

Assessing the economic and wider benefits of the Rainbow Seed Fund

Final Report to Midven Ltd on behalf of the Rainbow Seed Fund partners

December 2013



SQW

Executive Summary

1. SQW Ltd (SQW) was commissioned by Midven Ltd on behalf of the Rainbow Seed Fund (RSF) partners to conduct a study on the economic and wider impact of RSF.
2. RSF is a £14m seed fund investing in the earliest, and riskiest, stages of technology companies. It was established in 2002/03 by a group of Public Sector Research Establishments (PSREs) with funding from the then Department for Trade and Industry. This followed the 1999 Baker Report on realising the economic potential of PSREs. The Fund was set up with a dual mandate: on the one hand it was tasked with helping to increase the commercial exploitation of PSRE research through financial and other support; and on the other with earning a sufficient return to secure its long term existence.
3. The principal aim of this impact study was to estimate the economic contribution of the Fund through its investments in early stage companies, in particular in terms of the effects on employment creation and Gross Value Added (GVA), and also the wider potential benefits for society from commercialising research from the science base.

Background

4. RSF is managed by a private sector fund manager, Midven, with an advisory committee (Spectrum) consisting of the core partners¹ and experienced external members with relevant backgrounds in finance and technology. The Fund has invested at a steady rate over the past decade, with its first investments being made in 2002/03, and has now invested approximately £7m in 30 start-up companies and 39 “pathfinders” (early stage pump-priming investments of up to £25,000 each to fund exploratory work on commercial viability, often alongside technical proof of concept grants from other sources). Twelve of the pathfinders have since graduated into full investments within the 30 portfolio companies.
5. The Fund is positioned quite clearly at the seed stage of the finance escalator, 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.
6. The majority of the portfolio are still in the ‘Valley of Death’. Only one company has been through the full development cycle and is now in full sales mode (and after nine years is approaching profitability). Consultations with members of Spectrum suggested that there was cautious optimism that the modest profits on realisation of investments seen to date might be followed by some significantly larger gains in the future, thus producing funds for recycling into the next generation of investments. However, there was recognition of the potential volatility and the long term nature of seed stage investing, which means that the majority of the realisations probably remain several years away.
7. The Fund’s financial performance is regularly monitored by the Fund Manager, and some aspects of the wider economic impact are occasionally noted. However, the broader impact is of great importance to the partners and this study was commissioned to provide the first

¹ These are Biotechnology and Biological Sciences Research Council (BBSRC), Defence Science and Technology Laboratory (Dstl), the Natural Environment Research Council and the Science and Technology Facilities Council (STFC).

broad and coherent assessment of the Fund’s economic impact.. The study has examined in detail 25 companies that have been supported through the main activities of RSF². The assessment has drawn on a range of company information (e.g. financial performance, investment histories and company forecasts), and in-depth consultations with fund managers, partners, members of Spectrum, technology transfer officers and companies.

Summary of the main findings

The RSF has made a strong economic contribution

8. Based on the assessment of the 25 companies, the headline findings on the economic contribution to date that is attributable to RSF are as follows (see also Table 1):
- Current ‘additional’³ GVA generated = £21m (excluding multiplier effects⁴) and £32m (including multiplier effects).
 - A return on RSF investment⁵, based on GVA figures, of: 3:1 (excluding multiplier effects) and 5:1 (including multiplier effects).
 - Current ‘additional’ employment created = 104 (excluding multiplier effects) and 142 (including multiplier effects).
 - Co-investment levels from private investors (including from some other publicly-backed funds) of £127m (leveraged from just over £6m of RSF investment).
 - 73% of companies would not have been generated without RSF, meaning that 18 of the 25 companies are considered as ‘additional’.
 - An important contribution to government rebalancing objectives, including to the net trade balance with the companies operating in overseas markets. Data on the companies that are making substantive sales indicates that the proportion of sales being made overseas is in the range of 75-100%.

Table 1: Summary of key indicators on current economic contribution

Indicator	Additional Direct Impact Attributed to RSF	Additional Direct + Indirect Impact Attributed to RSF
GVA to Date (2002-2013)	£21,022,000	£32,106,000
Return on Investment (2002-2013)	3:1	5:1
Current Employment (2013)	104	142
Cost per Current Job	£48,373	£28,903
Exports to Date (2002-2013)	£10,370,000	£10,370,000

Source: SQW Analysis of RSF Data

² For two of the 25 companies included, we have included the costs, but not estimated impact because of a lack of available data. The Fund continues to invest, with 30 companies supported to date. The most recent five investments have been made in the last few months and so are too young to have had an impact, and so are excluded.

³ ‘Additional’ estimates mean that account has been taken of deadweight, leakage and displacement (defined in more detail in the main report).

⁴ Multiplier effects are the knock on effects that result from direct economic activity. In this study we have assessed indirect effects (i.e. supply chain linkages), though not included induced effects (i.e. the effects of employee spending).

⁵ This is based on the RSF investments into the 25 companies (plus the costs of other pathfinder investments), and excludes fund management costs. The main report provides further detail on the fund management costs and their effect on return on investment.

9. The companies are still in the early stages of their development, and so it is important to consider the future economic contribution of the portfolio. RSF's role in forming the companies at the early stage is so important that, even though other investors are now more involved, a proportion of this future economic activity would not have taken place at all, and it is therefore still attributable to RSF. Taking account of the forecast economic benefits increases the GVA contribution, return on investment and job creation (see Table 2):
- Forecast 'additional' GVA that could be generated in the future = £121m (excluding multiplier effects) and £202m (including multiplier effects).
 - A return on RSF investment of 21:1 including forecasts up to 2018 (excluding multiplier effects), and 34:1 (including multiplier effects).
 - 'Additional' employment creation is estimated to reach 254 jobs in the future (excluding multiplier effects) and 417 (including multiplier effects).

Table 2: Summary of key indicators on future economic contribution

Indicator	Additional Direct Impact Attributed to RSF	Additional Direct and Indirect, Impact Attributed to RSF
Future GVA (2014-2018)	£120,751,000	£201,910,000
Return on Investment (2002-2018)	21:1	34:1
Future Employment (max achieved to 2018)	254	417
Future Exports (2014-2018)	£91,342,000	£91,342,000

Source: SQW Analysis of RSF Data

10. Evaluation data on directly comparable early stage interventions is limited, and so we have looked at wider benchmarks covering knowledge transfer and business development interventions. Whilst care is needed in making comparisons between different types of programme, in terms of the return on investment figures and cost per job RSF compares favourably or on a par with other seed funds and knowledge transfer schemes for which evidence is available.
11. An important point to note is that RSF (in common with other seed funds) is 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 each pound of investment can be put to work again. The relative value for money of RSF is discussed further in section 4 of the main report.

Wider benefits for the economy and society

12. A review of the activities of the companies supported evidences their importance more widely to economy and society. A series of examples are presented in the main report. These identify different types of wider benefit resulting from commercialisation of research:
- Around one-fifth of firms are involved in **drug discovery and other areas of healthcare** such as medical diagnostics. These include improving cancer treatment (e.g. Crescendo and CellCentric), and progressing developments in fields such as the

resistance to antibiotic drugs (e.g. Procarta) and regenerative medicine (e.g. The Electrospinning Company).

- There are potential **environmental benefits** through the contribution that companies can make to the transition to the low carbon economy. Microbial Solutions Ltd's (MSL) waste treatments can help address metalworking waste, a 35 billion litre problem across the world, by significantly reducing the waste (by 96%), energy (by 85%) and water use (by 95%) from the process. In the area of industrial biotechnology, BioSyntha is developing ways of manufacturing high value chemicals from waste materials, which can help reduce the reliance on petrochemicals.
- There are examples of companies contributing to **security and defence**, for example through the application of Cobalt Light System's technology to challenges in scanning hand luggage for liquids at airports such as Heathrow, enabling the lifting of the ban imposed after 9/11.
- One company (BGS International, a spin off from the British Geological Survey) contributes to **international development**, with the Department for International Development (DfID) and the World Bank key customers for their expertise in resource mapping and training. This supports DfID objectives for properly managed exploitation of the mineral and hydrocarbon resources of emerging countries.
- Finally, one company highlights the benefit to the UK of creating capability through building companies out of technologies. In 2004 Dstl spun out a nanomaterials company, P2i, where the original research was based on a specific need to make the frontline battledress more breathable and weather-resistant. After substantial private investment, attracted by the technology's promise in other areas such as waterproofing of millions of mobile phones, the technology has been fully commercialised and the Ministry of Defence is able to procure improved clothing without the multi-million pound development cost it would otherwise have faced.

Developing the skills and knowledge of PSRE researchers and staff

13. A second set of wider benefits relate to the skills and attitudes of research and other staff engaged from PSREs. Consultation evidence here indicated three areas of progress:
- The role of RSF in working with technology transfer officers has helped to develop their skills and expertise in identifying and shaping new ideas that may have the potential for spin-out companies (and sifting out those that do not).
 - The process of research, spin-out and industrial collaboration has led to subsequent engagements between the research base and industry partners. In over 70% of the portfolio, the process of research, spin-out and industrial collaboration has involved continuing engagements between the "parent" research institute and the companies. These include staff splitting their jobs and working part-time for both the PSRE and the company, the company's location on a PSRE site, contracting the PSRE for further development work, and involvement at the board or Scientific Advisory Board.
 - The partner research staff involved in companies supported by the Fund have incrementally developed their own skills and experiences, which has contributed to

enterprising behaviour. This has resulted in subsequent commercialisation activity. For example, one of the researchers involved in the original research on microbes that led to metal-working applications (as part of the development of MSL) is working on further similar collaborative activity, but is also in the early stages of developing a potential commercial application of the microbes in the healthcare field.

How does RSF help to spin out companies from the research base?

14. The evidence presented in the main report indicates that RSF helps companies to become established and/or to develop in ways that would not have happened otherwise. There are several key underpinning arguments as to the important role that RSF plays:

- its core role as an investor that helps to bridge the ‘Valley of Death’ for early stage ideas and companies – it invests when the market views the risk as being too high
- as a lead or co-lead in early investment rounds, and in the confidence and comfort provided to co-investors when RSF invests, because it is seen as knowing how to develop companies of this nature
- networks through RSF (including Spectrum) that can help identify relevant investors (helping to leverage £127m of co-investment) and key staff
- the support provided during the initial stages of company development, in particular around business plan milestones, putting together investable propositions and acting as a trusted and friendly broker in valuation negotiations
- the on-going involvement at company board level, providing both useful strategic and financial advice to the company and an additional perspective for the PSRE “parent”.

15. The above points highlight that the role played by RSF is more than simply the funds provided through investment. The current CEO of one of the companies of the portfolio summed up the importance of RSF and the benefit of investing taxpayers’ cash as follows:

“If Rainbow didn’t exist, we should invent it. MSL wouldn’t be there without it. The taxpayer had invested in the research [that led to MSL] for 7 years before [MSL was created]. If RSF hadn’t invested in it, then it would probably still be sitting on the shelf.” (Will Pope, MSL)

Overall, RSF is making a critical contribution to commercialisation objectives

16. As a small, yet important, part of the knowledge exchange landscape, RSF makes an important contribution to the commercialisation objectives of its partners, in particular in relation to spin-out companies. In relation to the objectives of the RSF, it is evident from the summary of findings that significant progress has been made in filling a gap at the very earliest stage of spinning out a company by providing a source of early stage investment capital. In addition, progress has been made in relation to changing attitudes and developing skills within PSREs.

1. Introduction

- 1.1 SQW Ltd (SQW) was commissioned by Midven Ltd on behalf of the Rainbow Seed Fund (RSF) partners to conduct a study on the economic and wider benefits of RSF.
- 1.2 The principal aim of the study was to estimate the economic contribution of the Fund through its investments in early stage companies, in particular in terms of the effects on employment creation and Gross Value Added (GVA). In addition, the study was to assess the wider benefits of RSF, such as the wider effect on society brought about by commercialising research from the science base and the contribution to a culture of enterprise within publicly-funded research laboratories.
- 1.3 The study was not, therefore, 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.

Structure of this report

- 1.4 This report is structured as follows:
 - The next section provides the context and background of RSF and an overview of the approach taken to the assessment.
 - Section 3 discusses the role of RSF in the commercialisation of science, and in doing so we provide a judgement on the additionality of the companies created (i.e. the extent to which RSF is helping companies to become established that would not otherwise have been created).
 - Section 4 provides an assessment of the economic contribution of RSF in terms of employment and GVA to date, and the potential future GVA that may be realised.
 - In Section 5, we set out the evidence on the wider benefits of RSF, e.g. in terms of potential societal benefits and skills development.
 - Finally, Section 6 summarises the main findings and conclusions from the study.
- 1.5 A series of Annexes provide supporting information on the method for calculating the economic contributions (Annex A), a list of the companies supported (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 brief details of the Fund's governance arrangements (Annex E).

2. Background to the study

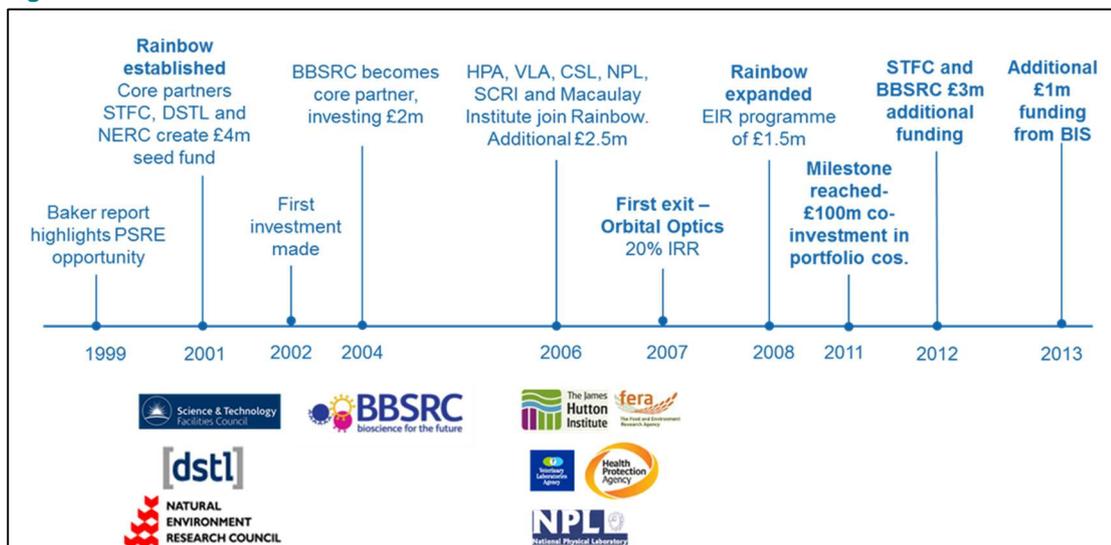
- 2.1 This section sets out the background to the Rainbow Seed Fund and the context within which the study has been undertaken, and provides an overview of the approach to the work. A fuller statement of the methodology, in particular to estimating the economic contribution of the RSF, is set out in Annex A.

Context of RSF

What is RSF?

- 2.2 The Rainbow Seed Fund is a £14m seed fund investing in the earliest, and riskiest, stages of technology companies. It was established in 2002/03 by a group of Public Sector Research Establishments (PSREs) with funding from the then Department for Trade and Industry's PSRE Fund, in order to provide a source of scarce seed stage funding for technologies spun out from PSRE laboratories. This followed the 1999 Baker Report, *"Realising The Economic Potential Of Public Sector Research Establishments"*. The Fund was set up with a dual mandate: on the one hand it was tasked with helping increase the commercial exploitation of PSRE research through financial and other support; and on the other with earning a sufficient return to secure its long term existence.
- 2.3 The Fund has evolved and grown since the first £4m injection by three PSREs, with additional capital and partners being added, as the timeline in Figure 2-1 below shows.

Figure 2-1: Timeline of RSF



Source: Rainbow Seed Fund

- 2.4 The Fund is managed by a private sector fund manager, Midven, with an advisory committee (called Spectrum) consisting of the core partners and experienced external members with relevant backgrounds in finance and technology.⁶

⁶ A brief description of the governance structure of the Fund is included as Annex E

- 2.5 The ceiling of investment that RSF could make was initially set at £250,000 per company, though in 2009 the Department for Business, Innovation and Skills (BIS, the Department for Trade and Industry’s successor) raised this to £500,000. The Fund’s investment mandate was initially limited to investment in technologies that were directly derived from work done at partner institutes, but in 2012 this mandate was broadened to allow the Fund to invest in early stage companies that are based on the campuses at certain sites of its core partners, the Biotechnology and Biological Sciences Research Council (BBSRC) and Science and Technology Facilities Council (STFC)⁷. The full list of partners is set out in Table 2-1.
- 2.6 RSF is one of a number of commercialisation activities funded or delivered by the partners, with others including funds such as proof of concept grants. The fit of RSF in this wider landscape is described in section 3.

Table 2-1: RSF Partners

Core partners	Other partners
<ul style="list-style-type: none"> • Biotechnology and Biological Sciences Research Council (BBSRC) • Defence Science and Technology Laboratory (Dstl) • Natural Environment Research Council (NERC) • Science and Technology Facilities Council (STFC) 	<ul style="list-style-type: none"> • Culham Centre for Fusion Energy (CCFE) • James Hutton Institute • Food and Environment Research Agency (FERA) • The Health Protection Agency (HPA) • Animal Health and Veterinary Laboratories Agency (AHVLA) • The National Physical Laboratory (NPL)

- 2.7 The Fund has invested at a steady rate over the past decade, with its first investments being made in 2002/03, and has now invested approximately £7m in 30 start-up companies. The Fund has made early stage pump-priming investments (of £25,000 each) in 39 “pathfinders”, 12 of which have since graduated into full investments within the 30 portfolio companies.
- 2.8 As might be expected from the breadth of activities within its partners, the Fund has invested across a range of sectors from cancer therapies to optics and nanomaterials. In broad terms, just under half the portfolio is targeted at the healthcare sector, with a quarter aimed at the security and space market, just under a fifth in cleantech and the remainder being spread across other areas.
- 2.9 Investment in healthcare by the Fund splits broadly into two: the therapeutics and the non-therapeutics (e.g. diagnostics, detectors etc.). The latter accounts for about two thirds of the healthcare investment (i.e. just under one-third of the whole fund). Of particular note is that the Fund has, unlike many others, been prepared to fund drug discovery work at the earliest stage and that a surprisingly large proportion (approximately one-fifth) of its portfolio is in this field. Seed investors normally avoid early stage drug discovery because of the very large sums of money involved and the extended time to market.

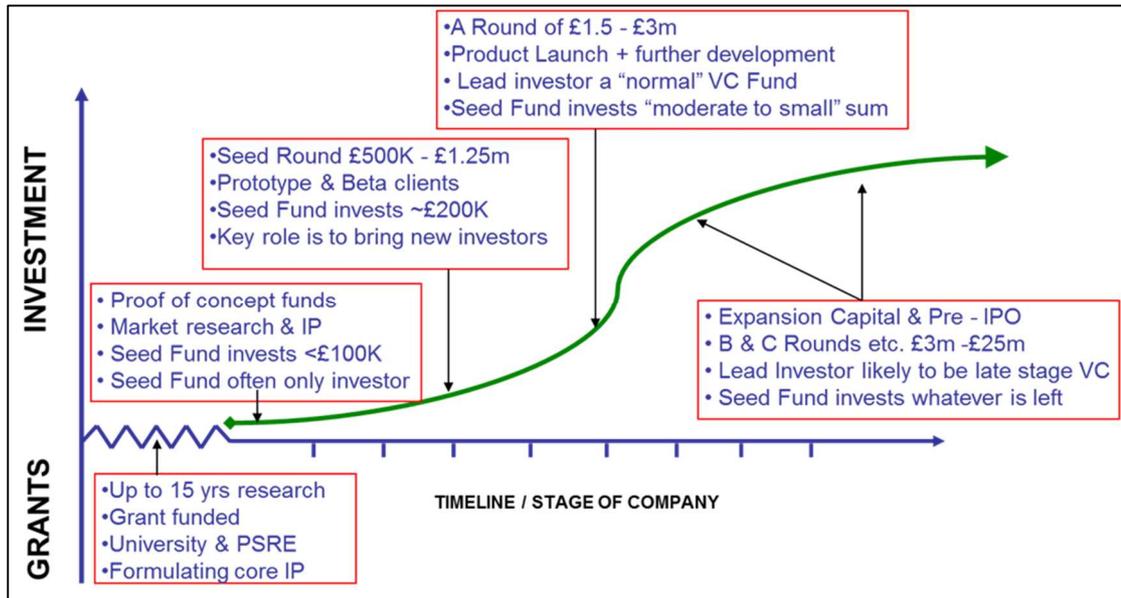
Rationale and objectives of RSF

- 2.10 The schematic in Figure 2-2 describes a fairly typical funding cycle for a technology start-up. It illustrates the critical importance of the seed fund at the very earliest stage, and how this

⁷ Specifically Babraham Research Campus and Norwich Research Park (BBSRC), Harwell and Daresbury (STFC)

reduces markedly as the funding rounds increase in size and the company nears the market and, eventually, financial sustainability.

Figure 2-2: Depiction of the funding cycle for technology start-ups



Source: Rainbow Seed Fund

- 2.11 In rationale terms, the Fund is positioned quite clearly at the seed stage⁸ 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. 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”⁹

- 2.12 Against the backdrop of this rationale, the objectives of the Rainbow Seed Fund 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, and for companies located on the main STFC and BBSRC campuses
- support the development of commercialisation activities within the partners and their campuses, building long term relationships with the technology transfer offices of the partners and helping to build a more entrepreneurial element within the PSRE culture

⁸ 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”.

⁹ House of Commons Science and Technology Committee report: “Bridging the valley of death: improving the commercialisation of research” 2013

- make itself sustainable over the long term (i.e. an “evergreen” fund) by realising its investments and recycling the proceeds into new investment.

Stage of companies and financial performance

- 2.13 The great majority of the RSF portfolio are still in the ‘Valley of Death’. Unlike other technologies such as software and mobile internet propositions which can be developed and launched rapidly, the development pathway for most of the technologies emerging from the PSRE base is a lengthier one. Drug development (approximately one-fifth of Rainbow’s portfolio) is well-known as being a lengthy process, but so is the cycle of development and adoption in, for example, the gas turbine market or security and defence. In these areas, large and often long-term programmes and slow-moving customers combine to create a slow adoption cycle and a difficult environment for SMEs that are seeking to develop new technologies.
- 2.14 The positioning of RSF at the start of the ‘Valley of Death’ and the development time required for companies have an effect on the financial performance that is achievable from seed funds such as RSF (and in particular the performance to date). Whilst not in the remit of this study, a brief overview of financial performance is worthwhile.
- 2.15 The fund manager’s latest report on the projected financial performance (from April 2013) suggests that the eventual value of the current investment portfolio¹⁰ is likely to be in the region of £10m, close to the figure of total cash spent to date (investment cost plus management and board charges over the period since inception). A number of factors underpin this performance to date:
- The Fund has yet to make any substantial financial returns from its investments, and several of the potentially large returns are a few years away from realisation.
 - The average age of companies supported is around five years. This is comparatively young for the types of businesses invested in so far given the development and adoption time for most of the technologies emerging from the PSRE base. The youngest company was only invested in several months ago. The first investment was made in 2002.
 - Only one company has been through the full development cycle and is now in full sales mode generating annual sales in excess of £10m (and after nine years is approaching profitability). A few other companies are making some sales of note. Based on latest data (either 2012 sales figures or anticipated sales figures for 2013), three others are making sales of over £1m, three are selling between £100k and £1m and a further two are making low levels of sales (<£100k).
 - Half of the older cohort of companies are involved in drug development and therefore remain very much in pre-sales mode; they would expect to license their programmes or sell the company well before actual product sales are made.
- 2.16 The average investment holding period for venture capital firms is of the order of seven years; RSF tends to invest at least 2-3 years before a typical venture capital fund would get involved,

¹⁰ This excludes the investment returns on the balance of cash remaining in the Fund

suggesting that RSF will have to hold its investments for an average of close to a decade before seeing returns. Discussions with board members and the fund managers indicated that they were excited about the prospects for several of the companies and pointed to the fact that over £150m of other investment had been co-invested across the whole portfolio, mainly by private investors whose motivation was purely return-driven, but that they did not expect any realisations in the immediate future.

- 2.17 Given the diversified nature of the portfolio, the Fund may achieve stellar returns from one or two companies, allowing funds to be recycled (contributing to RSF's evergreen objective), though in purely financial terms it is currently valued at around cost of investment, but with considerable promise. 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.

Approach to the study

- 2.18 Against this backdrop, the study's main aim was to complement the financial performance assessment with an estimate of the economic contribution of the Fund, in particular in terms of the effects on employment creation and GVA. In addition, the study was to assess the wider benefits of the investments made, e.g. in terms of commercialisation of research and skills development.
- 2.19 This sub-section sets out the broad approach, which follows HM Treasury Green Book logic, and has drawn on wider guidance (e.g. BIS evaluation guidance¹¹, and Scottish Enterprise guidance on economic impact assessment)¹² and consultation with BIS economists to tackle particular challenges in estimating the GVA contribution of early stage companies. More detail, in particular on the economic assessment, is provided in Annex A.

Assessing the economic contribution

- 2.20 The approach to the assessment of the economic contribution has focussed on the key indicators of employment created and an estimate of GVA generated. In both of these cases, we have estimated the effect to date and forecast. The assessment of GVA generated has followed the income approach. GVA to date has been estimated using employee costs (based on salaries) as a component of GVA. We acknowledge that this may underestimate GVA¹³, though this was considered to be the most appropriate and consistent approach given the early stages of the businesses supported. Future potential GVA has incorporated available and assumed forecasts for employment (and so employee costs) in forthcoming years, projected surpluses for the businesses that are expecting to turn to profit, and the future expected values of companies when they exit the RSF. The anticipated exit values have been used as a proxy for the downstream value (and so potential income) that buyers of the companies may expect to generate. This may underestimate the potential GVA contribution, given that beyond exit from RSF we have not taken into account further employee costs.

¹¹ Department for Business, Innovation and Skills (2011) *Guidance on Evaluating the Impact of Interventions on Business*, BIS, London

¹² Scottish Enterprise (2008), *Additionality and Economic Impact Assessment Guidance Note*, Scottish Enterprise, Glasgow

¹³ If we consider that GVA represents, philosophically, a measure of 'work done', by considering only the market value of employee inputs (i.e. their salaries) we are not taking into account the value that they add to the company's activities (including in conjunction with other non-employee inputs such as the use of capital equipment).

2.21 Other indicators of the economic contribution have covered levels of additionality, co-investment and exports.

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

- collation of financial and other performance data (including business planning forecasts) on the individual companies supported by RSF, in particular details of investments, other government inputs (notably Enterprise Investment Scheme (EIS) and Venture Capital Trust (VCT) tax relief), employment, wages, sales, level of exports, surpluses and estimated exit values; for some companies we have drawn on consultations to fill gaps in the data
- presentation of data as time-series data of employment and wages/surpluses/exit values – in order to calculate GVA estimates
- judgements on the degree of additionality of the companies supported, i.e. the extent to which they would have been created without support from RSF
- judgements on other additionality factors for leakage (based on whether employment activity is located overseas), displacement (based on known/anticipated competitors and markets) and multiplier effects (based on coefficients for relevant sectors drawn from ONS input-output tables)
- an assessment of the attribution of the impact to RSF – reflecting the importance of the earliest stage of investment to create companies, the attribution is based on the first rounds of investment (the proportion of RSF investment versus other government-backed investment/inputs and EIS and VCT inputs), and adjusted if there have been any ‘rescue’ rounds or other significant input made by RSF¹⁴
- attribution and additionality factors were then applied to ‘gross’ estimates to provide ‘net’ attributable estimates of the economic contribution of RSF.

2.23 Twenty-five of the 30 portfolio companies have been examined as part of the study¹⁵. This includes two for which costs have been incorporated but not the benefits (due to a lack of data – the levels of benefit would not have had a significant effect on our estimates).

Wider benefits

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

- the contribution that companies have made, or might make, more widely to the economy, society and environment because of the commercialisation of research
- the development of new skills within the PSRE research base and/or changes in attitudes towards commercialisation and knowledge transfer, which may help deliver further commercialisation in the future.

¹⁴ If RSF has played a significant role, then attribution has been increased by 10 percentage points.

¹⁵ The most recent five investments have been made in the last few months and so are too young to have had an impact, and so are excluded.

Gathering the evidence

- 2.25 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, independent members of Spectrum, representatives of core partners and their technology transfer officers and research institutes, and companies themselves. These consultations have enabled us to probe on issues around additionality and attribution, as well as to capture evidence on the wider benefits of RSF.
- 2.26 The assessment of additionality is based on perceptions of consultees, rather than by using a comparison group of companies. As we have explained in Annex A, a comparison group could not be meaningfully established given the nature of the companies in the portfolio. In addition to this evidence, we have had access to relevant Board papers and case material on individual companies, which has been used to provide the narrative around the performance of RSF.

3. Role of the Rainbow Seed Fund

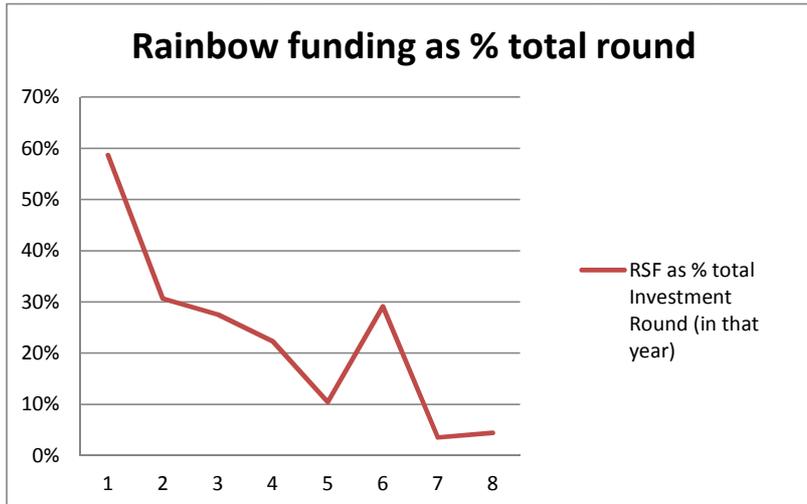
- 3.1 This section highlights the role played by the RSF in the commercialisation of science from the research base. In so doing we provide the evidence on the extent of *additionality* of the companies set up, and commentary on how RSF has sought to achieve its objectives.
- 3.2 The consultations, particularly with those partner and independent representatives on Spectrum, noted that the balance of focus on the objectives of RSF has been very much in favour of helping to establish businesses from the research base by providing early stage capital. The objectives around attitudinal changes and creating an evergreen fund have been second order. We identify issues relating to these later in this section.

Helping to establish early stage businesses

RSF's role

- 3.3 RSF plays a number of roles in helping to establish early stage businesses. First and most obviously it is an investor, though its role as an early stage investor is distinct from other potential investors:
- There are relatively few venture capital funds that invest in the early stages of commercialisation of academic research that help businesses become fledged for later stage venture capitalists. There are others that may invest at similar early stages, like Imperial Innovations (which invests higher amounts) and the Cambridge Capital Group (umbrella for business angels, which might invest similar sums to RSF), though these are few and far between. The Seed Enterprise Investment Scheme (SEIS) has provided a welcome boost to very early stage investing but the impact on Rainbow has to date been limited with no SEIS investment having been successfully sourced by any of the companies to date.
 - An important aspect of RSF is that, whilst it does want to generate a return on investment to contribute to its evergreen objective, its primary objective is to commercialise research. This means that RSF is willing to take a risk when a lot of uncertainty remains, but there is sufficient promise to proceed with investment. There are not many others that operate from such a set of objectives (University seed funds may operate from similar principles).
- 3.4 Reflecting RSF's role as an important early stage investor, Figure 3-1 (overleaf) shows that RSF is normally the main or one of the main investors in initial investment rounds (contributing an average of around 60% of investment value in the first round across a sample of the portfolio's companies).

Figure 3-1: RSF funding as % of total round for sample of the portfolio



Source: Rainbow Seed Fund data

3.5 A second key role of RSF is around the support it provides to researchers and technology transfer officers from public research laboratories. The research staff are used to operating on long-term timescales with the science looking ahead 10 or more years. The staff often have little experience of exposure to venture capital, the key issues around it and the milestones required for business development and achieving capital returns. RSF works with businesses from the earliest stage on a range of aspects, including the following:

- helping to hone business and investment plans
- ensuring investment propositions seek the right amount in future investment rounds that can take businesses to the next stage
- establishing appropriate milestones for the business as part of investment rounds
- advising on realistic valuations on the businesses to inform negotiations.

3.6 Bringing the first two roles together, RSF's dual mandate and its resulting positioning between the researchers and the technology transfer officers on the one hand and private investors on the other hand means that it has been able to understand and 'speak the language' of both sides. Therefore, it is trusted by both sides and, as noted by two company consultees, "provides comfort to other investors" because RSF knows the detail of the research and the commercial potential.

3.7 A third key role is that RSF extends its handholding going forward after investment is made, taking a seat or observer on the board in every company for at least the first year or two after initial investment, and often thereafter. This is a strong indicator of active involvement (passive investors do not take such roles on company boards), and allows the Fund to provide continued support. RSF's continued involvement has been key in some instances to resolving issues that have arisen and/or coordinating and backing rescue rounds of investment at later stages when progress had faltered. As examples, Microbial Solutions, CellCentric, Microvisk (see box below), Claresys, Oxsensis and Procarta have all received further investment from RSF some time after the Fund's first investment, but when other investors were hesitant. In these cases, RSF's long history of involvement gave them confidence that there was still an attractive future for the companies.

- 3.8 Combining these points, RSF is credible with other early stage investors, as one consultee noted:

"It [RSF] knows how to develop, manage [...] and exit firms, which is a rare set of skills." (Consultee with experience from Board representation on venture capital funds)

Case example: Microvisk Technologies

Founded in 2004, Microvisk is a developer of novel micro-electromechanical sensor (MEMS) technology. The Microvisk technology was developed during micro-robotics research funded by the European Space Agency and the company retains a facility at STFC's Rutherford Appleton laboratories.

The company is currently focussed on the application of its core MEMS technology to point-of-care blood viscosity diagnostic devices. This goal reflects a pressing need for a cheap, fast and reliable diagnostic to support the monitoring and treatment of patients with circulatory conditions. The market is a major one, with some 10m patients in the developed world alone requiring regular monitoring of their condition to regulate medication and keep them "within range".

RSF has played a critical role at two stages of Microvisk's development. In 2005, RSF was the sole funder of the 'proof of concept' phase, brought in the first CEO, and played a lead role in attracting co-investment from the angel network. Without this intervention, Microvisk would not have progressed as readily as it has done so.

RSF continued to invest over the 2005 to 2013 period. The importance of this support was particularly marked in 2009 when the company required substantial refunding, at the depths of the financial crisis, in order to progress its research and development programme. Again, RSF played a lead role in coordinating the financial package and introducing all of the incoming investors. Without the investment secured in 2009, Microvisk may well have ceased its operations.

Looking forward, Microvisk is progressing to Food and Drug Administration (FDA) trials in the US in the New Year and expects to launch the product in 2014. In addition, the technology's applications for a range of other fluid system monitoring applications (including printing and lubricants) is being investigated.

Fit within the wider landscape of partners' activities

- 3.9 For the partners of RSF a key part of their organisations' wider objectives, and an area that has increased in prominence in recent years, is that research makes a difference to the economy and society. There are various ways in which this can be done, and it is important to note that translation of research is not simply about spin outs (or indeed licensing). RSF was set up to plug a gap in commercialisation (and specifically in relation to spin outs), and so it provides a small yet important contributor to the wider arena of translation. In Higher Education this gap is covered by such things as the Higher Education Innovation Fund and University Challenge Seed Funds (though many of the latter are no longer actively investing). For the core partners, RSF complements other provision that is available, in particular proof

of concept funding which could lead on to RSF. The following provides examples of this alignment, with reference to the core partners:

- For BBSRC, RSF aligns with Enterprise Fellowships and the Follow on Funds that cover the proof of concept stage, as well as the work of its campuses (at the BBSRC-sponsored institutes).
- For NERC, RSF is potentially a next step following the Innovation Fund and Follow on Funds.
- For STFC, RSF again aligns with internal proof of concept funding and its campuses.

For Dstl, RSF complements the Centre for Defence Enterprise (CDE), which funds research into high risk innovations, and provides an entry point for those new to the defence sector/supply chain, for which barriers can exist for SMEs.

- 3.10 A final point to make in relation to partners' activities, is that for Dstl RSF provides a vehicle to achieve other objectives in relation to national security. An important aspect to this is in bolstering UK-based supply chains in the defence sector.

Assessment of additionality

- 3.11 Given the role that RSF plays as an early stage investor, we have assessed additionality¹⁶ as being high. Fundamentally, this is because there is a strong underpinning rationale for RSF itself, as set out in section 2 with reference to the 'Valley of Death' and the seed funding environment. This is reinforced by the role played by RSF, which fills a gap in the market, and the disciplines of the Investment Policy established through RSF's governance, which results in supporting those companies that are unlikely to have been established otherwise.

- 3.12 There have been four judgments on the levels of additionality based on the consultations, as set out in Table 3-1¹⁷.

Table 3-1: Summary of additionality judgements

Judgement on additionality (non-deadweight)	No. of companies	Commentary
Full	10	Very unlikely that the company would have gone ahead, or if it had done so, it would have withered in the absence of support that RSF could provide
High, i.e. c. 75% additional	6	Company unlikely to have gone ahead, though small chance it would have done
Medium, i.e. c. 50% additional	5	Company may well have gone ahead, though likely to have taken more time, and may have been less well-focussed and at reduced scale for longer
Low, i.e. 0-25% additional	2	Likely that the company would have gone ahead, much to the same degree of scale, focus and timing. RSF seen mainly as a 'friendly' co-investor.

Source: SQW, based on consultation evidence.

¹⁶ I.e. the extent to which companies would not have been established at all, as quickly or in the same way in the absence of RSF.

¹⁷ This covers the 23 companies for which benefits have been considered. This excludes the two companies where costs have been incorporated but not the benefits.

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

3.14 **First**, in some cases other investors would not invest at all, or RSF 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. This is frequently the case for companies in the portfolio, with Orbital Optics (see box below) providing an illustrative example.

Case example: Orbital Optics

Orbital Optics developed technology for high resolution cameras to go on satellites in space. Whilst there was a small amount of business angel investment at the outset, given “interests” in space kit, other investors would not have gone close, which illustrates the point made earlier in this section that with high levels of uncertainty private investors are unlikely to invest, whereas RSF will do so if there is sufficient promise.

- In the case of the 39 “pathfinder” investments, 12 of these have graduated to become full investments. The purpose of these investments is to fund exploratory work on commercial viability, often alongside technical proof of concept grants from other 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 RSF’s pathfinder funding.
- As an initial co-investor, RSF has been 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 the input of RSF has provided confidence for other investors to go ahead. In the absence of RSF, 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. Two particular points were made in relation to the reliance on angel investors for the types of companies supported by RSF:
 - As one consultee noted, in comparison to Angels, RSF “*plays a useful hands on role with companies to help things along and make investment cases subsequently*”, which helps “*to accelerate*” company development.
 - Angel investors often look to a fund such as RSF to carry out the legal and other due diligence, because they do not have the time or expertise.

3.15 The **second aspect of additionality** is that without RSF’s input as an active investor businesses are unlikely to have been able to progress beyond initial rounds. RSF’s input here comes in different forms, such as support to companies’ management on business planning and investment proposals and through its networks – see the case example of Oxsensis below. In contrast, Angels do not have the capacity to provide such support to the same level as RSF.

Case example: Oxsensis

In the case of Oxsensis, if RSF had not worked with the management team to hone the business plan and help develop an investor ready proposal, it was felt that the business would not have been successful in securing its important second round investment.

- 3.16 The **third aspect of additionality** is that without RSF's support at later stages, some businesses may have collapsed or lost focus. There have been some examples where RSF's on-going support has saved and/or helped businesses. For example, in the case of Microbial Solutions Limited, RSF was instrumental in renegotiating terms of the intellectual property agreement (see box below), and in the case of BioSyntha (which was spun out of another company, Novacta), the operation would have ceased without RSF's intervention (see box below).

Case example: Microbial Solutions Limited (MSL)

MSL emerged in late 2007 from research into complex groups of bacteria at NERC's Centre for Ecology and Hydrology (CEH), and has now progressed to the point of a collaboration agreement with a major multinational covering a programme of full scale trials at large industrial sites.

The problem targeted is the waste metalworking fluids from engineering facilities in large industries such as automotive manufacturing, where current treatments are costly in terms of capital equipment and expensive to run with high energy and water use. This is a worldwide issue and a particular problem in places suffering water stress, including some key emerging markets such as India and China. It also represents a potentially huge market, with well over 35 billion litres a year requiring treatment and environmental pressures meaning that users in many markets have to meet increasingly high standards for disposal.

A CEH collaboration with a division of a major oil company found that groups of bacteria could be used to work together to 'clean' the water, which could then be disposed of much more easily and cheaply. The technology is genuinely ground-breaking with the main competitors using physical or chemical (as opposed to microbial) approaches. But the process had only been trialled at modest scale and there remained questions about the ability of the lab-based technology to translate to the much tougher world of industrial sites.

RSF initially funded some exploratory analysis of the market through a small £25,000 "Pathfinder", following that up later with a role as co-lead investor in the first "proper" funding round that brought £1.25m in to launch the company. More recently, RSF has been leading the provision of further funding, renegotiating the intellectual property agreement with NERC and representing investors in the commercial negotiations with the multinational partner, which will allow the company to progress. All of these stages have been critical to MSL's progress, in particular leading the provision of additional funding when the other large shareholder was unable to do so.

The next steps for MSL are to prove the technology conclusively, at which point the industry partner has an option for longer collaboration, or it may decide to buy the company. There is potential for significant sales in the medium term, with each engineering site likely to involve a long term contract worth hundreds of thousands annually. In addition, there are wider environmental benefits, i.e. helping car manufacturers move towards zero waste model, which are discussed in section 5 of this report.

Based on the role played, MSL would not exist without RSF. Displacement is assessed as being limited given the furthering of technology to solve the problem of waste and the predominant presence of competitors overseas.

Case example: BioSyntha Technology Ltd

BioSyntha was established in early 2012 as a spin out of the industrial biotechnology research group and associated facilities of Novacta BioSystems Ltd. Novacta was a company that was itself founded with the support of RSF in 2003, based on a combination of technology developed at the John Innes Centre with expertise from the GSK Natural Products Group and the natural products company, Zylepsis.

Biosyntha is an industrial biotechnology company with expertise in metabolic pathway engineering for biofuels, renewable chemicals and natural products, strain development, biocatalysis, and fermentation. The company is currently engaged in the provision of bespoke contract research focussed on the fuels sector and is developing novel approaches for the generation of “green” chemicals from waste streams.

In 2011 the controlling investor in Novacta decided to focus entirely on its clinical portfolio and proposed to close the industrial biotechnology group. RSF led the group of investors who felt there was an opportunity to create a sustainable and exciting new company. RSF subsequently played a lead role in negotiating the divestment, coordinating the financial and legal underpinning of the new company, and recruiting the first CEO.

Biosyntha continues to engage in collaborative research and development of novel fuels and novel fuel technologies with industrial partners operating on a global footing. Through such work, the company is a contributor to the BBSRC’s industrial biotechnology strategic priority area.

RSF played the central role in the genesis of BioSyntha Technology Ltd. In the absence of this intervention, the company is unlikely to have existed otherwise.

- 3.17 In many cases, the arguments above are combined to provide a strong case for high levels of additionality associated with RSF’s investment and wider support. One company, for example, noted the role of RSF’s investment, but also the longer-term purview alongside the attitude towards risk. This is illustrated in the following quote:

“RSF investment provided us with the breathing space to develop our business model ... without the RSF, which was commercially savvy enough to accept the risk of delaying commercialisation, the business wouldn’t be the same organisation that it is today” (Company consultee)

- 3.18 In addition, the example of Cobalt illustrates the importance of the combination of RSF roles including its early engagement, help in finding co-investment and on-going support (see box below; further detail on Cobalt is provided in a case study in section 4).

Case example: Cobalt Light Systems Ltd

Cobalt’s technologies, developed at the Central Laser Facility at STFC’s Rutherford Appleton Laboratory, use the powerful analytical technique of Raman spectroscopy to determine the composition of chemical mixtures. In diffusely scattering samples such as powders or tablets conventional Raman tends to be limited to surface or near-surface measurements. Cobalt’s innovations promote measurement into the bulk of objects, often extending the analysis through diffuse samples to many millimetres or centimetres of depth and applying the advantages of Raman to sub-surface analysis.

RSF engaged early providing pathfinder funding (along with Nesta) in November 2005 that allowed the investigation of commercial applications for the fledgling technology. RSF was then instrumental in the forward strategy and finding co-investment, culminating in 2008 with a further £150k of RSF investment as part of a £1m round (relatively large for a seed funding round) that brought in a VC fund and a high profile local angel. RSF’s networks were used to find and introduce the incoming managing director to Cobalt, who also invested in this round. This allowed the first proper prototype to be built and the company to start taking on basic costs such as premises. RSF’s support has continued as a board member on Cobalt and through assistance in subsequent funding rounds.

The technology has particular application in airport security, and the company has increasingly focused on the large potential security market that started to emerge in 2009/10 as negotiations started regarding the relaxation of the ban on liquids in aircraft cabin luggage.

- 3.19 There is a caveat to note around additionality, which is that some companies go to RSF as first investor. In this sense, RSF is seen as a first choice investor, before other options may have been exhausted. In almost all cases, there have been grounds for RSF to be involved, based on the arguments set out above. As the remit of RSF extends onto STFC and BBSRC campuses (which have businesses of more varying stages as tenants), it is important to continue to ensure high levels of additionality by considering alternatives to the publicly-backed RSF.

Leakage and displacement

- 3.20 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 a couple of exceptions, and higher levels

of leakage may apply if company exits result in activity moving overseas. There is certainly one case where there may be a degree of leakage following exit.

- The competition for companies is often outside of the UK, because many of the companies supported operate in global markets. Moreover, in some 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

- 3.21 The upshot of the assessment of deadweight, leakage and displacement is that average levels of additionality (excluding multipliers) are estimated at 0.73. Put another way, 73% of the businesses created would not have been established in the absence of RSF, which in simple terms means that 18 out of the 25 businesses assessed are 'net additional'¹⁸.
- 3.22 With the inclusion of multiplier effects (covering supply chain effects based on ONS input-output tables), the average level of additionality is estimated at 1.2.

Not all of the investments have worked

- 3.23 Given the risks inherent with early stage investments, inevitably some have not worked as planned (the risk profile of RSF is discussed on the next page). Several lessons have been learnt from these, including the following:
- companies that start from too far behind existing technology are higher risk
 - related to the previous point, if too much investment is required to get to market then the chances of success are reduced
 - the existence of serious players in the relevant markets can also be an issue prompting lower chances of success (depending on how novel the technology is)
 - the intents of co-investors can be detrimental to progress, for example if there is a misalignment of interests between investors, between those in it for the 'long haul' those who want a 'quick win'.
- 3.24 It is important to note that whilst some investments have not worked from RSF's perspective, the basis of the technology supported may still go on to have economic benefit, e.g. because companies are resurrected subsequently or because it leads to further industry collaborations. As an example of this, Thruvision died twice though now forms part of an AIM-listed company, and we understand that it is employing staff and generating exports¹⁹. Therefore, whilst RSF wrote off its investment, the UK economy still benefits from employment and export earnings, and UK military and security agencies have continued to access UK-based capability in surveillance technology.

¹⁸ If grossed up to the portfolio of 30 companies, this results in 22 net additional businesses created.

¹⁹ As cited in RSF Paper to the Board Meeting of Spectrum, *Review of Portfolio Performance and Impacts*

Role in meeting RSF's other two key objectives

Changing attitudes within PSREs

- 3.25 Consultees noted that, at the outset, the venture capital option was unfamiliar for PSREs. RSF has represented an investor viewpoint, whilst also being able to work well alongside PSREs, thereby speaking the language of both. As a result, there has been important learning delivered by RSF on:
- writing investment proposals
 - PSREs recognising which proposals will stand up to scrutiny and which will not
 - imparting knowledge through technology transfer offices to others.
- 3.26 According to consultees from Spectrum, the result has been that the proposals that come for review have all been of higher quality than they might have been. They have fallen within the scope and remit of the Fund, and Spectrum has been sufficiently persuaded by the maturity of the proposals such that consultees indicated that c. 75-90% of those submitted are given a "yes" to progressing to the investment committee.
- 3.27 Overall, consultees observed that there have been some changes in attitudes within PSREs, in particular through the remits of directors of institutes/centres where exploitation is higher on the agenda, and in terms of behaviours and skills development. Further evidence on skills and attitudinal benefits is presented in section 5, with the use of specific examples.

Risk profile of the RSF and its evergreen objective

- 3.28 The RSF has a high appetite for risk of various kinds. It is willing and able to invest earlier than most investors and in technology areas, such as drug development, that other investors would shy away from. It is also willing to put up money before the investment proposition is sufficiently rounded to be able to attract most private investors, and it provides help in building the business case.
- 3.29 In addition, RSF also invests up to £25,000 in pathfinder investments to fund exploratory work on commercial viability, often alongside technical proof of concept grants from other sources. This usually takes place even before the company has been incorporated and is extremely high risk, with 70% having been written off to date. Nevertheless, there are strong grounds for making these small investments, because 12 of the 39 pathfinders have been developed into companies that would not have been established otherwise.
- 3.30 This appetite for risk is possible, because decisions are taken from the basis of the commercialisation imperative. However, as noted in section 2, it does have a dual mandate being also tasked with earning a sufficient return to secure its long term existence. This represents the evergreen objective, and there are issues in how far RSF can focus on this objective.
- 3.31 First, it could be said that RSF is structured to increase its risk profile. Most seed and venture capital funds expect high attrition rates but aim to balance their failures with high rates of

return on their successes and, crucially, into which they will invest as much as they can²⁰. However, RSF is constrained by its investment cap of £500,000 per company (initially set at £250,000 per company). This means that RSF cannot “follow its money” by investing in companies that have genuine potential to generate returns as a normal venture capital fund would do. As a result, the proportions of equity held by RSF become diluted and quite small by the time of exit, thereby limiting the returns.

- 3.32 Second, the types of companies invested in involve a long time path to market, and consume investment as they do so (see section 2 on the ‘valley of death’ and development time for companies). This means that RSF has to be in it for the long-term, and cannot generate returns quickly.
- 3.33 For some consultees, the achievement of the evergreen objective was not a significant issue, though others were more bullish on this point. In particular, increasing the critical mass of the portfolio, which is expected to happen over time, or extending the investment cap further, perhaps to £750,000 or £1m (this could be on an exception basis, e.g. authorised by government), were both identified as ways in which RSF could move closer to achieving the evergreen objective.
- 3.34 From the perspective of ensuring the additionality of public funds, the investment cap is quite important: if RSF could follow its money in later rounds, then this could ‘crowd out’ other investors. However, it does highlight the slight conflict in its dual mandate, because “filling the gap” to facilitate commercialisation aligns strongly with arguments around the additionality of public funds; whereas becoming self-sustaining might mean following up with some non-additional slices of investment.
- 3.35 The upshot is that the evergreen element is useful in the background for the board to keep in mind as an aspiration, and one which can yield some recycling of funds. However, it is not fundamentally important to the success of RSF in its prime pursuit of turning research ideas into sustainable and viable businesses. Therefore if RSF cannot be entirely self-sustaining, even though there will be some recycling of funds, it will require on-going funding.

²⁰ A common “prudential limit” would mean a cap at no more than 20% of a fund’s total capital. That would translate in Rainbow’s case to a maximum investment of £2.8m in any one company.

4. Estimates of the economic contribution

- 4.1 This section sets out our estimates of the economic contribution of the RSF. In doing so, we follow the underlying logic of the scheme (and HM Treasury Green Book logic) starting with investment inputs followed by the immediate results in terms of employment effects. The section then turns to consider resulting business performance in terms of export sales. The last step in quantifying the benefits of RSF is set out with the final outcomes, in terms of GVA.
- 4.2 In summary, therefore, the economic contribution of the RSF is assessed through three key metrics:
- employment created
 - contribution to the net trade balance through export sales
 - an estimate of the GVA contribution.
- 4.3 Using available benchmarks, we also consider how the benefits of RSF compare with other government-funded schemes in commercialisation and knowledge transfer. The section is concluded with analysis regarding the variation of economic impact across the RSF portfolio.
- 4.4 As noted in section 2 of this report, 25 of the 30 portfolio companies have been examined as part of the study²¹. This includes two for which costs have been incorporated but not the benefits (due to a lack of data – the levels of benefit would not have a significant effect on our estimates). When assessing Value for Money, therefore, the total benefits across the 23 firms are set against the investment costs for the wider set of 25 firms supported.
- 4.5 For each of the indicators of economic contribution, we provide estimates of the benefits to date or the current level of benefits (in the case of employment), and we also provide forecast benefits. It is important to note that the scale of the *economic contribution to date* reflects the maturity of the RSF portfolio. As was discussed in section 2, the majority of the companies in the RSF portfolio are still in their early stages (i.e. still in the ‘Valley of Death’ with many still on the negative part of a “J curve” trajectory, which is typical of the types of technology company supported by RSF). As a result, an assessment of the full economic contribution of the existing portfolio is not possible for some time. However, in order to provide as full an account of the economic contribution, we have estimated *forecast benefits* for the existing portfolio using available data.
- 4.6 Several technical terms are used in this section, and their meanings are presented in Table 4-1. Further detail is provided in data tables in Annex D of this report. Within this it is important to note that the values for these terms have been calculated on an individual company basis²². Further detail on the data supporting this section’s analysis is provided in Annex D of this report.

²¹ The most recent five investments have been made in the last few months and so are too young to have had an impact, and so are excluded.

²² This means that the assessment of impact is undertaken for each individual company and aggregated to arrive at an overall value of the contribution of the RSF. As a result, ‘averages’ quoted are arithmetic averages across the companies considered.

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 RSF	= 100 employees
Additional 'direct' effect ²³	The direct effect of a firm(s), e.g. in terms of employment or GVA, that would not have happened without RSF input, and that takes account of potential displacement* and leakage**	= $100 \times (1 - Dw) \times (1 - D) \times (1 - L)$ where: Dw = deadweight (say, 0.25 or 25%) D = displacement (say, 0.1 or 10%) L = Leakage (say, zero) e.g. $100 \times (0.75) \times (0.9) \times (1) = 67.5$ employees
Additional 'direct' effect attributed to RSF	The effect above that is attributed to RSF's input (i.e. by taking account of RSF's role versus the inputs of other government-backed investments)	= $100 \times (1 - Dw) \times (1 - D) \times (1 - L) \times (1 - NA)$ where NA = non attributable (say, 0.4 or 40%) e.g. $67.5 \times 0.60 = 40.5$ employees
Additional 'direct' + 'indirect' effect attributed to RSF	The effect defined the row above plus an estimate of indirect supply chain multiplier effects***	= $100 \times (1 - Dw) \times (1 - D) \times (1 - L) \times (1 - NA) \times M$ where M = indirect multiplier (say, 1.2) e.g. $40.5 \times 1.2 = 48.6$ employees (additional 'direct' + 'indirect' employment effect attributed to RSF)

Source: SQW

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

*** in the case of the RSF, indirect multiplier effects occur when a firm supported by the fund purchases goods and services in the economy, thereby resulting in second and third round employment and GVA benefits Balance of investment

4.7 In the period 2002 to 2013, the RSF fund has invested a total of £6.5m in the 25 investee firms being analysed, accounting for 5% of the total investment received by those firms in the same period (see Table 4-2)²⁴. However, as noted in section 3, the proportion of RSF investment is inversely correlated with the maturity of the company, with RSF funds comprising approximately three-fifths of all investment in the initial funding round, a proportion which reduces in subsequent rounds.

4.8 In addition to the investments in the 25 companies analysed, a further £490,000 has been invested in 26 pathfinders that were not converted into full investments. Full investments have been made in five other companies that have not been included in the analysis, and there have been an estimated £2.68m of fund management costs from 2002 to March 2013.

²³ It is important to note that the average additionality level of 0.73 (excluding multiplier effects) 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.

²⁴ In addition, £0.49m of Pathfinder funding was committed to activity that did not result in a company start-up.

Table 4-2: Balance of Investment (2002-2013)

Type of Investment	Total	Average
RSF Investment	£6,369,000	£255,000
Co-Investment	£126,791,000	£5,513,000
RSF Investment as a % of Total Investment	5%	5%

Source: SQW Analysis of RSF Data

- 4.9 As noted in section 2, since 2009 maximum RSF investment has been capped at £500,000. Only one firm (Crescendo) has received this maximum investment, whilst four others have received over £450,000. The lowest level of investment made in a company to date by RSF was £50,000 (Inscentinel), though we note that levels of RSF investment may relate to the maturity of the firm.

Employment

- 4.10 Here we present the employment associated with RSF firms. As described in Table 4-1, this is shown in terms of (i) gross employment, (ii) additional direct employment attributable to RSF and (iii) additional direct and indirect employment attributable to RSF. Employment data is presented across two metrics: current employment (2013); and maximum forecast employment (2014 – 2018)²⁵.
- 4.11 Between 2002 and 2013, the aggregated peak of gross employment across the 23 investee was 393 individuals. In 2013, gross employment for the year stands at 255 individuals across the 23 firms (an average of c. 11 per firm). The trajectory of employment growth is reflective of both a firm’s performance and its maturity in relation to its growth model. Indeed, the early stages of development activity for most RSF firms tend to be undertaken by small numbers of highly-skilled technologists. Once firms near production, capacity is required in-house on a full time basis, meaning that job numbers can escalate rapidly. This has been most notably demonstrated by P2i and Microvisk Ltd.
- 4.12 In this context, the ‘direct’²⁶ additional impact on employment that is attributed to RSF is presented in Table 4-3. Extending the analysis, Table 4-4 includes the ‘indirect’²⁷ (i.e. including multiplier effects) impact on employment that is attributed to RSF.

Table 4-3: Additional Direct Impact on Employment Attributed to RSF

Annual Employment Metric	Total	Average
Current (2013)	104	5
Maximum forecast (2014-2018)	254	11

Source: SQW Analysis of RSF Data

²⁵ Maximum forecast employment is derived from the maximum anticipated for each company based on available forecasts, and then aggregated for the portfolio (rather than maximum across the portfolio at any one point in time).

²⁶ ‘Direct’ impacts result from the expenditure and operation of the investee firm.

²⁷ ‘Indirect’ impacts result from the expenditure and operation of suppliers to the investee firm.

Table 4-4: Additional Direct and Indirect Impact on Employment Attributed to RSF

Annual Employment Metric	Total	Average
Current (2013)	172	7
Maximum forecast (2014-2018)	417	18

Source: SQW Analysis of RSF Data

Contribution to export sales

- 4.13 To date (2002-2013), the 23 investee firms have, in gross terms, exported nearly £39m of goods and services, with a further £262m forecast for the period 2014 to 2018.
- 4.14 Table 4-5 provides an analysis of the direct additional impact on exports attributed to RSF investment²⁸.

Table 4-5: Additional Direct Impact on Exports Attributed to RSF

Export Value Metric	Total	Average
To Date (2002-2013)	£10,370,000	£451,000
Forecast (2014-2018)	£91,342,000	£3,971,000

Source: SQW Analysis of RSF Data

- 4.15 In the period 2002 to 2013, Claresys, BGSI and P2i Ltd accounted for £8.6m of the quoted total additional direct impact. Forecasts for 2014 to 2018 are also dominated by a small subset of firms, with Microvisk Ltd and P2i Ltd accounting for c. £70m of the total additional direct impact.
- 4.16 For over one-half of the companies making substantive sales, the proportion of sales overseas is 90-100%. For the remainder, the proportions of sales overseas are also estimated at high levels, at 60-75%. The proportion of export sales of RSF-supported companies indicates a positive effect on the net trade balance, and means that the companies created are contributing to government's rebalancing objectives.

GVA contribution

- 4.17 In the analysis below we present (i) the gross contribution of RSF to GVA, (ii) the additional direct impact on GVA attributed to RSF, as well as (iii) the additional direct and indirect impact on GVA attributed to RSF (re-visit Table 4-1 for definitions of gross, direct and direct + indirect). For these last two measures, we show GVA to date (2002 – 2013), and forecast GVA (2014 – 2018).
- 4.18 In the period 2002 to 2013, the 23 investee firms contributed nearly £68m in GVA (gross) to the economy. Available forecasts for the 2014 to 2018 period from the 23 firms sum to over £330m in GVA (gross).
- 4.19 In this context, the 'direct' additional impact on GVA that is attributed to RSF is presented in Table 4-6. As with the employment analysis, the inclusion of 'indirect' impacts (i.e. multiplier effects) can be considered. Table 4-7, therefore, presents the additional 'direct' and 'indirect'

²⁸ Multiplier effects are not appropriate here, and so have not been incorporated into the assessment of export sales.

additional impact on GVA attributed to RSF. The multiplier effect estimates the knock-on impact on other businesses because of the goods and services purchased by RSF-supported companies²⁹. For example, Tokamak Solutions currently has a small central team of staff, and subcontract expertise from a network of over 20 UK based suppliers. This model is adopted by other companies in the RSF portfolio, especially for those that are still in the early stages of development as well as those operating in the biotech field where it is increasingly common for specialist services to be outsourced.

Table 4-6: Additional Direct Impact on GVA Attributed to RSF

GVA	Total	Average
To Date (2002-2013)	£21,022,000	£914,000
Forecast (2014-2018)	£120,751,000	£5,250,000

Source: SQW Analysis of RSF Data

Table 4-7: Additional Direct and Indirect Impact on GVA Attributed to RSF

GVA	Total	Average
To Date (2002-2013)	£33,444,000	£1,454,000
Forecast (2014-2018)	£201,910,000	£8,779,000

Source: SQW Analysis of RSF Data

A note on forecast GVA estimates

Forecast GVA estimates include the 'Expected Value of Company (EVC)', which is a forecast valuation of the investee firm at the point in time the RSF investment is scheduled to mature and the fund exits as a shareholder. This is included, because it represents an estimate of downstream profits that a purchaser of an RSF-supported company may expect to generate (see Annex A for details of how EVC is calculated and used in the impact analysis). Within the impact analysis carried out for this study, the EVC is a significant component in the calculation of GVA.

There is a risk that the EVC overestimates future GVA contribution, because companies may be purchased by overseas buyers, who may move activities out of the UK (resulting in leakage). In Annex D, therefore, we include a sensitivity test to illustrate how possible leakage, which RSF has no influence on, could affect forecast GVA.

The flip-side is that there is also the risk that the EVC underestimates the future GVA contribution of the firm since it does not include the GVA associated with wages from employment beyond the exit of the company from the Fund (EVC represents the profit component of GVA only). Where forecast employment data is available, this has been included in the analysis, though this is normally not available beyond expected exit years. Note that the same issue of leakage may apply following company purchase and exit from RSF.

- 4.23 In the boxes below we present two case studies of companies that are expected to make up a significant part of the GVA contribution of RSF. These are Cobalt Light Systems Ltd, developed at STFC's Rutherford Appleton Laboratory (estimated additional direct and indirect GVA

²⁹ In practice, multiplier effects have been estimated at the level of the portfolio (rather than the firm) using national sectoral multipliers

attributable to RSF of £946,000 to date, and £8.3m forecast to 2018), and Crescendo, located at the Babraham Research Campus (estimated additional direct and indirect GVA attributable to RSF of £1.7m to date, and £33.4m forecast to 2018).

Case example: Cobalt Light Systems Limited

Cobalt's technologies, developed at the Central Laser Facility at STFC's Rutherford Appleton Laboratory, use the powerful analytical technique of Raman spectroscopy to determine the composition of chemical mixtures. In diffusely scattering samples such as powders or tablets conventional Raman tends to be limited to surface or near-surface measurements. Cobalt's innovations promote measurement into the bulk of objects, often extending the analysis through diffuse samples to many millimetres or centimetres of depth and applying the advantages of Raman to sub-surface analysis.

RSF provided pathfinder funding (along with Nesta) in November 2005 that allowed the investigation of commercial applications for the fledgling technology. RSF was then instrumental in the forward strategy culminating in 2008 with a further £150k of RSF investment as part of a £1m round (relatively large for a seed funding round) that brought in a VC fund and a high profile local angel, as well as investment by the incoming managing director, whom Rainbow found and introduced. This allowed the first proper prototype to be built and the company to start taking on basic costs such as premises.

Over the next couple of years early sales were made of single units into the pharmaceutical industry (mainly for QA purposes, often the inspection of incoming bulk materials) but the company remained in development mode, and increasingly focused on the large potential security market that started to emerge in 2009/10 as negotiations started regarding the relaxation of the ban on liquids in aircraft cabin luggage. US insistence on adequate pre-boarding screening as a condition for relaxation started a rush to develop suitable technologies, and Cobalt's solution emerged as the leading performer in a series of tests at airports around the world during 2011-12. The drive into this market has been supported by subsequent rounds of investment, and it is hoped to raise working capital requirements through bank debt.

The first orders for the security product, along with growing demand from pharma companies, saw the company finish last year employing 24 staff (up from just 4 in 2009) and running close to break-even on £2.4m of sales. The future order book is very strong at £3.3m and growing, with Heathrow and Gatwick just two of the airports who have recently committed to buy Cobalt's system.

Whilst RSF's holding is now somewhat diluted (just over 10% of the company), it is difficult to see how the company could have reached this stage without its initial investment and ongoing investment contributions and advice.

The next couple of years should see Cobalt consolidate its position in the airport market. The current thinking amongst investors is that the company would then be an attractive acquisition target and that a number of industry players would be interested if it were put up for sale. It is too early to speculate as to its value, but the expectation is that RSF would make several times its original investment.

Case example: Crescendo Biologics Ltd

Crescendo is developing two proprietary platforms for biological therapeutics. These have been developed from Babraham Institute research:

- A transgenic mouse which produces heavy chain only antibodies: Crescendo aims to exploit its unique transgenic antibody fragment platform to create differentiated medicines developed through in-house product development and strategic partnerships. Crescendo's transgenic mice contain the world's first 'triple knockout' background in which mouse immunoglobulin heavy chain, kappa light chain and lambda light chain loci are all functionally silenced. This is critical to the efficient generation of human heavy chain-only antibodies in transgenic mice.
- A proprietary ribosome display platform: Crescendo aims to use this for the optimisation of antibodies.

Technically, Crescendo is making good strides in developing its technology platform to create therapeutic antibodies, which is commercially a significant global market worth tens of billions of dollars per annum worldwide. Given the nature of the business, which is to develop the technology, it may not make sales itself; rather it will sell the technology on through licensing, sell as part of a fee service or partner with a major pharma firm to develop and sell products. RSF has invested £500k in the company, with co-investment currently at £7m. It currently employs 17 staff.

Crescendo's initial development was supported by Aitua, which was a funding vehicle that RSF helped to set up, and which had first refusal on all Babraham Institute intellectual property. As a key partner of Aitua, RSF was an important part of the consortium (along with Avlar) to bring in another investor Sofinnova. RSF has also helped to frame the technology and took a role on the board. Without RSF's involvement, Crescendo may have still been established, but it would have taken longer and may have taken a different form: Aitua and the input of RSF provided the platform for the firm to develop to where it is today. This example demonstrates RSF's willingness to take on drug discovery companies at an early stage, when few other funds would have gone anywhere near such a daunting technology.

Indicators of Value for Money

- 4.24 The analysis of impact provides an opportunity to calculate measures of value for money for the RSF investments (covering costs and benefits for 23 investee firms analysed, and the investment costs for two further investee firms).
- 4.25 In terms of the value for money represented by the 'direct' additional impact on GVA attributed to RSF, Table 4-9 indicates a return on RSF investment of £3 for every £1 invested in the period 2002 to 2013, building to a ratio of 21:1 when the period is extended to 2018 (when more investee firms emerge from their start-up phase and RSF exits begin). With the

inclusion of ‘indirect’ impacts (i.e. multiplier effects) that are additional and attributed to RSF, these ratios are increased to: 5:1 for 2002 to 2013 and 34:1 for 2002 to 2018 (see Table 4-8).

Table 4-8: Value for Money (VfM) Indicators for Additional Direct and Indirect Impact Attributed to RSF

Indicator	Based on additional direct impact attributed to RSF	Based on additional direct and indirect impact attributed to RSF
Return on Investment (2002-2013)	3:1	5:1
Return on Investment (2002-2018)	21:1	34:1

Source: SQW Analysis of RSF Data

4.26 Note that these return on investment figures include inputs made through investments in “pathfinders” (including those that did not proceed to full investments), for which no benefit is attributed, but excludes the fund management costs. Including the fund management costs to March 2013 (£2.68m), affects these return on investment figures, as follows:

- Based on the direct impact (i.e. excluding multiplier effects) that is additional and attributable to RSF, the return on investment in the period 2002 to 2013 is 2:1, which builds to a ratio of 15:1 when the period is extended to 2018.
- Based on direct and indirect impact (i.e. including multiplier effects) that is additional and attributed to RSF, the return on investment in the period 2002 to 2013 is 4:1, building to a ratio of 25:1 when the period is extended to 2018.

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 RSF (see Table 4-9). This is based on the level of current employment, and so is a measure of the cost per job that has been sustained to date, and the forecast average employment for the 2014-18 period for companies supported. 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 4-9: Cost per Job – Additional and Attributed to RSF

Indicator	Current	Forecast (maximum to 2018)
‘Direct’ Job	£65,990	£27,024
‘Direct’ and ‘Indirect’ Job	£39,837	£16,458

Source: SQW Analysis of RSF Data

Benchmarking the RSF

4.28 Benchmarking the value for money of RSF is tricky, because there are few directly comparable schemes for which evaluation evidence is available. Moreover, evaluation methodologies differ, which can affect the value for money metrics assessed. In Table 4-10 we provide benchmarks on three other schemes in order to assess the value for money of RSF. One of these three is comparable to RSF, the Scottish Enterprise Seed Fund, though the methodology adopted was slightly different in how initial losses of firms were treated (which means that the return on investment metric is relatively low for the Scottish scheme). With this caveat, RSF compares well with the return on investment of 34:1 (for RSF) similar to the 26:1 for the Scottish seed fund. The cost per net additional job is also more favourable for RSF compared to the Scottish Enterprise Seed Fund (£40k compared to £48k). As the evidence base on other

funds improves, there ought to be more material with which to understand the relative position of RSF. For example, we are aware that BIS is in the process of evaluating the impact of several funds delivered through Capital for Enterprise Limited.

- 4.29 Other benchmarks are drawn from evidence on knowledge transfer partnerships and Regional Development Agency (RDA) interventions to support businesses. These programmes are quite different in nature, and so the benchmarks here serve to show how RSF fits into the wider business support and commercialisation landscape. The evidence indicates that short-term value for money in terms of job creation and return on investment is less good for RSF compared with more ‘standard’ business support under the RDAs (as you would expect given the nature of RSF), but that RSF is comparable, certainly in terms of return on investment to date, with knowledge transfer partnerships.
- 4.30 In considering the relative value for money of RSF and other seed funds (including the Scottish Enterprise Seed Fund) it is important to note that funds are designed to be at least partially self-renewing. This means that, as investment funds, they hold assets (i.e. stakes in companies) with the intention to realise these as returns in future years. If returns are made, then these proceeds can be recycled into further investments in the future. This contrasts with grant-based schemes, where funds are invested once, but no proceeds are earned to be re-invested. Clearly different investment models (whether grant, loan, equity etc.) are required in different circumstances, depending on the rationale and the context. However, in favour of the value for money of seed funds such as RSF is that each pound of investment can be put to work again.

Table 4-10: Benchmarks

Programme	Return on Investment	Cost per net additional job	Commentary on comparability
RSF	5:1 (to date) 34:1 (including forecast)	£40k (to date)	
Scottish Enterprise Seed Fund	26:1 (based on benefits in 2011-21)	£48k (to date)	Similar scheme, though method adopted is slightly different with losses included as negative contribution to GVA
Knowledge Transfer Partnerships	5:1 (based on achieved cumulative, i.e. excludes forecasts)	£56k to £61.5k (to date)	Different type of scheme, which is not directly comparable to RSF
Regional Development Agency interventions on business development	7:1 (to date) 12:1 (including projected benefits)	£14k (to date)	Varying types of scheme not directly comparable to RSF. Methods used to derive benchmarks focused on assessment of jobs created; and varying treatment of issues such as forecast benefits

Source: SQW analysis; PACEC (2013) Economic Impact of the Scottish Enterprise Seed Fund, Final Report to Scottish Enterprise; Regeneris (2010) Strategic Review of Knowledge Transfer Partnerships, Report to Technology Strategy Board; PricewaterhouseCoopers (2009) Impact of RDA Spending, Report to the Department for Business, Enterprise and Regulatory Reform

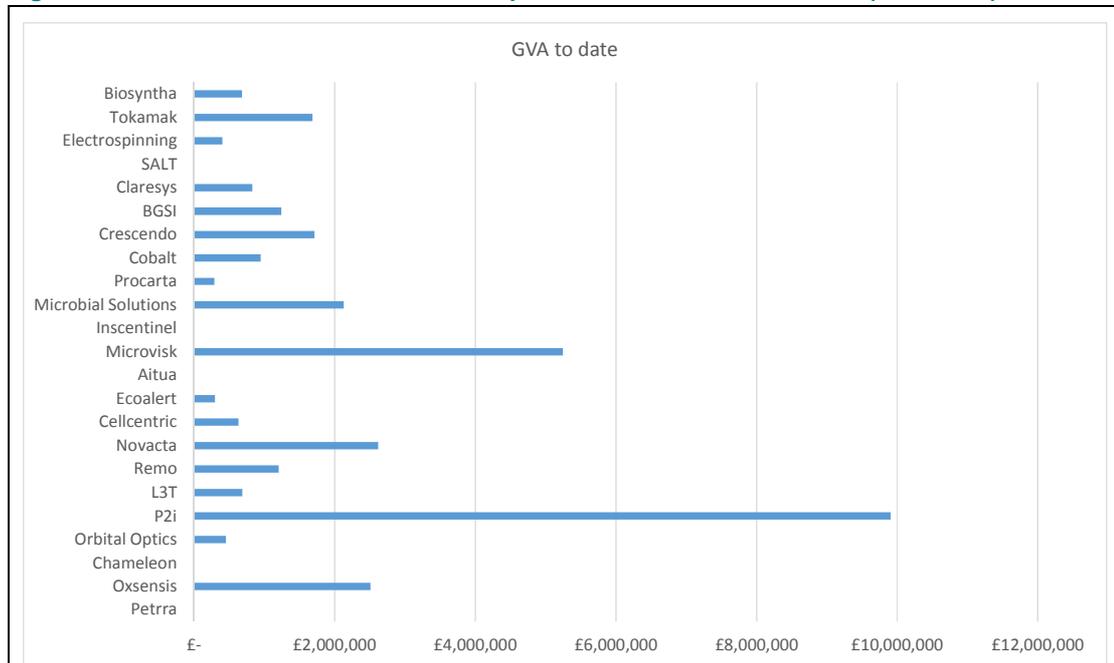
Analysis of variation

4.31 The preceding commentary has focussed on the aggregate and average effects that are attributable and additional to RSF. The analysis undertaken has highlighted that the benefits can vary significantly across the portfolio³⁰. An illustration of this variation is provided with two charts showing the additional direct and indirect impact on GVA attributed to RSF for each of the 23 investee firms where benefits have been assessed. The first plot is for the period 2002 to 2013 (Figure 4-1), and the second is for the period 2014 to 2018 (Figure 4-2). Both plots show:

- A wide range of values, from £0 to £10m (for 2002-13) and £0 to £50m (for 2014-18)
- Limited clustering with high standard deviations relative to the means ($\sigma = £2m$ for 2002-13 and $\sigma = £14m$ for 2014-18)
- The top five contributors account for 67% of the GVA effect to date and 74% of the GVA effect for 2014-18
- Microvisk Ltd and P2i Ltd are the two dominant contributors to the total to date, with Crescendo a third key contributor once future effects are taken in to account.

4.32 It is often the case for venture capital funds that a few star performers tend to dominate when looking at financial performance. From this analysis, we see that this is also true when we look at economic performance indicators such as GVA and employment.

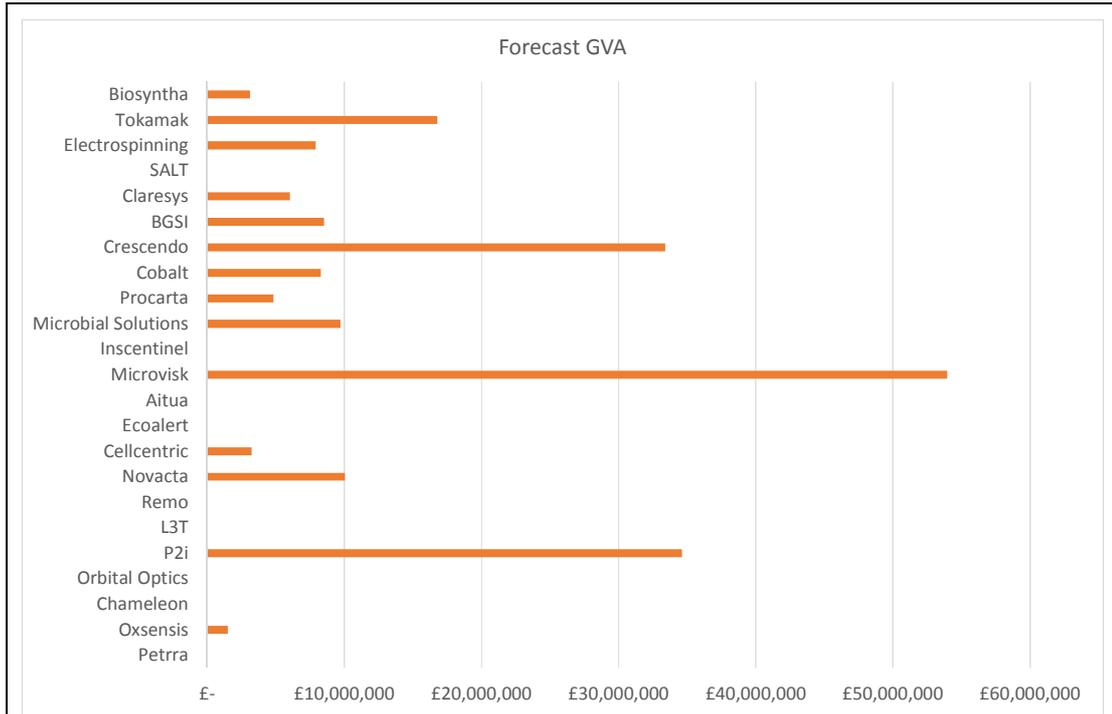
Figure 4-1: Additional Direct and Indirect Impact on GVA Attributed to RSF (2002-2013)



Source: SQW Analysis of RSF Data

³⁰ We have found that key indicators, such as employment and GVA effects, have high standard deviations relative to the mean. This means that observations for employment and GVA for individual companies are spread out across a large range, and often some distance from the average.

Figure 4-2: Additional Direct and Indirect Impact on GVA Attributed to RSF (2014-2018)



Source: SQW Analysis of RSF Data

Summary of benefits

- 4.33 The analysis reveals significant additional direct, indirect, and induced impact on employment, export, and GVA can be attributed to RSF investment. A summary of key figures is provided in Table 4-11:

Table 4-11: Summary of Impact Indicators

Indicator	Additional Direct Impact Attributed to RSF	Additional Direct + Indirect Impact Attributed to RSF
GVA to Date (2002-2013)	£21,022,000	£33,444,000
Future GVA (2014-2018)	£120,751,000	£201,910,000
Return on Investment (2002-2013)	3:1	5:1
Return on Investment (2002-2018)	21:1	34:1
Current Employment (2013)	104	172
Future Employment (maximum to 2018)	254	417
Cost per Current Job	£66,000	£40,000
Cost per Forecast Job	£27,000	£16,000
Exports to Date (2002-2013)	£10,370,000	£10,370,000
Future Exports (2014-2018)	£91,342,000	£91,342,000

Source: SQW Analysis of RSF Data

5. Wider benefits of the Rainbow Seed Fund

- 5.1 This section sets out the evidence on the wider benefits of the RSF. This looks at two key aspects: the role of RSF in contributing to the objectives of the key partners, in particular commercialising the science base to contribute to economy and society; and the softer skills development and behavioural changes of those involved in spin out companies.

Contributing to the objectives of the key partners

- 5.2 The partners of the RSF have, as part of their organisational objectives, a remit to ensure that the science and research that they fund makes a contribution to the economy and society through the application of new technologies and ideas. Commercialisation through spin outs forms a part of this. In addition, for Dstl a core objective of commercialisation is to ensure strengths exist in UK-based supply chains in relation to defence, which is important to national security and ensuring value for money for the taxpayer through Ministry of Defence spending.
- 5.3 As was identified in section 2, RSF has invested across a range of sectors and technologies including the healthcare sector (just under one-half targeted on this sector), the security and space market, and cleantech. From this range of technologies there are some particularly interesting examples of the wider benefits. The following box examples cite case studies of wider benefits.
- 5.4 The first box identifies three companies involved in drug discovery work, with potential benefits in relation to cancer treatment and addressing growing issues in drug resistance³¹. It is difficult to quantify the potential benefits to healthcare at this stage. The length of time to market is a barrier to attracting investment for these companies, and so RSF has played a key role in establishing the businesses or accelerating their development.

³¹ 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.

Case examples: companies involved in drug discovery

CellCentric is a drug discovery company that is developing small molecule inhibitors for cancer. It was originally set up working with a pool of Cambridge academics in the field of epigenetics, which RSF then advised should include research being undertaken at the Babraham Institute. The business's programme now focusses on a deubiquitinase enzyme that is strongly associated with prostate cancer. The programme could, therefore, improve the treatment of prostate cancer, a leading cause of mortality amongst men. It may also have clinical use in the treatment of non-small cell lung, breast and colon cancer. RSF has been instrumental in establishing the link with Babraham and in developing the business model of the firm.

Crescendo Biologics Ltd is developing two proprietary platforms for biological therapeutics. These have been developed from Babraham Institute research and are: a ribosome display for the optimisation of antibodies; and a transgenic mouse which produces heavy chain only antibodies. Technically, Crescendo is making good strides in developing its technology platform to create therapeutic antibodies, which is commercially a significant global market. In terms of health benefits, the programme will now develop targets for the antibodies, such as lung cancer. Aitua, a funding vehicle that RSF helped to set up, supported the early development of Crescendo. Without RSF, it is considered that Crescendo would have taken longer to become established.

Procarta Biosystems Ltd, a spin out from John Innes Centre science, is developing a novel approach to antibacterial drug development that offers a radical new way to counteract the growing problem of drug resistance. This offers potentially significant benefits to health and health service providers given the major threat identified to medical treatment from drug resistance. RSF was an initial co-investor with the Icen Fund, a University Challenge seed fund. Without the co-investment from these two government-backed funds, Procarta is unlikely to have become established. In addition RSF found a major second round investor from the United States in 2009.

- 5.5 The second set of case examples includes two companies that have the potential to contribute to environmental benefits. The first is drawn from BBSRC research in the field of industrial biotechnology, and the second company (MSL, detailed in section 3) has drawn on NERC research with benefits in relation to reduced energy, waste and water use in manufacturing.

Case examples: contributing to a low carbon economy

BioSyntha Technology Ltd operates in the field of industrial biotechnology³², offering bespoke contract research services to a range of sectors. It also develops proprietary systems for the fermentation of high value chemicals from renewable raw materials. Industrial biotechnology has been identified by BBSRC in its Strategic Plan as a high level strategic priority area for the next five years as a way of helping to reduce dependency on petrochemicals and helping the UK to become a low carbon economy, so contributing to the targets for reducing emission of green-house gases. RSF played an instrumental role in coordinating and funding the company's spinning-out from Novacta Biosystems in 2013. The company is currently working with major multinationals, supporting the development of novel fuels and novel fuel applications.

Microbial Solutions Ltd (MSL) has developed an innovative bacterial process that can treat waste metal working fluids in a much more environmentally friendly manner. The process produces grey water that is safe to dispose of in the sewerage system. Water re-use is also possible, which is a potential benefit especially in countries under 'water stress'. Relatively speaking, it is estimated that MSL's approach means using 85% less energy, 95% less water and results in 96% less solid waste as compared to the alternatives. The company is testing industrial-scale programmes, which could have widespread use in automotive and aerospace manufacturing. Therefore, there are significant potential environmental benefits, helping manufacturers move towards a zero waste production model.

- 5.6 The third set of case study examples focuses on the benefits to the defence sector and to national security. The first draws on Cobalt (referenced also in section 4) and the application of its technology, developed at an STFC laboratory, in airport security (alongside other potential uses). The second example looks at military security, drawing on Claresys, a Dstl company.

³² Industrial biotechnology is a set of cross-disciplinary technologies that use biological resources for producing and processing materials and chemicals for non-food applications.

Case studies: defence and national security

Cobalt Light Systems Limited's technologies, developed at the Central Laser Facility at STFC's Rutherford Appleton Laboratory, use the powerful analytical technique of Raman spectroscopy to determine the composition of chemical mixtures. This allows for an accurate and robust chemical analysis of objects where the contents are obscured (e.g. because they are in a container) and is much improved on previous technologies. This has significant potential in the area of national security, because it could be used for explosives detection in security checks and also in screening of liquids being carried through security at airports. There are also wider potential uses, including in biomedical screening and tissue analysis and in pharmaceuticals to scan for counterfeits in pharmaceutical products such as tablets. RSF and Nesta provided initial pathfinder funding, which led to the demonstration of the technology, which was a key milestone in establishing the business. RSF was also key in developing the company's forward strategy, putting together the second significant investment round and drawing on its networks to introduce Cobalt to its current managing director.

Claresys Ltd develop and supply unique lens solutions for covert surveillance, based on patented technologies from Dstl. The Claresys offer is based on the provision of high performance lens solutions that are less susceptible to detection than conventional surveillance solutions. Alongside bespoke commissions, the Compact Optically Scanning Enhanced (COSE) pinhole camera is a principal feature of the company's portfolio. Currently, Claresys' primary clients are in the defence, homeland security, and police sectors. RSF has been the company's sole investor in the period 2009 to 2012, enabling Claresys to validate the technology and ultimately bring its offer to market in 2010. The operation has subsequently been able to secure investment capital from co-investors in 2013 for the purposes of expansion, in terms of the portfolio and market reach.

- 5.7 In addition to these three sets of wider benefits, commercialisation also offers other benefits. The last case examples look at two quite different companies, one operating in international development, and the other working on a wide range of applications of its advanced processes in product coatings.

Case example: international development

In 2008 the British Geological Survey was considering the future of its international operations. It had an excellent track record in winning business in emerging markets for large scale resource mapping exercises, used by developing country governments as the first step towards proper management of the exploitation of their natural resources. But it was not necessarily “core business” for BGS and needed additional impetus. NERC asked RSF to get involved and, over an extended period of three years, RSF worked alongside the individuals and BGS to develop the basis for what, in 2011, became **BGS International**. The outcome has been very successful, with the company recently winning over £4m of tenders around the world. The company is developing a good working relationship with the Department for International Development, which recognises the value that a good understanding of natural resources brings to developing countries. Both RSF and BGS continue to be closely involved at Board level, and the company retains close operating links with BGS, contracting staff from BGS’s site at Keyworth (near Nottingham) on several projects.

Case example: the application of advanced materials

Porton Plasma Innovations (P2i) Ltd was established to commercialise technologies developed by Dstl. RSF contributed 25% of the first £1m investment round when the company was formed in 2004, and a small proportion of a subsequent investment round. P2i has a growing patent portfolio of over 65 families, and through development and acquisition it has technology applications in areas such as antimicrobial, super hydrophobic and protein resistance coatings.

It has brought to market advanced coating processes that hugely enhance fluid protection without compromising on weight and usability. This was initially developed for military purposes to improve the performance of front line battledress. This has applications in the lifestyle sector through P2i’s ion-mask™ technology, which keeps treated articles dry by repelling water. This has practical performance advantages for products such as footwear and football goalkeeping gloves, and by resisting the absorption of water and dirt it can help guard against stains, making products look newer for longer.

The company is now making substantial inroads into electronics through its Dunkable™ and splash-proof technologies. This could be a mass market application for products such as smartphones to help consumers’ phones survive accidents such as bathroom mis-haps³³.

³³ A more common issue than you might think, research from Plaxo in the USA in 2011 indicated that one-third of smartphone owners had lost or damaged their phone. Of those one-third, 19% had dropped it in the toilet. See: <http://pressroom.plaxo.com/plaxo-mobile-trends-study-infographic/> [accessed 09/09/13].

Opportunities going forward

- 5.8 RSF continues to invest and the research establishments that formed the core of the original fund remain very interesting sources of novel technologies. In addition, the recent expansion into the BBSRC and STFC campuses has brought a broader range of deal flow than before, and this is further helped by increasing variety of company type (such as service-based businesses). NERC envisages potential opportunities around 'big data' given the seven data centres that it runs and the amount of data it holds. For Dstl, a point was raised on broadening the scope of the eligibility criteria of RSF to respond to a shortage of risk finance for defence SMEs; though it was noted that this would have implications for the distribution of an already stretched investment pot.
- 5.9 As well as further funding recently committed by BBSRC and STFC, we understand that RSF will manage a fund dedicated to investment in the area of synthetic biology. This is a new and emerging area and the intent is to accelerate the application of synthetic biological science and help create companies using the science, in particular new tools companies.
- 5.10 Conversations with partners confirmed that the position of RSF as a rare resource supporting high risk, early stage investments has endured and is expected to do so over the long term. A couple of the consultations identified the need to add scale to RSF in order to enable the operation to reach the critical mass required. Some of the recent funding developments, and the opportunities identified may help towards this.

Skills development and behavioural changes

- 5.11 Overall, consultees indicated that it is absolutely critical to ensure that collaboration and sharing happens between academics and businesses to help develop understanding and skills. For the academics, they benefit from seeing how a business operates. This is important given the potentially clashing cultures: academics are interested in precision however long it takes; businesses want something that works, and want speed and commercial discipline.
- 5.12 Benefits through skills development and behavioural changes are difficult to evidence comprehensively across the portfolio, because individuals' skills and subsequent collaborative behaviour is not tracked. Nevertheless, the consultations identified a number of examples that are worth highlighting, as follows:
- The R&D phases/programmes of companies often involve studentships, e.g. in the case of CellCentric. The founder and Chief Scientific Officer of Procarta, has continued to work part time at the John Innes Centre supervising PhD students and leading research programmes in related areas.
 - Companies continue to have links with the "parent" site where the original research was undertaken, with subsequent collaborations and/or sharing of staff. STFC's Harwell site has seen several such relationships: Cobalt, Oxsensis, The Electrospinning Company and Microvisk have all retained physical presences and employed staff on a shared basis (i.e. part-time at both the company and the PSRE).
 - Individual researchers may go on to engage in other similar collaborations. The Babraham researcher involved in the science that led to the creation of Crescendo has since worked with another industry partner and subsequently moved to work for

them. The post-doctoral researcher that was involved in the original research for MSL is doing more work on metal working applications; but also in another field (cystic fibrosis) where groups of microbes may help with medical treatment.

- Buyers of companies have had continued relationships with the researchers involved in the original science, e.g. in the case of Chameleon and Orbital Optics.

5.13 The Electrospinning Company provides an example of on-going collaborations between the research base and industry (see box below). In addition, Procarta provides an example of strong links between the originating research location, the John Innes Centre, and the commercial enterprise (see box below).

Case study: On-going collaborations between research base and industry

The Electrospinning Company develops and manufactures electrospun polymer scaffolds, which provide an ideal environment for supporting the growth of cells in 3D. It makes lab consumables to aid the accuracy of drug discovery work in the laboratory.

The founder and inventor remained at STFC at Harwell, doing work under contract for the company, until moving to Nottingham Trent University where he has continued to build links with the Electrospinning Company and also a second start-up based at STFC's Daresbury campus.

The Electrospinning Company itself is collaborating with a number of other institutions, including through BBSRC funding (with Keele University) and the Engineering and Physical Sciences Research Council's Centre of Innovative Manufacturing in Regenerative Medicine.

Case study: Enduring relationships between a research centre and spin out with Procarta

The two founders of Procarta Biosystems Ltd maintain positions as senior supervising scientists and project leads within the John Innes Centre's Molecular Microbiology Group.

Following the establishment of Procarta, members of the team have been involved in further enterprise projects, including the establishment of the John Innes Enterprise company, StrepTech.

The relationship has facilitated knowledge exchange, benefitting the strategic steer of projects within Procarta and the John Innes Centre. In addition, there has been some cross-over of graduate and post-doctoral researchers between the organisations. Whilst the founders may have already possessed some entrepreneurial intent, this is being utilised for wider knowledge exchange activities and for facilitating skills development of other researchers.

6. Conclusions

6.1 This final section sets out our overall findings and conclusions from the study.

Economic contribution of RSF

6.2 The headline findings on the economic contribution to date that is attributable to RSF, based on the assessment of the 25 companies covered, are as follows (see also Table 6-1):

- Current 'additional' GVA generated = £21m (excluding multiplier effects) and £32m (including multiplier effects).
- A return on RSF investment³⁴, based on GVA figures, of: 3:1 (excluding multiplier effects) and 5:1 (including multiplier effects).
- Current 'additional' employment created = 104 (excluding multiplier effects) and 142 (including multiplier effects).
- Co-investment levels from private investors (including from some other publicly-backed funds) of £127m (leveraged from just over £6m of RSF investment).
- 73% of companies would not have been generated without RSF, meaning that 18 of the 25 companies of the portfolio are considered as 'additional'.
- An important contribution to government rebalancing objectives, including to the net trade balance with the companies operating in overseas markets. Data on the companies that are making substantive sales indicates that the proportion of sales being made overseas is in the range of 75-100%.

Table 6-1: Summary of key indicators on current economic contribution

Indicator	Additional Direct + Indirect Impact Attributed to RSF	Additional Direct Impact Attributed to RSF
GVA to Date (2002-2013)	£21,022,000	£32,106,000
Return on Investment (2002-2013)	3:1	5:1
Current Employment (2013)	104	142
Cost per Current Job	£48,373	£28,903
Exports to Date (2002-2013)	£10,370,000	£10,370,000

Source: SQW Analysis of RSF Data

6.3 The companies are still in their early stages of development, and so it is important to consider the future economic contribution of the portfolio. This future contribution is still attributable to RSF investment that has already been made. Taking account of forecast economic benefits increases the GVA contribution and return on investment (see Table 6-2):

³⁴ This is based on the RSF investments into the 23 companies (plus the costs of other pathfinder investments), and excludes fund management costs. Section 4 provides further detail on the fund management costs and their effect on return on investment.

- Forecast ‘additional’ GVA that could be generated in the future = £121m (excluding multiplier effects) and £202m (including multiplier effects).
- A return on RSF investment of 21:1 including forecasts up to 2018 (excluding multiplier effects), and 34:1 (including multiplier effects).
- ‘Additional’ employment creation is estimated to reach 254 jobs in the future (excluding multiplier effects) and 417 (including multiplier effects).

Table 6-2: Summary of key indicators on future economic contribution

Indicator	Additional Direct and Indirect, Impact Attributed to RSF	Additional Direct Impact Attributed to RSF
Future GVA (2014-2018)	£120,751,000	£201,910,000
Return on Investment (2002-2018)	21:1	34:1
Future Employment (max achieved to 2018)	254	417
Future Exports (2014-2018)	£91,342,000	£91,342,000

Source: SQW Analysis of RSF Data

- 6.4 Evaluation data on directly comparable early stage interventions is limited, and so we have looked at wider benchmarks covering knowledge transfer and business development interventions. Whilst care is needed in making comparisons between different types of programme, in terms of the return on investment figures and cost per job RSF compares favourably or are on a par with other seed funds and knowledge transfer schemes, for which evidence is available.
- 6.5 An important point to note is that RSF (in common with other seed funds) is 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 each pound of investment can be put to work again.

Wider benefits for the economy and society

- 6.6 A review of the activities of the companies supported and the nature of the technology being applied evidences their importance more widely to economy and society. A series of examples were presented in section 5 of the report detailing the types of benefit, as follows:
- Around one-fifth of firms are involved in **drug discovery and other areas of healthcare** such as medical diagnostics. These include improving cancer treatment (e.g. Crescendo and CellCentric), and progressing developments in fields such as the resistance to antibiotic drugs (e.g. Procarta) and regenerative medicine (e.g. The Electrospinning Company).
 - There are potential **environmental benefits** through the contribution that companies can make to the transition to the low carbon economy. Microbial Solutions Ltd’s (MSL) waste treatments can help address metalworking waste, a 35 billion litre problem across the world, by significantly reducing the waste (by 96%), energy (by 85%) and water use (by 95%) from the process. In the area of industrial

biotechnology, BioSyntha is developing ways of manufacturing high value chemicals from waste materials, which can help reduce the reliance on petrochemicals.

- There are examples of companies contributing to **security and defence**, for example through the application of Cobalt Light System's technology to challenges in scanning hand luggage for liquids at airports such as Heathrow, enabling the lifting of the ban imposed after 9/11.
- One company (BGS International, a spin off from the British Geological Survey) contributes to **international development**, with DfID and the World Bank key customers for their expertise in resource mapping and training. This supports DfID objectives for properly managed exploitation of the mineral and hydrocarbon resources of emerging countries.
- Finally, one company highlights the benefit to the UK of creating capability through building companies out of technologies. In 2004 Dstl spun out a nanomaterials company, P2i, where the original research was based on a specific need to make the frontline battledress more breathable and weather-resistant. After substantial private investment, attracted by the technology's promise in other areas such as waterproofing of millions of mobile phones, the technology has been fully commercialised and the Ministry of Defence is able to procure improved clothing without the multi-million pound development cost it would otherwise have faced.

Developing the skills and knowledge of PSRE researchers and staff

6.7 A second set of wider benefits relate to the skills and attitudes of research and other staff engaged from PSREs. Consultation evidence here indicated three areas of progress:

- The role of RSF in working with technology transfer officers has helped to develop their skills and expertise in identifying and shaping new ideas that may have the potential for spin-out companies (and sifting out those that do not).
- The process of research, spin-out and industrial collaboration has led to subsequent engagements between the research base and industry partners. In over 70% of the portfolio, the process of research, spin-out and industrial collaboration has involved continuing engagements between the "parent" research institute and the companies. These include staff splitting their jobs and working part-time for both the PSRE and the company, the company's location on a PSRE site, contracting the PSRE for further development work, and involvement at the board or Scientific Advisory Board.
- The partner research staff involved in companies supported by the Fund have incrementally developed their own skills and experiences, which has contributed to enterprising behaviour. This has resulted in subsequent commercialisation activity. For example, one of the researchers involved in the original research on microbes that led to metal-working applications (as part of the development of MSL) is working on further similar collaborative activity, but is also in the early stages of developing a potential commercial application of the microbes in the healthcare field.

RSF role in spinning out companies from the research base

6.8 The evidence presented in the report indicates that RSF plays an important role in creating spin-outs from the research base. Additionality, on the whole, was assessed as being very high, though there have been one or two exceptions where it is considered that the companies may have been created without RSF to similar timescales, scale and focus. The assessment of high additionality is underpinned by the strong underpinning rationale for RSF, the willingness to take on risk where private investors are reluctant to do so, and the role RSF plays beyond the cash investment. As part of these factors, a number of different arguments have been identified, in particular:

- RSF's core role as an investor that helps to bridge the 'Valley of Death' for early stage ideas and companies – it invests when the market views the risk as being too high
- as a lead or co-lead in early investment rounds, and in the confidence and comfort provided to co-investors when RSF invests, because it is seen as knowing how to develop companies of this nature
- networks through RSF (including Spectrum) that can help identify relevant investors (helping to leverage £127m of co-investment) and key staff.
- the support provided during the initial stages of company development, in particular around business plan milestones, putting together investable propositions and acting as a trusted and friendly broker in valuation negotiations
- the on-going involvement at company board level, providing both useful strategic and financial advice to the company and an additional perspective for the PSRE "parent".

6.9 The above points highlight that the role played by RSF is more than simply the funds provided through investment. The current CEO of one of the companies of the portfolio summed up the importance of RSF and the benefit of investing taxpayers' cash as follows:

"If Rainbow didn't exist, we should invent it. MSL wouldn't be there without it. The taxpayer had invested in the research [that led to MSL] for 7 years before [MSL was created]. If RSF hadn't invested in it, then it would probably still be sitting on the shelf." (Will Pope, MSL)

Overall, RSF is making a critical contribution to commercialisation objectives

6.10 As a small, yet important, part of the knowledge exchange landscape, RSF makes an important contribution to the commercialisation objectives of its partners, in particular in relation to spin-out companies. In relation to the objectives of the RSF, it is evident from this report's findings that significant progress has been made in filling a gap at the very earliest stage of spinning out a company by providing a source of early stage investment capital. In addition, progress has been made in relation to changing attitudes and developing skills within PSREs.

Annex A: Method for estimating the economic benefits

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

Measures of economic benefit

A.2 Given that many of the businesses are pre-sales, and almost all are yet to generate surpluses, our approach recognises the need to consider a basket of indicators to reflect the economic contribution of the RSF. 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 businesses³⁵. An estimate of GVA is provided as part of the assessment, as per the objectives of the client Brief and in line with BIS guidance³⁶, which recommends estimating GVA where this is possible. In Table A-1 we provide the measures of economic benefit assessed and the principal sources of evidence³⁷.

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	RSF historic data on company investments
Level of additionality	Gives an indication of the extent to which the RSF is supporting the commercialisation of research and start-up of new businesses that would not have happened otherwise	Consultations with fund managers, Tech Transfer Officers, RSF Board Members and partners, and companies – qualitative insight to probe on what would have happened otherwise (<i>and also applied to indicators in rows below</i>)
New businesses created	Indicates number of <i>additional</i> new businesses	Data on Fund portfolio from fund managers (including starts, exits, current companies)
Employment created	Provides an irrefutable indication of economic activity generated	Company account data
Value & proportion of sales that are exports	Injection to circular flow of income, and provides indication of contribution to 'rebalancing' agenda	Company account data
GVA	Values the economic contribution that can be compared to other investments	Derived from company account data (on employee costs, and gross operating surpluses), forecasts and future expected values – methods discussed in more detail below

Source: SQW

³⁵ Scottish Enterprise (2008), *Additionality and Economic Impact Assessment Guidance Note*, Scottish Enterprise, Glasgow

³⁶ Department for Business, Innovation and Skills (2011) *Guidance on Evaluating the Impact of Interventions on Business*, BIS, London

³⁷ We considered also formally setting out the evidence on net R&D expenditure. However, whilst some data on R&D spend was available on companies, this was not comprehensive, and would have resulted in a very partial picture being presented.

A.3 The focus has been on providing an absolute assessment of RSF's impact. A relative assessment is provided in broad terms drawing on benchmarks from wider evaluation evidence. Caution is needed when using benchmarks, in particular given the differences between programme activities (there are very few interventions that are the same or indeed similar to RSF) and in approaches. We note that comparing business survival rates for early stage schemes is fraught with difficulties, because the support in itself can mask genuine business survival³⁸.

Additionality and attribution

Assessing the counterfactual

A.4 BIS guidance on evaluating the interventions on business³⁹ recommends adopting 'stronger' methods of evaluation design, i.e. using some form of comparison or control group of non-beneficiaries. The nature of RSF and its companies makes this very difficult, and there are a number of reasons why a comparison group cannot be established:

- RSF-supported companies are very much non-standard businesses, as they often require seed funding to develop and start to demonstrate their technology (RSF 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.
- The identification of companies to support with RSF is highly selective. There is no 'application process', and those ideas that are not supported tend not to result in new businesses. For example, the RSF has supported a series of 'pathfinders' with small investments (of £25k). Where these have showed promise, a small number of pathfinders have been taken forward as full investments. All but one of the others that did not receive full investments have not resulted in new businesses.

A.5 Therefore, in the absence of a sensible comparison group, we have drawn on feedback of fund managers, technology transfer officers, RSF Board members and partners who know companies well, companies themselves, and co-investors on the likelihood of the business being able to start in absence of RSF (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. With the expansion of RSF to STFC and BBSRC campuses, there could, at some point in the future, be a comparison between RSF-supported companies and other campus tenants. However, the extent of fit as a formal comparison group will need to be tested.

³⁸ We note that interventions that support early stage businesses can result in high survival rates, because the support itself helps to subsidise 'inefficient businesses'. Therefore, survival or failure rates are not necessarily good indicators of success.

³⁹ Department for Business, Innovation and Skills (2011) *Guidance on Evaluating the Impact of Interventions on Business*, BIS, London

Attribution/apportionment

A.6 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 RSF versus other funds. 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 is based on government-backed inputs and investment (i.e. government-backed investment funds, including European funds, grants such as Technology Strategy Board grants, or inputs derived from investment through EIS and VCT relief). A second point to note is that RSF 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, although normally 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 first round (and sometimes second round) of investment. In addition, given its role RSF 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.7 Our approach to attribution, therefore, has been as follows:

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

Leakage and displacement effects

A.8 Leakage has been treated in a UK context, i.e. leakage will be deemed to exist if any activity is taking place overseas. This information has been obtained from fund managers on a case-by-case basis where this is relevant.

A.9 Displacement effects have been considered 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 used this evidence to make a judgement on displacement effects on the basis of Table A-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 A-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

Multiplier effects

A.10 We have used input-output tables from the ONS, drawing on those based on the most closely aligned sectors for individual companies. A selection of relevant output multipliers is set out as follows:

- Pharmaceuticals 1.8
- R&D 1.4
- Electronic components 1.6
- Medical and precision instruments 1.7
- Chemicals 1.7
- Aerospace 1.6

A.11 In practice, therefore, total employment and GVA estimates, including indirect effects, have been presented by multiplying direct effects by these multiplier values. The alternative to this approach would have been to collect specific data on the purchasing of individual companies. Given the patchy information available on this, this would have been too resource-intensive an exercise. Nevertheless, examples of purchasing behaviour have been identified, which justify the use of multiplier effects in undertaking the economic impact assessment.

Assessment of GVA

A.12 The assessment of GVA benefits has been undertaken in stages to provide a structured analysis that is clear on the derivation of data.

A.13 The first stage of 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^{40,41}. We note that this is likely to underestimate the economic benefits of the RSF, and so we have supplemented these ‘to date’ estimates with forecasts of projected benefits based on:

- individual company projections of employee costs

⁴⁰ Scottish Enterprise (2008), *Additionality and Economic Impact Assessment Guidance Note*, Scottish Enterprise, Glasgow

⁴¹ We note that the PACEC study on the Scottish Seed Fund includes operating losses in calculating GVA to date – see PACEC (2013), *Economic Impact of the Scottish Enterprise Seed Fund*, PACEC, Cambridge. We have only included operating surpluses/losses in the future for those businesses in sales stages of development, reflecting more strictly the guidance of Scottish Enterprise. This also reflects that the RSF has supported a number of businesses that remain in R&D phase, and are not expected to generate sales even by the time of exit from the RSF. These are particularly in the biomedical/life sciences area.

- for those businesses generating sales, individual company projections of surpluses/losses
 - the expected value of companies at the proposed exit date from the RSF – 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 business⁴².
- A.14 The expected company values are calculated by taking four estimates of company values drawing on company expectations that are conservatively adjusted downwards as appropriate: a write-off; low valuation; medium valuation; and high valuation. Each of the four valuations is assigned a probability, and so the value is calculated as a probability function. The probability is lowest for high valuation (below 10%). The other probabilities range as follows: a write-off (15-40%); low (25-50%); medium (25-50%).
- A.15 The GVA estimates have been presented in different ways, in line with other recent approaches⁴³, as follows:
- cumulative to date (note that employment has been presented using headline figures for maximum employment and current employment)
 - projected cumulative.
- A.16 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 age of the investments of RSF (maximum of 10 years and many more recent), and the anticipated exit years from the fund (up to 2018), the persistence of benefit is within a 15 year window. In light of this we have included future benefits as far as anticipated exit years from the Fund⁴⁴. In some cases, this has involved assuming a *status quo* or has involved using a simple trend analysis to take currently available company forecasts forward to anticipated exit years.

Optimism bias

- A.17 HMT Green Book advises taking account of optimism bias, with the guidance specifically taken from an *ex ante* appraisal perspective and focussed on capital works (in terms of duration and expenditure). Whilst part of the assessment of the RSF is *ex post*, the examination also includes projected benefits.
- A.18 Individual company forecasts have already been adjusted by fund managers to ensure a 'realistic' perspective is taken; and the calculations of expected values already include the use of differing probabilities to account for risk. Therefore, 'optimism bias' is already captured in

⁴² 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.

⁴³ E.g.: PACEC (2013), *Economic Impact of the Scottish Enterprise Seed Fund*, PACEC, Cambridge. Geoff White Inc and SQW (2011), *Derivation and use of BCRs in BIS Evaluations*, recommends greater consistency on this matter with results presented transparently and clearly to take account of appropriate levels of persistence.

⁴⁴ For two of the companies, one which has already exited and one due to exit in the future, actual data since exit and forecasts are used instead of expected values given that these data represent more accurate depictions of actual and potential GVA effects.

the data provided. We have not made any further adjustments made to this data, though company forecasts have been tested with fund managers.

Social time preference

- A.19 In line with HM Treasury Green Book we have discounted future benefits using the social time preference rate of 3.5% per annum.

Annex B: Portfolio companies

Table B-1: Portfolio companies

Companies assessed as part of the study	Other companies supported by RSF
Aitua	Cytox
BGS International	Eagle Genomics
BioSyntha	Keit
CellCentric	Perfectus Biomed
Chameleon	ProKyma (costs of investment included in the study)
Claresys	Thruvision (costs of investment included in the study)
Cobalt	Contego
Crescendo	
Ecoalert	
Electrospinning	
Inscentinel	
L3T	
Microbial Solutions	
Microvisk	
Novacta	
Orbital Optics	
Oxsensis	
P2i	
Petra	
Procarta	
Remo	
SALT	
Tokamak	

Annex C: Consultees

Table C-1: Consultees

Name	Representing
Derek Jones	Babraham Bioscience Technologies Ltd
Ann Kramer	BioSyntha and The Electrospinning Company
Celia Caulcott	BBSRC
Will West	CellCentric
Paul Loeffen	Cobalt
Andrew Seedhouse	Dstl
Will Pope	Microbial Solutions
Simon Jackman	NERC and formerly BGSi
Andy Muir	Rainbow Seed Fund Investment Director
Mark White	Rainbow Seed Fund Investment Manager
Bruce Smith	Spectrum
Ian Buckley-Golder	Spectrum, Oxsensis and Petra
Tim Bestwick	STFC and Cobalt
Kate Ronayne	STFC Innovations

Annex D: Extended data analysis

- D.1 This Annex provides extended detail of the estimates of economic contribution detailed in section 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 RSF
Additional 'direct' effect ⁴⁵	The direct effect of a firm(s), e.g. in terms of employment or GVA, that would not have happened without RSF input, and that takes account of potential displacement and leakage
Additional 'direct' effect attributed to RSF	The effect above that is attributed to RSF's input (i.e. by taking account of RSF's role versus the inputs of other government-backed investments)
Additional 'direct' and 'indirect' effect attributed to RSF	The 'direct' effect as outlined above, but also including a multiplier effect to estimate the 'indirect' effect in the supply chain.

Source: SQW

- D.3 Note that 'averages' presented in this section are arithmetic averages across the 23 companies for which costs and benefits have been assessed. As a result, the averages differ from the 'total' indicators. Where relevant, totals include the costs associated with the two portfolio companies for which benefits have not been included, as well as the costs of pathfinder investments.

Balance of investment

- D.4 Table D-2 outlines the balance of investments made by RSF and its co-investors in the 25 investee firms during the 2002 to 2013 period:

Table D-2: Balance of Investment

Metric	Total	Average
RSF investment	£6,369,000	£255,000
Co-investment	£126,791,000	£5,513,000
RSF as % of Total Investment	5%	5%

Source: SQW Analysis of RSF Data

- D.5 Gross outcomesTable D-3Table D-3 outlines the overall performance of the 23 investee firms:

⁴⁵ It is important to note that the average additionality level of 0.73 (excluding multiplier effects) 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.

Table D-3: Gross Outcomes

Indicator	Total	Average
Gross Estimates		
Current employment	255	11
Maximum Employment 2014-2018	576	25
GVA to date	£67,699,000	£2,943,000
Forecast GVA	£331,175,000	£14,399,000
Levels of exports to date	£38,506,000	£1,674,000
Forecast exports 2014-2018	£261,521,000	£11,370,000

Source: SQW Analysis of RSF Data

Additionality & Attribution

- D.6 Table D-4 outlines the factors applied for ‘additionality’ and ‘attribution’ within the impact model:

Table D-4: Additionality and Attribution Factors

Metric	Average
Additionality Factor (w/o. Multiplier Effect)	0.73
Additionality Factor (inc. Multiplier Effect)	1.18
RSF Attribution Factor	58%

Source: SQW Analysis of RSF Data

Direct impact

- D.7 Table D-5 presents the impact and value for money calculations for the RSF investments in the 23 investee firms. This analysis estimates the ‘direct’ impacts before ‘indirect’ impacts are considered (see above).

Table D-5: Direct Impact

Indicator	Total	Average
Additional Estimates		
Current employment	142	6
Maximum Employment 2014-2018	315	14
GVA to date	£32,106,000	£1,396,000
Forecast GVA	£169,647,000	£7,376,000
Levels of exports to date	£13,673,000	£594,000
Forecast exports 2014-2018	£110,157,000	£4,789,000
Attributed & Additional Estimates		
Current employment	104	5
Maximum Employment 2014-2018	254	11
GVA to date	£21,022,000	£914,000
Forecast GVA	£120,751,000	£5,250,000
Levels of exports to date	£10,370,000	£451,000
Forecast exports 2014-2018	£91,342,000	£3,972,000
VfM Indicators⁴⁶		
Rol (2002-2013) – Gross Estimates	£10	£10
Rol (2002-2018) – Gross Estimates	£58	£59
Rol (2002-2013) – Additional Estimates	£5	£6
Rol (2002-2018) – Additional Estimates	£29	£38
Rol (2002-2013) – Additional & Attributed Estimates	£3	£4
Rol (2002-2018) – Additional & Attributed Estimates	£21	£29
Cost per Gross Current Job	£26,947	£20,770
Cost per Additional Current Job	£48,373	£28,815
Cost per Additional and Attributed Current Job	£65,990	£49,613

Source: SQW Analysis of RSF Data

Direct and indirect impact

- D.8 Table D-6 presents the impact and value for money calculations for the RSF investments in the 23 investee firms. This analysis includes estimates of ‘indirect’ impacts through application of the multipliers (see above).

⁴⁶ Overall indicators of value for money include the investments into the two companies for which benefits have not been assessed as well as the cost of investments into pathfinders. The average indicators of value for money are arithmetic averages across the 23 portfolio companies for which costs and benefits are assessed.

Table D-6: Direct and Indirect Impact

Indicator	Total	Average
Additional Estimates		
Current employment	237	10
Maximum Employment 2014-2018	523	23
GVA to date	£52,332,000	£2,275,000
Forecast GVA	£288,388,000	£12,539,000
Levels of exports to date	£13,673,000	£594,000
Forecast exports 2014-2018	£110,157,000	£4,789,000
Attributed & Additional Estimates		
Current employment	172	7
Maximum Employment 2014-2018	417	18
GVA to date	£33,444,000	£1,454,000
Forecast GVA	£201,910,000	£8,779,000
Levels of exports to date	£10,370,000	£451,000
Forecast exports 2014-2018	£91,342,000	£3,971,000
VfM Indicators⁴⁷		
Rol (2002-2013) – Gross Estimates	£10	£10
Rol (2002-2018) – Gross Estimates	£58	£59
Rol (2002-2013) – Additional Estimates	£8	£10
Rol (2002-2018) – Additional Estimates	£50	£63
Rol (2002-2013) – Additional & Attributed Estimates	£5	£7
Rol (2002-2018) – Additional & Attributed Estimates	£34	£48
Cost per Gross Current Job	£26,947	£20,770
Cost per Additional Current Job	£28,903	£17,148
Cost per Additional and Attributed Current Job	£39,837	£28,934

Source: SQW Analysis of RSF data

Expected Value of Companies (EVC)

D.9 Table D-7 shows the relative size of the EVC component within the estimates of impact on GVA.

⁴⁷ Overall indicators of value for money include the investments into the two companies for which benefits have not been assessed as well as the cost of investments into pathfinders. The average indicators of value for money are arithmetic averages across the 23 portfolio companies for which costs and benefits are assessed.

Table D-7: EVC and Additional Direct and Indirect Impact on GVA Attributed to RSF

EVC Metric	Total	Average
EVC as a % of GVA Impact (2002-2013)	0.1%	0.4%
EVC as a % GVA Impact (2014-2018)	61%	38%

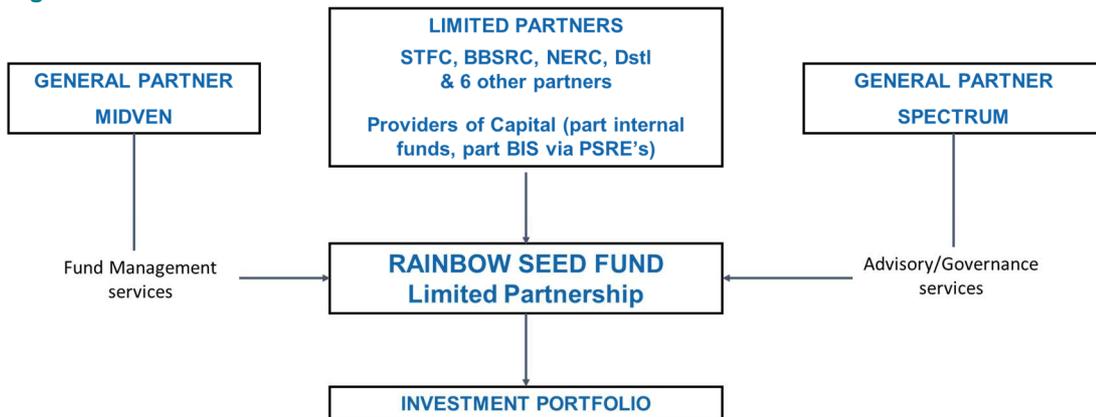
Source: SQW Analysis of RSF Data

- D.10 Naturally, as there are few RSF exits between 2002 and 2013, EVCs represent a negligible component of the estimates for additional direct and indirect impact on GVA attributed to RSF over that period. However, this is in contrast to the same analysis for the 2014 to 2018 period, when the majority of exits are scheduled to occur.
- D.11 Overall, EVCs account for 61% of the total additional direct and indirect impact on GVA attributed to RSF for the 2014 to 2018 period, and, on average, 38% of the estimate for each of the investee firms. In four of the 23 investee firms, the EVC accounts for more than 90% of the additional direct and indirect impact on GVA attributed to RSF in the period 2014 to 2018 (the four are: Crescendo, Microbial Solutions Ltd, Novacta, and CellCentric).
- D.12 This analysis indicates the high exposure of the analysis to the EVC estimates and the magnitude and timing of RSF exits. There is a risk, therefore, that this GVA effect (which is premised on downstream returns made by those acquiring RSF portfolio companies) may leak out of the UK. As a sensitive test, if we were to assume that 50% of the forecast GVA accounted for by EVCs leaked out of the UK, then this would reduce the forecast GVA estimate to the following:
- £86m for additional direct impact on GVA attributed to RSF (from £121m)
 - £141m for additional direct and indirect impact on GVA attributed to RSF (from £202m).
- D.13 With respect to Return on Investment estimates, figures are also dependent on the realisation of EVCs, and again the risk of leakage from the UK is an issue. As a sensitivity test, again reducing the contribution of EVCs by 50% to account for the risk of leakage changes the return on investment figures to the following:
- For additional direct impact attributed to RSF, the RoI (2002-2018) is reduced from 21:1 to 16:1.
 - For additional direct and indirect impact attributed to RSF, the RoI (2002-2018) is reduced from 34:1 to 25:1.

Annex E: Rainbow Seed Fund – Structure and Governance

- E.1 The structure of Rainbow is substantially similar to most private equity or venture capital funds in being a Limited Partnership, a structure that has existed in English law for over a century and which is widely used in the Venture Capital and Private Equity industry. It provides for a separation of duties between the providers of capital (Limited Partners) on the one hand and the providers of services – the fund manager and the advisory body (General Partners) – on the other. In tax terms it is a transparent structure, with partners receiving the gross proceeds of investments when realised and being taxed accordingly in their own jurisdictions, making it suitable as a vehicle for bringing together investors of different types (private, charitable and public sector) as well as those from different countries.
- E.2 Most Limited Partnerships are established with one General Partner, the fund manager. Rainbow is slightly unusual in having two General Partners with the Advisory Board (Spectrum) having been created as a General Partner alongside the fund manager (Midven), as is shown in Figure E-1. As is discussed in more detail below, the second General Partner (Spectrum) ensures good governance and provides advice to the Limited Partners, in particular given the use of public funds.

Figure E-1: Structure of Rainbow Seed Fund



Funding

- E.3 The initial capital was provided by BIS as a donation through the “PSRE Fund” mechanism, of which there were four separate rounds. This was the source of the first £10m raised by the fund. The funding was provided via the partners, who provided only nominal capital but hold the equity interest in the partnership. Recent funding has been provided directly from BBSRC and STFC with a further £940,000 from BIS.
- E.4 Proceeds from realised investments are reinvested into the Fund and are available for future investment. This “evergreen” model is relatively rare in the venture capital community, where private investors typically require their money back after an agreed term, often ten years.

Limited Partners

E.5 As described in the main body of this report, the Limited Partners in Rainbow consist of the “Core Partners” and six others. The “Core Partners” are:

- Biotechnology and Biological Sciences Research Council (BBSRC)
- Defence Science and Technology Laboratory (Dstl)
- Natural Environment Research Council (NERC)
- Science and Technology Facilities Council (STFC)

E.6 The other partners are:

- Culham Centre for Fusion Energy (CCFE)
- James Hutton Institute
- Food and Environment Research Agency (FERA)
- The Health Protection Agency (HPA)
- Animal Health and Veterinary Laboratories Agency (AHVLA)
- The National Physical Laboratory (NPL)

Role of Limited Partners

E.7 The role of the Limited Partners is, as the name suggests, limited in nature. Limited Partners supply capital but are required to avoid intervening in the business of the partnership. Therefore, they are neither involved in investment decisions, nor do they play an active role in the management of the fund. The Limited Partners will often, of course, hold shares in the portfolio companies in their own right in return for licensing or assigning the intellectual property behind the technology, but this is held and managed separately from the indirect interest held via the Fund.

Role of General Partners

E.8 Limited Partners play no direct role in the management of the Fund but engage one or more General Partner(s) to do so. The Limited Partners have contracted Midven as the General Partner to manage the Fund and have created a second general partner (Spectrum) to act in an advisory capacity as advisors to the Limited Partners.

Role of Spectrum General Partner

E.9 The board of Spectrum reports to its shareholders, who are the Limited Partners in the fund itself. The core Partners (STFC, BBSRC, NERC, Dstl) have the right to appoint non-executive directors to the board of Spectrum alongside a (larger) number of independent non-executives with substantial background and networks in venture capital funds and science and technology based businesses.

E.10 The role of Spectrum is that of ensuring good governance and to oversee the general direction of the Fund and Midven's management of it. An audit sub-committee of Spectrum is responsible for overseeing the audit of the Fund. Formally, Spectrum has the power to bind the manager (Midven) to:

"interpret the Investment Policy of the Partnership as determined by the Limited Partners from time to time and to veto any investment proposal made by Prism [the Midven General Partner vehicle] as outside the scope of such Investment Policy".

E.11 Consultation evidence indicated that Spectrum members interpret this in the following two key ways:

- Ensure that investments fit within the Investment Policy so that:
 - investments could not embarrass government, because of the nature of the activities (there have been no examples to date)
 - investments are not those that would attract private funding anyway (i.e. be a non-additional use of public funds)
- Provide advice to Midven as to whether propositions are viable. The expertise of the Spectrum board is often of considerable help and is consulted by the manager on a regular basis, but since the actual management of the fund is the role of Midven, Spectrum limits itself to advising whether they are happy to allow Midven to take a proposition forward for consideration by the Midven Investment Committee.

E.12 Spectrum is therefore not involved in the day to day management or the investment decisions made by the fund manager.

Role of Midven General Partner

E.13 Midven is an independent, privately-owned fund manager that was appointed in 2002 to manage the fund on a day to day basis and receives an annual fee from the partnership to do so. Midven reports to the board of Spectrum on a quarterly basis, with full portfolio reviews semi-annually. The fund and Spectrum are audited annually; the audit committee of Spectrum oversees both audits.

E.14 It is responsible for liaising with the technology transfer offices (including working with technology transfer staff to help bring technologies forward) and the marketing of the Fund within PSREs and their campuses, reviewing proposals and deciding which ones to investigate further. When a proposition looks promising the fund manager will: conduct further due diligence on the technology, market and company; help to source co-investment; negotiate outline investment terms; and establish any pre-conditions to investment (e.g. the appointment of a suitably experienced Chairman).

E.15 The investment is then presented to the Spectrum Advisory Board and, as described above, will either be rejected or allowed to proceed for further consideration by Midven's Investment Committee. The Investment Committee, an internal board consisting of experienced individuals drawn from across the various funds run by Midven, will review the whole proposal and will consider in more detail (than is normally the case at Spectrum) the

investment terms. If the Investment Committee gives its consent then the fund managers will finalise legal negotiations and complete the investment.

- E.16 Following the investment, the fund managers will monitor the investment closely, usually sitting as a Board Observer or Director and attending regular board meetings. Rainbow will usually, as described in the main body of the report, play a significant role in further fund-raising in the early years of a company's expansion. However, as a company grows and larger investors come on board, Rainbow's participation and ability to support expansion through further investment will inevitably decline, and board positions will be relinquished.