atelerix (**£186,000 invested from Core Fund**), a spin-out from the University of Newcastle, has developed an innovative cell encapsulation technology that allows cells to be stored and transported at room temperature. Cryo-shipping – the prevalent method for transporting cells – is costly and typically causes some cells to die during transit. Atelerix's method for preserving and transporting cells is a more effective alternative to freezing them, and the only existing solution for those cells that cannot be frozen. In effect, it helps to lengthen the life of cells.

The firm's key clients include companies involved in drug discovery or developing cell therapy products. The benefits of this technology are illustrated in the case of a customer in India with a cell treatment for the reversal of blindness caused by scarring of the cornea. The company's therapy had been proved effective, but the cells they use only live for a maximum of eight hours. Without being able to ship these cells, the company was limited in its ability to reach patients. The technology from Atelerix has extended the shelf life of cells to up to five days, enabling transportation to anywhere across the subcontinent.

Security and defence

5.11 The second set of benefits relates to defence and national security. The first case study example below draws on Cobalt Light Systems and the application of its technology, originally developed at an STFC laboratory, in security and more widely. The second example looks at Oxford Space Systems, a business based at the Space Cluster in Harwell, which has developed the next generation of deployable antennas.

Case studies: Defence and national security

Cobalt Light Systems (**£432,000 invested from Core Fund**) was established as a spin-out from STFC's Central Laser Facility at the Rutherford Appleton Laboratory (RAL) in Harwell. The company's innovative technology is able to measure concentrations of materials and substances inside containers with a high degree of accuracy. Using this Raman spectroscopy based technology, Cobalt Light Systems has developed a portfolio of four benchtop and handheld instruments. The non-invasive, through-barrier chemical analysis has applications in security: the scanners are widely deployed at EU airports, providing screening of liquids, aerosols and gels (see photo). The handheld portable unit can be deployed to detect hazardous chemicals, explosives and narcotics, for instance by first responders on crime scenes or at environmental disaster zones. Outside security, there are applications in pharmaceutical research and production, helping to produce cheaper and more reliable drugs.

Case study: Space

Oxford Space Systems (**OSS, £346,000 invested from Core Fund**) has developed its own proprietary materials which can be used to produce a range of products for the satellite industry. Specifically, this relates to the next generation of deployable satellite antennas and space structures such as boom systems and panel arrays (photo below shows a deployable wrapped rib antenna). One innovative material allows the company to produce lighter, less complex, and more cost-efficient antennas for the commercial space industry. This gives OSS a considerable competitive advantage, enabling it to exploit the opportunities presented by the ongoing changes in the industry (particularly the so-called 'new space' movement lowering barriers of entry). In 2016, the company set a world record moving from product concept to successful on-orbit demonstration in less than 30 months.

In January 2019, OSS was awarded a £1m contract from the Ministry of Defence (MOD) to develop an innovative antenna to improve UK's capabilities in the space domain. This would make the UK the first country in Europe with a flight-proven parabolic deployable antenna. In collaboration with Dstl and the Defence Innovation Fund, it is the largest contract placed with a first-time supplier by the Defence and Security Accelerator (DASA) and MOD. This contract represents a major inflection point for the company, and the credibility added by the UKI2S investment was

considered to have *"helped phenomenally to secure it."* It has also recently been announced that OSS antennas are likely to be used by the MOD in Project Oberon, a project tasked with developing a cluster of military radar satellites for the UK.

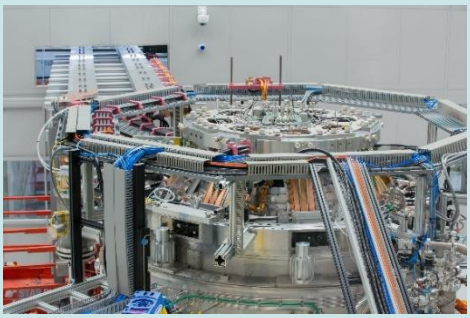
The firm's proprietary materials have a wide range of applications. For instance, OSS has the potential to become a major supplier of antenna technology to constellations that are providing the next generation of Internet connectivity. This would have global benefits, improving internet access in developing countries. The satellite technology can also be used for near real-time earth observation with high accuracy and at high resolution. In this area, potential applications include land use monitoring, disaster monitoring, urban planning, and illegal activity monitoring.

Environment and sustainability

5.12 The third area of wider societal outcomes relates to environmental benefits. UKI2S has invested in several companies contributing to a transition towards a low carbon economy. Two such examples, Tokamak Energy and MIRICO, are provided in the box below.

Case examples: Contributing to a low carbon economy

Originally spun out from the Culham Centre for Fusion Energy, **Tokamak Energy** (**£400,000 invested from Core Fund**) is developing commercial fusion power, based on the reaction that powers the sun and the stars. By combining spherical tokamaks (see photo) with the latest generation of high temperature superconducting magnets, the firm is seeking to build a device capable of replicating the sun's processes on Earth. Fusion is an alternative to fission, the form of energy creation currently used by all nuclear power plants. Compared with fission, fusion is safer (with no risk of meltdown and no by-product of radioactive waste), has extremely high energy density, and the fuel is abundant. It therefore presents the potential to be a cheaper and more sustainable long-term source of energy. The company forecasts that by 2050, fusion energy could account for a fifth of total energy production, resulting in the equivalent of a 25% reduction in current CO2 emissions globally. The high temperature superconducting magnet technology – where tokamak energy has world-beating technology - has a range of potential applications outside tokamak fusion including proton beam therapy, particle accelerators, scientific research magnets, energy storage, and energy efficient industrial processes.



Another company, **MIRICO** (**£350,000 invested from Core Fund**), is working on innovative spectroscopic instruments for highly accurate gas analysis. Originally developed at STFC, this laser sensing technology has a breadth of applications, delivering laboratory standard measurements of air quality and atmospheric gases. By delivering a more accurate environmental monitoring solution, it enables scientists to better understand the impacts of climate change. Other applications for MIRICO's technology include emissions monitoring on oil and gas facilities and industrial process monitoring.

5.13 Another portfolio company, Tropic Biosciences, contributes to sustainability by addressing the environmental burden caused by the growing world population (see box below).

Case example: Innovation in agricultural production to meet nutritional demands

The rapidly growing population in the Tropics presents nutritional challenges for the region, and a demand for more productive and environmentally friendly agricultural production. **Tropic Biosciences** (**£241,000 invested from SynBio Fund**), based at Norwich Research Park, seeks to address these additional needs by using the CRISPR genome editing technology to develop new, high-yielding varieties of tropical crops. It is, for instance, for instance, developing varieties of bananas with increased resistance to diseases. The business is about to start field trials for its banana and coffee plant varieties, and plans to utilise the technology on other crops in the future. In addition to environmental benefits relating to more sustainable agricultural practices and a reduction in waste, the more versatile and nutritious plant varieties are expected to increase grower wellbeing and enhance consumer health.

Contributing to the development of new knowledge and skills

5.14 The second set of wider benefits relates to the Fund's role in contributing to the development and sharing of new knowledge. Consultation evidence identified two broad areas where these impacts have occurred: collaboration between research and industry; and skills development.

Developing and sharing new knowledge through collaborative activity

5.15 Consultations with Core Fund companies indicated that they continue to have strong links with the research base, including the "parent" site where the original research was undertaken. This includes arrangements for sharing of staff and access to laboratories or office space during the earlier stages, and subsequent collaborations even after the physical links no longer exist. In many cases, the companies have also engaged with new partners across the wider research base. Oxford Space Systems provides an example of strong connections with the research campus at Harwell and beyond (see box below).

Case example: on-going collaborations between research base and industry

Based at the **Harwell Space Cluster**, part of the national science and innovation campus in Oxfordshire, **Oxford Space Systems** (**OSS, £346,000 invested from Core Fund**) is at the heart of the internationally recognised space cluster. Established in 2013, it was at the time one of only four space companies based there. Over time, the campus has grown considerably, now hosting over 90 organisations operating within the space sector. OSS makes extensive use of the facilities and expertise of this vibrant ecosystem. For the first couple of months after inception, the firm was based at the Satellite Applications Catapult, and has over the years maintained a close working relationship with the Catapult. STFC's RAL Space Laboratory has provided OSS with access to its test facilities, and the two organisations have identified potential projects to co-develop technologies in the future. Outside Harwell, the firm has academic collaborations with the University of Oxford through sponsoring a PhD, the advanced composites lab at Bristol University

and the material science department at Nottingham Trent University. They are also currently exploring opportunities to collaborate with the National Composites Centre.

5.16 Although the SynBio Fund places less emphasis on connections with the research base (and this is not part of the application criteria), similar linkages are visible across the portfolio. For instance, Synthace and CytoSeek have developed and facilitated working relationships with a number of universities.

5.17 There is also evidence of continued relationships with the researchers involved in the original science following exit. There are examples of scientists both joining the company on a formal basis (e.g. MIRICO and Procarta), or taking a more informal advisory role and *"continuing to inspire"* the firm's work (e.g. Cobalt Light Systems and Quethera).

Developing innovation and commercialisation skills

5.18 Through the process of building a company, the individuals involved have incrementally developed their own skills and experiences. Although difficult to evidence or quantify, the benefits through skills development are visible across the portfolio. For Quethera, the experience of setting up a successful company has led to further enterprising behaviour following the company's exit (see example box below). Similarly, the academic Co-Founder of Atelerix has established a new business but remains active in both. In the case of CytoSeek, this effect expands beyond the company. After helping CytoSeek go through the process of spinning out, a member of staff at Bristol University's technology transfer office has moved on to become the CEO of another spin-out company from the university.

Case example: Facilitating enterprising behaviour

Quethera (**£237,000 invested from SynBio Fund**) was developing novel treatments for glaucoma using gene therapy. In 2018, the firm exited the SynBio Fund portfolio following acquisition by Astellas, a major Japanese pharmaceutical company. Since then, one of its co-founders has set up another company – Ikarovec – to use the same technology platform for treating other common eye diseases, initially targeting diabetic macular oedema. The other co-founder, a professor at Cambridge University, is informally supervising a PhD student working on this technology at the university's lab facilities. The experience of building a company to a successful acquisition helped the team to develop commercialisation skills and establish a network of contacts. In June 2019, the original management team was recognised with the British Venture Capital Association Management Team Award. As the founding investor, UKI2S remained on the board until exit and provided strategic advice over the years.

The founder of Quethera turned to UKI2S for funding for his next venture, **Ikarovec.** This has recently been concluded, with UKI2S leading a seed funding round of £2.4m.

5.19 The consultations also identified two other related examples worth highlighting, as follows:

- The R&D phases/programmes of companies often involve studentships or engagement with other early career professionals/researchers, e.g. in the case of Oxford Space Systems (sponsoring a PhD student) and Tokamak Energy (a number of PhD students, and one Knowledge Transfer Partnership).
- Some individuals have moved between portfolio companies, e.g. the former COO of CellCentric joined Synthace, and the current CEO of Atelerix moved from Abeterno (now dissolved).

5.20 The above evidence, therefore, clearly shows that the impact of companies supported by UKI2S extends beyond the economic contribution to also deliver wider societal benefits. Many of the technologies developed by the portfolio businesses are closely aligned with the four Grand Challenges set out in the Industrial Strategy, particularly relating to the clean growth and ageing society challenges.

6. Conclusions

6.1 We present below our overall findings and conclusions from the study.

Role of UKI2S in supporting spin-outs and early-stage research-intensive companies

6.2 The evidence presented in this report indicates that UKI2S helps companies to become established and/or to develop in ways that would not have happened otherwise. The upshot of the assessment is that around 78% of the businesses would not have been established or would not have continued to operate in the absence of UKI2S.

6.3 The role played by UKI2S extends far beyond simply the funds provided through investment. The Fund maintains an interest in supporting its portfolio companies from the initial investment until the eventual exit. The key roles that UKI2S has played are as follows:

- the Fund's core role is as an investor that helps to bridge the 'Valley of Death' for early stage companies by investing when the market views the risks as being too high
- as a lead or co-lead in early investment rounds – UKI2S is typically one of two or three within a consortium that invests at the outset
- helping companies find further funding (£340m of private co-investment and £40m of public co-investment has been leveraged to date), both directly and indirectly through:
  - using its networks to identify potential investors and make connections – as one consultee recognised, the Fund is *"always championing the next investment"*
  - signalling credibility to other investors
- utilising its extensive networks to identify key staff or other relevant connections
- the support it provides during the initial stages of company formation and development, including help with developing a business plan, building an experienced team, and helping to navigate the investment landscape
- the on-going involvement at company board level, providing strategic and financial advice to the company, and an additional perspective alongside other board members
- the support it provides at crunch times when a change of focus or even more substantive action is required such as coordinating rescue or pivot rounds.

Economic contribution of UKI2S

6.4 The headline findings on the economic contribution to date that is attributable to UKI2S, based on the assessment of the 37 companies covered, are summarised in Table 6-1.

Table 6-1: Summary of key indicators on economic contribution to date (2002-19)

Impact and value for money indicators	Additional direct impact attributed to UKI2S
GVA[55]	£82,351,000
Ratio of GVA to UKI2S investment	7:1
R&D expenditure	£67,078,000
Ratio of R&D expenditure to UKI2S investment	6:1
Combined maximum employment of firms	296
Cost per maximum job	£39,000
Exports to date	£55,870,000

Source: SQW analysis of UKI2S data

Contribution to societal outcomes

Benefits resulting from commercialisation of new technologies

6.5 A review of the types of technologies developed by the portfolio companies evidences their importance more widely to society. In the main report, we present a series of examples to illustrate where benefits from commercialisation have or are expected to occur. These cover a wide range of technologies and potential applications from healthcare to clean energy.

6.6 Many of the technologies developed by the portfolio businesses are therefore closely aligned with the four Grand Challenges set out in the Industrial Strategy, particularly relating to the clean growth and ageing society challenges.

Benefits resulting from development and sharing of new skills and knowledge

6.7 A second set of wider benefits relates to the Fund's role in contributing to the development and sharing of new knowledge. Consultation evidence identified two areas where these impacts have occurred:

- **Developing and sharing new knowledge through collaborative activity**: Many companies have strong links with the research base. In the case of Core Fund companies, this includes the "parent" site where the original research was undertaken. Examples of these continued relationships include arrangements for sharing of staff and access to laboratories or office space during the earlier stages, and subsequent collaborations even after the physical links no longer exist. There is also evidence of both Core and SynBio Fund companies engaging with new partners across the wider research base.
- **Developing innovation and commercialisation skills**: Through the process of building a company, the individuals involved have incrementally developed their own skills and experiences. Although difficult to evidence or quantify, the benefits through skills development are visible across the portfolio, e.g. in cases where the experience of setting up a successful company has led to further enterprising behaviour.

[55] As measured by the value of employment over time.

Overall, UKI2S is making a critical contribution to commercialisation objectives

6.8 UKI2S therefore makes an important contribution to producing economic and broader impact from its partners' investment in research and infrastructure. It is evident from this summary that the Fund plays an important role in filling a gap in the provision of early stage ultra-patient capital for deep tech companies. Moreover, it is shown that the Fund's role in supporting the formation and development of businesses extends far beyond the funding provided.

Annex A: Method for estimating the economic benefits

A.1 This Annex sets out a methodology statement for the analysis of the economic contribution.

Measures of economic benefit

A.2 The approach recognised the need to consider a basket of indicators to measure the economic contribution of UKI2S. This reflects that companies in the portfolio were established to build their value through their knowledge and intellectual property assets, which means that surpluses can take a significant amount of time to be achieved. This follows Scottish Enterprise guidance, which highlights the importance of considering alternative measures (to Gross Value Added, GVA) to fully assess the impact of schemes on pre-commercial or early stage businesses[56]. An estimate of GVA was provided as part of the assessment, as per the objectives of the client Brief. In Table A-1we provide the measures of economic benefit assessed and the principal sources of evidence.

Table A-1: Key measures and principal sources of data

Indicator of economic benefit	Justification	Principal sources of data
Co-investment	Provides, in 'gross' terms, an indicator of the leverage of other investment	UKI2S-held data on company investments through CAP tables + data from consultations
Estimate of the 'net' number of companies created	Gives an indication of the extent to which UKI2S is supporting the commercialisation of research and start-up of new businesses that would not have happened otherwise	Interviews with Fund Managers and companies on whether the company would have been created otherwise.
Employment created	Provides an indication of economic activity generated	Company account data Outsourcing has been assessed separately for significant cases – based on data held by the Fund Manager
Cost per job	Indicates the ratio between overall value of investment in companies and jobs created	Derived from ratio between employment and UKI2S investment
Value & proportion of sales that are exports	Injection to circular flow of income	Company account data
GVA	Values the economic contribution that can be compared to other investments	Derived from company account data (on employment costs)
R&D expenditure	Investment in knowledge that can be translated into future economic value; key policy relevance as an important metric for the Industrial Strategy	Derived from company account data or R&D tax credit information

Source: SQW

[56] Scottish Enterprise (2008) Additionality and Economic Impact Assessment Guidance Note, Scottish Enterprise, Glasgow

A.3 The remainder of this Annex sets out the technical detail on the approach, in particular on assessing additionality, attribution and GVA effects. A summary of data collection approaches is provided at the end of the Annex.

A.4 This updated assessment has considered how the effects have evolved from the 2013 review when the substantive portion of the economic value was expected, rather than achieved. This has been done at the level of the 'core fund' and focussed on overall progress, with additional narrative provided on how the fortunes of one or two companies have made a significant difference to the whole.

Additionality and attribution

Assessing the counterfactual

A.5 The most rigorous methods for assessing the counterfactual normally use some form of comparison or control group of non-beneficiaries. The nature of UKI2S and its companies makes this very difficult, and there are a number of reasons why a comparison group cannot be established:

- UKI2S-supported companies are very much non-standard businesses, as they often require seed funding to develop and start to demonstrate their technology. UKI2S is a funder with a risk appetite that is not acceptable to private investors. By investing when the market considers the risk to be too high, UKI2S specifically targets companies that have been discouraged from accessing finance elsewhere. (UKI2S is normally a last resort funder for commercialising the research from which the business is derived).

- There are no standard comparisons that can be drawn from standard datasets such as the Small Business Survey or administrative data, and no expected business growth rates given the highly differentiated nature of the businesses. Whilst a matched group could potentially be found, e.g. using Beauhurst datasets, there is a further reason why any assessment would be challenging. The performance of UKI2S and other similar companies is hugely heterogeneous with small numbers of star performers. With such a high level of variance and with very small numbers of companies (under 50 in total in UKI2S) it would not be possible to detect a statistically significant difference.

- The way in which UKI2S identifies companies for investment is highly selective. There is no 'application process', and those ideas that are not supported tend not to result in new businesses. For example, UKI2S has supported a series of 'pathfinders' with small investments (of up to £50k). Where these have showed promise, a small number of pathfinders have been taken forward as full investments.

A.6 Therefore, in the absence of a sensible comparison group, we have drawn on feedback of Fund Managers and companies themselves on the likelihood of the business being able to start in absence of UKI2S (e.g. securing alternative investment elsewhere). This qualitative insight has informed a judgement on the levels of additionality associated with commercialisation and each new business venture, and this has been applied to other key indicators around employment, value of exports and GVA.

Attribution/apportionment

A.7 Closely related to additionality is the issue of attribution or apportionment of benefits (i.e. benefits relating to employment, value of exports and GVA) to UKI2S versus other funds or grants. Evaluation practice indicates a need to attribute between various government inputs to assess the benefit attributable to a particular intervention. Therefore, our assessment of attribution was based on government-backed inputs and investment (i.e. government-backed investment funds, including European funds, grants such as Innovate UK grants, or inputs derived from investment through EIS and VCT relief). A second point to note is that UKI2S is normally a first round (or at least early round) investor, i.e. when risk is highest. There are co-investors, either at the same time or, more commonly, with more substantial sums invested in later rounds once technology becomes more proven. We needed to ensure that we appropriately apportion impacts based on when risk is highest, and so we have focussed the attribution calculation on the seed rounds (i.e. first and potentially second rounds) of investment. In addition, given its role UKI2S often provides support and advice to companies at the start and through subsequent investment rounds, including organising rescue rounds. The approach to attribution has taken this into account.

A.8 Our approach to attribution, therefore, was as follows:

- Apportion based on UKI2S, and other public-backed investment (including relief on private sector investment) made in the first round or two of funding provision.
- The default apportionment was based on the proportion of value of the first one or two rounds of investment, i.e. if UKI2S invested 50% of government-backed investment, then 50% of the employment and GVA benefits were judged to be attributable to UKI2S.
- Where applicable, we have adjusted this percentage (by a small amount of 10 percentage points) depending on whether UKI2S did/did not play other key roles in formation or in subsequent rescue rounds. For example, if UKI2S orchestrated and contributed to a rescue round, we have increased the apportionment value from 50% to 60%.

Leakage and displacement effects

A.9 Leakage has been treated in a UK context, i.e. leakage was deemed to exist if any activity is taking place overseas. This information was obtained from Fund Managers and companies on a case-by-case basis where this is relevant.

A.10 Displacement effects have been assessed by considering two key factors: the location of businesses' markets or likely markets (i.e. are they UK or international); and the location of direct competitors (i.e. are they UK, international or does the business have no direct competitors). The latter factor is the critical one, though the former can be instructive in the absence of conclusive data/perceptions. We have sought to estimate the proportion of sales or likely sales that would be taken by UK competitors if the company were to cease to exist. If this is not possible to answer, then we have used the responses to make a judgement on displacement effects on the basis of Table 6-2, noting that any available relative proportions between different markets and competitors have informed actual percentage assumptions for

displacement (e.g. if 10% of competitors are UK-based, then it may be appropriate to assume a low level of displacement, such as 10%).

Table 6-2: Displacement judgements

	UK competitors	International competitors	No direct competitors
UK markets	Med/High displacement	No displacement	No displacement
International markets	Low/med displacement	No displacement	No displacement

Assessment of GVA

A.11 GVA is used to measure the economic value of the investment fund through the creation and development of the companies. It is normally used to measure the economic value of areas, sectors or whole nations, and so applying it to firms is subject to a number of limitations. In addition, GVA is often critiqued (and increasingly so), because of how it is measured and what it includes/excludes. For example, it does not take account of a range of economically useful activities such as looking after dependants, and is constrained when measuring non-market things like knowledge and the environment.

A.12 Some of these issues are particularly exacerbated when dealing with the types of companies that are supported by UKI2S. For instance, many companies are pre-sales and so standard approaches such as profits plus employee costs or sales minus costs of production are not possible. In addition, companies often have a primary purpose to build their knowledge and intellectual property so that the value to a possible purchaser is enhanced. However, measuring this value in terms of GVA is challenging using standard approaches.

A.13 The assessment of GVA benefits has focussed on 'actual' effects (i.e. achieved to date). Expected effects, from forecasts, have been excluded, because of the uncertainty associated with these. The slight exception to this is the separate reporting of GVA associated with exit values – see below.

A.14 The analysis has estimated GVA to date by looking at employee costs (as a component of GVA). The focus on employee costs follows Scottish Enterprise guidance, which indicates that this is an appropriate approach given the pre-sales nature of many of the businesses[57]. Effectively, this is measuring the value of a portion of R&D activities, thereby the investment of resources now for commercial returns later. This provides our estimate of GVA to date.

A.15 In addition, we have followed the same approach as the 2013 assessment by including an allowance for the exit value for those companies that have exited the Fund. This is based on the assumption that this reflects a discounted return that a buyer of the business may be expected to receive as a result of purchasing the business[58]. This is reported separately as further GVA potential, because it is essentially a downstream expectation.

A.16 We are aware that there are limitations to this approach and potential risks of under- or over-stating the GVA effect. For example, it could be argued that the R&D jobs now are generating

[57] Scottish Enterprise (2008) Additionality and Economic Impact Assessment Guidance Note, Scottish Enterprise, Glasgow
[58] Current values of companies are also available, but these are likely to under-estimate the potential future benefits, because it is anticipated that current/recent investments will help businesses to improve their potential.

value that is captured in future exit values anyway, or that by only capturing the value of R&D jobs we are not taking account of the full value of the knowledge and intellectual capital that they are generating. Expected values are also likely to reflect expectations of surpluses and so do not take account of employee costs. Nonetheless, we believe the approach set out is pragmatic, in particular given the data available.

A.17 We also note that recent research sets different precedents on this issue (e.g. PACEC study on the Scottish Seed Fund[59]; Bank of England research on firm-level productivity[60]) with some firms associated with negative GVA because they are making losses. However, this arguably misses the point about the nature of the companies and the development of knowledge-based, rather than commercially-based, value, especially in the short-term.

Persistence effects

A.18 There is no strong empirical evidence on how long benefits persist for. Major capital works apply up to 60 years of persistence (e.g. for transport investments). Capital works in the science and innovation arena use up to 30 years of persistence and take account of a decay in benefit from 15 years onwards as infrastructure becomes more dated. Given the precedents and the timescales required to for deep technology companies such as these, we have captured effects for up to 15 years.

A.19 Given that the focus is on actual effects to date, in practice all actual effects are in scope within these 15 years. Exit values have been reported separately (given that they have an in-built assumption of future effects). For companies that have exited, we have assumed that employment, and so GVA effects, have flatlined following exit – unless we are aware that companies have declined in size or that activities have left the UK.

Social time preference

A.20 In line with HM Treasury Green Book have discounted future benefits using the social time preference rate of 3.5% per annum.

Summary of data collection

A.21 We have summarised the key measures of economic benefits assessed and the corresponding data sources in Table A-2.

[59] PACEC (2013) Economic Impact of the Scottish Enterprise Seed Fund, PACEC, Cambridge
[60] Barnett, A., Chiu, A., Franklin, J. and Sebastiá-Barriel, M. (2014) The productivity puzzle: a firm-level investigation into employment behaviour and resource allocation over the crisis, Bank of England Working Paper No. 495

Table A-2: Summary of data collection

Indicator (where applicable to the company)	Data from Fund Managers		Data from company representatives		Derived from collected data
	Portfolio data collected	Discussions	Discussions	Phone call/email	
Turnover	■				
Profits/losses	■				
Investment in companies	■	▨	▨	▨	
Companies created					■
Employment created	■				
Cost per job					■
Value of exports	■	▨	▨	▨	
GVA					■
R&D expenditure	■	▨	▨	▨	
Attribution					■
Deadweight		■	■	▨	
Leakage		■	■	▨	
Displacement		■	■	▨	

Legend

■ Principal source of data

▨ To cover any gaps in data from principal sources

■ Derived from various sources of collected data

Annex B: Portfolio companies

Table B-1: Portfolio companies

Companies assessed as part of the study	Other companies supported by UKI2S
1. AgPlus Diagnostics	38. Abeterno
2. Aitua	39. Antiverse
3. Atelerix	40. Camstech
4. CellCentric	41. Celixir (was Desktop Genetics)
5. Chameleon Biosurfaces	42. CHAIN Biotech
6. Claresys	43. C-Major Medical
7. Cobalt Light Systems	44. CytoSeek[61]
8. Crescendo Biologics	45. Genowe
9. Cytox	46. Glialign
10. Eagle Genomics	47. Jupiter Diagnostics
11. Ecoalert	48. Linear Diagnostics
12. Inscentinel	49. MicrofluidX
13. International GeoScience Services (IGS)	50. Myodopa
14. Keit	51. Pencil Biosciences
15. Microbial Solutions	52. ProKyma
16. Microvisk	53. SFH Oxford
17. MIRICO	54. Smart Green Shipping Alliance
18. Nemesis Bioscience	55. The Smarter Food Company Ltd
19. NorthRow	56. ThruVision
20. Novacta	57. Zentraxa Ltd
21. Orbital Optics	
22. Oxford Space Systems	
23. Oxsensis	
24. P2i	
25. Perfectus Biomed	
26. Petrra	
27. Pireta	
28. Procarta	
29. Quethera	
30. Remo	

[61] A representative from CytoSeek was consulted, and so they have provided qualitative evidence on the role of UKI2S. However, no company data has been provided and so they are not formally included in the economic assessment.

Companies assessed as part of the study	Other companies supported by UKI2S
31. Salt	
32. Spectral Edge	
33. Synthace	
34. The Electrospinning Company	
35. Tokamak Energy	
36. Tropic Biosciences	
37. ZuvaSyntha	

Annex C: Consultees

Table C-1: Consultees

Name	Representing
Business consultations	
Mick McLean	Atelerix
Will West	CellCentric
Craig Tombling Darren Andrews	Cobalt Light Systems
Adam Perriman	CytoSeek
Abel Ureta-Vidal	Eagle Genomics
Mohammed Belal Linda Bell	MIRICO
Mike Lawton	Oxford Space Systems
Samantha Westgate	Perfectus Biomed
Chris Hunt	Pireta
Andrew Lightfoot	Procarta
Peter Widdowson	Quethera
Tim Fell	Synthace
David Kingham	Tokamak Energy
Gilad Gershon	Tropic Biosciences
Fund Manager consultations	
Andy Muir	Midven
Mark White	Midven
Oliver Sexton	Midven

Annex D: Extended data analysis

D.1 This Annex provides extended detail of the estimates of economic contribution detailed in Chapter 4 of this report.

Key Terms

D.2 Table D-1 defines key terms necessary to the interpretation of the subsequent analysis:

Table D-1: Key terms

Term	Meaning
Gross (as in 'gross' effect)	Overall direct effect, e.g. in terms of employment, made by a firm(s) supported, before any account is made of the influence of contribution made by UKI2S
Additional 'direct' effect[62]	The direct effect of a firm(s), e.g. in terms of employment or GVA, that would not have happened without UKI2S input, and that takes account of potential displacement and leakage
Additional 'direct' effect attributed to UKI2S	The effect above that is attributed to UKI2S's input (i.e. by taking account of UKI2S's role versus the inputs of other government-backed investments)

Source: SQW

Additionality and attribution

D.3 Table D-2 outlines the factors applied for 'additionality' and 'attribution' within the impact model[63].

Table D-2: Additionality and attribution factors by fund

Metric	Average
Total UKI2S (Core + SynBio Funds)	
Additionality factor	0.78
UKI2S attribution factor	65%
Core Fund	
Additionality factor	0.79
Core Fund attribution factor	72%
SynBio Fund	
Additionality factor	0.75
SynBio Fund attribution factor	36%

Source: SQW Analysis of UKI2S Data
Base: Core Fund = 27; SynBio Fund = 7

[62] It is important to note that the average additionality level of 0.78 is an arithmetic average across the portfolio of companies assessed. It is not possible to simply use this coefficient to move from 'gross' to 'additional' effect, because additionality varies across the companies and the calculation of the additional effect is affected by the relative significance of each company.
[63] This covers the 34 companies for which both benefits and costs have been considered (including 28 Core Fund and 6 SynBio Fund companies). It excludes the three companies where costs have been incorporated but not the benefits.

Balance of investment

D.4 Table D-3 outlines the balance of investments made by the two UKI2S funds and its co-investors in the firms during the 2002 to 2019 period.

Table D-3: Balance of investment by fund (2002-19)

	Total	Average
Core Fund		
Core Fund investment – total	£8,950,000	£289,000
Core Fund investment – start-up funding	£3,034,000	£98,000
Core Fund Investment as a % of total UKI2S investment	77%	
Co-Investment – total	333,511,000	11,117,000
Co-Investment – public	35,071,000	1,169,000
Co-Investment – private	298,440,000	9,948,000
SynBio Fund		
SynBio Fund investment – total	£2,693,000	£449,000
SynBio Fund investment – start-up funding	£643,000	£107,000
SynBio Fund Investment as a % of total UKI2S investment	23%	
Co-Investment – total	£46,332,000	6,619,000
Co-Investment – public	£4,666,000	667,000
Co-Investment – private	£41,666,000	5,952,000

Source: SQW analysis of UKI2S data
Base: Core Fund = 30; SynBio Fund = 7

D.5 Table D-4 shows the balance of investments by UKI2S in medical/biotechnology companies, and other types of technologies.

Table D-4: Balance of investment by type of technology (2002-19)

	Total	Average
Medical / Biotechnology		
UKI2S investment – total	£5,633,000	£331,000
Start-up funding	£2,081,000	£69,000
Investment as a % of total UKI2S investment	48%	
Co-Investment – total	£166,128,000	£9,772,000
Co-Investment – other public	£15,288,000	£899,000
Co-Investment – private	£150,840,000	£8,873,000
Other technologies		
UKI2S investment – total	£6,010,000	£301,000
Start-up funding	£1,596,000	£228,000
Investment as a % of total UKI2S investment	52%	
Co-Investment – total	£213,714,000	£10,686,000

	Total	Average
Co-Investment – other public	£24,449,000	£1,222,000
Co-Investment – private	£189,266,000	£9,463,000

Source: SQW analysis of UKI2S data
Base: Medical/biotechnology = 17; Other technologies = 20

Summary of economic contribution

Key economic impact indicators by fund

D.6 Table D-5 below summarises the headline findings on the economic contribution to date for each of the two UKI2S funds. When comparing the impact estimates for the two funds, it is important to consider that the SynBio Fund was set up a decade after the Core Fund, and is therefore considerably less mature. This is reflected in the relatively lower average employment for the SynBio Fund, resulting in a smaller effect on GVA and, in turn, a lower return on investment to date.

Table D-5: Key indicators on current economic contribution by fund

Impact and value for money indicators	Core Fund	SynBio Fund
GVA	£78,901,000	£3,450,000
Return on investment	9:1	1:1
R&D expenditure	£65,836,000	£1,242,000
Combined max employment of firms	280 (out of 696 gross jobs)	17 (out of 76 gross jobs)
Current employment	208 (out of 597 gross jobs)	5 (out of 54 gross jobs)
Exports to date	£55,843,000	£27,000

Source: SQW analysis of UKI2S data
Base: Core Fund = 30; SynBio Fund = 7

Gross impact

D.7 Table D-6 shows the gross estimates of key economic indicators.

Table D-6: Gross estimates of outcomes

Indicator	Gross estimates	
	Total	Average
Total UKI2S		
R&D expenditure	£155,994,000	£4,216,000
Current employment (2019)	651	18
Maximum employment to date (2002-19)	772	21
Levels of exports to date (2002-19)	£169,239,000	£4,574,000
GVA to date (2002-19)	£220,487,000	£5,959,000

Source: SQW analysis of UKI2S data

Direct impact

D.8 Table D-7 shows the direct impact of UKI2S funds, including estimates for both additional impact as well as the additional impact attributed to UKI2S.

Table D-7: Additional direct impact estimates of outcomes

Indicator	Additional estimates		Additional & attributed estimates	
	Total	Average	Total	Average
Total UKI2S				
R&D expenditure	£104,795,000	£2,832,000	£67,078,000	£1,812,912
Maximum employment to date (2002-19)	445	12	296	8
Current employment (2019)	349	9	213	6
Levels of exports to date (2002-19)	£68,379,000	£1,848,000	£55,870,000	£1,510,000
GVA to date (2002-19)	£119,059,000	£3,218,000	£82,351,000	£2,226,000

Source: SQW analysis of UKI2S data

Annex E: UKI2S investment policy

E.1 For companies to be eligible for UKI2S investment, they must fulfil at least one of the following criteria:

- companies working in the field of engineering (aka synthetic) biology
- spin-out companies from a UKI2S Partner, an institute or centre with strategic research and capability funding from a UKI2S partner, or a Catapult
- companies substantially based on IP licensed from a UKI2S Partner or a Catapult, in all cases endorsed by a UKI2S Partner or Catapult
- spin-out companies from an Associate Partner organization, or a company substantially based on IP licensed from an Associate Partner organisation, and endorsed by an Associate Partner
- companies based on a National Research and Innovation Campuses (as determined from time to time by the UKI2S Partners, but including Norwich Research Park, Rothamsted, Babraham, Daresbury, NOC Southampton and Harwell), where the business has been based on that Campus for at least 6 months (unless it is a start-up or has not yet had a physical location) and is also endorsed by a UKI2S Partner or Catapult on that Campus
- companies working with a Catapult under a competitively awarded funded programme (including Catapult Opportunities tenders), and are also endorsed by that Catapult
- companies working with one of the Centres for Agricultural Innovation (Agrimetrics, CHAP, CIEL or Agri-EPI) as part of a partnership programme, and endorsed by BBSRC
- members of the Fund, who may submit proposals to the Fund only in partnership with a UKI2S Partner; the current members are FERA and NNL.