UNIVERSITY OF CAMBRIDGE

UCI POLICY EVIDENCE UNIT

UNIVERSITIES | COMMERCIALISATION | INNOVATION

OBSERVATIONS FROM A CRITICAL REVIEW OF THE FIRST ITERATION OF KNOWLEDGE EXCHANGE FRAMEWORK

ZOI ROUPAKIA
TOMAS COATES ULRICHSEN

UNIVERSITIES | COMMERCIALISATION | INNOVATION

Authors

The authors of this briefing note are Zoi Roupakia and Tomas Coates Ulrichsen.

The views and arguments expressed in this report are of the authors and do not represent the positions of organisations or expert groups of which the authors are currently, or were previously, members.

Citation

Please cite this work as: Roupakia, Z. and Ulrichsen, T.C. (2021). Observations from a critical review of the first iteration of Knowledge Exchange Framework. UCI Policy Evidence Unit, University of Cambridge, Cambridge, UK.

Contact us

For more information, contact Zoi Roupakia at zr216@cam.ac.uk and Tomas Coates Ulrichsen at tc267@cam.ac.uk.

ABOUT UCI

The University Commercialisation and Innovation Policy Evidence Unit (UCI) is based at the University of Cambridge and aims to support governments and university leaders in delivering a step change in the contributions universities make to innovation and economic prosperity – nationally and locally – through their commercialisation and other innovation-focused activities and partnerships.

UCI seeks to improve the evidence base and tools available to key decision makers in public policy and university practice as they develop new approaches for strengthening university research-to-innovation and commercialisation pathways. To do so it draws on the latest advances and insights from both academic research and policy practice, as well as lessons learned from experiences in the UK and internationally.

The Policy Evidence Unit is funded through a generous grant from the Research England Development Fund. It is based at the Institute for Manufacturing (IfM) at the University of Cambridge and is being developed in partnership with the IfM's Centre for Science, Technology, and Innovation Policy (CSTI) and the UK National Centre for Universities and Business (NCUB).

Find more about our work: UCI Policy Evidence Unit

The copyright of all materials in this publication belongs to UCI.

Published by the University Commercialisation and Innovation Policy Evidence Unit, Institute for Manufacturing, University of Cambridge

© 2021 UCI Policy Evidence Unit, Institute for Manufacturing

Contents

EXECUTIVE SUMMARY 5

1 INTRODUCTION 8

2 CURRENT KEF APPROACH 11

2.1 WHAT IS THE KEF? 11
2.2 OVERVIEW OF THE KEF APPROACH 11

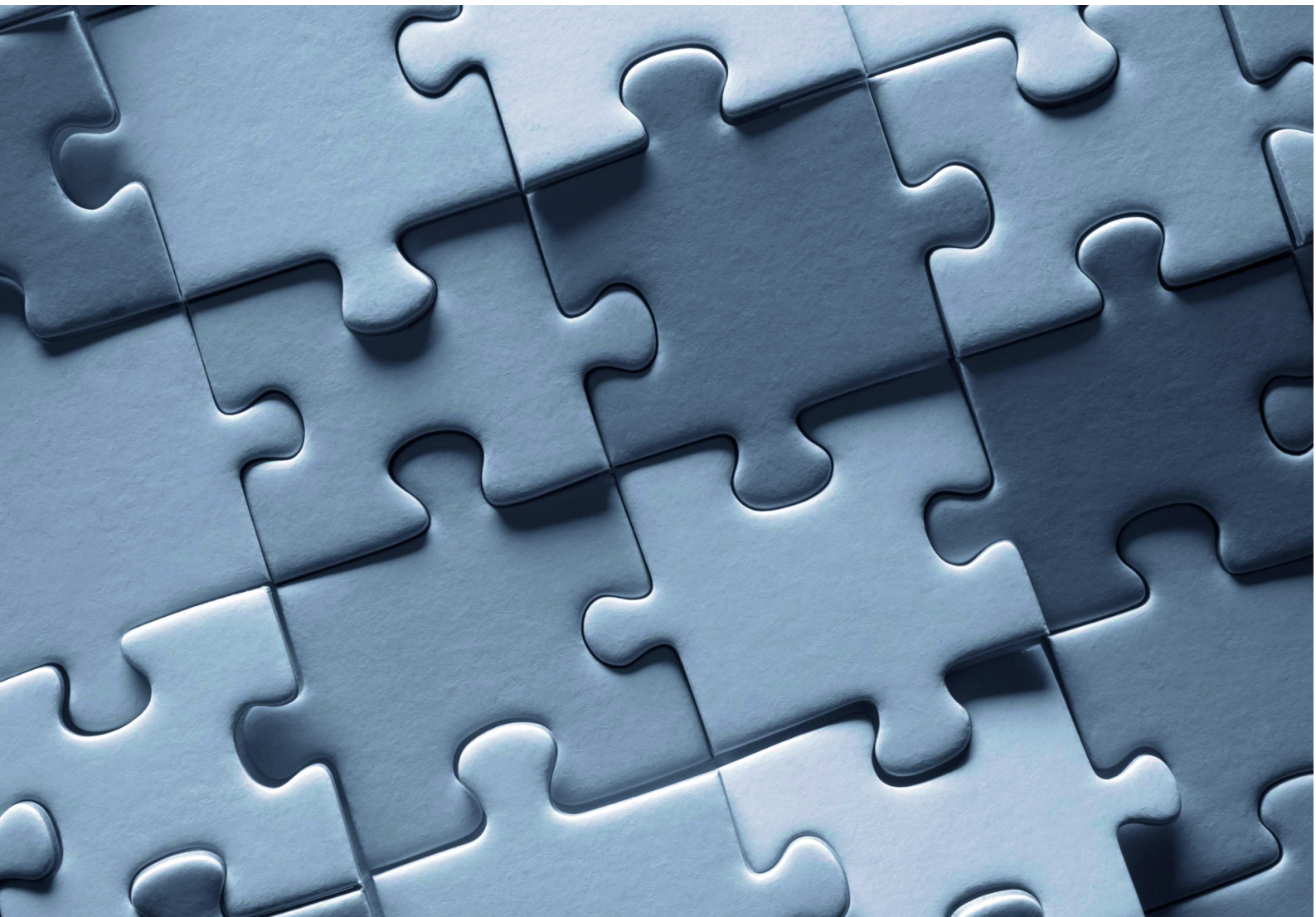
3 CRITICAL REVIEW OF KEY KEF ELEMENTS 19

3.1 DATA SOURCES 19
3.2 METRICS 23
3.3 METHODOLOGY 26
3.4 VISUALISATION 33

4 CONCLUSIONS 37

4.1 FAIRNESS AND 'WHAT GOOD LOOKS LIKE' 37
4.2 THOUGHTS ON THE WAY FORWARD 38

REFERENCES 40



Executive Summary

Executive summary

In March 2021, the results from the first iteration of the Knowledge Exchange Framework (KEF) were published. The KEF was built to assess the performance of English universities across a range of knowledge exchange (KE) activities. The new framework represents a significant step forward in capturing information on the KE activities undertaken by universities in a visible, accessible, and structured way to reveal the diversity of KE across different universities and enable easier benchmarking of universities and their KE activities.

Research England is currently reviewing the first application of the KEF and is seeking feedback from the sector and the users. Within this context, the UCI Policy Evidence Unit at the University of Cambridge undertook a rapid and critical review of the KEF methods and data. While this review was intended to cast a critical eye over the KEF methods and data, and thus identify key problems and issues, we cannot emphasise enough the significant contribution it has made to our ability to publicly and transparently explore KE activity and performance across English universities.

Our findings are detailed in this report and provide observations on the different components of the KEF. We highlight areas for further consideration or improvement. In particular, we suggest action could be taken in the following areas:

Data sources

- Improve the HEBCI survey guidelines to the universities to strengthen existing data on KE, and accelerate the HEBCI Review to enable new metrics to be captured.
- Improve the robustness of data by deploying more systematic checks on the validity of the data.
- Consider adopting international definitions for key variables to enable international comparisons.
- Improve the understanding of the data by separating missing data from true zero values.
- Include more sources of information from other public datasets and explore the collection of more granular data about disciplines, technologies, and sectors.

Metrics

- Work to include non-monetary metrics to assess the value and impact of low-income generating activities, such as social enterprises and open-source products.
- Review the normalisation of the metrics to avoid skewing the results by very small denominators.
- Make more easily visible and quickly accessible key contextual information for each university to capture key points about the universities' KE strategy.
- Develop the metrics further to better capture the *progress* of universities in developing their KE activities.

Methodology

- Review the approach of handling the missing and sparse data.
- Review the approach of using deciles, which in combination with sparse data has the effect of universities with zero performance being positioned in high deciles.
- Consider employing rules of exclusion for universities that do not engage in particular forms of KE (e.g. spinouts).
- Review the approach to aggregating and weighting to avoid double counting and to deal with compensability and fair rankings.
- Begin a discussion involving key stakeholders to clarify the scope of the KEF, what good looks like, and what fairness looks like, to inform methodological choices and technical decisions the approach.
- Consider whether, given other issues relating to the data available, it might be better to avoid data aggregation altogether and the direct or indirect ranking of universities. An alternative would be to present easily accessible comparisons of universities against comparators or the cluster for each key metric. These could be grouped by perspective but would not necessarily be aggregated into a perspective score.

Visualisation

- Encourage the within-cluster comparisons of the universities and discourage the national level comparisons.

Introduction

1 Introduction

The 2017 government's Industrial strategy promised a significant increase in public investment in research and development (R&D) and set the ambitious target to reach a spending on R&D of 2.4% of GDP by 2027. In response to this, the then Minister of State Jo Johnson announced the plans for a new framework to "*evaluate the contribution our universities make to the exploitation of knowledge" and to "provide comparable, benchmarked and publicly available performance information about universities' knowledge exchange activities*".

The new framework, the Knowledge Exchange Framework (KEF), aims to assess the performance of the universities across the breadth of their knowledge exchange activities. It aims *"to allow universities to better understand and improve their own performance in knowledge exchange, as well as provide businesses and other users with more information to help them access the world-class knowledge and expertise within English providers of higher education."*[1]

In March 2021, after an extensive consultation and piloting process, Research England (RE) published the inaugural KEF results, with data visualised in interactive dashboards (available at www.kef.ac.uk). The KEF represents a recognition that knowledge exchange (KE) and commercialisation are essential activities for universities, alongside teaching and research.

At the same time, the interactive visualisation of KE data was a major step forward and represented an important experiment in the use of visual analytics in policy and decision making in this domain. Further, central to KEF's original purpose was the fairness of comparisons between universities. To this end, Research England employed various levelling mechanisms, including incorporating a broad spectrum of KE activities, allowing all universities to show their strengths, and adopting a clustering system to facilitate comparisons between universities that share similar characteristics.

With the first iteration of the KEF now published, Research England has embarked on a review process looking both at the coverage of metrics and how this can be improved, and where and how the methods and data can be strengthened. The review process involved both focus groups with representatives from across the English university system and the establishment of a group of experts to critique the methods and suggest improvements. This learning process is a crucial part of the journey towards embedding a robust and enduring framework for capturing and benchmarking the performance of universities and their KE activities. Indeed, this part of the process is critically important should the decision be made to link the KEF with any allocation of KE funding in the future[2].

In light of this context, this report presents the findings of a critical review of the KEF by the UCI Policy Evidence Unit. It reviews three distinct elements central to the first iteration of the KEF: the data sources, the metrics, the methodology and the visualisation, to identify potential areas for consideration and improvement to inform the current policy discussions. In doing so, it is important

[1] https://kef.ac.uk/, accessed 15th July 2021

[2] https://re.ukri.org/knowledge-exchange/the-higher-education-innovation-fund-heif/: *"Our decision to review the funding method reflects that we have made good progress to develop the KEF as a more accurate approach to measuring KE performance, which is the focus of the HEIF allocation method; and our progress has been noted by Government as meeting government priorities."*

to recognise the very challenging objectives for the KEF set by the Minister of State to construct a robust performance measurement system for KE while not putting an extra burden on universities. This meant that the first iteration had to rely largely on existing data. Our review identifies a number of key areas where improvements could be made.

The rest of the report is structured as follows. Chapter 2 presents an overview of the current KEF approach, while chapter 3 analyses the key components of the KEF. A table with detailed comments and boxes with example cases based on real data are provided for each component. Conclusions are drawn in chapter 4, alongside some recommendations for the next iteration of the KEF on the way forward.

Current KEF Approach

2 Current KEF approach

2.1 What is the KEF?

The Knowledge Exchange Framework (KEF) is a framework to assess the performance of the universities in a breadth of knowledge exchange activities. According to Research England, the purposes of KEF are to provide (Research England, 2018):

- Universities with new tools to understand, benchmark and improve their individual performance
- Businesses and other collaborators or users with more information on universities' individual strengths in KE
- Greater public visibility and accountability of university KE activities.

The 2017 Industrial strategy set ambitions to significantly increase investment in R&D to unlock the industrial competitiveness of the UK, recognising that the UK's economy lagged far behind other advanced economies in terms of R&D intensity. In response to the large, planned increases in R&D spending – including at universities, the then Minister of State for Universities, Science, Research and Innovation, Jo Johnson, challenged the university sector to 'find a near gear' in terms of how they work with businesses and others to unlock new opportunities for R&D and wealth creation. As part of this effort, he commissioned the Higher Education Funding Council of England (HEFCE)[3] to develop a performance measurement framework to sit alongside the Research Excellence Framework (REF) and Teaching Excellence Framework (TEF) to provide "*comparable, benchmarked and publicly available performance information about universities' knowledge exchange activities*".

After a lengthy development and consultation process, Research England published the decided methodology and approach in (Research England, 2020a, 2020b). Then in late March 2021, the first results from the first iteration were published at www.kef.ac.uk. The results were visualised in dashboards that provide institution-level information on key metrics aimed to capture the performance of English universities in different areas of KE, including research partnerships, working with businesses, public and third sectors, skills and workforce development, supporting local growth, and IP commercialisation.

The timeline below (Figure 1) illustrates the multi-stage process of KEF development.

2.2 Overview of the KEF approach

The KEF is based on a quantitative metrics approach. One of the decisions and constraints of the first iteration of the KEF was to be "*based on data already collected via existing statutory returns or other means*" (Research England, 2020a). These data should be useful, robust, universal, timely and focussed (Research England, 2019a). Most importantly, the KEF exercise wanted to put as minimal a burden as possible on universities and institutions to gather and submit new data and metrics. However, Research England is actively looking to develop and refine the metrics used and increase the robustness of the data to improve the overall effectiveness and robustness of the KEF. However,

[3] Part of HEFCE became Research England with the formation of UKRI.

Research England is actively looking to develop and refine the metrics used and increase the robustness of the data to improve the overall effectiveness and robustness of the KEF.

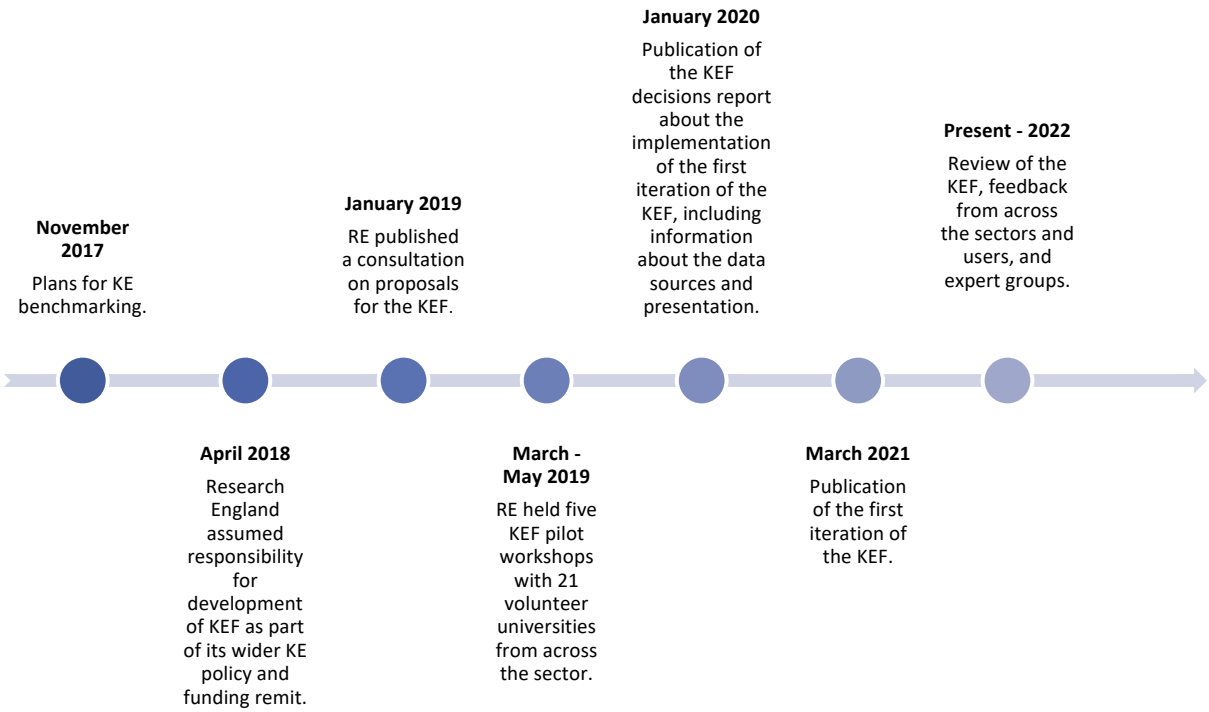


Figure 1| Timeline of KEF Development. Source KEF website. UCI Visualisation.

Data sources

The primary source of data underpinning the majority of metrics for the KEF is the Higher Education Business & Community Interaction (HEBCI) survey managed by the Higher Education Statistics Agency (HESA). The HEBCI survey has been collecting financial and output data related to knowledge exchange annually since 1999. It provides information on a range of KE activities from collaborative and contract research to consultancy and the commercialisation of intellectual property, including outputs associated with graduate and staff start-ups, social enterprises, and university spinouts. It also captures information on other important KE activities intended to have direct socio-economic benefits, such as continuing professional development and continuing education courses, the provision of facilities and equipment services, regeneration and development programmes, and the delivery of public engagement activities such as lectures, exhibitions, and other cultural activities. For many of the above areas, data is broken down by the type of partner, distinguishing between SMEs, non-SME commercial organisations, and public and third sector organisations.

Importantly, guidance on variable definitions is issued to universities to inform their data collection and reporting activities. After 20 years of data collection, a major review of the HEBCI survey, led by HESA, is currently underway.

Other data sources used to inform the KEF include:

- Information from Innovate UK (on funding to universities)
- Information on co-authorship of publications between universities and external organisations from SciVal (an Elsevier product)
- Information on core funding to universities and student numbers from HESA

The HEBCI survey and HESA data are provided by academic year, the Innovate UK data by financial year and the SciVAL data by calendar year.

Perspectives and metrics

The KEF assesses the performance of the university across a diverse range of KE activities. It focuses on seven perspectives looking at different areas of KE:

- Research partnerships
- Working with business
- Working with the public sector
- Skills, enterprise, and entrepreneurship
- Local growth and regeneration
- IP and commercialisation
- Public and community engagement

Within each perspective, several metrics (from one to five) were developed to capture university performance in that area. In total, seventeen metrics have been employed.

Individual metrics are normalised to adjust for institution size. The normalising factor varies by metric, although most are normalised by a measure of 'HEI income', defined as the sum of "tuition fees & education contracts, funding body grants, and research grants and contracts". Others are normalised by the number of specific outputs, such as active spinouts or publications.

Two of the perspectives – "Local growth and regeneration" and "Public and community engagement" – lacked sufficient data to inform a purely metrics-based assessment of performance. For these perspectives, universities were asked to complete a narrative statement covering strategies/planning and their identified needs, activities to address the needs, outcomes and impacts in the previous three academic years. For "Public and community engagement", they were also asked to self-assess their performance using a scoring system and structured process developed in collaboration with the National Co-ordinating Centre for Public Engagement (NCCPE) (National Co-ordinating Centre for Public Engagement, 2020).

It is also important to note that though the submission of narrative statements was not compulsory in the first iteration of the KEF, 87% of the universities have submitted such statements (NCUB, 2021).

Details of the perspectives and individual normalised metrics are shown in Table 1.

Table 1| Perspectives, metrics, and data sources of the KEF.

Perspective	Approach	Metrics	Data sources	
			Numerator	Denominator
Research partnerships	Metrics only	*Collaborative research cash contribution* as a proportion of public funding contribution	HEBCI	HEBCI
		Co-authorship with non-academic partners as a proportion of total outputs (provided by Elsevier SciVal)	SciVal (Elsevier)	SciVal (Elsevier)
Working with business	Metrics only	*Innovate UK income* (KTP and grant) [4] as a proportion of research income	Innovate UK	HESA
		Contract research income with non-SME business (HE-BCI) normalised by HEI income	HEBCI	HESA
		Contract research income with SME business (HE-BCI) normalised by HEI income	HEBCI	HESA
		Consultancy and facilities income with non -SME business (HE-BCI) normalised by HEI income	HEBCI	HESA
		Consultancy and facilities income with SME business (HE-BCI) normalised by HEI income	HEBCI	HESA
Working with the public sector	Metrics only	*Contract research income with the public and third sector* (HE-BCI) normalised by HEI income	HEBCI	HESA
		Consultancy and facilities income with the public and third sector (HE-BCI) normalised by HEI income	HEBCI	HESA
Skills, enterprise, and entrepreneurship	Metrics only	*CPD/CE income* (HE-BCI) normalised by HEI income	HEBCI	HESA
		CPD/CE learner days delivered (HE-BCI) normalised by HEI income	HEBCI	HESA
		Graduate start-ups rate (HE-BCI) by student FTE	HEBCI	HESA

[4] We believe this includes income to support Catapults where they are owned by a university.

Local growth and regeneration	Metrics + narrative	*Regeneration and development income from all sources* (HE-BCI) normalised by HEI income	HEBCI	HESA
		Additional narrative/contextual information - optional in year 1	Institutions	n/a
IP and commercialisation	Metrics only	*Estimated current turnover of all active firms* per active spinout[5] (HE-BCI)	HEBCI	HEBCI
		Average external investment per formal spinout [6](HE-BCI)	HEBCI	HEBCI
		Licensing and other IP income (HE-BCI) as a proportion of research income	HEBCI	HESA
Public and community engagement	Narrative + self-assessment score	Self-assessment-based metric - optional in year 1	Institutions	n/a
		Additional narrative/contextual information - optional in year 1	Institutions	n/a

Methodology

Fair comparisons

In developing the KEF, Research England recognised the limits of whole sector rankings, particularly in the area of KE, where we know that the scale and nature of KE opportunities are shaped by the structural characteristics of universities (such as the scale and focus of their research portfolios, disciplinary focus, and physical assets available).

To address this issue, Research England asked the KEF Technical Advisory Group on Metrics to recommend an approach to enable fair comparisons between institutions. The approach recommended and adopted was to cluster universities into groups based on similarities across a range of structural characteristics known to shape the scale and nature of KE opportunities available. The ambition was that the clusters would allow for fairer comparisons between universities of broadly similar types, while amplifying and celebrating the diversity of KE within different types of universities across England. For more about clusters, read the technical annex (Tomas Coates Ulrichsen, 2018).

Research England also adopted a key recommendation from the Advisory Group that the KEF should not focus on comparisons between clusters but on within-cluster differences in performance. They comment explicitly on the www.kef.ac.uk website that: *"it is important to note that the KEF clusters are not ranked in any way – the clusters are not a ranking in themselves – they are intended to promote fair comparisons between similar sorts of institutions in a very diverse sector."*[7] Further, it states that

[5] We believe, the number of active firms which have survived at least 3 years is used, instead of the number of active firms.
[6] Number of newly registered companies within the reporting period.
[7] https://kef.ac.uk/about, accessed on 15th July 2021

"No one cluster is better or worse than another – they are simply a means to enable fair comparison across a very diverse higher education sector"[8].

Metric scores

The scores for each metric and the overall perspective were developed based on the following approach:

- Individual metrics are calculated as three-year averages using the last three years of data available
- Individual metric averages are then normalised to a 0 – 1 scale using a feature scaling method
- The perspective score is calculated as the arithmetic mean of all normalised individual metrics within the perspective.
- The perspective score is then ranked across all English universities, and the perspective decile in which a given university falls is determined.
- Cluster averages are calculated for each perspective by taking the mean average of the perspective deciles for the institutions belonging to that cluster.

Research England captured this process in the following two diagrams.

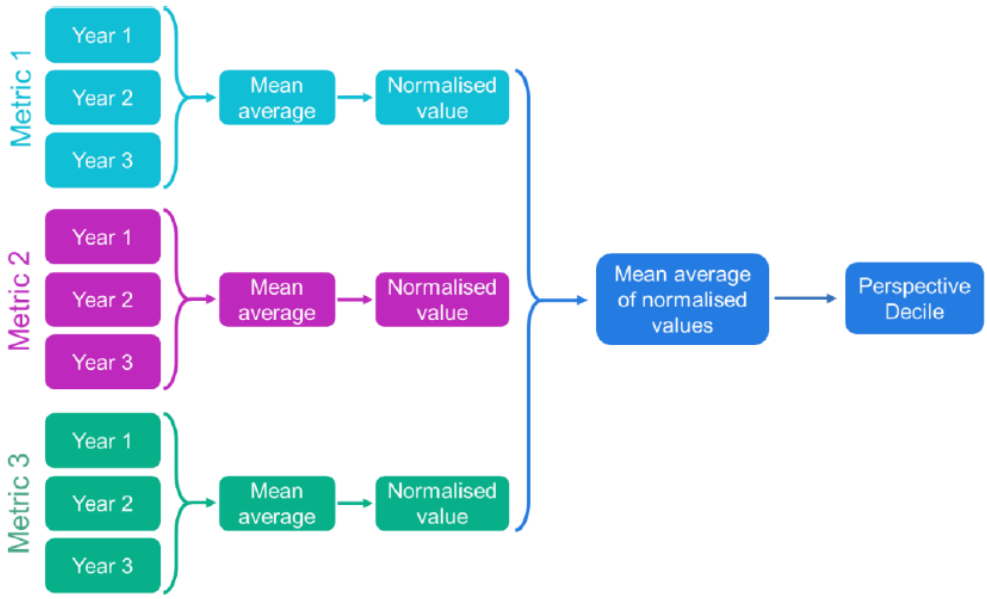


Figure 2| Example process for calculating a perspective decile for an individual HEI. Source (Research England, 2020a).

[8] https://kef.ac.uk/notes, accessed on 15th July 2021

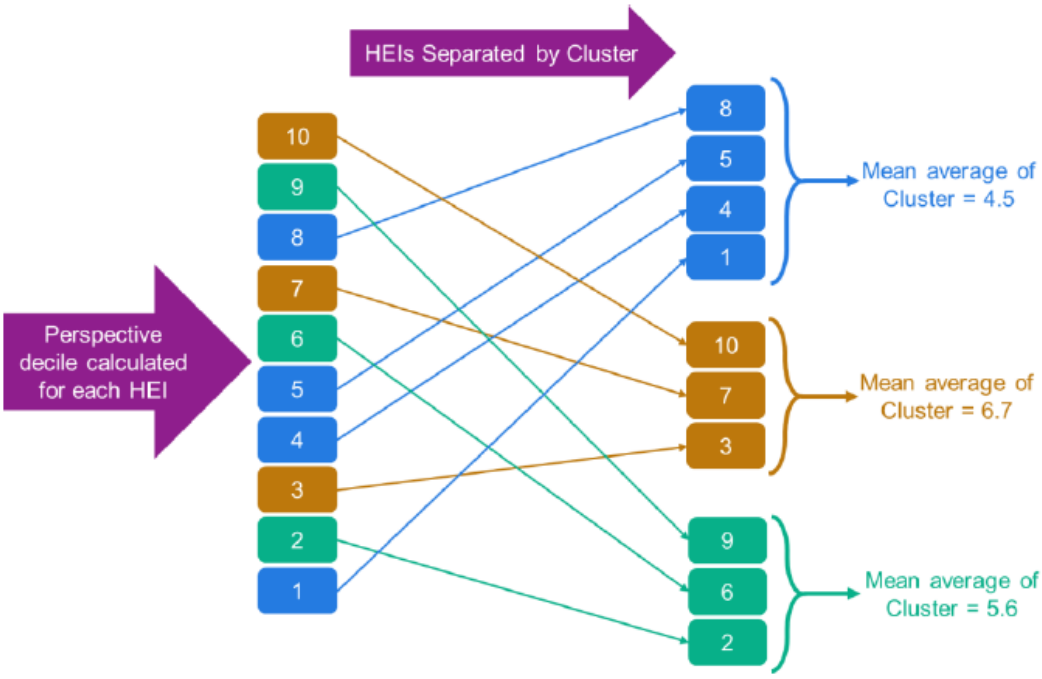


Figure 3| Calculation of cluster averages. Source (Research England, 2020a).

Critical Review of Key KEF Elements

3 Critical review of key KEF elements

Following the publication of the results of the first iteration of the KEF, the University Commercialisation and Innovation Policy Evidence Unit (UCI) at the University of Cambridge undertook a critical review of the methods and data used to identify key areas where improvements could be made. This section presents the key observations emerging from this review. They broadly fall into four categories: data sources, metrics, methodology (the choice of methods and approach to compute the perspective scores and the ranking of the universities) and, finally, visualisation.

3.1 Data sources

A key constraint applied to the development of the KEF was to minimise any additional burden on universities and focus efforts for the first iteration primarily on what could be done using existing datasets. As described in section 2, the data sources used the HEBCI survey, project data provided by Innovate UK, information on co-authorship of publications provided by Elsevier, and information from HESA on different types of funding to universities and their student numbers.

Our review of the data underpinning the KEF revealed key issues around: the strength of guidance provided to universities for submitting data to the HEBCI survey; limited data in key areas; and the robustness (and variability) of data collection efforts within universities. Key issues are captured in the following table.

Key observations are summarised in the following table:

Table 2| Key observations on the KEF data sources.

Category	Comments
Variety of data sources	▪ Existing data sources are limited to the HEBCI survey, Innovate UK funding, SciVAL data on universities and external organisations co-authorship, and HESA data on universities funding and student numbers. ⇒ **Suggestion:** Explore potential for including additional sources, for example, on spinouts.
Guidance on HEBCI data collection (See Example 1 [9])	▪ HEBCI guidance and variable definitions provided to universities is relatively weak in places, particularly for variables hitherto not used to drive funding allocations[10]. ▪ There is no guidance provided to universities on how to approach the estimation of variables where this is required (external investment into spinouts, turnover, and employment).

[9] For the rest of the report, the data included in the examples were accessed in September 2021. Sources https://hesa.ac.uk and https://kef.ac.uk .

[10] This was recognised in the HESA HEBCI major review consultation analysis report (2020).

Category	Comments
	▪ The definition of what constitutes a spinout is weak and can lead to different interpretations of eligibility between universities. For example, when does a spinout stop being a spinout? What happens when about spinouts acquired or merged with larger companies? ▪ Lack of clarity on the eligibility criteria for collaborative and contract research, and what constitutes a "learner day" in continuing professional development and continuing education. ▪ It is currently not possible to determine whether a zero value is due to a university not collecting data on the activity or a case of zero activity**.** ⇒ **Suggestion:** HEBCI survey data collection should be adapted to distinguish between 'missing data' and 'true zero' activity, and guidance should be developed accordingly.
Limited or hidden data (See Example 2)	▪ **Hidden income:** Innovate UK funding channelled through third parties (e.g. Catapults) to universities is likely to not appear in funding databases. In some cases, this can be substantial, such as funding to set up and run a translational research and innovation centre. ▪ Innovate UK funding includes both funding to universities to develop operate major translational R&D and innovation centres (including Catapults), and funding to support specific R&D and innovation projects with businesses**.** While this is important to capture the former in the KEF, these major funding allocations will easily overwhelm other types of project-based funding Innovate UK provides to universities. There is a strong case to separate these types of support into distinct variables. ▪ **Limited data**: Information is only available at the university level and not at the discipline/sector/technology. This makes it hard to adjust for structural differences between universities. ▪ **Limited data**: While Innovate UK-funded translational R&D and innovation centres are captured in the KEF, funding from UKRI Research Councils to establish and operate major translational R&D facilities are not included.
Robustness of data (See example 3)	▪ There is likely to be variability in the strength of KE data collection within universities, with larger and more decentralised universities, and where many KE activities are driven at the individual, or group levels, likely to face greater difficulties and costs in assembling a comprehensive data submission to HEBCI. ▪ The above phenomenon is intensified for KE activities that individuals are not required to formally notify the university, such as consultancy or staff/graduate start-ups. ▪ As mentioned in the guidance category, it is unclear what a zero value means in HEBCI datasets, whether it refers to no activity or lack of data

Category	Comments
	on that activity. This contributes further to the sparsity of data and has implications for the fairness of comparisons. ⇒ **Suggestion:** Potential additional checks could be done to validate the data provided by universities to HEBCI (see details in Example 3), looking at both internal consistency as well as external validity (e.g. by comparing data to existing alternative datasets where available (e.g. on spinouts). ▪ Under careful examination, in a number of cases the data from the KEF dashboards do not correspond to the data from the official HESA – HEBCI webpage. Through our review it was not obvious what the cause of this problem is.

EXAMPLE 1 – Guidance on HEBCI data collection

Perspective: IP and Commercialisation **Metric:** Average external investment per formal spinout

The guidance on HEBCI data collection is not sufficiently strong, particularly in the case of university spinouts. For example, it is not clear when a spinout stops being a spinout and whether the external investment attracted by an acquiree company is eligible for inclusion. Some universities may treat external investments into spinouts that have been acquired by other companies as eligible for inclusion into this data point, and others might not.

The variability in data on spinouts is highlighted when one compares the HEBCI aggregated estimated external investment for all active spinouts in the period 2011-2020 with evidence available through other sources such as the equity investments into university spinouts published in "Spotlight on Spinouts" (Royal Academy of Engineering & Beauhurst, 2021). The table below compares the data for selected universities and shows that while the data are similar for some universities, for others, such the University of Cambridge, and University College London, the two numbers are very different. While we make no judgement as to which dataset is more robust, it does point to variability in the data that needs to be better understood.

	HEBCI Survey Estimated external investment for active spinouts		Spotlight on Spinouts, RAEng Equity investment
	2011-2020	**2010-2020**	**2011 – Nov 2020**
University of Cambridge	£428.6m	£628.9m	£1.9b
University of Oxford	£1.85b	£1.9b	£2.4b
Imperial College of Science, Technology and Medicine	£1.2b	£1.3b	£1.1b
University College London	£349.9m	£363.1m	£661m
University of Bristol	£202.3m	£208.5m	£216m

EXAMPLE 2 – Limited data

Perspective: Working with business **Metric:** Innovate UK income as a proportion of research income.

When funding to a university is channelled through a third party such as a Catapult, it can be hidden from the KEF when this data is sourced from project-based funding datasets.

For example, the Innovate UK metric is based on the agency's database of funded projects which provides information on who receives their funding (including universities). However, it appears to only identify the direct recipient of the funding and does not identify any flow-through of funding to other partners. For example, Innovate UK awarded £72 million to an alliance involving the University of Cambridge, the Manufacturing Technology Catapult and BRE (the Building Research Establishment) to establish a national Core Innovation Hub to transform productivity in the construction sector. This award is listed in the Innovate UK projects database as an award to the Manufacturing Technology Centre, with no other partners identified. As such, the proportion awarded to Cambridge is 'hidden' and will not feed through into the KEF metric. Including this information would significantly change the University of Cambridge's ranking on this metric.

EXAMPLE 3 – Robustness of data

Perspective: IP and Commercialisation **Metric:** Estimated current turnover of all active firms per active spinout.

In 2016, 2017 and 2018, the University of Sheffield reported several active firms that survived three years. However, though in 2018 there was a turnover, the previous years the turnover was reported to be 0. We believe that this is most likely to be the result of data collection issues rather than a real absence of turnover from their spinouts.

Academic year	Estimated turnover of all active firms	Number of active firms (See a)
2018	21057000	26
2017	0	28
2016	0	26

Other issues worth noting:

a) Though the guidance on KEF metrics data source table states that the denominator of this metric is the number of active firms, a closer examination it appears that the number of active firms that have survived three years is used.

EXAMPLE 3 – Robustness of data (continued)

b) In a number of instances, the data downloaded from the KEF dashboard does not correspond to the data from the official HESA page (https://www.hesa.ac.uk/data-and-analysis/business-community/ip-and-startups#spinoff) . For example, for the University of Sheffield, in the HESA page, the estimated turnover for the active firms is £17,592K in 2017 and not zero. Moreover, the number of active firms that survived three years is 25, not 26. We are not sure whether this is due to a lack of interoperability, the data is being updated, or whether it is an issue requiring further investigation.

Another example is the discrepancies between the numbers of active firms and active firms that survived 3 years. The number of active firms would be expected to be bigger than the number of active firms that survived three years. However, in the case of Brunel University, in 2018, 1 active firm was reported, while the number of active firms that survived 3 years was 5. In a close examination of the data, whilst this does not happen often, it raises the question whether easy checks and flags could increase the robustness of data.

Universities with larger reported number of active firms that survived 3 years than total number of active firms		
2016	**2017**	**2018**
University of Northumbria at Newcastle	Brunel University of London	Brunel University of London
	The University of Brighton	The University of Brighton
	Kingston University	The University of Cambridge

3.2 Metrics

This section presents observations about the metrics employed in the first iteration of the KEF. While much progress has been made in developing metrics that capture the breadth of KE activity across English universities, there are a number of limitations, many of which result from being largely constrained to using existing datasets. Limitations include:

- Metrics do not capture the value of any high-impact but low- or no-income generating activities. For example, other areas not well captured include:
  - The value of low-income generating KE activities that help to seed further high-income activity
  - The value of social enterprises, which can be high impact but lower-income activities
  - The value of open-source or products and software.
- Metrics cannot distinguish between the value of a small number of very big deals (e.g., in IP licensing activities, research partnerships, or contract research) compared with larger numbers of small deals. The metrics can be skewed by these few big deals/ contracts.

While this is not necessarily misleading, it raises the question of what "good" looks like and the comparability of universities across different clusters.

- Metrics do not capture the value of spinouts/start-ups that do not attract external investment or do not have a big turnover, either because the specific sector/technology does not need/attract significant venture capital financing or because they follow a softer path to growth through consultancy, or companies in sectors where it takes a long time for products to reach the market and generate turnover. There are also cases where the companies are acquired before reaching the point of having a turnover.

The following table comments in more detail on issues related to metrics.

Table 3| Key observations on the KEF metrics.

Category	Comments
Monetised metrics	▪ In many perspectives such as "Working with Business", "Working with the public sector", and "IP & Commercialisation", metrics capture only the monetary values of activities, such as the income value of consultancy activities, IP licensing and so on. ⇒ **Suggestion:** Alternative metrics in "Working with Business" or "Research partnerships" could include the duration of the partnerships and the satisfaction/quality of the partnership through repeat business. ▪ The creation and impact of social enterprises is poorly captured, not least as they will typically develop with less external investment and generate lower turnover than for-profit businesses. ▪ Many KE activities with the public and third sectors do not generate income, such as volunteering, pro-bono work, providing advice to policymakers, engaging with parliamentary select committees, and so on. The metrics do not capture the many and varied engagements our academics have with policymakers at local, national and supranational levels.
Bias towards certain KE activities and outcomes (See example 4)	▪ In general, any low-income but high impact KE activity or more informal, non-transactional interactions are not recognised. ▪ In "Research partnerships", the co-authorship metric potentially suffers from biases towards those sectors and types of partners (often larger companies) that are willing and able to engage in co-authoring publications with academics. ▪ In the same perspective, the collaborative research metric is likely biased towards projects with cash contributions rather than "in-kind" contributions. ▪ In "Skills, enterprise, and entrepreneurship", social enterprises have been excluded from the analysis despite some data being available through HEBCI (See example 4). ▪ In the same perspective, the metrics do not well capture other entrepreneurship outcomes, such as the formation of consultancies, design, creative arts, app/software development. ▪ In "IP and Commercialisation", the KEF metrics depend on estimated values of turnover, or define success narrowly in relation to external investment.

Category	Comments
	This biases against spinouts that develop through other mechanisms, for example, following a softer path to growth through consultancy or providing contract services. They also bias against companies in sectors where there is a significant time lag between start-up and products reaching the market generating turnover. ⇒ **Suggestion:** Alternative metrics could focus more on impact, such as the number of jobs created. ▪ Through the normalisation process, the metrics favour having a small number of high-revenue KE outcomes such as spinouts or IP licensing deals rather than more KE outcomes that generate moderate amounts of revenue. ▪ Other IP outcomes such as open-source products, software are not captured. The metrics do not capture the value of royalty-free licenses.
Definitions' issues	▪ In "IP and Commercialisation", the metrics are not clearly defined. Though they are normalised by formal spinouts or active firms, it appears that the number of newly registered spinouts (both spin-offs with HE ownership and formal spin-offs, not HE owned) and the active firms which survived at least three years have been used instead, respectively. ▪ In the same perspective, the average external investment is normalised by formal spinout, which is the number of newly registered companies within the reporting period. However, because of the lag time between the registration of a company and the successful attraction of external investment, this external investment is mainly attracted by the active firms. ⇒ **Suggestion:** The definitions of metrics and normalisation variables should be carefully re-examined.
Granularity of metrics	▪ The metrics are not granular; they do not distinguish between different sectors/technologies. Even within KEF clusters, this could be driving some of the observed differences in KE performance. For example, the research in some universities may be more conducive to the formation of spinouts in sectors/technologies that are able to attract significant amounts of external investment to grow and develop, thus performing better than universities whose research portfolio is such that their spinouts tend to develop through other means, or do not require as large an investment to develop successfully.
Sparsity of data underpinning the metrics	▪ The data underpinning some metrics is very sparse. For specific metrics, that affects the denominators, which will result in the metrics being skewed. For example, in "Average external investment per formal spinout", 56.6% of the universities have zero value for newly registered companies in the reporting period.

Category	Comments
Narratives	▪ The richness of how universities contribute to the development of the local cluster is poorly captured through the regeneration and development metric. ⇒ **Suggestion:** The narratives of "Local growth and regeneration" could form the basis of a score as with the "Public and community engagement" perspective.

Example 4 – Social enterprises

HEBCI defines social enterprises in the following way: "Social enterprises include all legal organisational structures including charities and all business structures. Enterprise/ventures which are established to deliver products or services which bring about positive social change are reported, i.e. organisations that rate their success on their social outcomes equally or more than their commercial outcomes (only registered companies should be reported)."
Though HEBCI collects data about social enterprises, they are not included in this iteration of the KEF. The sector was concerned that the lack of metrics in this area could disincentivise the creation of social enterprises (Research England, 2019b). For example, Plymouth College of Art has zero performance in "IP & commercialisation", or "Skills, enterprise and entrepreneurship" as it does not have spinouts, graduate or staff start-ups. However, it does report social enterprises with estimated turnover and external investment. This activity is not depicted in the current iteration of the KEF.

Aggregated Metrics for Plymouth College of Art	2016 -2018
Estimated current turnover of all active firms (£ thousands)	43
Estimated external investment received (£ thousands)	159
Number of active firms	2
Number still active which have survived at least 3 years	0

3.3 Methodology

As seen in section 2, each perspective is represented by the aggregate result of the respective normalised metrics. The universities are ranked nationally, and the perspective decile for each university is calculated. The average of each cluster is estimated as the mean average of these (nationally-determined) perspective deciles.

We believe that technical decisions about how to change the methodology should be informed by a discussion involving the sector and key stakeholders around (i) the scope of the KEF, and (ii) what 'fair' is and what 'good' looks like. Views on these important issues will have implications for technical choices regarding:

- How we handle the sparse vs missing data. Sparse data means that many values are zeros. Missing data means that we do not know the actual values. Currently, sparse data and missing data are treated the same. HEBCI survey does not capture which data is missing and imputes the missing values as zeros adding to the data sparsity and potential data misinterpretation. Zero values can mean that:
    - Universities have attempted to generate activity in a specific KE area but are not successful. Thus, the zeros are valid values, and the data is sparse.
    - Universities have activity in this specific KE area but, for whatever reason, this activity is not captured by the KEF data sources. Thus, the zeros are missing data.
    - The universities have no (or little) activity in a specific KE area by deliberate strategic choice. Thus, the zeros (or low values) are by strategic design rather than poor performance. This latter point requires a debate about how the KEF should deal with strategic decisions to not engage in a particular type of KE. Unless addressed it would signal to the sector that a university that engages well across *all* types of KE is doing 'better' than one that chooses to specialise in fewer types of KE activities.

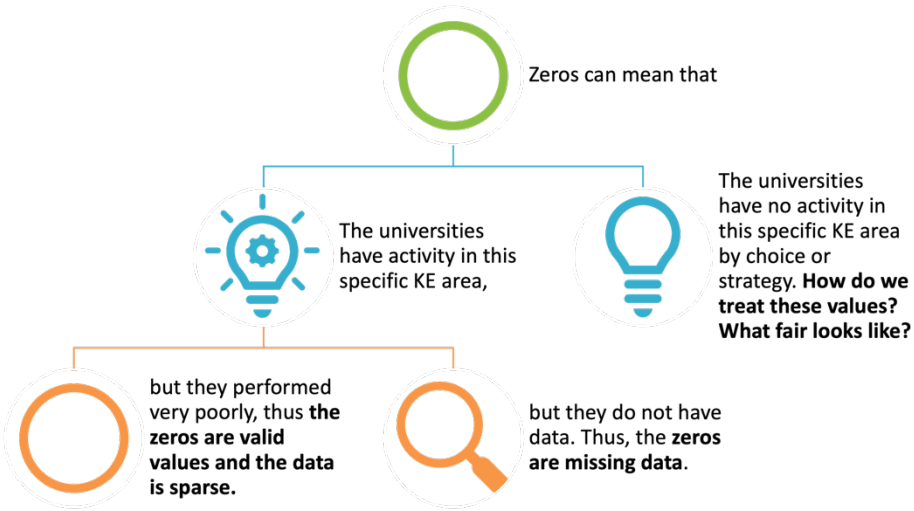


Figure 4| Explanation of what zeros can mean: sparse and missing data.

- The KEF approach depends on a composite perspective score. Composite indicators have been the subject of debate in the literature (Saltelli, 2007; European Commission Joint Research Centre & Organisation for Economic Co-operation and Development, 2008; Saisana & Tarantola, 2016). They help summarise multi-dimensional issues, provide the big picture, and benchmark performance. However, there is a concern when used in policy as they could be misleading and misinterpreted. Further, the final score depends on choices such as the aggregating and weighting method. Compensable aggregating methods favour universities that excel in one metric but perform poorly in others.
- The current scaling is sensitive to outliers. In combination with sparse data and specific metric normalisation approaches, the feature scaling method results in outliers having a significant impact on the results.

The following table presents our observations in detail.

Table 4| Key observations on the KEF methodology.

Category	Comments
Sparse/missing data (See Example 5)	▪ Missing values (missing data) and zero values (sparse data) are treated the same. ⇒ **Suggestion:** Explore the possibility of clarifying whether these zeros are missing values or actual "zero' values, and thus the data is sparse.
Scaling/normalisation (See Example 5)	▪ The Min-Max scaling compresses all inliers in a narrow range, and it is highly influenced by the minimum and maximum values of the data. If these latter are outliers, the scaling is going to be biased. ▪ Many metrics are normalised by a measure of an HEI's research and education-related income. If this income is low (i.e., the denominator takes a small value), then the metric can have a high value even if the nominator is low. This can lead to peculiar results with small institutions positioning in the highest decile while large research-intensive universities positioning in lower deciles. ▪ Normalisation also has the effect of exaggerating the importance of outliers in the data; as such the normalisation approach should be carefully selected. ⇒ **Suggestion:** Other forms of scaling more robust to outliers are worth investigating.
Outliers (See Example 4)	▪ Many outliers need further careful examination. A big presence of outliers could indicate: ○ A problem with the data collection or the guidance about which data is eligible ○ The metrics are not robust enough, and there are issues with the normalisation ○ The metrics are based on very small numbers of KE projects For example, universities that have with a very small number of low-value collaborative research projects that do not attract much public funding can be placed in top deciles. ▪ There are issues with how outliers are handled. We find very small universities in the top deciles, while universities with known established activities at lower deciles. Though in principle it might be correct, i.e., established university does not necessarily mean top performer, it might also be the result of normalisation issues or metrics being based on very small numbers of KE projects/activities (e.g. one collaborative research project or one spinout). It also highlights the importance of comparing universities within the clusters and not nationally.

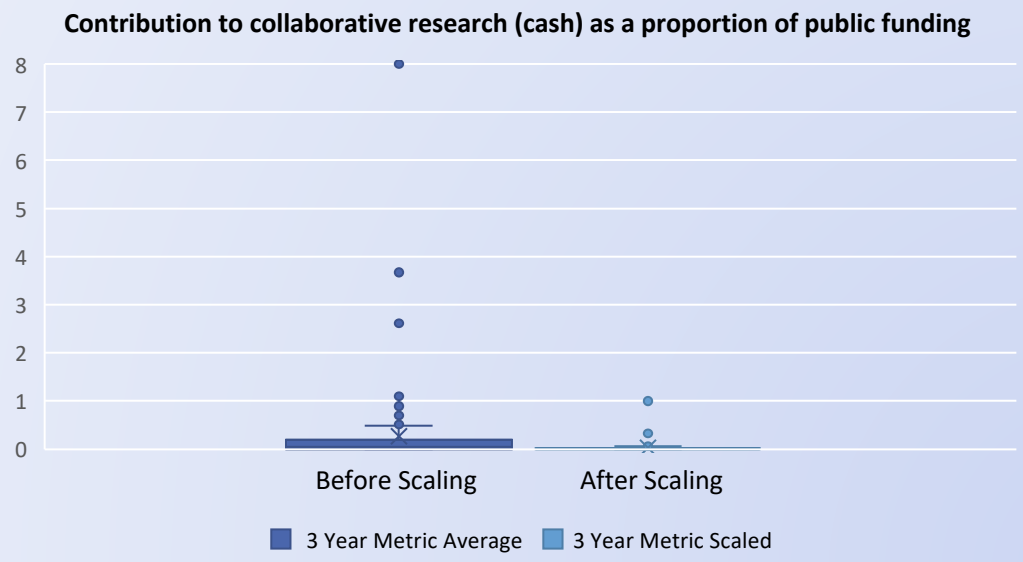
Category	Comments
The choice of deciles	▪ Given the sparsity of data (and missing data), the decile process can lead to peculiar results. We find universities with zero metrics in high deciles for specific perspectives due to a combination of sparse data and the decile system. For example, Anglia Ruskin University, with *zero* average external investment per formal spinout, is ranked in the top 30% of spinouts. ⇒ **Suggestion:** A potential solution would be to investigate the use of quartiles instead, including the universities with zero activity in a separate or lowest category possible.
Aggregating (See Example 6)	▪ The composite score of each perspective employs the arithmetic mean. In linear aggregation, a unit that performs very well in one indicator can offset a poor performance in another, proportionally to the ratio of their weights (European Commission. Joint Research Centre. & Organisation for Economic Co-operation and Development., 2008; Greco et al., 2019). ▪ An undesirable feature of additive aggregations is the implied '*full compensability*', whereby sufficiently high values in some indicators compensate for poor performance in other indicators. ▪ Different aggregating methods affect the ranking system. The choice depends on the priorities for the KEF and an understanding of what 'good' looks like. The more compensable the aggregation method, the less broad a spectrum of KE a university is expected to perform well in. ⇒ **Suggestion:** A partial solution is to use the geometric aggregation that allows a smaller degree of compensability. While linear aggregation assumes constant trade-offs for all cases, geometric aggregation offers inferior compensability for metrics with lower values. ⇒ **Suggestion:** Other non-compensatory aggregation methods include Borda's or Condorcet's rule. Borda's rule is preferable when only one alternative should be chosen, and Condorcet's rule is better to rank all the considered alternatives.
Weighting	▪ There is no weighting scheme in estimating the perspective score. One issue of this approach emerges when there are multiple indicators focusing on the same KE activity. This results in that KE activity type being overweighted within a perspective compared with those that are captured by a single metric. This might favour some universities that are particularly strong in the KE activity captured by multiple metrics within a perspective. ▪ For example, in IP & commercialisation, there are two metrics about spinouts and only one for IP licensing activities. In the skills, enterprise

Category	Comments
	and entrepreneurship category, there are two metrics focused on CPD and CE. ⇒ **Suggestion:** One potential solution would be to aggregate the common indicators before the aggregation into the perspective score. ▪ Another issue of not having weights is that the perspective score is the unweighted arithmetic mean of the individual metrics and does not exploit the full range of information. ▪ **However, the introduction of non-equal weights would introduce a perspective ranking system, which will lead to specific behaviour and preference for specific activities by universities.**
Ranking	▪ Though the KEF discourages comparing the universities belonging to different clusters, the overall decile result is estimated considering all the universities, thus enabling a national ranking system.

EXAMPLE 4 – Outliers and scaling

Perspective: Research partnerships **Metric:** Collaborative research cash contribution as a proportion of public funding contribution

The KEF approach uses min-max scaling. However, as demonstrated in the graph below, this approach is not robust to outliers. As it uses the maximum (and minimum) values in the process, the presence of outliers biases the scaling, while the inliers are compressed in a narrow range. The graph below shows the three-year average for the metric "Collaborative research cash contribution as a proportion of public funding contribution" before and after the scaling.



Example 5 – Sparsity of data and normalisation

Perspective: IP and Commercialisation

The metric "Average external investments per formal spinout" is problematic because of sparse data. This metric refers to investments in active spinouts, however appears to be normalised by the number of newly registered companies. This leads to situations where, the external investment is positive, but, because there are no newly registered companies, the performance is zero. As seen in the table below, almost 57% of universities do not report any newly registered companies. By contrast, 41% of universities report zero active spinouts. Most importantly, around 8% of the universities have non-zero estimated external investment but zero denominator, as they do not have newly registered companies.

Another issue of normalisation by "newly registered companies" is that many universities generate very small spinouts each year; that leads to very small denominators and volatile ratios. Almost 67% of the universities report one or fewer newly registered company.

The following example highlight the effects of the methodological issue of the normalisation in combination with the data sparsity. The University of Surrey performs very well in the other metrics of "IP and Commercialisation" perspective, but its performance in "Average external investments per formal spinouts" is zero. Though it reports external investment for the 3-year period, it has zero newly registered companies. This has a double effect. First, the results are skewed towards universities with a very small number of newly registered companies. Second, combining with the decile system, many universities with zero metric value end in the top deciles (see Figure 7 in section 3.4 on visualisation), such as Anglia University, which also affects the cluster average.

	2016	2017	2018	3-year period
% of universities with no newly registered companies within the reporting period	71.3%	74.6%	67.2%	56.6%
% of universities with zero estimated external investments received	68.9%	66.4%	63.9%	59.8%
% of universities with non-zero estimated external investment but no newly registered companies	9.8%	11.5%	9.8%	8.2%
% of universities with one or fewer newly registered company	81.1%	84.4%	82.0%	67.2%
% of universities with active firms (spinouts)	55.7%	54.9%	57.4%	59.0%

EXAMPLE 6 – Aggregating/ Weighting Function

Perspective: IP and Commercialisation

The following table shows selection of four universities and their respective scaled 3-year averaged metrics in the "IP and commercialisation" perspective. Of these institutions, the University of West London performs the best in "Licensing and other IP income as a proportion of research income", but very badly in the other two metrics. The University of Oxford and University College London perform better across the different metrics.

	Average external investment per formal spinout	Estimated current turnover of all active firms per active spinout	Licensing and other IP income as a proportion of research income
The University of Sussex	1	0.036970087	0.000981285
The University of West London	0	0	1
The University of Oxford	0.551102966	0.295386777	0.031686607
University College London	0.831992969	0.076118227	0.009301878

The ranking of these universities in each metric is as follows

Licensing and other IP income as a proportion of research income	Average external investment per formal spinout	Estimated current turnover of all active firms per active
The University of West London	The University of Sussex	The University of Oxford
The University of Oxford	University College London	University College London
University College London	The University of Oxford	The University of Sussex
The University of Sussex	The University of West London	The University of West London

With the above in mind, the table below now presents the perspective's average score, first using the method deployed in the KEF (which is 'fully compensable'). We then present two alternative aggregation methods using decreasing levels of compensability. The table clearly shows the effect of the choice of aggregation methods on the final perspective score.

Perspective ranking estimating with various aggregating methods Decreasing value of compensability →		
Arithmetic Mean	Geometric Mean	Borda's rule
The University of West London	The University of Sussex	The University of Oxford
The University of Sussex	The University of Oxford	University College London
University College London	The University of West London	The University of Sussex
The University of Oxford	University College London	The University of West London

3.4 Visualisation

The visualisation of the KEF results is a critically important part of the ambitions of the Knowledge Exchange Framework. The first iteration has made important strides in improving access to the data, thanks largely to the investment of time and effort in visualising the results. The interactive platform encourages the engagement of the community and policymakers with the data and increases transparency.

Our critical review of the KEF has, though, identified a number of areas regarding visualisation that could be addressed to improve the engagement of the community and communication of the results. These are discussed in the table below. In our view, the visualisation of the KEF results should:

- Not encourage whole-sector universities comparisons. The "top/bottom XX%" dominates in the dashboard, and as such, the visual presentation prioritises whole sector ranking between institutions, which, given the current methodology, we believe to be inappropriate.
- Improve user-friendliness, providing more prominent information about the perspectives and the clusters to the first-time use.
- Find a way of highlighting more prominently key points from the narrative statements on local growth and regeneration and public and community engagement.

Table 5| Key observations on the KEF visualisation.

Category	Comments
Comparisons (See Figure 5)	▪ The whole-sector decile ranking of each institution ("top/bottom XX%) is dominant in the dashboard, while the black line in the spider chart that shows each institution's decile score against the average decile score for the cluster is much less visible. (Figure 5) ⇒ **Suggestion**: The dashboard should not encourage cross-cluster comparisons as clusters were meant to recognise that different types of universities will engage in KE in different ways with different sets of opportunities. There should be further consideration of whether the whole-sector decile ranking of each institution should appear in the dashboard. ▪ When comparing each university to cluster level, not enough information is provided to the viewer. What does the viewer get from this, and who else is in the cluster?
Discrepancies (See Figure 6, Figure 7)	▪ Although metrics are sometimes zero in the perspective pages for the institutions, the "top XX%" percentage label is still reported. We believe that this is the result of how zeros are handled and the decile system. (Figure 7) ⇒ **Suggestion:** There should be a disclaimer whether data is missing, or values are indeed zero. ▪ In the metrics pages, the bar chart presents the average value of a metric over three years, and the table next to it presents the values for each year.

	Sometimes, when there are zero values, the bar average value does not correspond to the average value in the table, indicating a discrepancy in the way averaging has been computed in the back end. It is also a visualisation issue, which has the potential to confuse the user. (Figure 6)
User-friendliness (See Figure 5, Figure 7)	▪ The landing page takes the user straight to the Anglia Ruskin University page. Critical information regarding the categories/perspectives and the cluster rationale is not visible to a first-time user. (Figure 5) ⇒ **Suggestion:** The landing page should explain the categories/perspectives, then the cluster rationale and then show the data. ▪ The narratives are very interesting as they include lots of contextual information about the institution and how it engages in a particular type of KE. However, they are not prominent; the user has to hover over the metric to realise there is a link to a narrative page. Moreover, the user cannot quickly extract the most critical points. ⇒ **Suggestion:** Some "key highlights" (e.g. 3-5 bullet points) that capture the essence of the narrative or key word clouds would help the user extract the key points. ▪ It is unclear whether the numbers in the middle in the perspective view (Figure 7) are for cluster or national level.

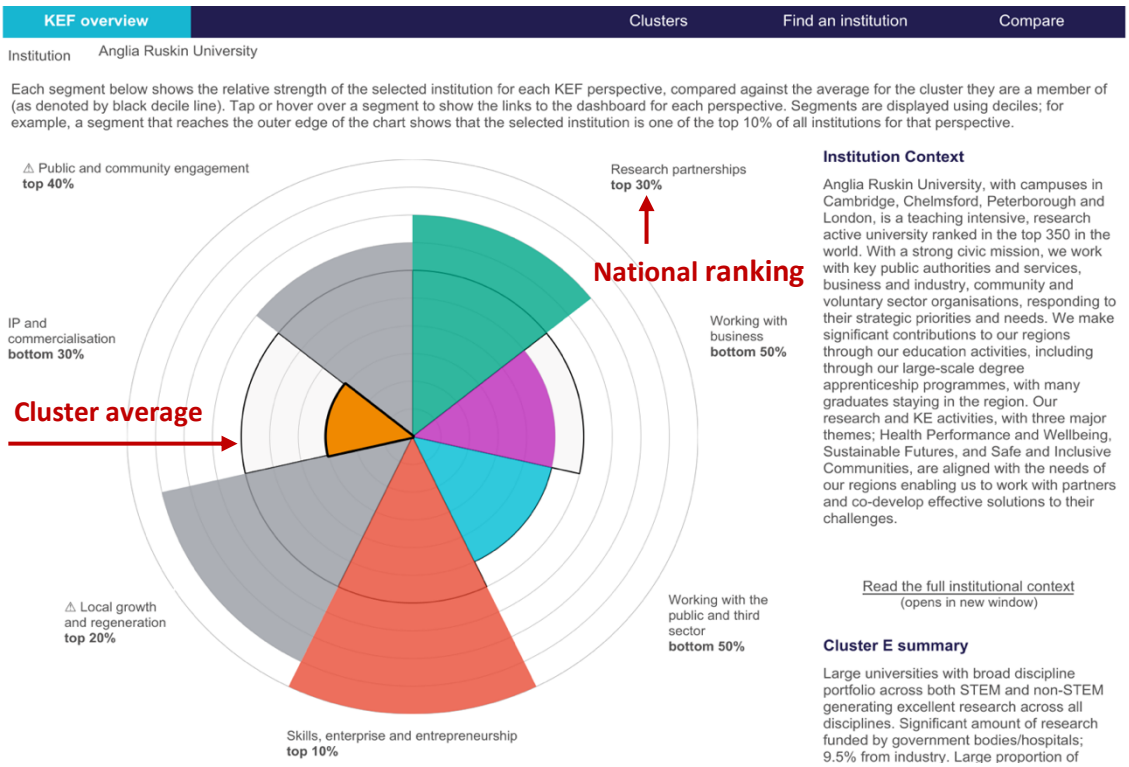
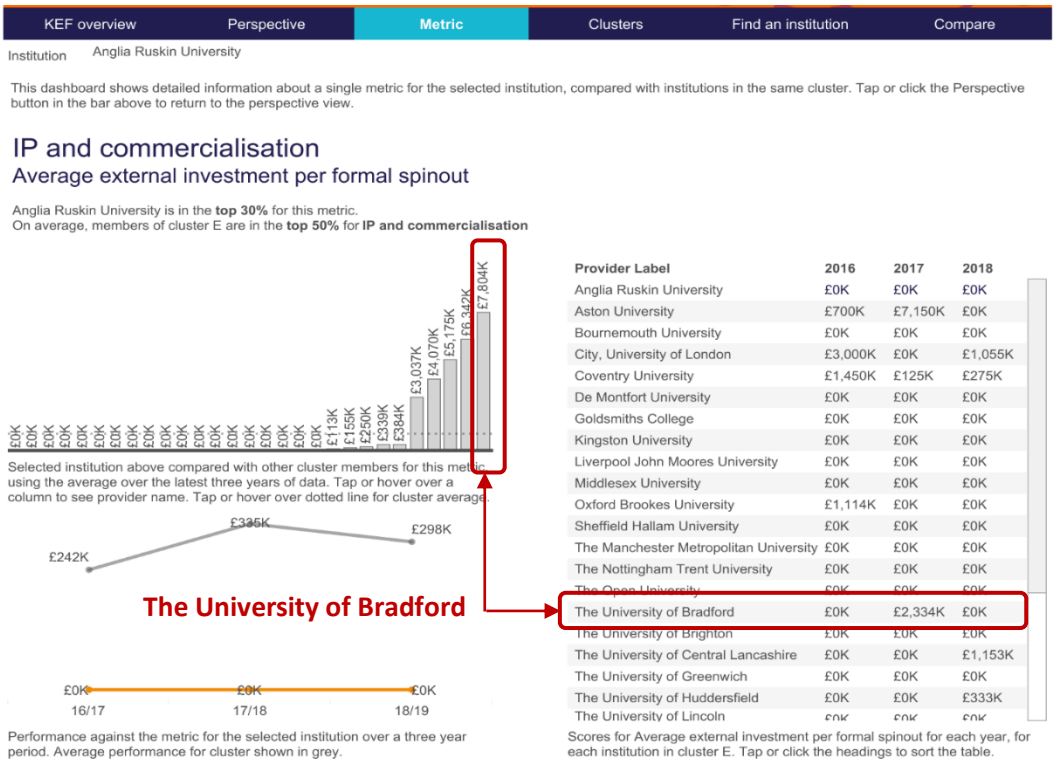


Figure 5| Overview of KEF dashboard. Landing page. Though the KEF wants to ensure fair comparisons within-cluster universities, the most prominent part in the page is the "XX%", which is estimated by nationally ranking the universities. The cluster average is the grey line, which is much less prominent.



Provider Label	2016	2017	2018
Anglia Ruskin University	£0K	£0K	£0K
Aston University	£700K	£7,150K	£0K
Bournemouth University	£0K	£0K	£0K
City, University of London	£3,000K	£0K	£1,055K
Coventry University	£1,450K	£125K	£275K
De Montfort University	£0K	£0K	£0K
Goldsmiths College	£0K	£0K	£0K
Kingston University	£0K	£0K	£0K
Liverpool John Moores University	£0K	£0K	£0K
Middlesex University	£0K	£0K	£0K
Oxford Brookes University	£1,114K	£0K	£0K
Sheffield Hallam University	£0K	£0K	£0K
The Manchester Metropolitan University	£0K	£0K	£0K
The Nottingham Trent University	£0K	£0K	£0K
The Open University	£0K	£0K	£0K
The University of Bradford	£0K	£2,334K	£0K
The University of Brighton	£0K	£0K	£0K
The University of Central Lancashire	£0K	£0K	£1,153K
The University of Greenwich	£0K	£0K	£0K
The University of Huddersfield	£0K	£0K	£333K
The University of Lincoln	£0K	£0K	£0K

Figure 6| Metrics view in KEF dashboard. The bar chart presents the average external investment per formal spinout over three years. The table presents the metric values for each year. The zero values in the table are due to the normalisation. In 2016 and 2018, the University of Bradford recorded external investments but not newly registered companies. This presentation confuses the user as the bar average value does not correspond to the average value in the table.

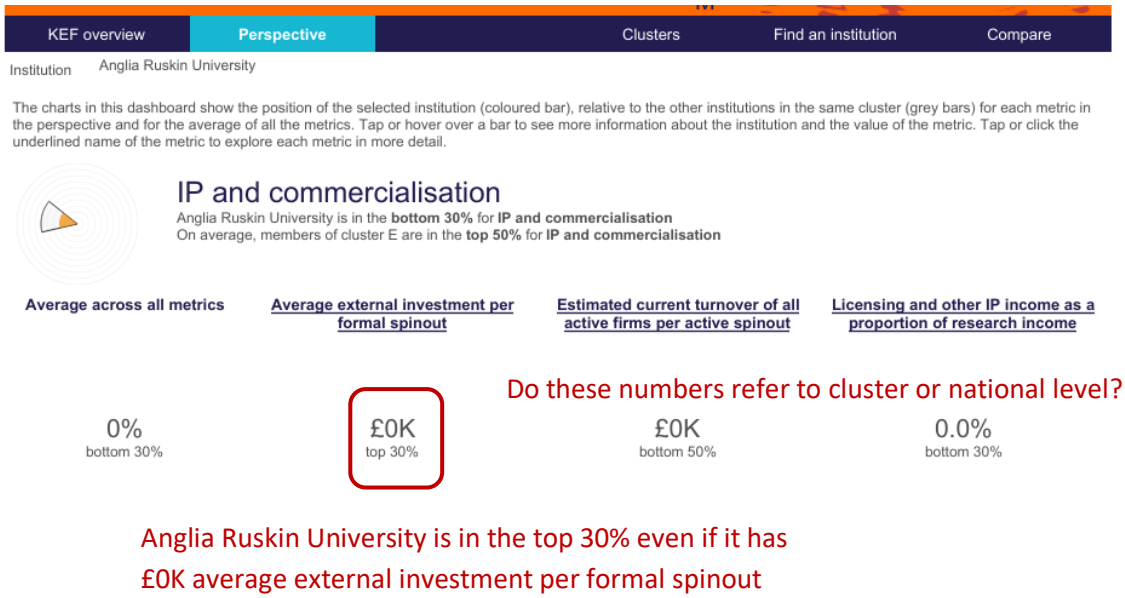


Figure 7| Perspective view in KEF dashboard. Anglia Ruskin University is in the top 30% even with £0K average external investment per formal spinout.

Conclusions

4 Conclusions

The KEF represents an important step forward in providing an accessible tool to explore the KE activities of English universities. The first exercise has helped reveal the diversity of KE and celebrated the successes of a wide range of universities in KE, some of whom can be overlooked in analyses based on simple rankings. It has also provided universities with a new tool to assess their performance in KE against other comparable universities, recognising of course the limitations of the data and that such quantitative benchmarking exercises should be integrated with other evidence gathering exercises to assess performance.

The development and publication of the KEF has also prompted some universities to strengthen their data collection efforts and has helped to shine a light on where better and more robust data on KE is required. In this regard, the current HEBCI Review being led by HESA is crucially important for the success of future iterations of the KEF.

The interactive dashboard, while having its limitations, also represents a significant step forward towards increasing user engagement with KE data, increasing KE data transparency and public visibility.

Overall, the inaugural KEF has been an insightful and valuable exercise. The first iteration of the KEF was always meant to be part of a learning process of how to improve our ability to capture and assess performance in KE, and it has provided much learning of what now needs to be done. Our review aimed to provide some key observations on the methodology and data to support this learning process.

4.1 Fairness and 'what good looks like'

With the results of the first iteration of the KEF now published, as we look to the long-term future of KEF we suggest it would be useful for key stakeholders to begin a discussion about what 'good looks like' for the KEF and about how it can deliver fair comparisons. This is important because longer-term methodological choices and data gathering efforts are strongly dependent on a consensus on these issues. For example:

- Should universities that have average performance across a wide range of KE metrics perform better than those that excel in specific areas of KE metrics? This will influence the choice of the aggregation method.
- Should universities be included in those KE metrics where they may have strategically decided to specialise elsewhere *and as a result* present very low levels of KE activity? This will influence how sparse data is treated and whether the KEF should incorporate rules of exclusion by type of KE. It is also advisable not to use a composite perspective score at this point, as normalisation issues and missing/sparse data issues could affect the score.
- Should we treat missing data (which are set to zero) and sparse data ('true zeros') in the same way? If not, the HEBCI survey will need to be modified to include different flags.

- Should we better adjust for discipline variability, given that the metrics are income-based and some disciplines have the potential to secure KE of higher monetary value than others? The cluster methodology deals with this to some extent, although not completely as even within clusters there is significant variation in discipline portfolio of universities. If not, more granular data sources should be developed to underpin this framework.
- Should we focus performance assessments solely on the relative differences in KE activities between universities and not examine the 'direction of travel' (for example, how each the level of KE activity is changing over time)? If not, how can progression metrics be developed and incorporated into the KEF?
- Should we expand measures of success beyond monetary metrics? How can we better capture the value of low-income, high-impact knowledge exchange activities?

4.2 Thoughts on the way forward

The inaugural exercise of the KEF did not want to place any additional data collection burden on universities. Given this, as we look to the longer-term future of KEF, it will be important to improve KE data collection processes and the HEBCI survey guidance provided to universities. To improve the robustness of the data, the sector should also explore the potential to expand the data sources available and find ways to include more granular information, particularly around KE from different disciplines. Furthermore, it is important to separate missing data from true zero values.

As we confront a major review of the HEBCI survey, we should also explore the potential to develop/ adopt common international definitions for key variables. This would enable important international comparisons in KE, which many universities look for, and help to unlock new key insights in knowledge exchange.

The first iteration of the KEF focused primarily on activities that generate income. However, as some KE activities that do not generate much (if any) income can have a high impact, as a sector, we should explore ways of developing metrics that could better capture this category of activity. We should also reflect on the normalisation process to ensure that small denominators cannot skew the results, as was the case for some universities in the inaugural KEF.

The metrics present the absolute performance of the universities over the past three years, but do not examine the direction of travel. Progression metrics might be worth investigating. We believe that this could usefully complement the existing performance metrics, with KEF examining performance both in terms of relative differences in the level of KE activity and relative differences in the development of KE over time.

The KEF covers a wide range of activities in which some universities might not engage through strategic choice (this is particularly likely in the IP commercialisation category). It would be worth exploring how this information could be included in the KEF, both methodologically, and to provide important context for those looking to interpret the results. For example, how could the institutional statements be developed to provide strategic information and context on the university's involvement in each of the perspectives?

Related to this, it may be worth exploring whether rules of exclusion for universities should/could be developed to account for the fact that either universities do not engage in certain activities by strategic choice, or do not have enough KE activity to enable robust comparisons (e.g. an HEI secures one relatively low-value project but due to the way the normalisation process works it leads to a very high metric value). We also suggest it is necessary to review the approach to scaling and deciles. This, combined with the sparsity of data, leads to universities with very low/zero KE activity in a perspective being awarded a high decile rank.

The current approach employs composite indicators to rank the universities based on their perspective score. As such, we suggest that the aggregating and weighting methods should be reviewed. The sector needs to decide about the acceptable level of compensability, which relates to choices about how to best incentivise and reward university engagement in KE (in particular, how we trade-off universities that do better in a wide range of activities compared with those excelling in a smaller number of areas). Depending on the answer, alternative approaches to aggregation that employ a less compensable aggregation method than the arithmetic mean could be explored. In addition, in two of the perspectives, multiple metrics capture the same type of KE activity. The use of the arithmetic mean and equal weighting means that this KE activity is effectively double-weighted in the perspective score.

In reviewing the KEF and developing the second iteration, it is critically important to recognise that there is no right or wrong solution to many of these issues, and it is incredibly difficult to create a 'general purpose framework' that meets a wide variety of very different objectives. The sector therefore needs to determine what is most important to them, 'what good looks like', and what is fair. These decisions will dictate any technical methodological decision and changes.

As the KEF moves forward, there are many things we can learn from its first iteration. **While this review was intended to cast a critical eye over the process and thus identify key problems and issues, we cannot emphasise enough the significant contribution it has made to our ability to publicly and transparently explore KE activity and performance in the English HE sector.** We are already seeing signs that it has helped universities to: reflect even more strongly on their involvement in KE; improve internal data collection processes; focus attention on where and how to improve the definitions and guidance provided to universities for collecting KE data; and renew the search for new and better data to underpin novel metrics. Overall, the KEF is helping to drive better data for KE, which will help both policies and university leaders develop more targeted and effective approaches to enabling and facilitating knowledge exchange.

References

European Commission Joint Research Centre & Organisation for Economic Co-operation and Development (2008) Handbook on constructing composite indicators: methodology and user guide. OECD, 158.

Greco S, Ishizaka A, Tasiou M & Torrisi G (2019, January 15) On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness. Social Indicators Research. Springer Netherlands.

National Co-ordinating Centre for Public Engagement (2020) KEF Public and Community Engagement guidance and template.

NCUB (2021) An in-depth look at what the KEF narratives can tell us about local growth and regeneration. Authored by Zakaria Ismail, https://www.ncub.co.uk/insight/an-in-depth-look-at-what-the-kef-narratives-can-tell-us-about-local-growth-and-regeneration/.

Research England (2018) Knowledge Exchange Framework (KEF) Note on the relevance and use of UKRI Research Council data Background.

Research England (2019a) Knowledge Exchange Framework Consultation.

Research England (2019b) Knowledge Exchange Framework: Outcomes of Consultation and Pilot Exercise.

Research England (2020a) Knowledge Exchange Framework, Decisions for the first iteration.

Research England (2020b) Research England Knowledge Exchange Framework Clustering and narrative templates.

Royal Academy of Engineering & Beauhurst (2021) Spotlight on Spinouts.

Saisana M & Tarantola S (2016) State-of-the-art report on current methodologies and practices for composite indicator development. European Commission.

Saltelli A (2007) Composite indicators between analysis and advocacy. Social Indicators Research, 81(1): 65–77.

Tomas Coates Ulrichsen (2018) Knowledge Exchange Framework Metrics: A Cluster Analysis of Higher Education Institutions, A Technical Report for Research England.

UNIVERSITY OF CAMBRIDGE

UCI POLICY EVIDENCE UNIT

University Commercialisation and Innovation Policy Evidence Unit

Institute for Manufacturing, University of Cambridge, 17 Charles Babbage Road, CB3 0FS