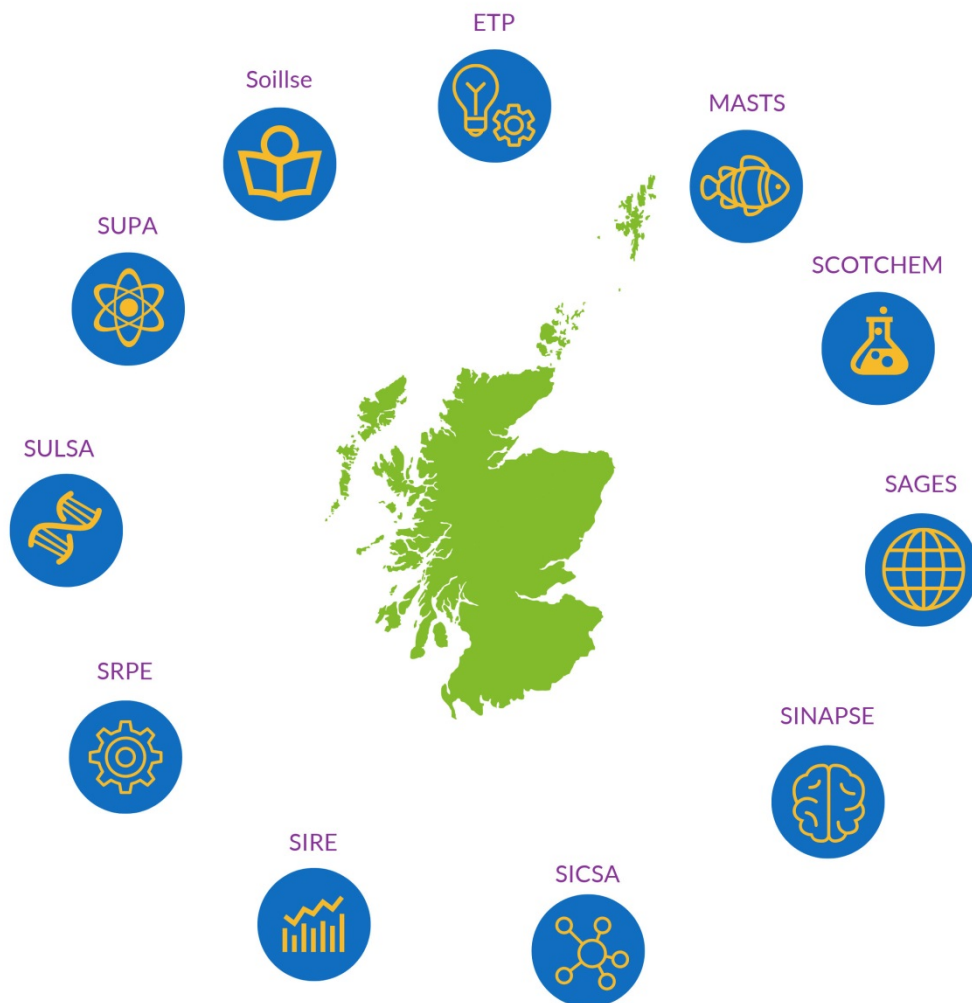


Independent Review of the Scottish Funding Council's Research Pooling Initiative

Chaired by Professor Louise Heathwaite CBE FRSE



Contents page

Preface

Executive summary

1. Introduction
2. The review process
3. Brief background to the Research Pooling Initiative
4. The evidence base
5. Evidence analysis
6. Conclusions and recommendations
7. List of advisory panel members
8. Appendices

Preface by Professor Louise Heathwaite CBE FRSE



I was delighted to be asked by Mike Cantlay OBE (Chair of the Scottish Funding Council, SFC) and Professor Lesley Yellowlees CBE (Chair of SFC's Research and Knowledge Exchange Committee, RKEC) to lead this independent review of the Research Pooling Initiative (RPI). Scotland's major investment in, and long-term commitment to growing critical mass and driving collaboration across its core science disciplines was prescient and has been copied widely elsewhere. Since 2005, SFC has invested over £155m in eleven research pools, matched by over £330m from Scottish Universities and co-funding of almost £10m from the Office for Science & Technology and the Chief Scientist's Office.

Given the continued evolution of the research landscape in Scotland and the UK, now is a good time to evaluate whether the concept of research pooling remains fit for purpose. My remit was to undertake a high-level and summative analysis to establish the impact of SFC's investment in the pooling initiative on the Scottish research environment to date and to provide recommendations on the development of this and SFC's future investment in research.

I am hugely grateful to every member of my Advisory Panel for their valuable guidance and critical insight throughout the review process and particularly for their fortitude and good humour during the oral evidence sessions when the days were very long indeed. My thanks go also to Hazel McGraw of SFC for acting as secretariat for the review and font of all knowledge regarding the detailed workings of the RPI. Further thanks go to Dr Kirsty Collinge, University of Edinburgh for her excellent benchmarking and quantitative analysis of the RPI and to Morag Campbell, SFC and Dr Fiona Smith, Lancaster University for their valuable support.

I am also grateful to those who contributed to the review through written evidence and attendance as witnesses for the oral evidence sessions; and of course to the Research Pool Directors present and past for their candid views and ready feedback to the various questions and requests for information over the review period. Thank you.

Louise Heathwaite, August 2019

Executive Summary

My independent review has built a substantive written, oral and quantitative evidence base. Starting in October 2018, and using a Parliamentary select committee approach, together with my advisory panel we reviewed over 90 written evidence submissions; recorded over 12 hours of witness statements over 15 evidence sessions across 3-days and contracted independent benchmarking of the performance of the research pools.

We found: -

The Research Pooling Initiative (RPI) has built critical mass and research excellence in a number of disciplines important to Scotland's research base and continued global science leadership.

- Growing critical mass and developing a collaborative research culture across Scotland's Universities takes time, and the SFC are to be applauded for their commitment to this initiative as a long-term investment.
- The outputs from the research pools that we benchmarked are highly cited and exceed the UK average; there is some evidence that performance is associated with growth in international collaboration. In terms of market share of total research income, a number of disciplinary research pools are in the top three in the UK.
- Investment in multi-institution graduate schools is a common currency for virtually all the research pools and most have increased their UK market share of doctoral degrees awarded over the past 10 years.
- There is little evidence that research pooling is embedded in the strategic investments of the individual Scottish Universities, which questions the longer-term sustainability of the initiative.
- The evidence points to lost opportunities in building strong strategic alignment between the research pools and other structures, most notably the Scottish Innovation Centres.

Over the timeframe of the RPI so far, the wider research and innovation landscape in the UK has not stood still, and the original aims of research pooling no longer fit the modern research landscape where the search for new knowledge and solutions increasingly crosses disciplines and sectors.

- Change is needed to enable Scotland to perform well in this interdisciplinarity and challenge-led culture. My review has shown the critical mass to build Scotland's research powerhouse of the future exists, but it lacks the *integrated and innovative capacity* to respond strategically and effectually to research and societal challenges such as the decarbonisation agenda.
- My review does not prescribe a gentle evolution but calls for a relaunch of the sunk investment in the RPI, with the research pools forming a building block in the transition to Scotland's research powerhouse of the future. The proposed model also offers the opportunity to engage constructively and for the long-term with Scotland's research institutes.

We make **four recommendations**. In summary these are: -

R1 A major investment at scale that builds on the *collective* critical mass of the RPI but re-orientated to address the strategic cross-disciplinary research challenges important to Scotland by coupling to other disciplines and research and innovation structures. This is the basis of Scotland's research powerhouse of the future.

- R2 Direct financial underpinning of the existing research pools by SFC stops.** The most effective coordination activities of the current discipline-based research pools are supported to cover the transition period between now and the implementation of Recommendation 1 (the 'transition pools').
- R3** The **international presence** of the 'transition pools' is enhanced to ensure Scotland remains an attractive place for research and international graduates.
- R4** Scotland's complex research-innovation landscape is reformed to ensure that **the function and purpose of the 'transition pools' and Innovation Centres are aligned**, going forward as a seamless and integrated 'cradle to grave' model that can play effectively into Recommendation 1.

1. Introduction

The Research Pooling Initiative (RPI) was developed by SFC with the vision of supporting Scottish institutions to establish collaborative research pools. The aim was to grow a critical mass of excellent research in Scotland, in order to compete effectively for funding, research staff and doctoral students both nationally and internationally. Since 2005, SFC has invested over £155m in 11 research pools. The bulk of the funding was allocated in Phase 1 (£150m, 2005-2017). Phase 2 (£5m, 2015-2023) has largely funded the continued administration of the research pool collaborative networks.

Over the 15-year timeframe of the RPI to date, the pools have evolved in a largely self-organised 'bottom-up' manner that, from the evidence, worked well to secure research community buy-in. **The bespoke models of ambition and operation that emerged for the research pools have made genuine inroads in changing research culture in the disciplinary areas that were supported under the initiative.** Whilst this diversity in approach is commendable and was necessary, it also means it is challenging to measure the impact of research pooling in Scotland as a whole. A Parliamentary Select Committee model was used to tease out the evidence used to support the review, coupled with some limited independent quantitative analysis drawing from publicly available data. A similar approach was used in the earlier Reid Review of the Scottish Innovation Centres. In line with the [terms of reference](#) of *this* review to produce a high-level and summative analysis of the impact of SFC's investment in the pooling initiative on the Scottish research environment, recommendations on the development of this and future initiatives are also presented. Individual summaries of the written and oral evidence and a full report on the quantitative evidence are provided as Appendices to the report.

1.1 Research capacity and quality in Scotland and the UK

This review builds on a number of earlier reports into the quality of research and funding in Scotland and the UK. Notably, the Scottish Science Advisory Council's 2019 report on Scotland's science landscape¹ concluded that Scotland's researchers are highly productive relative to the total UK output, and the research is of high quality. Further, Audit Scotland's 'Audit of Higher Education in Scottish Universities'² reported that '*Universities play an important role in Scotland's development, both economically and socially.*' Further, the 'Independent Review of the Scottish Innovation Centres Programme'³ reported that there could be opportunities for the Innovation Centres to work more closely with research pools.

Other pertinent reviews include the National Centre for Universities and Business's 'Growing Value Scotland Task Force Report'⁴ that examined Scotland's spending on research and development in comparison to the rest of the UK and globally; Sir Paul Nurse's review of the UK Research Councils,⁵

¹ SSAC, 2019 A metrics-based assessment of Scotland's science landscape (2007-2016)

² Audit Scotland, July 2016, Audit of higher education in Scottish universities

³ Independent Review of the Innovation Centres Programme, Chaired by Professor Graeme Reid, September 2016

⁴ NCUB, May 2016, The step change: business-university collaboration powering Scottish innovation

⁵ Nurse, Paul, Department for Business Innovation and Skills (BIS), November 2015, Ensuring a successful UK research endeavour: a review of the UK research councils

and the House of Lords Science and Technology Committee review of science research funding in universities.⁶

1.2 The research funding landscape in Scotland

Significant changes have taken place in the research landscape in the UK recently that impact on Scotland, including the formation of UKRI; the growing emphasis on research-led innovation; the widespread shift to building capacity in the skills base through doctoral training partnerships (DTPs) and Centres of Doctoral Training (CDTs), and the implications of *Brexit* for scientific research.

Some of these wider changes are reflected in the balance of public funding for research in which Scottish HEIs operates. Funding is administered under a 'dual support' system whereby SFC provide annual research funding for Scottish institutions through a quality related core grant, the Research Excellence Grant (REG) and the UK Research Councils provide funding for specific research projects and programmes.

Figure 1 shows the distribution of core research, and knowledge exchange and innovation grants over the lifetime of the Research Pooling Initiative. Audit Scotland in 2016 note a real terms downward trend in the value of the REG since 2014.² The split of strategic research and innovation funding allocated by SFC over the period of the RPI is shown in Figure 2, illustrating the growth in investment in Scottish Innovation Centres and in knowledge exchange since 2011. An early analysis of the value of the Innovation Centres is covered in the Reid Review.³

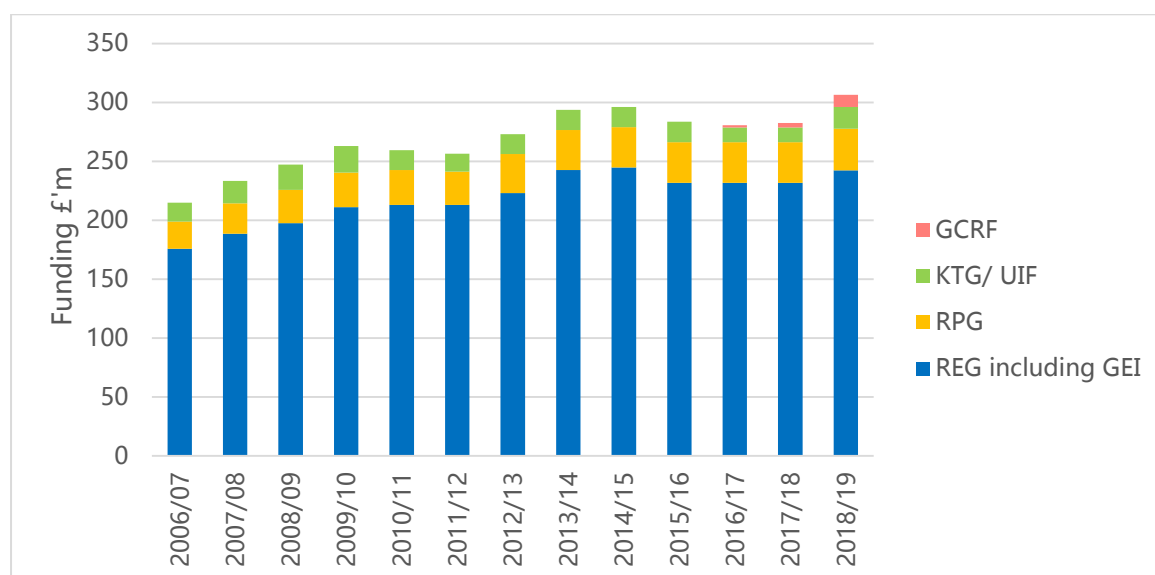


Figure 1: Balance of funding over the lifetime of the Research Pooling Initiative, showing the allocation of funding to the Research Excellence Grant (REG) including the Global Excellence Initiative (GEI), Research Postgraduate Grant (RPG), Knowledge Transfer Grant (KTG), Universities Innovation Fund (UIF) and Global Challenges Research Fund (GCRF).

⁶ Science and Technology Committee (Lords) Science Research Funding in Universities Inquiry, 2019

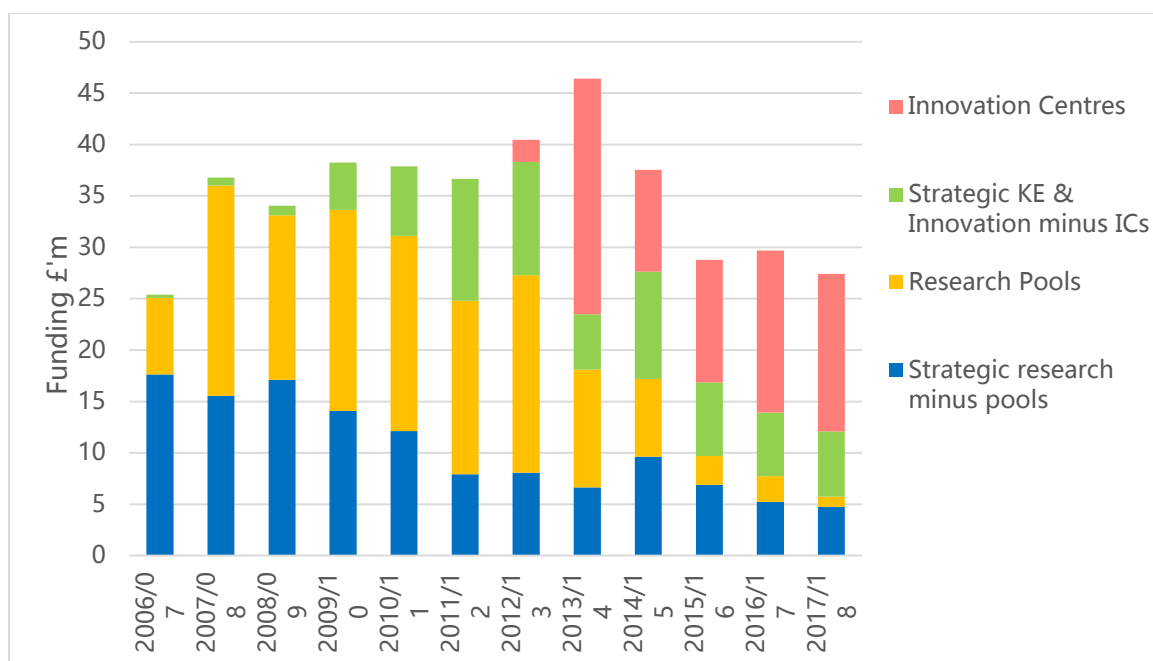


Figure 2: Strategic research and innovation funding over the period of the Research Pooling Initiative

1.3 The changing research funding landscape in the UK

The UK has a world class research base that is internationally leading for its size. In the UK, 24% of R&D is performed in the Higher Education sector (£11.5bn of £47.4bn), with most of the rest performed in business (68%). In 2017/18, the total HEI income in the UK was £38.2bn, and in Scotland it was £3.8bn (Table 1).

Income of UK and Scottish HE providers by category and year	2015/16		2016/17		2017/18	
	UK	Scotland	UK	Scotland	UK	Scotland
Tuition fees and education contracts	16,811	1,010	17,757	1,085	18,875	1,185
Funding body grants	5,167	1,142	5,105	1,151	5,112	1,134
Research grants and contracts	5,886	791	5,916	775	6,225	797
Other income	6,045	585	6,165	548	7,203	575
Investment income	261	30	254	38	248	32
Donations and endowments	578	28	585	40	586	41
Total	34,748	3,585	35,783	3,637	38,250	3,765

Table 1: Income (£millions) of UK HE and Scottish HE providers by category and year (source: HESA)

The impact and value of research pooling as a model of investment needs to be read in the context of wider financial constraints on universities at large. Whilst overall UK and Scottish HEI research income over the past decade has grown (Table 2), total spending on research has exceeded it, leading to a deficit in 2017/18 of £4.3bn.⁶ This is not a new issue but the size of the deficit is increasing⁷ and this influences investment decisions such as commitments to matched funding.

⁷Mind the gap: Understanding the financial sustainability challenge, HEFCE, 2016

Historically, most of the research deficit was met via a large surplus made from the teaching of overseas students⁸ but *Brexit* uncertainties challenge this option as a long-term gap-filler.

Year	UK Research income (nominal)	Scotland	UK Research income (real, 2017/18 prices)	Scotland
2007-08	6,469	862	7,695	1,025
2008-09	7,042	967	8,156	1,120
2009-10	7,454	1,006	8,513	1,149
2010-11	7,608	1,028	8,530	1,153
2011-12	7,738	1,027	8,563	1,136
2012-13	8,068	1,074	8,752	1,165
2013-14	8,416	1,151	8,965	1,226
2014-15	8,802	1,252	9,257	1,317
2015-16	9,500	1,263	9,912	1,318
2016-17	9,760	1,275	9,957	1,301
2017-18	10,026	1,281	10,026	1,281

Table 2: Research income in UK and Scottish HEIs, 2007/08 to 2018/19 (£millions) based on OfS TRAC data and TRAC returns in Scotland.

Concurrent with changes in the balance of funding in Universities is a hugely changed UK research environment since research pooling was initiated. Many of the changes have happened relatively recently since the formation of UKRI in April 2018. UKRI now delivers c.70% public R&D funding in the UK, 30% of which is cross-cutting. Aligned with this budgetary power is a greater focus on collaboration and on consortia addressing complex societal challenges through multidisciplinary collaboration. Underpinning this shift is the assurance that research and innovation form the pathway to growth: the 'I' in UKRI is critically important, hence the investments in industry-led research through the Industrial Strategy Challenge Fund, and in international development through the Global Challenges Research Fund. The nature of these investments present particular challenges in a Scottish context where the predominance of SMEs as the bedrock of Scotland's economy potentially constrains the capacity to grow innovation and business expenditure on R&D. Scotland's total gross expenditure on R&D as a share of GDP at 1.54% (2016 data) continues to be less than the UK average of 1.67%.

There are huge opportunities to be realised in Scotland from the UK-level ambition to increase R&D investment to 2.4 per cent of GDP by 2027.⁹ Not least, this ambition will need to increase the number of active researchers in the UK by the order of approximately 50 per cent (John Kingman speech, Royal Society Changing Research Cultures Conference, Oct 2018) with a growing emphasis on data analysis related skills and research technology professionals.¹⁰ These changing needs play into the operating model of the research pools with regard to graduate schools and to the upskilling offered through Scotland's Innovation Centres.

⁸ The determinants of international demand for UK higher education, HEPI, 2017

⁹ <https://www.ukri.org/about-us/increasing-investment-in-r-d-to-2-4-of-gdp/>

¹⁰ Chapter 8 (e-infrastructure) UKRI Infrastructure Roadmap, p78, 2019

1.4 International context

In the QS 2020 World University rankings, Scotland has maintained its position with four HEIs in the top 200, albeit three of these have lower rankings than 2019. The Scottish Science Advisory Council's 2019 Science Landscape Report attributes part of the explanation to increasing global competitiveness resulting in a decline in the share of global publications. Scotland benefits more than the rest of the UK from European collaborations, as a consequence *Brexit* presents additional challenges for Scotland in maintaining a competitive position.

2. The review process

Key message: Using a Parliamentary Select Committee process, this independent review has been able to curate and analyse an evidence base that seeks to properly test the lasting impact of research pooling in Scotland through qualitative (written, oral) and quantitative measures.

This Review is a high-level summative analysis of the RPI and is focused on the delivery of the original vision of the Research Pooling Initiative and the impact this has had on the Scottish research environment. The process and timelines for the review are summarised below. The Terms of Reference of the review and a description of the process in detail are available [here](#).

PROCESS FOR THE REVIEW



3. Brief background to the Research Pooling Initiative

Key message: Scotland's major investment in, and long-term commitment to growing critical mass and driving collaboration across its core science disciplines was prescient and has been copied widely elsewhere. Of the £160m (SFC/co-funders) and £325m (Scottish Universities) invested in the first phase of the RPI (2005-17), around 84% was invested in infrastructure and salaries. Just six universities were awarded over £10m SFC funding; in all cases this award was more than matched by institutional support. Investment in people supported over 100 Professors, more than 40 Senior Lecturers and nearly 150 Lecturers across all research pools. The infrastructure and academic investments formed the bedrock of the critical mass built through research pooling.

In response to challenges to the Scottish research landscape including emerging international competition and a poor RAE2001 performance, the SFC developed the concept of research pooling with the aim of growing a critical mass of excellent research in Scotland in order to compete effectively for funding, academic staff and research students. Bespoke models for different sections of the research base were proposed and developed iteratively with SFC's executive. The resulting

models are summarised [here](#). The research pools and balance of funding over time is visualised in Figure 3.

SFC and co-funders committed £160m to the first phase of research pooling, matched by £325m from Institutions. In phase 2, SFC committed c.£5.5m matched by Institutions; the purpose was sustaining central administration and support positions. Funding was also made available to the Energy Technology Partnership (ETP), a pool which had self-organised and whose core organisation SFC had not previously funded. The balance of Institution vs SFC funding across all institutions for phase 1 of the RPI is shown in Figure 4.

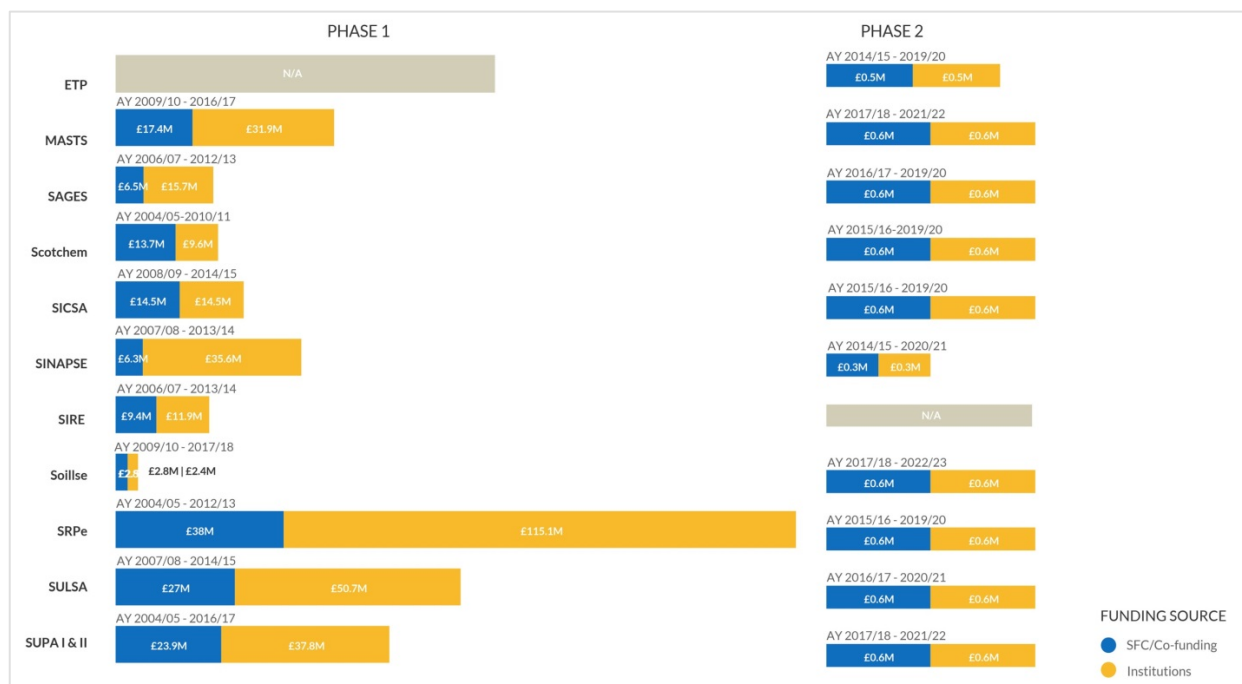


Figure 3: The balance of funding for Phase 1 and Phase 2 of the Research Pooling Initiative. In Phase 1 of the Initiative ScotCHEM and SRPe consisted of three regional pools, WestCHEM, EaStCHEM and HeriotWattCHEM and NRPe, GRPe and ERPem respectively.

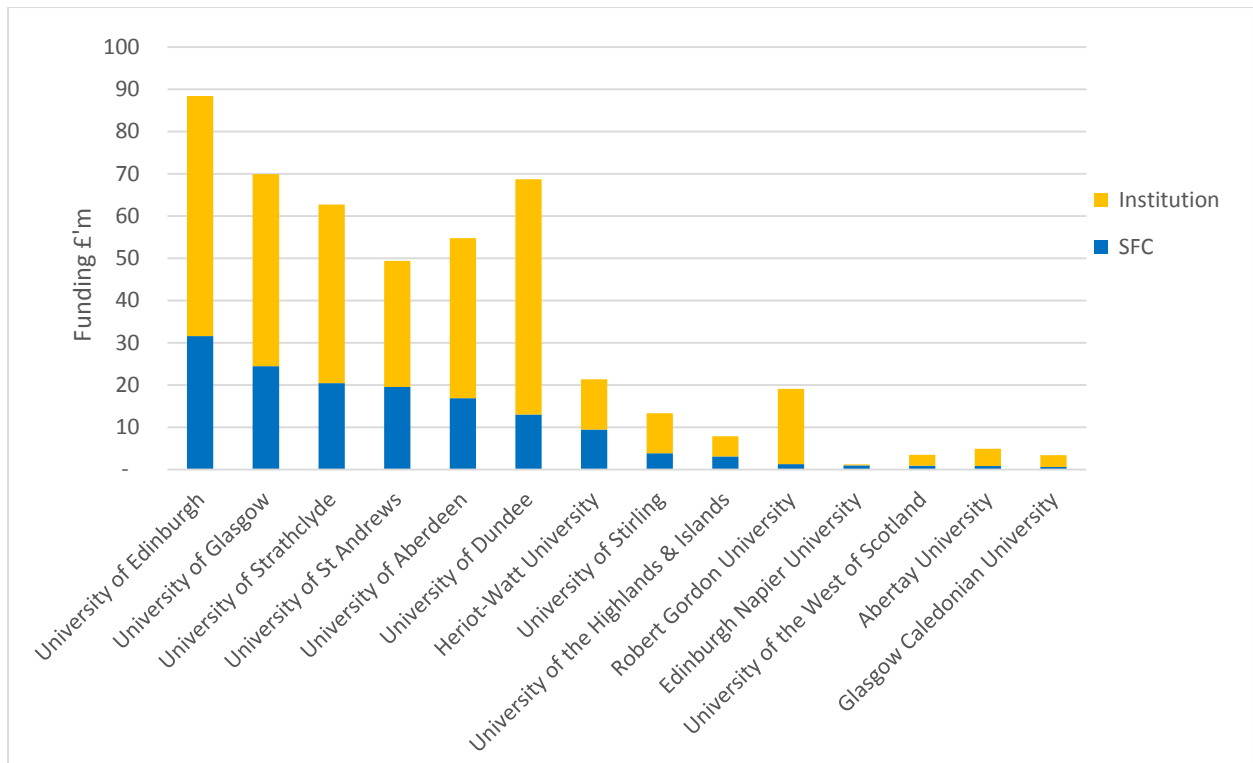


Figure 4: Scale of match funding contributed and SFC funding received by each institution in Phase 1 of the Research Pooling Initiative.

The uses to which research pools put their funding in phase 1 is shown in Figure 5. The actual balance of funding for individual pools varied according to the needs of the disciplinary research base.

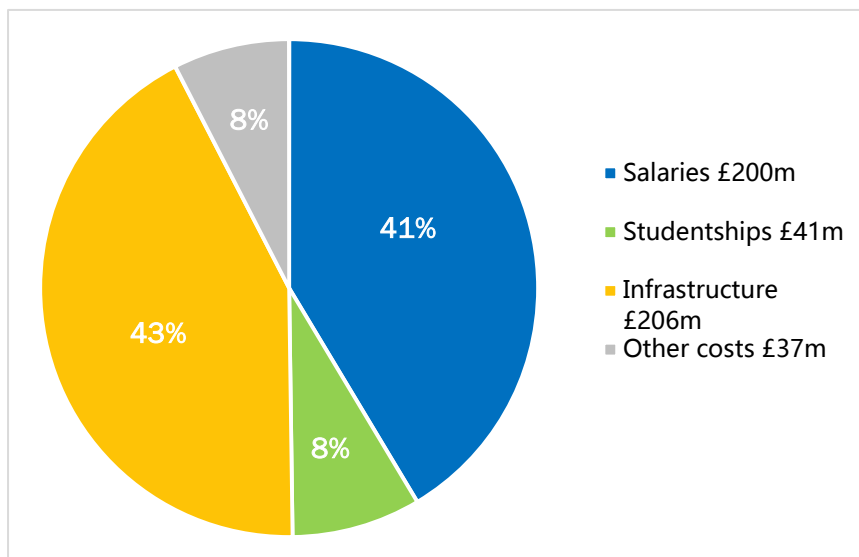


Figure 5: Split of funding allocations across all research pools supported through the Research Pooling Initiative.

Over £206m (43%) of the Phase 1 investment was used to fund capital infrastructure, including refurbishment of laboratory space and purchase of specialist equipment. Pooling allowed equipment to be purchased strategically, reducing duplication across institutions. Furthermore,

facilities and equipment purchased through pooling were available to all pooling members on the same basis as for those in the host institution.

The investment in academic and technical staff totalled c.£200m (41%) (Figure 5) and was used to support over 100 Professorial appointments, more than 40 Senior Lecturer/Reader appointments and nearly 150 Lecturer appointments to new positions within Scotland’s institutions. The relative balance of these appointments for each research pool is shown in Figure 6.

The RPI also supported over 600 collaborative PhD studentships with an investment of £41m (8% of the total). All of the pools, with the exception of SULSA, supported graduate schools. Support was often extended to affiliated students (e.g. SAGES) or the whole student population in Scotland (e.g. SICSA).

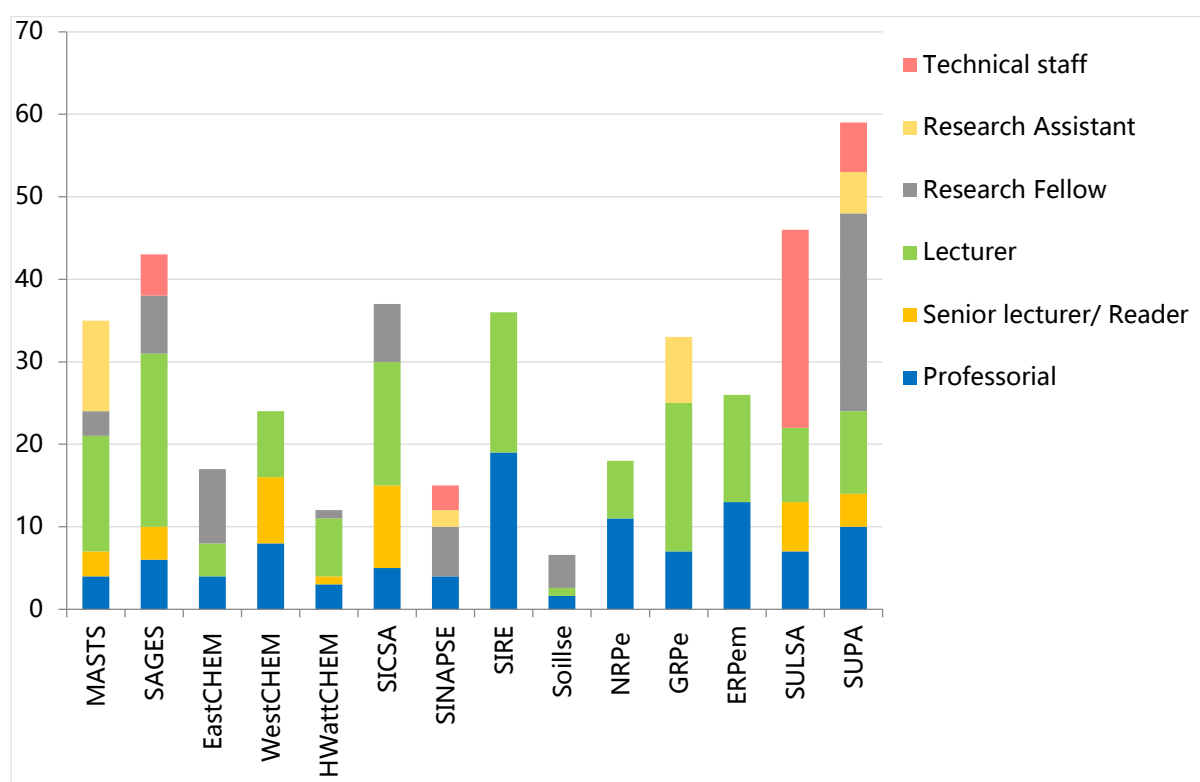


Figure 6: Staff appointments made by each research pool in phase 1 of the Research Pooling Initiative.

4. The evidence base

Key messages: Each research pool has a bespoke model of operation, and whilst this ensured fit to discipline and goals, undertaking a high-level and summative analysis of the evidence base has been challenging to evaluate purposefully because the research pools all function differently. It was not in the Terms of Reference of this review to undertake a forensic analysis of each research pool rather the focus has been on characterising their overall value and contribution to the research base in Scotland in addition to understanding their relative impact compared to models of research clustering developed elsewhere in the UK.

4.1 Written and oral evidence

The written and oral evidence procurement process and outcomes are illustrated in Figure 7. The evidence was obtained sequentially over a 6-month period, beginning with the written evidence (November-December 2018) and followed by the oral evidence (February-March 2019) and subsequent additional written evidence in April 2019 (see Section 2).



Figure 7: Procurement of written and oral evidence to support the review of the Research Pooling Initiative

The full written evidence is available [here](#). All oral sessions were recorded and transcribed and will be available [here](#). Summaries of both the written and oral evidence are given in [Appendix 1](#) and [Appendix 2](#), respectively. The majority of the written evidence was obtained from representatives of, or individuals and organisations associated with, the research pools. There are gaps in the evidence base from an international perspective; at a UK-level (e.g. UKRI and research councils); from Learned Societies (Royal Society of Edinburgh, Royal Society of Chemistry only), and from other research clusters (e.g. the N8 Research Partnership, the GW4 Alliance). There was limited written evidence from industry, although this sector was not a target for the RPI.

4.2 Quantitative evidence on the impact of research pooling

In addition to the oral and written evidence the review also commissioned an independent analysis of quantitative evidence from publicly available data sources. The key trends to emerge from the quantitative analysis are given below. The full report is available in [Appendix 3](#). These quantitative analyses must be interpreted with caution and contain a number of caveats because the research pools do not align directly with publicly available data on research outputs, research income and doctoral degrees awarded. The analyses should be read only as high-level indicators of research pool impact.

4.2.1 The overall performance of the research pools

The 2019 SSAC Report¹ provides evidence that Scotland is increasing its research output, but at a slower rate than the UK and world average (Scotland increase, 15.34%, UK 16.72%, and Global

20%). And whilst Scotland’s share of Research Council funding per capita remains ahead of the UK, it is decreasing from 15.7% in 2012/13 to 13.7% in 2017/18 (HESA, 2017). England, Northern Ireland and Wales have all increased their share of this resource over the same period. Accordingly, analysis of two key indicators of performance, research outputs and research income, was undertaken.

To evaluate *research outputs*, each research pool identified up to 50 academic staff who they considered to have proactively leveraged opportunities related to research pooling. The overall performance of the research pools is given in Table 3. The methodology used is given in Appendix 3.

Research Pool	Number of papers identified	FWCI	% research papers in top 10%	% international collaboration
MASTS	176	1.6	18	48
SAGES	913	2.2	27	55
ScotCHEM	2,557	1.6	22	46
SICSA	302	1.7	21	54
SINAPSE	947	1.8	26	38
SRPe	973	1.6	18	48
SULSA	1,375	2.0	33	55
SUPA	3,611	2.1	32	70

Table 3: Total research outputs and research quality using standard metrics for the 50 academic staff identified by the research pools for the first phase of the RPI only. FWCI: field-weighted citation impact.

The UK-wide average FWCI is 1.57 based on evidence submitted to the Science and Technology Committee (Lords) Science Research Funding in Universities Inquiry, 2019. **All the research pools for these selected staff report a FWCI above the UK average.** A high proportion of individuals identified by pools were well-established senior researchers, which may in part account for the high FWCI recorded.

To gain a general indication of how the research pools have performed in terms of *research income*, data were extracted for all staff and research income reported to HESA Cost Centres by pool member institutions. The analysis is shown in Table 4. Clearly, the HESA Cost Centre codes do not map directly onto the research pools, so there are caveats with this analysis and detailed interpretation is not possible. **Notable performance, where the ‘research pools’ come in the top 3 in the UK include SULSA, which has the top market share for the discipline in the UK, and SICSA, which is second.** SAGES & MASTS are top and SULSA and SUPA have the second highest income per R&T FTE in the UK. The methodology is given in Appendix 3.

Research Pool	Market share of total research income (2013/4 to 2017/8)	Income per Research & Teaching FTE (average over 2013/4 to 2017/8)
Research pools aligned with relevant HESA Cost Centre codes		
SAGES & MASTS	Third in UK £149m, 13% of UK total	Top in UK £536k per R&T FTE
ScotCHEM	Third in UK £158m, 14% of UK total	Fifth in UK £898k per R&T FTE
SICSA	Second in UK £138m, 18% of UK total	Third in UK £307k per R&T FTE
SIRE	Fifth in UK £11.6m, 7% of UK total	Seventh in UK £69k per R&T FTE
SRPe & ETP	Fifth in UK £425m, 9% of UK total	Sixth in UK £556k per R&T FTE
SULSA	Top in UK £678m, 20% of UK total	Second in UK £1.15m per R&T FTE
SUPA	Third in UK £253m, 15% of UK total	Second in UK £1.1m per R&T FTE
Benchmark non-pooled disciplinary areas aligned with relevant HESA Cost Centre Codes		
Mathematics	Sixth in UK £40m, 8% of UK total	Sixth in UK £164k per R&T FTE
Psychology & Behavioural Sciences	Third in UK £54m, 9% of UK total	Fourth in UK £190k per R&T FTE

Table 4: The market share of total research income and research income per FTE using HESA cost centre analogies for the research pools. SOILLSE and SINAPSE are excluded as they form only small components of very broad cost centre codes. SAGES and MASTS are combined because both pools return staff/income to the same cost centres. Two non-pooled disciplinary areas were included as comparators.

4.2.2 Comparative trends in research competitiveness

The broad model of research pooling has been increasingly emulated outside Scotland over the period of the RPI. Indeed, one of the reasons the RPI was initiated was the perceived increasing competitiveness of English HEIs, particularly the 'golden triangle' institutions as a consequence of the English White Paper 'The Future of Higher Education'.¹¹

"At the time of initiation, the pool programme was novel, but we increasingly see more strategic collaborations in nations or regions of the UK which aim to drive up quality and competitiveness across the UK." Universities Scotland

To understand how the research pools have performed relative to clusters of research excellence outside Scotland, we took the three research pools that are most closely aligned with the units of assessment (UoAs) of the two most recent UK-wide research assessment exercises (ScotCHEM, SICSA and SUPA) and compared them with the performance of the N8 Partnership¹² and the GW4 Alliance.¹³ The trend analysis is shown in Figure 8, and the detailed methodology is given in Appendix 3. The pattern of increased citation performance between the 2008 Research Assessment Exercise and the 2014 Research Evaluation Framework shown is regarded as a UK-wide trend.¹⁴

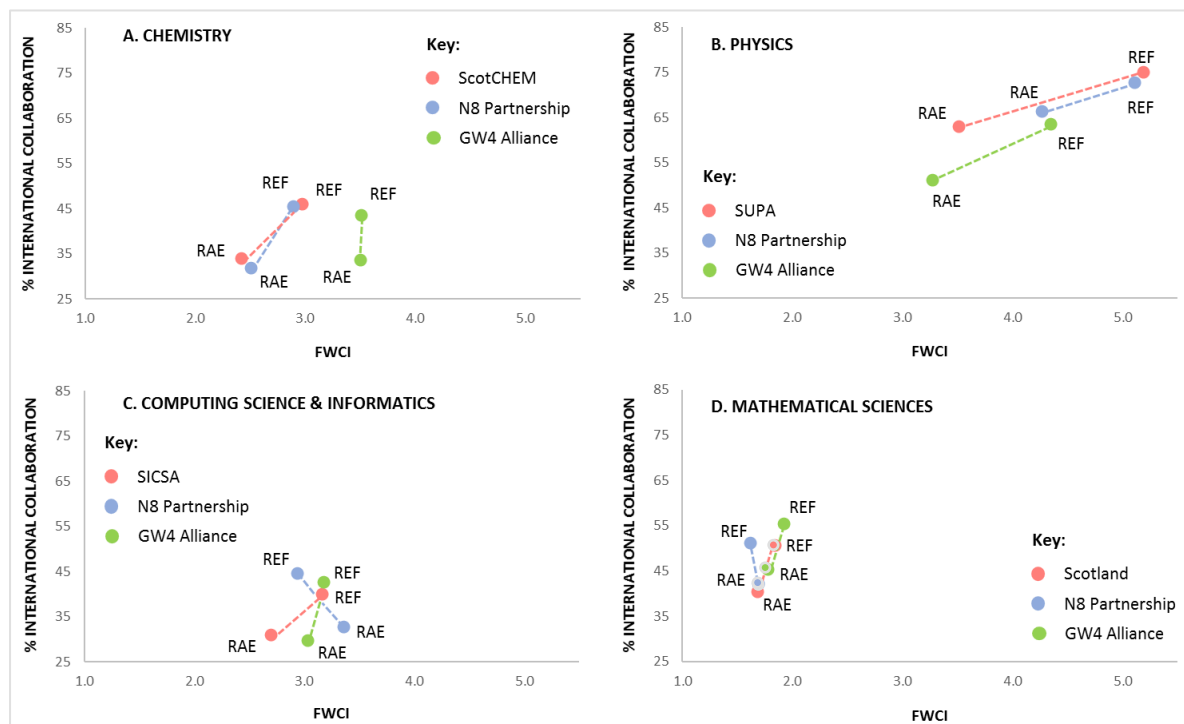
¹¹ <http://www.educationengland.org.uk/documents/pdfs/2003-white-paper-higher-ed.pdf>

¹² <https://www.n8research.org.uk>

¹³ <https://gw4.ac.uk>

¹⁴ <https://www.ref.ac.uk/2014/results/analysis/comparisonwith2008raeresults/>

There is some evidence that increased citation performance is associated with growth in international collaboration.



Assessment (UoAs): Chemistry (A), Physics (B) and Computing Science & Informatics (C). UoA Mathematical Sciences (D) is included as comparator non-pooled disciplinary area.

4.2.3 Investment in the skills base: trends in doctoral degrees awarded from 2007-2018

Graduate training has been described as one of the 'jewels in the crown' of the Research Pooling Initiative. A high-level analysis was undertaken to evaluate the trends in doctoral degrees awarded and changes in the UK market share of these awards for the research pools compared with other regions in the UK. The general trends are shown in Table 5. The detailed mapping and underpinning data are given in Appendix 3. **The analysis suggests that over the past decade most of the Scottish research pools examined have increased their UK market share of doctoral degrees awarded, and this is underpinned by very strong rates of growth.**

Research Pool	% growth doctoral degrees awarded (2007-09 vs. 2016-18)	UK Rank 2016-18 (change since 2007-09)
Pooled disciplinary areas		
SAGES & MASTS	40% ↑	5th (-)
ScotCHEM	53% ↑	1st (+2)
SICSA	10% ↑	3rd (-1)
SIRE	367% ↑↑↑	5th (+4)
SRPe & ETP	90% ↑↑	4th (+2)
SULSA	30% ↑	1st (+1)
SUPA	115% ↑↑↑	3rd (+1)
Benchmark non-pooled disciplinary area		
Mathematics	29% ↑	5th (-2)

Growth 0-29%
Growth 30-50%
Growth 50-100%
Growth >100%

Table 5: Trends and UK market share for doctoral degrees awarded for the research pools mapped using the HESA Joint Academic Coding System.

5. Evidence analysis

Key messages: Growing critical mass and developing a collaborative research culture takes time and the impact of the investment in the RPI is still emerging. A collaborative ethos is one of the key cultural shifts achieved through the Research Pooling Initiative, albeit this is challenging to quantify. Investment in multi-institution graduate schools are a common currency for virtually all the research pools and have built a critical mass of early talent that is distributed across Scotland. The written and oral evidence points to lost opportunities in building stronger strategic alignment between the research pools and other structures, most notably the Scottish Innovation Centres; these tensions are not new but attempts to address them do not appear to have been effective so far. The written and oral evidence acknowledges the growing emphasis in the modern research landscape on interdisciplinarity, challenge-led funding and the importance of 'place' as well as a move to large collaborative funding opportunities at UK-level.

The written and oral evidence collated through the review process described in Section 2 are the key vehicle for exploring answers to the questions posed in the Terms of Reference for this review. The nature of the questions and the structure of the evidence base mean that, on the whole, the analysis in this section is a *qualitative* interpretation that is informed by the quantitative analysis described in the previous section. A detailed summary of the written and oral evidence is given in Appendix 1 and 2, respectively. The raw material for both the written evidence received for the review and the transcripts of the witness statements forming the oral evidence are available [online here](#).

5.1 Impact of the RPI

The vision for the collaborative research pools was to grow a critical mass of excellent research in the relevant disciplines in Scotland, in order to compete effectively for funding, research staff and doctoral students both nationally and internationally. Universities Scotland said: "We consider this

approach to have been pioneering in the early 2000s when research pooling was initiated.” This review asks whether research pooling has made a difference to the research competitiveness of Scotland.

We conclude that: -

The RPI has produced strong disciplinary pools such as SUPA and SULSA; thematic or challenge-facing pools such as SAGES, MASTS, SOILLSE and ETP, and some of the more discipline-based pools such as SRPe are growing a stronger thematic focus or industrial engagement such as ScotCHEM. Collaboration between pools is beginning to emerge, usually around leverage opportunities such as medical imaging, involving three research pools (SUPA, SINAPSE and SULSA).

5.1.1 Collaboration and critical mass

An investment of £160m by the SFC and co-funders in phase 1 has been used to support growth of the critical mass of the research disciplines through the RPI. The final reports from the research pools regard the recruitment as mostly successful and state explicitly that posts were retained following the end of phase 1 funding, and in many cases were added to. The written evidence (summarised in Appendix 1 and in full online [here](#)) generally corroborates the ambition of the RPI of increasing the critical mass of the research base.

Whilst institutions continue to support these posts, challenges were noted in maintaining the networks associated with research pooling under the reduced funding of phase 2 of the RPI.

[In the first phase] "heads of departments and vice principals of research, were obviously highly engaged in that process [...] But nowadays, now that we're in an administration funding only role, it's much more difficult to actually get their attention." SUPA.

For research pools where engagement with policy makers in Scotland is regarded as particularly important (i.e. MASTS, SAGES, ETP), this second phase of funding has been a particular challenge in terms of achieving impact.

The oral and written evidence points to the importance of strong leadership and a clear strategic vision. Professor Julian Jones, speaking on behalf of the RSE said:

[Research pooling] "worked best where people were able to look beyond the benefits to their own institutions and focus on what they could achieve together."

A collaborative ethos is clearly important as one of the key cultural shifts achieved through the Research Pooling Initiative. A review of the international comparative performance of the UK research base in 2016 reminds us that: *"Research collaboration that is grown out of informal discussions and information sharing accounts for as much as half of all collaborations"*¹⁵

It remains challenging, however, to quantify the impact of 'collaboration.' One example of the impact of collaboration is given in Figure 8, which suggests the increased citation performance between RAE2008 and REF2014 might be in part explained by associated growth in international

¹⁵International comparative performance of the UK research base 2016, Elsevier

collaboration. This finding is corroborated by the SSAC 2019 report that concluded that Scotland's share of joint publications with EU partners is higher than England and Wales. The caveat here is both the analysis in Section 4 and in the SSAC report cannot be differentiated easily on the basis of research pools themselves because the data for the research assessments are institution-derived measures. Clearly, some research pools align more closely than others with the UoAs.

Both the written and oral evidence point to the benefits of collaboration as including access to shared facilities; speaking with a single voice for each research discipline; and opportunities to leverage research funding through joint research proposals.

"Had there not been a research pool in our particular field, then Scotland would not have been represented at the European Marine Board." MASTS

'The model of pooled resources is highly effective for medical imaging research' SINAPSE

The independent quantitative evidence described in Section 4 and in full in Appendix 3, provides **evidence of the leverage of the RPI on the market share of total research income to Scotland relative to the rest of the UK**. Using analogues of HESA Cost Centre data for relevant research pools, SULSA, lies top in the UK, holding 20% of the UK market share of total research income, and SICSA lies second; MASTS and SAGES, ScotCHEM and SUPA lie third in the UK (see Table 4). In terms of research income per FTE, SAGES & MASTS lie top and SULSA and SUPA lie second in the UK. Despite the caveats given earlier in Section 4 these are strong data demonstrating the impact of pooling and the benefits to Scotland.

Where quantitative indicators or analogous measures exist, discerning the impact of the RPI model is easier to evaluate but such indicators probably fail to capture the breadth and depth of the outcomes of the RPI, such as where research pooling has influenced outcomes through a collective voice or through influence on policy.

5.1.2 Research excellence

The recent Scottish Science Advisory Council Report on Scotland's science landscape¹ concluded that Scotland's researchers are highly productive relative to the total UK output, and the research is of high quality. A general trend in increased citation performance is detected in the research assessments¹⁴ and regarded as UK-wide. This trend is supported by the quantitative analyses in Appendix 3 and there is some evidence that the trend is associated with **growth in international collaboration**, but this is not necessarily a consequence of research pooling since mathematical sciences record a similar trend (Figure 8). Clearly the inference that can be made from interpreting research pool outcomes in the light of the 2008 and 2014 research assessment exercises is limited both because they do not align directly to UoAs, and the evaluation exercises themselves have evolved over time.

Using a research-pool selected cohort of academic staff who were considered to have proactively leveraged opportunities related to research pooling, an independent analysis of the quality of the research outcomes was undertaken, which is given in full in Appendix 3 and summarised in Section 4. The data suggest that all the research pools examined have a FWCI¹⁶ >1.00, indicating

¹⁶ FWCI is defined as the ratio of the number of citations received by an article to the typical number of citations for articles in the same field. Source: Elsevier, International Comparative Performance of the UK Research Base 2016

that research papers in this group have been cited more than expected based on the world average for similar papers. Indeed, SAGES, SULSA and SUPA have scores >2.0, indicating the research outputs are c.100% more cited than expected. Similarly, a high proportion of research publications attributed to the researchers identified by the pools are present in the top 10% most cited papers in the world. These analyses follow similar lines of argument in the SSAC Report, which found that publications in Physical Sciences account for the largest share of Scottish publications, followed by Clinical Sciences and Biological Sciences. This may be attributed to research pooling (i.e. SUPA, SULSA) but humanities, which is not pooled, experienced the highest relative increase in total publications and citation impact over the ten-year period (SSAC).

5.1.3 Investment in the Scottish skills base and training future leaders

Investment in multi-institution graduate schools are a common currency for virtually all the research pools and are clearly regarded as important in building a critical mass of early talent that is distributed across Scotland.

"Of particular benefit to us have been the pan-Scottish Graduate Schools which have improved postgraduate provision, improved mobility of students, encouraged and supported internships." University of Aberdeen

Analysis of Scotland's market share of UK doctoral degrees awarded using HESA data (Section 4) illustrates strong rates of growth for disciplinary areas aligned with the research pools. For example, physics and astronomy in Scotland record the fastest rate of growth in doctoral degrees awarded in the UK over the period 2007-09 vs 2016-18, outpacing London and the South-East. Economics in Scotland likewise recorded the fastest rate of growth in the UK (see Section 4) and SULSA and ScotCHEM both showed increases in the UK market share of doctoral degrees awarded. Mathematics, computer science and information science all saw a decline in market share over the same period.

The model of graduate school provision, which it could be argued has been championed in Scotland through the RPI, has been copied widely across the UK through funding for Doctoral Training Partnerships and Centres for Doctoral Training.¹⁷ There is evidence for individual research pools (e.g. MASTS, SINAPSE) of building on the RPI to win research council support for new doctoral training initiatives. Yet whilst graduate training is perceived as one of the 'jewels in the crown' of the Research Pooling Initiative, UKRI alone spends about £600 million every year on PhDs, fellowships and other skills interventions. Indeed, written evidence for this review argues that "*£140 million is not a lot of money to spend as a stimulus package for nationwide research over a period of 15 years*" (Professor Sir Ian Boyd, written evidence). So, there is a question here regarding what needs to be achieved in the future in terms of the skills base and how should it best be supported.

5.1.4 Engagement

Based on the available evidence, research pooling in general does not appear to have the UK and international engagement it is claimed to have, although MASTS representation of Scotland on the European Marine Board is an exception. On an individual pool basis there are examples of strong engagement, for example, SRPe and the National Manufacturing Institute for Scotland

¹⁷ <https://www.ukri.org/skills/funding-for-research-training/>

(NMIS). In the oral evidence, most research pools expressed a desire to be more international in outlook and to have an increased international presence.

The call for written evidence produced only limited direct response from the business sector and none from any of the business organisations such as CBI and FSB. Responses were received from business-facing organisations such as Interface and Technology Scotland. The lack of witnesses from industry coming forward may reflect that engagement with industry and economic impact was not in the original remit of the RPI.

"Pooling was set up to boost the academic excellence and quality in the Scottish research base, to build capacity and capability and make us more competitive, the remit was never about engagement with industry."

Professor Paul Hagan, former SFC R&I Director

"This idea that they're [the pools] looking towards the industry/ business, it wasn't necessarily in the DNA of setting them up." Morven Cameron, Highlands & Islands Enterprise

However, the written and oral evidence both note that in phase 2 of the RPI, outreach to industry is growing and is often associated with co-funded industrial studentships. Some pools e.g. SUPA, were singled out by industry:

"SUPA is extremely active in supporting Scottish Optoelectrics Association initiatives." Technology Scotland

Further, Interface supported a role for pools in linking the academic and industrial sectors:

"Strong academic research pools [are] absolutely fundamental to supporting Scotland's industries."

In terms of policy engagement, the written evidence suggests MASTS has played a key part in raising the profile of marine science in Scotland in a brokerage role between academia and policy/practitioners; SICSA and ETP are similarly policy-facing. Scottish Enterprise added that the research pools:

"...add value by providing a platform on which to 'hang' other investments...and are neutral actors if they include all institutions."

5.2 The current and future research environment

5.2.1 The sustainability of the research pools

The research pools were originally set up to achieve research excellence, but the research landscape has changed across the UK towards one with greater focus on the role HEIs can play in stimulating the economy. In this context, the written and oral evidence acknowledges the growing emphasis on interdisciplinarity, challenge-led funding and the importance of 'place' as well as a move to large collaborative funding opportunities at UK-level. The RSE suggest that changes in the UK research environment:

"will increasingly require inter-institutional and interdisciplinary endeavour. Pools have helped to make it easier for different disciplines to connect."

Views varied on the capacity of the research pools to respond to this changed environment:

"The collaborative relationships and cultural shifts that have been created as a result of research pooling have positioned Scottish HEI sector in a good place to address the current funding landscape."

Dr David McBeth, University of Strathclyde

"Pooling is not the best way of promoting interdisciplinarity, to achieve this probably needs much more targeted research centres and a more challenge-led approach." Professor Derek Woolins, University of St Andrews

The scale of the challenge is captured in the written evidence from Universities Scotland, whereon:

"The funding model has changed in recent years and the review should closely consider whether the pools are sufficiently resourced to achieve their aims, particularly considering the evolving research environment."
Universities Scotland

and,

"A fundamental purpose of pooling is to support inter-institutional endeavour, and it remains one of the most powerful tools, currently available, to enable Scottish HEIs to achieve together what they would be unable to achieve separately." RSE

Clearly the sustainability of the RPI is of concern. The written evidence suggests that the investments made in pooling, such as academic appointments and facilities (see Section 3) have been sustained. There was, however, **little evidence that research pooling is embedded in the recruitment policies and/or strategic investments of Scottish HEIs, which challenges the longer-term sustainability of the initiative.** Further, the second phase of the RPI is generally regarded as too constraining for the research pools to continue without the license to operate and investment from SFC. A few pools have a commitment from partner institutions to continuing beyond the end of SFC phase 2 funding (e.g. ETP). However,

"If funding were to cease, the consensus is that pooling would not be sustainable long-term. Buy-in from partners would diminish, as well as scope of activities." SULSA

The evidence base also recognises the sustainability of the research pools may require a reorientation of priorities, for example,

"There is a clear opportunity for the research pools to be aligned more closely with DBEIS/Scottish Government priorities, especially in regard to the Industrial Strategy... There is an opportunity for a clearer alignment between the national priorities in research and development and the Scottish contribution to these."
Professor Neil Simco, UHI

5.2.2 The relationship between the research pools and the Scottish Innovation Centres

The written and oral evidence both point to lost opportunities in building strong strategic alignment between the research pools and other structures, most notably the Scottish Innovation Centres.

"The RSE would encourage SFC and the research pools to consider how they can extend and deepen their engagement with external initiatives and projects, for example developing closer relationships with the Innovation Centres." RSE

"Unless you've got a strong fundamental research base, you're never going to get any innovation. Should they be working together? Absolutely yes, they should. The Innovation Centres should be harnessing the quality in the research base in Scotland." Professor Lesley Yellowlees, SFC Research & Knowledge Exchange Committee

The challenges of co-working were noted by some of the research pools, for example:

"With some exceptions, it has been difficult to work effectively with the ICs. Their industry led funding model means we must often react instead of lead." ScotCHEM

The overall consensus was Scotland benefits from research pools and Innovation Centres but that currently they were not working together as effectively as possible. There are notable exceptions

here, the relationship between Datalab and SICSA appears to work well aided by the fast innovation cycle time between research and industry in this space.

"We need ICs for economic benefit and academic pooling for long term development of knowledge and skills."
MASTS

A further lost opportunity to emerge was addressing the relationship between Institutions and Scotland's research institutes.¹⁸ The Scottish Government invest around £45m per annum in environmental and agricultural research in Scotland. These institutes are not eligible to receive SFC funding and consequently were largely excluded from pooling arrangements.

"Pooling has failed, at least in my view, to address the future of the Scottish research landscape in the form of the relationship between its academic investments and its Main Research Providers... I think this has been a major failing" Professor Sir Ian Boyd (written evidence, personal view)

5.2.3 Securing Scotland's research competitiveness

Two issues dominated the written and oral evidence and analysis in terms of the future of pooling, and these are connected: (1) how to leverage from the long-term investment in the research pools to secure Scotland's position as a global leader in research, and (2) how to use the pools as platforms for international engagement. With caveats regarding the degree of alignment of the research pools with HESA cost centres, the data in Section 4.2.1 supports the leverage capacity invested in the research pools. **A number of research pools come in the top 3 in the UK in terms of their market share of research income.** Notably SULSA is top in the UK for the market share of total research income with 20% of the market; SAGES, MASTS, ScotCHEM, SICSA and SUPA all come in the top three. Caution should be used in attributing this to research pooling alone since behavioural sciences, which is not pooled also comes in the top three.

Much of the written evidence suggests that research pools in the future could be aligned better to the modern research landscape, which is driving highly collaborative research that often requires multi-disciplinary approaches. **This is a very different concept to the original vision for the RPI.**

"Challenge-focused research will necessitate the greater involvement of a wider range of research disciplines including the social sciences. These subjects are not well covered across the current pools..."
Universities Scotland

"There would be value in considering the merits of establishing new pools in other areas – this might include pools based on challenge areas (e.g. ageing) as opposed to subject disciplines as well as the development of new pools to further improve alignment with evolving national and international research strategies." RSE

5.2.4 International outreach

The written and oral evidence highlighted, especially in the context of *Brexit*, the criticality of the engagement of the Scottish research base overseas so that Scotland can remain internationally competitive.

"The pools have an important role to play in supporting continued collaboration with Europe and facilitating wider international partnerships." RSE

¹⁸ James Hutton Institute, Scotland's Rural College, BioSS, Moredun Research Institute, Rowett Institute, Royal Botanic Gardens Edinburgh

"Pools should be encouraged to develop other UK and international partners so that they can operate in the global environment, characteristic of modern research in almost all areas."
Professor Sir James Hough, (written evidence, personal view)

In 2017/18, 22% of staff in Scottish universities with research, or research and teaching contracts, were EU nationals¹⁹ with a particularly high % conducting research in the physical sciences (35%), mathematics (33%), economics and econometrics (38%) and chemical engineering (38%). The focus on recruiting internationally-excellent graduates for most of the research pools may have influenced these data. Certainly, the independent quantitative data presented in Section 4.2.3 points to the **effectiveness of the research pools in significantly growing the % doctoral degrees awarded over the past 10 years**. Whilst these data are not differentiated in terms of nationality, some disciplines e.g. economics, physics and engineering show the fastest rates of growth in doctoral degrees awarded in the UK. Further, SULSA and ScotCHEM have increased their market share to 17% and 15%, respectively and both rank first in the UK.

6. Conclusions and recommendations

6.1 Conclusions

The Research Pooling Initiative has built critical mass and research excellence in a number of disciplines important to Scotland's research base and continued global science leadership. The collaborative culture supporting this critical mass is pervasive, with some research pools excelling at capitalising on, and communicating, this culture nationally and internationally.

It is important to sustain, in some form, the research capacity built on this pooling of excellence. This review concludes that **research pooling will not be self-sustaining** across all pools because they vary in calibre and perceived value - and consequently in the preparedness of Scottish institutions to continue to invest in them. Further, the evidence surmises that SFC endorsement of the research pools appears necessary as a 'licence to operate,' effectively tying the SFC into a never-ending commitment should research pooling continue in its current form.

Action is needed because, although Scotland's research quality is excellent (as evidenced for many of the research pools), it has not grown at the same rate as the rest of the UK or other competitor countries. It is more than happenstance that a recent Fraser of Allander report²⁰ also shows the Scottish economy to be continuing to grow but at a slow pace: sustained investment in science is an important part of economic growth.

*"The UK Government's agenda to increase the UK's R&D intensity to 2.4% of GDP by 2027, combined with the uncertainties caused by Brexit, means that the status quo is set to change."*²¹

This review also concludes that **the original aims of research pooling do not fit the modern research landscape**. Should SFC choose action as is recommended by this review, the sunk investment in that critical mass could be repurposed to fit the modern research landscape to: (1)

¹⁹EU Exit and Scottish colleges and universities, SFC, 2018

²⁰ Scotland in 2050 : Realising Our Global Potential, Fraser of Allander Institute, 2019

²¹ Strengths and barriers of the Scottish landscape for commercialisation of research, CASE roundtable with RSE, 2019

lever 'mission driven' research income into Scotland, and (2) provide resilience on the international research stage. **Repurposing the critical mass built through the Research Pooling Initiative is the bedrock for Scotland's research powerhouse of the future;** taking substantive action is strongly endorsed by this review. There is huge potential for large returns and capacity to compete head-on with the emerging 'powerhouses' in other regions of the UK such as the N8 and GW4.

The critical lessons learned from this review are: -

- 1) **Growing critical mass and developing a collaborative research culture takes time and the impact of the investment in the RPI is still emerging.** The SFC were clear leaders in the field when the RPI was initiated 15 years ago. The rest of the UK have caught on and caught up, especially by way of regional clusters of research intensity such as the N8 Research Partnership and GW4 Alliance, designed to take on the 'golden triangle' of universities.
- 2) **Requiring Scottish institutions to self-organise and self-direct their research pools rather than being driven 'top-down' was a brave move that widened inclusivity and accelerated the process of growing critical mass.** The SFC involvement gave legitimacy to the process and lent credibility to the outcomes. The ensuing bespoke models for the research pools have been challenging to evaluate purposefully because they all function differently. A pre-emptive focus on quantifiable measures of success and regular reporting of outcomes would have helped immeasurably. As such measures do not exist, it was not possible – nor was it a requirement - for this review to undertake a forensic analysis of the research pools.
- 3) **The failure to establish and agree early on, measures that capture effectively what 'success' looks like, have limited the opportunities to address weaknesses in the process over time, and to recognise fully the strategic impact of the RPI.** One consequence is there is a lack of transferability in the model of research pooling, effectively excluding other research disciplines such as the social sciences and arts and humanities from the mix.
- 4) **There are tensions in the Scottish research landscape** that have arisen where bottom-up (e.g. research pooling) and top-down (e.g. Innovation Centres) *should* align but the mechanism to do so does not exist. As a result, Scotland has a complex research and innovation landscape with many 'front doors' and 'gateways' competing for custom. This is not a new problem but clearly still requires effectual action.

The critical challenges looking ahead are: -

- 1) **Capitalising effectually on the sunk investment in the RPI.** If the funding tap is turned off, SFC (and Scotland) will not reap fully the rewards.
- 2) Finding ways to continue to support what are nowadays principally networks for inter-institutional collaboration under phase 2 of the RPI whilst at the same time opening up new strategic opportunities to the research base. **There is a place for Scotland's learned societies in supporting and sustaining these networks going forward.**
- 3) Celebrating the differences between the research pools and directing this towards the modern research landscape. Some pools appear already to be working more closely around shared research challenges and opportunities; this may be a model for the future.
- 4) **Ensuring the future investment in Scotland's research base is much more strategic to allow Scotland to maintain a position as a global research leader.** It may not be sufficient to allow

this to grow from the bottom up as before: that way, only the same disciplines will win through and these may not be the ones needed going forward - at least not in isolation.

"...encouraging inter-pool collaboration could place pools in a better position to align with changed national strategies and hence to win funding for future interdisciplinary projects with research outputs beneficial to the economy and society more generally." RSE

6.2 Recommendations

These recommendations are intended as guiding *principles* that align with the purpose of this review to undertake a high-level and summative analysis of the RPI. That said, **the recommendations herein are not intended to be viewed as a gentle evolution: they are offered as a *relaunch* of the sunk investment in the RPI, with the research pools forming a building block for the next steps in building Scotland's powerhouse.** Clearly, a transitional process will be needed to turn what was, into what will be.

These principles align with the Ministerial Letter of Guidance from the Scottish Government to the SFC, requiring: -

"Together with other funders, SFC should play an active role in encouraging Scottish universities and colleges to work together, and with other science and research organisations in Scotland, to add value to Scotland's research excellence and strengthen international collaborations. I would also expect research pools and innovation centres to play an increasing role in this."
Scottish Funding Council Letter of Guidance 2019-20.²²

Further, the letter calls on the collective weight of the RPI investment in supporting sustainable inclusive growth through a strong science base:

"...in light of the climate emergency declaration, I would also ask you to give urgent consideration of how you can support the Scottish economy to decarbonise at pace."

These principles are not intended to challenge unhypothecated research funding but should be regarded as an opportunity to *draw from it* through future strategic investments that build on the RPI. **Critical in any investment is having a clear understanding of what success looks like and how it should be measured** both quantitatively and qualitatively as this provides flexibility and agility to change course should opportunities change, or things not work out.

There are four recommendations. Recommendation 1 is the main recommendation from this review. Meeting it demands a relaunch of the sunk investment in the RPI so it can evolve to be relevant and competitive in the modern research landscape. Recommendations 2-4 are short-term and relatively minor investments and/or adjustments to current funding plans that enable the transition to Recommendation 1.

Recommendation 1: building Scotland's research powerhouse, 2020-2030

This review recommends the Scottish Government through the SFC consider a substantive (many millions) and collaborative investment across research disciplines and HEIs and research institutes

²² http://www.sfc.ac.uk/web/FILES/AboutUs/SFC_Letter_of_Guidance_2019-20.pdf

in Scotland to ensure these bodies remain fit for purpose in the modern research landscape. **This review has shown the critical mass to build Scotland's research powerhouse exists.**

The proposal is the disciplinary pillars of research excellence built through the RPI (*visualise the standing stones of Stonehenge*) are united with the cross-disciplinary capacity needed to compete effectively with emerging powerhouses in the modern research landscape (*visualise the horizontal stone lintels of Stonehenge*). A well-coordinated disciplinary base is still needed but it is its **modern cross-disciplinary alignment that achieves resilience** (*Stonehenge has been around for a long time*). The alignment comes through strategic challenge-driven investment and **may be best achieved through an open competition**. There will be winners and losers in terms of the research pools, and new entrants i.e. non-pooled research disciplines should be encouraged to engage. The outcome is an integrated capacity that is on tap and can respond nimbly and flexibly to research and societal challenges such as the decarbonisation agenda. The model also offers the opportunity to engage constructively and for the long-term with Scotland's research institutes.

The guiding principles of this recommendation are the strategic investment should be: -

1. An investment of **sufficient size and impact to command match-funding** and/or partnership opportunities with other major funders of research such as UKRI.
2. An **open competition**, allowing non-pooled disciplines to enter the stage.
3. **Encourages collaboration** built from combinations of existing pools and others that wish to become more strategic and challenge-orientated.
4. Welcomes engagement from the **Innovation Centres**.
5. Can be narrowly defined *if* Scotland chooses to pick what it thinks are its future winners, for example, the decarbonisation agenda.
6. Can be a single entity of a number of collaborating entities.

The guiding principles of this recommendation are for a **major investment** that: -

1. Capitalises on the sunk investment and critical mass invested in the RPI.
2. Capitalises on and further incentivises the capacity for collaboration built across HEIs in Scotland through the RPI, including working across the breadth of Scotland's research base.
3. **Builds a Scottish Research Powerhouse at scale from which to lever further investment.**
4. Drives investment in a modern research landscape *without* necessarily drawing on un-hypothecated REG, to deliver positive societal and economic outcomes.
5. **Enables the standing stones of excellent disciplinary science to be applied to interdisciplinary challenges but in a way that values both pure and applied research.**
6. Allows Scotland to develop, grow capacity and address complex societal challenges on a medium-term timescale (10-15 years): **Scotland should be in it for the long term.**

Recommendation 2: transitioning the research pools

Scotland's research pools have operated on a long-term agenda and pump-priming (e.g. phase 2 investment) has been needed to keep them on course; this phase 2 investment ends soon. The evidence points to this second phase providing the research pools with insufficient vested authority to operate. Something has to change. The recommendation is **SFC should halt the direct underpinning of the research pool networks**. Most of the phase 2 funding concludes in 2020.

Continuation funding should be provided for a *limited period only* (1-2 years) for a smaller number of the most effective research pool coordination activities (the 'transition pools') to cover the transitional period between now and the implementation of Recommendation 1. **The goal is to spread the jam less thinly and to prepare the ground for Recommendation 1.**

Recommendation 3: grow the international presence of key research pools

This recommendation is closely linked to recommendation 2. To capitalise on the RPI investment **the 'transition pools' identified above need to grow their international presence.** The underpinning currency of the Research Pooling Initiative is its **graduate skills base**, which is a huge asset from which to continue to ensure Scotland is an attractive place for international graduates. With appropriate support this capacity would align well with Scottish Government priorities²³ and could support delivery on the advice from the Campaign for Science and Engineering (CaSE) and the RSE.²⁴ One option is to invest further in high calibre international graduates in Scotland or by creating an integrated Scottish presence in Europe. Another option would be building on Scotland's success in the GCRF where Scottish Universities have been involved in 20.6% of GCRF awards, and have led 11% of all GCRF awards, with the average award amount going to Scottish institutions (c.£920k) above that of other UK institutions (c.£870k).²⁵

Recommendation 4: quality innovation come from quality research - addressing complexity in the Scottish research landscape

At a UK-level, research *and* innovation are the pathway to growth, as the 'I' in UKRI signifies. Major investments such as the Industrial Strategy Challenge Fund are closely allied to this perspective. Action should be taken to ensure that the 'transition research pools' and Innovation Centres are more closely aligned, going forward as a seamless and integrated 'cradle to grave' model that can play effectively into Recommendation 1; this can only be achieved by taking action to ensure the co-working and co-design of outcomes *are shared* by the IC's and 'transition research pools.'

Recommendation 4 is designed to challenge the view (recorded in the evidence base) that research pools and Innovation Centres are and should remain separate entities. The modern research landscape is at odds with the view noted in the oral evidence that pooling is 'about academic quality and Innovation Centres are about harnessing and translating this.' **Without intervention, research pools and Innovation Centres appear to be on a collision course** in a crowded Scottish research landscape. This is not a new observation. The relaunch of the sunk investment in the RPI is an opportunity to set measures in place to change it.

²³ Leaving the European Union, Scottish Government, 2018

²⁴ <http://www.sciencecampaign.org.uk/news-media/guest-blog/the-implications-of-brexit-rse.html>

²⁵ UKRI data

7. List of advisory panel members

Dr Cat Ball, Policy Manager, Association of Medical Research Charities.

Dr Alicia Greated, Global Director at Heriot-Watt University, member of SFC's Research and Knowledge Exchange Committee (RKEC).

Douglas Mundie, Deputy Chair of SFC's Board and member of SFC's Research and Knowledge Exchange Committee (RKEC).

Professor Philip Nelson, Professor of Acoustics, University of Southampton, formerly Executive Chair, EPSRC.

Dr John Rees, Director of Science for Earth Hazards and Observatories, British Geological Society and GCRF Challenge Leader, UKRI.

David Sweeney, Executive Chair, Research England, UK Research and Innovation.

Professor James Wilsdon, Professor of Research Policy and Director of Research and Innovation, Faculty of Social Sciences, University of Sheffield.

8. List of appendices

Appendix 1. Written evidence summary

Appendix 2. Oral evidence summary

Appendix 3. Independent Quantitative Analysis Report