



KNOWLEDGE EXCHANGE FUNDING REVIEW

Insights from a review of the literature

TOMAS COATES ULRICHSEN LEONARD KELLEHER ZOI ROUPAKIA

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Executive Summary

Research England (RE), in consultation with the Office for Students (OfS), is undertaking a long-term, comprehensive review of approaches to its knowledge exchange (KE) funding. This report aims to inform the review by exploring key questions raised by the review team through a detailed interrogation of the academic and practitioner literatures, including:

- Are RE-UKRI approaches to supporting KE appropriately aligned with key drivers of success in KE, and with key policy objectives around research funding and policy, students and teaching-related objectives, place and levelling up agendas, and economic growth?
- 2. How should success in KE be measured and demonstrated?
- 3. How can RE-UKRI ensure/enable that Higher Education Providers (HEPs) continue to innovate in their KE activities?
- 4. What does 'good' performance look like in KE?
- 5. How can funding be deployed to reward and incentivise effective knowledge exchange?

We examine these questions through an innovation and economic growth perspective on knowledge exchange. We of course recognise that other impact pathways for KE may benefit from and require other perspectives and conceptual framing (for example the broader societal and cultural impacts of KE).

To inform these questions, our report first presents a conceptual overview of key elements of the KE system and process, moving from a discussion of how HEPs function within innovation systems to the role of KE in enabling innovation and wider socio-economic outcomes, to the variety of KE mechanisms and support that have emerged to enable these contributions. We attempt to build an analytical framework that can guide our thinking on these topics, including on the many factors that drive and influence KE. We also review the latest thinking on the rationale for government funding for KE.

Key findings of the report are summarised below.

X.1 Knowledge exchange fundamentals

HEPs are part of a wider innovation system in which organisations of different types interact (through both market and non-market mechanisms) to generate, develop, and diffuse knowledge to drive innovation. As such HEPs must not be considered in isolation. Their set of viable KE opportunities are shaped not just by internal factors, strategies and decisions, but also by the behaviours, choices, and strategies of potential knowledge partners in the innovation system (i.e. operating on the 'demand side'), the conditions that underpin the ability of the organisations in the system to innovate, and the formal and informal institutions that create the 'rules of the game' and shape the behaviours of all those involved in the KE and innovation processes.

We know that HEPs contribute to innovation in many ways, not just through their research efforts to create new knowledge and ideas that lead to new inventions and innovations. Studies have shown they contribute much further along the 'innovation journey' not just by helping partners to develop, demonstrate and deploy their innovations, help solve technical problems and adopt the latest

innovations. Through their KE and wider efforts, and investments they also help to strengthen the capabilities of the innovation system to innovate.

The KE process is shaped by a wide range of factors. Barriers can emerge due to the capabilities and conditions of HEPs as well as those of their partners, due to the functioning of the interactions that form between them, and due to weaknesses in the institutional framework. They can also emerge at different levels of the system (for example at the leadership level of the HEP / partner or at the individual level such as academic, KE professional, HEP leader, or as a result of how the HEP or partner is organised.

HEPs are not a homogeneous group of organisations. Rather, evidence presented in the development of the KE clusters that currently underpin the Knowledge Exchange Framework (KEF) shows that they are a diverse group with very different knowledge bases from which to draw upon for KE, different levels of resources and capabilities available to invest in and support KE, different strategic ambitions and particular history and evolution, and are based in very different local socioeconomic contexts. All of these factors - some structural, others more easily changed - will shape 'viable KE opportunities' available to them and their staff/students, i.e. the types of partners they work with and the types of challenges and opportunities they work on together. It is therefore unsurprising that we witness such a variety of KE activity across the sector.

We bring together these insights within a simplified framework (Figure X.1), positioning universities and their KE interactions within the innovation system.

Figure X.1 A simplified framework for positioning universities and their KE interactions within the national innovation system



KEY FEATURES OF THE UNIVERSITY SYSTEM

- · Universities are not a homogeneous group; they have different missions and strategies shaped by internal and extern pressures as well as their historical evolution and local context
- Universities operate as part of a wider system of universities. variously collaborating and competing with each other
- · Universities are based in very different local enviro
- which shape their strategic choices
- Individuals (academic staff, KE staff, students etc.) within universities are shaped both by locally determined incentives as well as national and alobal incentives
- · Universities have access to different levels and types of resources (financial, human capital, social capital, physical & virtual capital etc.) to deliver their strategic objectives

SYSTEM-SPECIFIC STRUCTURE:

- · Actors in the public, private and third sectors creating, exchanging, and using knowledge e.g.: MNCs, indigenous large firms, SMEs, universities, research institutions, research and technology organisations, technical consultancies, government departments and agencies, hospitals, standards bodies, regulators, charities, civil society organisations etc.
- · Linkages e.g.: market, non-market, social/economic/political
- Institutions e.g.: legal/regulatory regimes; public policies; culture, norms etc.
- Accumulated knowledge & technologies
- INNOVATION OPPORTUNITIES SHAPED BY
- Capabilities of specific actors, their ability to interact and the institutional framework
- The strength and dynamics of the system that supplies the necessary resources and capabilities for innovation, and the demand conditions and dynamics of the sectors
- The choices and behaviours of other actors (i.e. there is interdependence)

X.2 Factors influencing the opportunities and challenges for knowledge exchange

A range of factors influence the KE process and outcomes (Figure X.2). operating at different levels of the system, on different parts of the system, and at different points in the KE process, including:

- The **university as a organisation**, focusing on the strength of the organisational leadership, strategies, incentives, resources and capabilities to support and deliver KE.
- The **individuals within the university** that are involved in delivering KE, including the academics and students, and the KE professionals that enable and facilitate the interactions.
- The external knowledge partner/user involved in the KE interactions.
- The **interactions and relationships** that form between individuals and groups within universities and their external partners.

These actors and interactions are also shaped by:

- The system-level **institutional framework** (national, regional, local, sectoral) that sets the "rules of the game" and shapes choices and behaviours.
- The structure, strength and dynamics of the system's **supply-side** developing or enabling access to necessary resources and capabilities either domestically or internationally.
- The structure, strength and dynamics of the system's **demand-side** that shapes the overall nature and direction of KE opportunities and may condition what is possible.

Figure X.2 Factors influencing the KE process and outcomes



and discussions

X.3 Types of policy instruments influencing KE

Our report highlights a range of failures and barriers in the functioning of the innovation system and the flows of knowledge between universities and partners that justify the involvement of governments in supporting and enabling KE. Building on our framework and the types of factors known to shape the functioning and success of KE, we have identified different types of policy instruments likely to influence KE outcomes. These are captured in the figure below.





X.4 Alignment of UKRI approaches with key drivers of success in KE and government priorities

Given Research England's remit, its core KE-related policy instruments – for example HEIF – focus on strengthening the capacity and capabilities of HEPs as *organisations* to deliver effective KE in line with government priorities, either working alone or in collaboration with other HEPs and partners. This compares with policy instruments deployed by other parts of UKRI that focus more on the capacity and capabilities of individuals, projects or research/technology spaces.

In evaluating the success of KE funding programmes, it is important to recognise that realising socioeconomic impacts from the KE activities enabled by these investments will be influenced strongly by the actions, effort and investments of others – for example companies across supply chains, investors, regulators, and public and charitable sector actors – as well as the institutions that shape decisions and behaviours towards innovation. As such the success of such programmes will be conditional on policy interventions elsewhere in the innovation system to alleviate the innovation and collaboration-related barriers faced by companies and others (for example policy instruments aimed at increasing the innovative and collaborative capacity and capability of KE partners).

The UK Government has a priority to raise the R&D intensity of the economy, our systems approach. Our systems approach highlights the range of ways in which HEPs, through their KE activities, have the potential to contribute. This includes, though not limited to, research leading to new technologies, business models, production processes, working practices and the like, that have the potential to unlock significant economic and societal value, attract investment and KE partners interested in developing them further. It also includes:

- HEPs working actively with external organisations in the economy and society to advance their own internal R&D efforts, including helping to identify new opportunities for R&D and innovation and adopt productivity-enhancing solutions.
- HEPs investing effort and resources, deployed through KE, to help develop and strengthen the resources and capabilities available within the innovation system that underpin the ability of companies to invest in, and successfully deliver R&D and innovation.
- HEPs increasingly contributing expertise and insights to inform efforts to shape the overall strategic direction of the innovation system (e.g. around climate change and local economic development).

Universities can contribute to the levelling up agenda of the UK Government in many ways, not least through the deliberate targeting of their wealth of expertise, resources and assets to address regional innovation priorities to deliver regional impact. This includes targeting all the above mechanisms on regional priorities. Furthermore, they can also take steps to help anchor and amplify the potentially significant spillover benefits arising from wider investments in, for example, building national centres of excellence in an emerging technology in their local economy. The figure below captures some of the ways in which this can happen.



Figure X.4 Different types of policy instruments aimed at delivering more effective KE

A recent survey by UCI of university KE leaders found that most HEPs – across different types – see significant and viable strategic opportunities for working with their local economies to increase innovation and economic prosperity locally. Furthermore, many also see important opportunities for working to support SMEs, many of which will likely be in their local economies.

More actively involving students in the KE activities of HEPs is likely to yield benefits to multiple stakeholders, including direct benefits to students – e.g. increased employment opportunities, employability, career development opportunities, and reduced employer/employee search costs – and enhancing the delivery potential of HEP KE.

On the priority relating to research funding and policy, evidence gathered over the past decade has shown that KE delivers significant positive benefits to the research endeavours of academics and HEPs – i.e. there are very strong synergies between KE and research. Indeed, HEPs are increasingly placing importance on investments that more effectively integrate research with KE in order to deliver greater impact from their work.

X.5 Measuring and demonstrating success of knowledge exchange

The past few decades have seen ever growing pressures on policymakers and funders of KE to measure and demonstrate the success of their investments and interventions. In England this has seen a mix of fund-specific evaluations, the development of national datasets capturing KE activities and outputs to aid performance measurement, and most recently, the development of the Knowledge Exchange Framework (KEF).

These experiences have highlighted several key challenges, arising not least due to the significant variety of KE pathways that link inputs to impacts in very different parts of the economy and society; the variety of knowledge being developed and exchanged; and the significant time lags between investment in KE and realised impacts coupled with the need for complementary investments by others for success. An implication of the latter is that attempts to measure the long-term KE impacts being realised now will inevitably be based on investments and decisions made many years prior, often under very different local, national, and global conditions that may no longer be appropriate.

These challenges have led many to increasingly focus on and monitor 'trajectory measures' that capture whether knowledge is being exchanged efficiently and effectively, and whether it is being productively used. Furthermore, efforts to understand the scale and nature of longer-term economic and societal impacts arising through KE are harder and costly to undertake regularly, and may be more appropriately be delivered through in-depth studies on a more periodic basis.

As we look to the future to strengthen our ability to measure and demonstrate success, it is very important to be clear about the purpose of any KE measurement framework. In section 4 we highlight different types of purpose, for example to monitor progress against benchmarks and trigger actions, to check the health of the system and communicate trends to external audiences to ensure public accountability of funding, and to facilitate learning and improvement. The *why* of performance measurement will shape *whose* success is measured, *what* is measured, *when* it is measured, and *how*.

The learning function of such measurement systems is often overlooked yet is incredibly important for enabling a KE system that continuously learns and improves. Contextualisation of data is critically important for enabling learning.

Subject to the purpose it is then important to develop a robust analytical framework to guide data collection. This needs to build on a strong conceptual understanding of how HEPs function within the wider innovation system, and how KE works to link knowledge partners with HEPs and contribute to the delivery of socio-economic impacts. Frameworks such as those developed in the field of evaluation can be useful (e.g. as presented below).



Figure X.5 Framework for investigating the success of KE for performance optimisation (A) BASIC LOGIC MODEL FOR KNOWLEDGE EXCHANGE

Source: Building on Hughes and Martin (2012) and Mayne (2015)

These types of frameworks can then help to identify what sources of evidence currently exist to inform our understanding of the success of KE, what insights each evidence source reveals, and how understanding of evidence sources can be integrated to capture and demonstrate success. A critical function of such frameworks is also to reveal where key gaps in evidence exist, allowing for a more thorough investigation of the potential biases that may emerge from any analysis of the data.

We must also recognise that different types of information will provide evidence on different parts of the performance framework and may be gathered on different timescales depending on their temporal stability and through different quantitative and qualitative methods. For example, trajectory measures may be obtained quantitatively with greater frequency than robust evidence of longer-term impacts. It is therefore very important not to see individual KE metrics or data sources in isolation from the wider set of information gathered but rather how evidence, gathered over time, fits together to inform our understanding of performance and impact; hence the importance of a strategic analytical framework to guide data collection and interpretation. In making progress with our ability to measure and demonstrate success in KE, a key challenge lies around our ability to integrate different data sources. There are opportunities for new data sources as well as data collection and analysis techniques to add insights on the success of KE (e.g. data science and machine learning tools to interrogate unstructured text). However, any use of these techniques needs to be carefully evaluated, with clear quality and robustness thresholds and criteria set. These may well vary depending on the purpose of the exercise (e.g. to understand variety of impacts or emerging impact areas vs allocating funding).

X.6 Enabling continuous learning and innovation in HEP knowledge exchange

For an organisation to improve, it must learn something new. For an organisation to continually improve, it must commit itself to learning systematically. How can public policy interventions can be used to incentivise and enable continuous innovation by HEPs in their KE activities?

A recent EU-wide study of research and innovation systems (not specifically on KE) highlighted four main ways that policy instruments can drive continuous learning. Applying these insights to the KE space would suggest the following mechanisms:

- Instruments aimed at improving the quality of KE and competitiveness of the KE system
- Instruments aimed at steering behaviours within the system to more positive outcomes
- Instruments aimed at increasing public accountability
- Instruments aimed at providing strategic information.

HEIF, the Knowledge Exchange Framework (KEF), and the Knowledge Exchange Concordat variously provide different elements of the above.

At the HEP level, the fields of organisational learning and knowledge management suggests that for organisations to continuously learn they need to embed not just individual learning but also incorporate this into organisational 'memory'; enable learning at work; create a learning climate; and develop appropriate 'learning structures'.

Our analysis of evidence from the stakeholder engagement exercise shows that the Concordat, KEF, and HEIF all influence the development of English HEPs to enable continuous improvement in KE. HEIF provides critical and flexible resources to enable new/improved KE activities; KEF enables shared visions and understanding of KE; and the Concordat enables organisational learning, shared understanding of changes needed and mechanisms for refining/improving existing rules and processes.

We also identified a number of issues with the Concordat and the KEF in particular, that may hamper HEPs' movement towards continuous learning and improvement. These include:

- An underdeveloped use of the Concordat and KEF data in challenging cause-and-effect assumptions to drive performance improvement
- Complexities of both the Concordat and KEF makes it difficult to socialise an understanding of KE performance improvement beyond the KE community

- A lack of contextualised KEF metrics to provide insights relevant to specific external stakeholders
- Issues in enabling community learning between HEPs
- Issues in the use of KEF to signal Government priorities.

While HEIF is very positively viewed by HEPs across the sector, a number of issues were raised that may reduce its effectiveness in incentivising continuous learning and improvement within in HEPs, in particular:

- The maximum cap reduces the incentives on HEPs safely above it to continuously improve and innovate in KE. This may have been countered to some extent by the KEF
- The use of income in the allocation of HEIF can create mixed signals to leaders of HEPs (particularly those less engaged with the KE agenda) to focus their efforts on KE activities that generate the most income at the expense of other valuable interactions. This is likely more of an issue for HEPs not receiving the maximum amount of HEIF.

X.7 What good KE performance looks like

In developing KE-focused performance frameworks, it is important to understand what 'good' looks like. Doing so must recognise that HEPs are not a homogeneous set of organisations and that the success of HEPs in delivering socio-economic impacts through KE will be conditioned by the capabilities of their partners, the wider supply-side and demand-side conditions, and the strengths and weaknesses of the institutional framework, that shape the innovation journey and whether, where and how impacts are realised. Furthermore, it is now widely recognised that there is no one-size-fits-all model for delivering effective KE.

Given the above, coupled with the significant challenges in measuring and demonstrating success in KE, we suggest that a 'good' and 'healthy' KE system is one that:

- Has **in place key building blocks** known to support different forms of KE, including many of the 'ordinary' operational capabilities emphasised in the Concordat
- Is able to **adapt and respond effectively** to emerging opportunities and threats, guided by high-level 'dynamic capabilities' that enable HEP leaders to identify opportunities, seize them, and transform and invest to open up new opportunities for growth
- Is continuously learning and investing in seeking out ways to improve performance
- Is actively seeking to reduce barriers and strengthen enablers to exchanging knowledge effectively with partners in the economy and society to unlock additional socio-economic benefits
- That sees the **knowledge assets generated and held within HEPs being utilised by partners** in the economy and society to deliver positive economic and societal benefits
- That enables and incentivises HEPs to **develop locally relevant and appropriate strategies and approaches** to delivering KE.

X.8 Objectives for KE funding other than rewarding / incentivising KE performance

The current formula-based method for allocating HEIF focuses on allocating funding based on realised KE performance, making an adjustment for the amount of activity undertaken by a HEP with SMEs. To release the funding HEPs have to provide RE with accountability statements that detail how the funding is to be spent in line with their strategy for KE and government priorities.

There are a number of limitations to this approach, including:

- The incentives for HEPs to improve KE performance are reduced for those institutions safely above the maximum cap on HEIF
- The sole focus on recent past KE performance may struggle to accommodate large and uneven system-wide shocks, which can disproportionately affect certain types of HEP
- A sole focus on performance can make it harder for HEPs with little current KE activity but ambitions to grow it to secure the necessary resources to do so
- It is possible that HEPs located at significant distance from natural partners for their knowledge (likely based in less innovative and weaker local economies) may experience greater challenges and incur greater costs associated with searching for, securing, and delivering effective KE opportunities than those based in more innovative and entrepreneurial hotspots
- Certain types of KE activities are less likely to generate income, or generate income significantly less than full economic costs. Income-based approaches may under-incentivise such activities that may be particularly important for delivering certain government priorities, such as levelling up
- Very broadly defined government priorities may struggle to provide a strong enough signal to influence the behaviour of HEP leaders in how they allocate their KE funds

Furthermore, the current set up provides few incentives aimed at the development of 'dynamic capabilities' within HEPs to identify and seize emerging opportunities more effectively. These are important for enabling HEPs to become more adaptive and responsive in an everchanging world. We believe that this demands further thought.

Overcoming these limitations could be tackled in different ways:

- Adjustments could be made to the funding formula to incentivise specific activities known to be important for delivering certain government priorities (e.g. levelling up)
- Strengthening incentives for continuous improvement for HEPs at the maximum HEIF cap through the KEF which introduces (potentially significant) reputational risks and the KE Concordat
- More targeted periodic reporting requirements to signal to HEPs the importance of investing in ways that are aligned to delivering on key government and RE/OfS priorities
- Other competitive, project-focused funding schemes, aimed at providing HEPs without HEIF to access resources focused on raising their KE capabilities.

X.9 Use of income as a proxy for impact of KE

The income from KE is often used as a *proxy* for the impacts derived from these activities insofar as it provides a measure of implied demand for KE that is valued by partners. This assumes that partners are rational economic agents; if they are willing to pay for KE they must believe that the value likely to be derived from the interactions at least exceeds the price paid. We also know from studies of companies engaged in KE that they benefit in many ways, with income likely not fully capturing the many multiplier, spillover and long-term systemic impacts on the economy and society. As such it likely represents a minimum bound to the impact realised.

The use of income-based proxies for KE success also has the advantage of being comparable across HEPs and, compared with other potential impact assessments, is relatively easy to collect and audit. Given the statutory requirement for HEPs to complete HEBCI, such measures are likely to be complete in terms of coverage across HEPs.

Nevertheless, income-based measures suffer from some important limitations, including:

- Not capturing areas of KE for which there is no monetary transaction but where value is nevertheless realised. This can be a significant issue if the object of the performance measurement exercise is to examine KE performance in that particular area
- Reinforcing structural biases across disciplines with STEM disciplines more likely than SHAPE to generate greater income due to the higher costs of delivery. Income measures will therefore be dominated by the dynamics of the former, making it hard to pick up signals of emerging pressures and opportunities for SHAPE disciplines. The lack of KE income data at the discipline level hampers our ability to control for this potential bias.
- Providing little intelligence on the nature of the impacts realised, which may be important for certain policy audiences, or on the journey to impact
- Sending confused signals to HEP leaders regarding the prioritisation of high incomegenerating KE activities over others. The latter is likely more pronounced for those HEPs not safely within the HEIF maximum cap, where prioritising KE activities with potentially lower socio-economic value but higher income-generating potential could lead to an increased funding allocation.

In considering whether income-based measures are appropriate, it is important to consider the purpose of KE performance measurement. For example, to allocate funding based on KE performance a robust proxy measure is needed that allows for the distribution of performance across HEPs to be estimated. Additional information should be included if it would alter in some way this distribution. If the purpose is evaluating and demonstrating KE success, it may be as important to reveal not just relative differences in aggregate performance across HEPs, but also to provide an understanding of the types and absolute scales of direct benefits and longer-term systemic impacts arising from KE (at the system-level or individual HEP-level).

Moving forward, a clear and transparent framework is important for helping to guide additional data collection efforts to create a system of evidence and insight able to capture and trace the KE journey from investment to impact. This would also help to position and contextualise income-based metrics alongside a wider range of metrics and information (quantitative and qualitative).

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Introduction

1 Introduction

Research England, in consultation with the Office for Students (OfS), is undertaking a long-term, comprehensive review of approaches to knowledge exchange (KE) funding (hereafter the 'KE review'). Research England carried out a stakeholder engagement exercise between May and July 2022 to gather views and insights to feed into the evidence base underpinning the review. Despite this, several key gaps remain. To help address this, Research England asked UCI to undertake a review to interrogate what is known in the academic and practitioner literatures on the following key questions to inform the final stages of the review:

- 1. Are RE-UKRI approaches to supporting KE appropriately aligned with key drivers of success in KE, and with key policy objectives around research funding and policy, students and teaching-related objectives, place and levelling up agendas, and economic growth?
 - Research funding and policy
 - Student/teaching related
 - Place and levelling up agendas.
 - 2.4%/economic growth
- 2. How should success in KE be measured and demonstrated?
- 3. How can RE-UKRI ensure/enable that Higher Education Providers (HEPs) continue to innovate in their KE activities?
- 4. What does 'good' performance look like in KE, including the value of breadth of activity across a number of aspects against depth within specific areas?
- 5. The current method (for the Higher Education Innovation Fund, or HEIF) aligns the way RE-UKRI provides evidence to Government on success of HEIF with drivers on HEPs rewarding and incentivising 'performance' which is used to demonstrate the return on investment of the funds. This makes the system pull together to deliver best/measurable outcomes as a composite whole.
 - Are there other objectives than rewarding/incentivising performance that UKRI should consider in devising a model?
 - Are there better means to align allocations and evidence of success of the programme?
 - Income is the best proxy RE-UKRI has for the impact of KE activities on the economy and society. However, it has a downside that it might appear to incentivise HEPs to focus on income not outcomes. What means are there to increase focus on measurable outcomes?

We examine these questions through an innovation and economic growth perspective on knowledge exchange. We of course recognise that other impact pathways for KE may benefit from and require other perspectives and conceptual framing (for example to capture the broader societal and cultural impacts of KE).

As part of this exercise we undertook a systematic review of the academic and other published policy-focused literatures from leading experts on knowledge exchange guided by each of the above question. In addition, we have attempted to construct and present analytical frameworks that may prove valuable in helping to framework policy-focused discussion on each of the key questions.

The report is organised into chapters built around each of the five core questions. These follow a more conceptual chapter that attempts to capture insights on what we term knowledge exchange fundamentals. This seeks to move from a discussion of how systems work and the position of HEPs within them to the role of KE in enabling innovation and wider socio-economic outcomes and the variety of KE mechanisms that form to enable these contributions. We attempt to build an analytical framework that can guide our thinking on these topics, including on the many factors that drive and influence KE. We also review the latest thinking on the rationale for government funding for KE.

Knowledge exchange fundamentals

2 Knowledge exchange fundamentals

Before tackling each of the core questions set by Research England, this first chapter provides some background insights on knowledge exchange and the funding in England that supports it. It begins by setting out the structure and function of the wider innovation system within which universities operate and the role and variety of interactions that form between universities and their partners to exchange knowledge for the benefit of society and the economy.

Innovation systems can be thought of as the collection of individuals and organisations interacting to generate, diffuse and develop knowledge into innovative products and services within a set of 'rules' governing choices and behaviours. Innovation systems can be examined at different levels, from the nation-state to a specific region, sector, or technology.

2.1 Universities in the innovation system

To aid our understanding of how universities deliver socio-economic impact through KE it is helpful to first conceptually ground our discussions within a framework that positions universities as part of a national innovation system that seeks to generate knowledge, and exchange, diffuse and develop it into applications for societal, economic, and environmental benefit. We know from many years of research that the innovation process that underpins this process is collective, often involving many individuals and organisations along the journey from idea to application.

We also know that the innovation process is shaped by the innovation system's *structure*, which typically distinguishes three core elements. The first element consists of the *actors* that make decisions, invest resources, build capabilities, and deliver the activities that progress the innovation process to deliver new products and services delivering socio-economic value. These actors include universities and other research organisations, technology development and innovation support organisations, private enterprise and investors, government departments and other publicly funded agencies and bodies, trade associations, hospitals, charities, and many others.

The second element is the *institutional framework* within which activities occur and which shapes the behaviours of the actors involved in the innovation process. This encompasses 'hard' institutional elements such as contract, labour, and intellectual property law, and standards and regulation, as well as 'softer' informal cultural norms/values and rules of the game governing agent interactions.

The third element is the set of *interactions* between actors that take place within the institutional framework. These interactions go beyond arms-length market-based interactions (the buying and selling of goods and services) to include the full set of formal and informal network and collaboration-based interactions. These interactions in turn take place within specific sets of physical (e.g. transport and IT) and science-based infrastructures provided by private and public sector organisations.

Crucially, innovation systems frameworks also emphasise the importance of the interaction between the supply side of the innovation system in generating new knowledge (dominated in the UK by universities) and the demand-side of the system in the ability of knowledge users (e.g. companies, public sector agencies, hospitals etc.) to engage effectively with knowledge producers and exploit emerging knowledge and ideas to solve problems that deliver impact.

For example, we know that the capabilities of firms to absorb and exploit the resources, knowledge and expertise generated within universities – i.e. their 'absorptive capacity' – is important in conditioning the nature and scale of value realised through their knowledge-based interactions. At a regional level, research has found that "regional [innovation] systems with stronger capabilities and a progressive knowledge base will also tend to be better equipped to exploit new technological opportunities, to adapt existing activities to emerging business environments, and to learn more rapidly about how to build new capabilities and advantages".

Any analysis of the effectiveness of university KE therefore needs to be conditioned by an understanding of the capabilities of knowledge users in the innovation system, and of the system as a whole (e.g. local economy) to acquire and exploit new knowledge generated within HEPs to deliver value for their organisation and for the economy and society more widely.

2.2 Universities and their contributions to innovation

Returning now to the innovation process at the core of the innovation system, this can be thought of as progressing through a number of value adding stages known as the innovation chain. These typically include: understanding the potential market (including needs, technical and economic feasibility, idea generation and selection etc.); research and development; design and prototype; demonstration and testing; production; and commercialisation and deployment in practice (Caraça et al., 2009; Kline and Rosenberg, 1986). Critically, these stages do not occur in isolation from each other, nor do they necessarily occur sequentially. Rather they are strongly iterative and coupled (Caraça et al., 2009; Kline and Rosenberg, 1986). Further, the different stages may be undertaken by different agents in the innovation system and are shaped by the system's institutional framework and the strength of the system functions. Evidence increasingly highlights the importance of collaboration and partnerships in delivering superior innovation outcomes.

Arguably, the most established and recognised roles of universities lie upstream in the innovation chain. Through their basic, use-inspired and applied research, universities generate new ideas, technologies and approaches (Stokes, 1997). These are diffused through varied pathways of knowledge exchange (KE), ranging from commercialisation (e.g. patenting, licencing, entrepreneurship) to more engaged and people-centric modes (e.g. collaborative or contract research, consulting, providing ad hoc advice, networking with practitioners). Through these interactions, universities contribute to a wide range of impacts, from ground-breaking innovations that transform the world to incremental innovations that help to drive efficiency and productivity improvements (Cohen et al., 2002; Hughes and Kitson, 2014; Lee, 2000; Perkmann et al., 2021, 2013; Ulrichsen and O'Sullivan, 2018).

Universities' research and KE endeavours extend far beyond contributions to technological advances, although this is sometimes overlooked due to an excessive focus on technology transfer (Hughes and Kitson, 2012a). Amongst other things, university research and KE activities help to drive

new business models and organisational practices to create and capture value; new ways of producing and supplying products and services in more efficient and sustainable ways; individual and population behavioural insights concerning responses and adaptation to new technologies; public policies, standards and regulations; and ethical frameworks that guide the development and diffusion of innovations (Hughes and Kitson, 2014; Jacobsson and Vico, 2010; Ulrichsen and O'Sullivan, 2018).

Research has also shown that universities contribute to innovation much further downstream in the innovation chain than previously thought, leveraging their expertise and infrastructure to support partners in delivering their innovation activities. This includes providing a range of services that apply existing knowledge bases and resources (e.g. facilities) to support their partners in the private, public and third sectors to: develop, demonstrate and test new technologies, processes and products/services; identify routes to market; provide technical problem-solving services; and help them to adopt the latest innovations and technologies to drive efficiency and productivity gains (Bercovitz and Feldman, 2007; Betz, 1997; Hughes et al., 2016b; Lee, 2000; Lester, 2005; Ulrichsen and O'Sullivan, 2018; Youtie and Shapira, 2008). Additionally, universities have been shown to help partners understand the need for innovations and identify new opportunities for innovation.

As well as these roles along the innovation chain, the past few decades have seen a growing evidence base on the strategic role that universities can play in stimulating economic growth by strengthening capabilities and conditions of the wider innovation system that shape the ability of organisations to collaborate and innovate, and for innovations to be introduced and diffused (Breznitz and Feldman, 2012; Gunasekara, 2006; Hughes and Kitson, 2012a; Kitson et al., 2009; Lester, 2005; Uyarra, 2010; Youtie and Shapira, 2008). Examples of their roles in this area include providing strategic insights and intelligence to inform regional and national sector and technology strategies; providing regional leadership alongside key stakeholders; building workforce technical and managerial skills; investing in physical infrastructure to support experimentation with new innovative ideas and very early-stage company growth; attracting inward investment; building research and innovation networks; facilitating knowledge spillovers that stimulate innovation in proximity to the university; and raising public understanding of the potential opportunities and societal implications of emerging technologies and innovations.

Universities are also typically very stable actors in the innovation system. This stability coupled with their relatively neutral environments politically and industrially, allows them to provide an important *public space* function. This creates a conducive environment for *catalysing* interactions within the innovation system, including between academics and innovators as well as between innovators involved in different parts of the innovation process. These often informal, non-transactional interactions may help to bridge disconnected or weakly connected actors in the innovation system and develop common interests, and may lead to more formal activities (Hughes, 2011).

Finally, universities have more recently become more actively engaged in helping to drive not just the pace of innovation but also in shaping its direction of travel along corridors of acceptable development paths, for example around environmental sustainability (Cuesta-Claros et al., 2021; Guzmán-Valenzuela, 2016; Trencher et al., 2014). Activities in this area include engagement with a broadened range of stakeholders involved in social change; critiques of problems to understand their socio-political dimensions; management of the knowledge required to drive transformative change; socio-technical experimentation and demonstration in real-world settings; and reform of built and natural environment (Parker and Lundgren, 2022; Trencher et al., 2014).

These diverse roles are brought together under three broad types of function universities serve in the development and deployment of new innovations and the functioning of the innovation system (Figure 1): (i) generating new knowledge, ideas and technologies that form the basis of new innovations; (ii) applying their existing knowledge base and resources (such as their physical infrastructure and social networks) to support partners in delivering their innovation activities; and (iii) shaping, developing, and strengthening the capabilities of the system to better enable organisations to innovate and for innovations to be introduced and diffused.

It also aims to recognise the different types of innovations these functions support, from developing new technologies and products to ways of producing and supplying them, organisational strategies and practices, and the development of the system that underpins organisations' ability to innovate.

While innovation is often understood in terms of technological inventions, and linked back to advances and activities in STEM disciplines (science, technology, engineering and mathematics), it must be stressed that the social sciences and arts and humanities are known to actively engage in delivering many of these contributions (Alan Hughes et al., 2011; Paunov et al., 2017), and their participation is increasingly important in the area of responsible research and innovation (Stilgoe et al., 2013; Ulrichsen, 2019).





2.3 Universities, knowledge exchange and innovation

The past twenty years or so have seen universities become more strategically active in working with partners in the private, public and third sectors to more actively contribute to innovation and in strengthening of the capabilities and capacity of the system that underpins innovation.

This has been facilitated by a significant increase in policy focus on, and public resources devoted to, helping universities build up their KE capacity, capabilities, and infrastructures, to engage with external partners to work on activities delivering positive impacts on the economy and society. These developments have seen universities move well beyond their traditional knowledge diffusion mechanisms through scholarly publication and the movement of students into the labour market and dramatically expand more *direct* interactions with partners to exchange knowledge. Importantly, these KE interactions are fundamentally shaped by the type of knowledge generated and held by universities, or accessible through them (e.g. through collaborations).

Studies have also frequently highlighted the many *mechanisms* through which knowledge is exchanged between universities and non-academic organisations. The volume and value of common KE mechanisms are captured annually for all UK universities in the Higher Education Business and Community Interaction (HE-BCI) survey and are shown in Figure 2 and Figure 3. These form a subset of a wider range of KE mechanisms that have been identified that often involve academics, but may also be driven by other communities within the HEP (see e.g. Hughes et al., 2016a; Hughes and Kitson, 2012b; PACEC, 2012; PACEC/CBR, 2009; Philpott et al., 2011). Figure 4 provides insights on the variety of types of KE interactions that academics in particular have with external partners in the private, public and third sectors, based on the findings of a large-scale survey of UK academics undertaken in 2015 (Hughes et al., 2016a).





Source: HESA HEBCI surveys



Figure 3 Key commercialisation-related metrics

* Data is not available for the number of income generating licenses prior to 2014/15

Figure 4 Coverage of HE-BCI survey metrics across the variety of KE mechanisms



Source: Hughes et al. (2016a)

2.4 'Push', 'pull', and 'co-developed' KE opportunities

Some KE opportunities arise through what one might term *'KE-push'* engagements: opportunities that emerge as a result of the research activity undertaken within the HEI. For example, new knowledge and novel technologies developed through research may lead to new commercialisation opportunities (e.g. through spin-outs and licensing).

Other opportunities are driven more by decisions in the private sector (and indeed government departments, public organisations such as the NHS, and charities) to engage externally to acquire knowledge to feed into their innovation and wider business activities. This creates a *pull* for KE engagements. Examples might include firms looking to commission research, testing or consultancy services from academics, or taking part in training courses to build new capabilities to innovate and compete. There are also *co-developed* and collaborative KE opportunities that emerge through the interactions of HEIs and non-academic organisations, for example co-investing in collaborative research projects.

2.5 Supporting and enabling knowledge exchange

Evidence suggests that the KE activities of HEPs benefit from investments by HEIs in developing the capabilities and capacity to enable, facilitate, and support interactions between HEP staff and partners in the wider economy and society (see e.g. Galán-Muros et al., 2017; Galan-Muros and Davey, 2017; PACEC/CBR, 2009; Perkmann et al., 2013; Ulrichsen, 2015b).

A detailed (unpublished) analysis by Ulrichsen of how English HEPs were investing in the 2010s to support and strengthen KE reveals a wide range of initiatives being developed aimed at strengthening different parts of the HEP's organisational system in support of KE. These are highlighted in Figure 5. Crucially, it found that while some investments aim to strengthen KE in all its forms (i.e. are agnostic to the type of KE), others explicitly target a particular type or combination of KE (e.g. technology transfer, research partnerships, workforce training). Appendix A provides illustrative examples of the types of initiatives being developed.

Figure 5 Share of initiatives aimed at strengthening different organisational factors influencing KE (%)



Figure 6 presents a framework adopted by Research England to capture the variety of support being put into place by HEIs to support different forms of KE. This emerged from detailed case study research undertaken in the early 2010s on a stratified sample of different types of English universities looking at the system of infrastructure being put into place to better support and enable KE. The research revealed that, while the specific organisation of KE support may vary across HEPs, it was possible to identify common support functions across the different types of HEPs studied. The framework that emerged distinguishes between the efforts being made to strengthen the leadership, strategic capabilities and incentives for KE, and the internal capabilities of both academics and KE staff to support the process, from the support functions being built up to support different types of KE, covering:

- Facilitating the research exploitation process (non-technology transfer) through, for example, supporting the collaborative and contract research process, or consultancy activities.
- **Commercialisation of research (technology transfer)** through for example support provided for the licensing of IP and spinouts.
- Skills and human capital development of academics, students and those external to the HEP through, for example, CPD, training for academics and students, providing entrepreneurship and employability training etc.
- Entrepreneurship and enterprise education, including social enterprise activities.
- **Knowledge networks/diffusion**, including the stimulation of interactions between those in the HEP and those in the economy and society through, for example, the development of networks, and holding events that bring academics and external organisations together to share ideas and knowledge.
- **Exploiting the physical assets** of the HEP through, for example, the development of science parks, incubators, design studios, hiring of specialist equipment, as well as museums, exhibition space and so forth.
- **Supporting community and public engagement** through, for example, outreach and volunteering, widening participation programmes and so on.



Figure 6 Framework capturing the types of support for KE being developed within English HEPs

Source: Ulrichsen (2014, 2019)

For about a decade Research England has collected data from HEPs on how their HEIF allocation is spent across these key KE infrastructure categories, along with a breakdown within each box of whether the funding supports:

- **Dedicated KE staff**: Specialists employed solely for providing support for, and driving forward, KE. Examples include the staff in KE offices who support collaborative and contract research, and consultancy activities; and commercialisation and technology transfer related staff.
- Academic staff KE activity: This includes buying out of academic time to develop KE practice, as well as academic leadership and development activities in KE (e.g. training).
- Other costs and initiatives: This includes all forms of projects (such as proof of concept, seed-corn funding and pump-priming) as well as the costs of managing KE activities (such as marketing and evaluation).

Figure 7 provides the breakdown of HEIF spending by the type of KE support infrastructure and type of expenditure. Figure 8 shows that the spending profiles across these categories varied significantly across different types of HEP.

Figure 7 Proportion of HEIF spending on different types of KE support infrastructure (panel A) and type of expenditure (panel B) in 2019/20



Source: data drawn from Technopolis (2022)





Source: data drawn from Technopolis (2022)

Previous evaluations of institution-level funding for KE (such as HEIF in England) have shown such funding to be important in enabling HEIs to build up these long-term capabilities and capacity to engage, respond flexibly to opportunities, invest in strategically important areas of KE, experiment with novel approaches to engagements, and leverage additional, project-specific funds for KE (PACEC/CBR, 2009; Ulrichsen, 2014).

2.6 Towards a framework for universities and KE in the innovation system

Figure 9 presents a simplified framework for capturing the role of universities in the innovation system. It brings together the insights presented above on the structure and function of innovation systems, the contributions of universities to innovation building on their core expertise and capabilities, and the emergence of different types of interactions that create more direct channels between universities and knowledge users to exchange knowledge aimed at delivering benefits for the economy and society.

Figure 9A simplified framework for positioning universities and their KE interactions within the
national innovation system



- pressures as well as their historical evolution and local context
 Universities operate as part of a wider system of universities, variously collaborating and competing with each other
- Universities are based in very different local environments which shape their strategic choices
- Individuals (academic staff, KE staff, students etc.) within universities are shaped both by locally determined incentives as well as national and global incentives
- Universities have access to different levels and types of resources (financial, human capital, social capital, physical & virtual capital etc.) to deliver their strategic objectives

- Actors in the public, private and third sectors creating, exchanging, and using knowledge e.g.: MNCs, indigenous large firms, SMEs, universities, research institutions, research and technology organisations, technical consultancies, government departments and agencies, hospitals, standards bodies, regulators, charities, civil society organisations etc.
- Linkages e.g.: market, non-market, social/economic/political
- Institutions e.g.: legal/regulatory regimes; public policies; culture, norms etc.
- Accumulated knowledge & technologies
- INNOVATION OPPORTUNITIES SHAPED BY:
- Capabilities of specific actors, their ability to interact and the institutional framework.
- The strength and dynamics of the system that supplies the necessary resources and capabilities for innovation, and the demand conditions and dynamics of the sectors
- The choices and behaviours of other actors (i.e. there is interdependence)

The framework also recognises that universities are not a homogeneous group but form part of a wider system of universities, each with their own locally determined mission and strategic objectives shaped by internal and external pressures and their own histories (i.e. there is a significant degree of path-dependence in the system) and their local socio-economic and industrial contexts.

Internally, their scale, disciplinary focus, resources, and expertise, all shape where and how they are able to contribute within the innovation system. We must recognise too that universities also have different internal communities that may well have different motivations, resources, and capabilities for driving forward a KE agenda and engaging with it. These include, among others, the university

leadership, faculties and departments, the academic community, student cohort, and of course, the system of knowledge exchange support.

The framework also recognises that the opportunities for KE are shaped not just by the capabilities, priorities, and investments of the university in the system, but also by the needs, capabilities, and conditions of the wider innovation system with which the university is engaging, and the formal and informal 'rules' that shape the choices and behaviours of organisations and individuals. It is this interaction between the 'supply-side', 'demand-side', and institutional rules that shape the sets of viable opportunities and challenges for KE facing a university (or group of universities).

Universities also variously collaborate and compete with each other to deliver different types of research, teaching, and KE activities. Indeed, given the significant autonomy of the academic body it is highly likely that universities will be both collaborating and competing with each other on different projects at the same time.

This diversity of institution, including its external context, is important, with HEIs of all types – research-intensive, teaching-intensive and specialists – working with different types of economic and social actors, contributing in different ways to different socio-economic, technological, industrial and regional challenges. Importantly, structural differences between HEIs, coupled with their local economic context, shape both KE opportunities and barriers.

Any attempt to develop a metrics framework to explore KE performance needs to account for this diversity of KE opportunity potential. Assessments of KE performance can then focus on how well a university, given its particular 'quasi-fixed' knowledge and physical asset base, is able to marshal these resources to pursue KE opportunities and, through these, deliver socio-economic impacts.

An attempt to identify and cluster English universities into similar types was undertaken in Ulrichsen (2018). The analysis treated specialist institutions (e.g. focusing on the arts or STEM disciplines) as distinct and having a unique character and KE opportunity potential compared to broad discipline HEIs. The cluster analysis was applied to broad discipline HEIs and resulted in five clusters of institution with broadly similar structural characteristics that are likely to affect how they engage with external partners to develop, exchange and deploy knowledge (Figure 10) with defining characteristics set out in Table 1.

These clusters now underpin the English Knowledge Exchange Framework (KEF) for English universities. Results from KEF2.0 show reveal how clusters with quite different structural characteristics lead to quite different KE 'footprints' (Figure 11).

Figure 10 Disaggregating the English HE sector into clusters of similar universities



Table 1 K	ey characteristics o	f each KE cluster
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Cluster	Characteristics
Cluster E	Large universities with broad discipline portfolio across both STEM and non-STEM
	generating excellent research across all disciplines
	 Significant amount of research funded by gov't bodies/hospitals; average of 9.5% from industry
	Large proportion of part-time undergraduate students. Small postgraduate population
	dominated by taught postgraduates.
Cluster J	 Mid-sized universities with more of a teaching focus (although research is still in evidence)
	Academic activity across STEM and non-STEM disciplines including other health, computer
	sciences, architecture/planning, social sciences and business, humanities, arts and design
	 Research activity funded largely by government bodies/hospitals; average of 13.7% from industry.
Clustor M	INDUSTRY
Cluster IVI	Academic activity across disciplines, particularly in other health domains and non-STEM
	 More research activity funded by gov't bodies/bospitals: average of 14.7% from industry
Cluster V	Very large, very high research intensive and broad-discipline universities undertaking
	significant amounts of excellent research
	 Research funded by range of sources including UKRI, other government bodies and
	charities. Average of 10.2% from industry.
	Significant activity in clinical medicine and STEM
	• Student body includes significant numbers of taught and research postgraduates.
Cluster X	Large, high research intensive and broad-discipline universities undertaking a significant
	amount of excellent research
	 Much of research funded by UKRI and other government bodies. Average of 8.5% from
	industry
	 Discipline portfolio balanced across STEM and non-STEM although less or no clinical
	medicine activity
	Large proportion of taught postgraduates in student population
Arts specialists	 Specialist institutions covering arts, music and drama (as defined by a very high
	concentration of academic staff in these disciplines). A range of sizes of institutions,
	although many are relatively small and specialist.
Science,	Specialist institutions covering science, technology, engineering and mathematics (as
Technology,	defined by a very high concentration of academic staff in these disciplines). Often high
Engineering and	amounts of excellent research, particularly in bioscience & veterinary and engineering.
Maths (STEM)	• Note: This group has been further split into three groups to highlight the different nature of
specialists	institutions within the 'STEM' umbrella.
Source: Research Englar	nd (2020) Knowledge Exchange Framework: Clustering and Narrative Statements, available at
https://www.ukri.org/w	rp-content/uploads/2021/10/RE-01102021-KEFClusteringNarrativeTemplateReport-

Oct21deadline.pdf



Figure 11 KE 'footprint' for each of the KE clusters of English HEPs based on the KEF results

2.7 Factors influencing the opportunities and challenges for knowledge exchange

in order to harness the innovation potential of HEPs through KE, it is important that we understand the range of factors that can influence the ability of universities (and their academics, students, KE professionals and others) to form interactions with external partners (companies, central and local governments, hospitals, charities, investors and others) to exchange knowledge aimed at delivering socio-economic benefits. Building on our framework set out in section 2.5, and the academic, practice and policy literatures, Figure 12 captures the range of factors that are known to shape the opportunities and challenges for KE. We deliberately distinguish between factors that shape different parts of the KE process and different actors (and key communities within them). In particular we isolate:

- The **university as a organisation**, focusing on the strength and effectiveness of the organisational (university/departmental) leadership, strategies, incentives, resources and capabilities to support and deliver KE. Key factors here include the ability of university leadership to identify emerging strategic opportunities and headwinds/challenges, and steer the organisation to seize them. Building a culture that embraces and enables KE is also key as is enabling experimentation at all levels of the organisation to explore new ways of working and opportunities. Further, the system of KE support and the processes that facilitate KE interactions are also key.
- The individuals within the university that are involved in delivering KE, including the academics and students, and the KE professionals that enable and facilitate the interactions. Some factors here are structural, for example with evidence of differences in KE engagement between genders, between academics undertaking different types of research in different disciplines, and between those born overseas and those born in the UK. Other factors are related to their capabilities and prior experiences, their capacity to engage, and their ability to access funding and support to advance their specific KE opportunity.

- The **external knowledge partner/user** involved in the KE interactions. The types of KE opportunities and scale of impact that can be realised through KE are crucially shaped by the strategic objectives and direction of the external knowledge partner, along with their internal resources and capabilities available to engage and collaborate externally to acquire, absorb and exploit knowledge generated by HEPs. Also key is the awareness of these partners of the benefits of working with HEPs, and their ability to identify potential partners.
- The **interactions and relationships** that form between individuals and groups within universities and their external partners. Key factors here include the alignment of goals, strategic objectives and expectations; a mutual understanding of needs and roles and the compatability of working cultures and practices; trust; the appropriateness and diversity of KE mechanisms available; the transaction costs of engagement; and the flexibility and adaptability of these interactions.

These actors and interactions are also shaped by:

- The system-level **institutional framework** (operating at different levels from the nation to specific regions and sectors) that sets the "rules of the game" and shapes choices and behaviours. This will include the national legal and IP frameworks, tax regime, government policies, regulations and standards, as well as cultural norms and practices.
- The structure, strength and dynamics of the supply-side of the innovation system
 responsible for developing or enabling access to necessary resources and capabilities either
 domestically or internationally. The ability of universities and external partners to engage in
 KE and deliver impact is shaped by the wider conditions of the supply-side of the innovation
 system. This includes the availability and access to funding programmes able to invest in
 specific KE opportunities, the talent pool (technical, commercial, managerial,
 entrepreneurial etc.) and complementary knowledge required for those involved in the KE
 project to develop the idea towards a real-world application delivering economic and
 societal benefits, and the infrastructure (physical and virtual) that facilitates and enables the
 KE project.
- The structure, strength and dynamics of the **demand-side of the innovation system** that shapes the overall nature and direction of KE opportunities and may condition what is possible. This includes the structure and maturity of the sector within which the external partner is based and the dynamics and innovativeness of the sector (e.g. some sectors are more risk averse than others, experience significant obstacles to innovation, and are highly regulated; all of which will shape the nature, scale and challenges of the KE opportunities available).

Figure 12 Factors influencing level and success of knowledge exchange activities between universities and external partners



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2.8 The rationale for government funding for knowledge exchange

Why do governments need to provide funding to universities for KE?

Traditionally R&D and innovation policies are justified through an assessment of the existence of failures in the price and market mechanisms which lead to underinvestment by the private sector in these activities. If markets were working perfectly then there would be no need for government intervention. Perfect in this context would mean that all costs and benefits are fully reflected in market prices. This would require no spillovers into the rest of society (costs and benefits to others arising from the firm's actions that are not reflected in the market price). In addition, consumers and producers can have no monopoly or other powers to distort markets. They also have perfect (full) information not only about current production and consumption possibilities but also of all future possible contingencies so that they can make perfect decisions.

In the context of R&D and innovation, market failures include the difficulty of firms to appropriate the full value of their expenditures on these activities, or from investing in collaborative linkages with, for example, universities (A. Hughes et al., 2011). In addition, high uncertainty in returns to R&D and innovation investments, and the inability of financial markets to price uncertainty can lead to capital market failures in the supply of finance for innovative activity (Hughes and Ulrichsen, forthcoming). These market failures need to be 'corrected' and provide the focus for government intervention.

A conceptual problem with this approach is that the conditions which cause these market failures (and thus need to be eliminated), are precisely those that characterise the research and innovation process. As Dodgson et al. (2011, p. 1146) note:

"The problem that now arises is that these "failures" are an intrinsic consequence of the process of innovation itself and could only be eliminated if innovation ceased. Thus the model of perfect competition in a stationary state, a world in which innovation, or indeed any change of human knowing is absent, can serve only as a distorting mirror in which to reflect the innovation policy problem ... "[on the contrary]" ... a knowledge driven economy cannot be stationary ... competition is therefore a process of disequilibrium dynamics not a state of equilibrium affairs."

To overcome these issues, innovation policy scholars have, since the late-2000s, increasingly focused on innovation systems theories to shape their approaches. This enables policymakers to adopt a more holistic view of the innovation process and where problems may arise that hinder the achievement of innovation outcomes.

A central implication of this approach is to expand the basis of policy intervention beyond the standard 'market failure' approach to include failures of the system within which innovation takes place that cause blockages and hamper the ability of knowledge to be developed, diffused and exploited for socio-economic gain (Crafts and Hughes, 2013; A. Hughes et al., 2011; Hughes and Martin, 2012; Hughes and Ulrichsen, 2019).

The systems approach thus adopts a much more holistic view of the innovation process and the functioning of the system within which innovation takes places. It recognises that failures can

emerge in different parts of the system which cause blockages and hamper the process of innovation. Should the market mechanism not be able to remove or ease these blockages, then government intervention is required. Failures could be linked to: the inter-related and co-evolving nature of the agents and their capabilities; the physical, and science and knowledge infrastructure in which agents interact; the institutional framework which governs those interactions; and the network structure of the system (see e.g. Carlsson and Jacobsson, 1997; Edquist, et al., 1998; Grillitsch and Trippl, 2018; Johnson and Gregersen, 1995; Malerba and Orsenigo, 1997; Smith, 1999; Woolthuis et al., 2005).

The use of the innovation systems concept is not mechanistic. Rather, it is organic with innovation systems constantly evolving. A well-functioning economy will therefore have dynamic innovation systems able to form and reform as innovation problems and conditions change. From this perspective innovation policies, such those focused on KE, that facilitate adaptability in innovation processes are particularly important (A. Hughes et al., 2011).

In the context of KE and the realisation of socio-economic impacts from investments in the university system, common system failures identified include (Hughes et al., 2011; Hughes and Martin, 2012; Hughes and Ulrichsen, 2019; PACEC/CBR, 2009):

- Institutional failures arising from, for example, different norms and values governing agent behaviour operating in academia and the private sector. This can result in interactions not forming, difficulties in collaborating even once formed, and problems exchanging and absorbing knowledge for productive gains
- *Network failures* arising through sparse or missing linkages between agents. This hampers the development of mutual learning and awareness of complementarities within the system, and limits the diffusion of best practice
- Agent capabilities failures that constrain the ability of the system to adapt or adopt new product and process technologies, new organisational innovations or to respond to new opportunities
- Lock-in failures with agents in the system suffering from 'opportunity blindness' and fail to identify new possibilities or move away from pre-existing system configurations. This can arise because of huge sunk costs in particular sectors and technologies alongside the necessary complementary infrastructure, institutions and networks associated with them

Appropriately deployed, KE funding can help address these types of innovation system failures.

More recently, a new rationale for government interventions around KE is becoming increasingly influential. This criticises both the market and system failure rationales because they involve reactive approaches to policy design – i.e. government interventions are developed after a failure has happened. As the Covid-19 pandemic has demonstrated, reactive approaches can prove ineffective and costly in addressing today's complex sociotechnical challenges.

This new rationale emphasises a more proactive approach to policy design, involving anticipatory and action-oriented government interventions to facilitate disruptive technology emergence; the shaping of direction of innovation activities along acceptable development paths; and the destabilisation of existing, locked-in socio-technical systems (Weber and Rohracher, 2012). These policies are intended to effect *system transformation*; fundamental transformation in models of

production and consumption needed to prevent major societal threats or seize significant new opportunities.

This proactive approach sees a series of transformational failures augmenting the system failures described above:

- *Directionality failures* arising from the lack of, for example, a shared vision for the transformation; coordination between diverse agents of systemic change; consolidating regulations and standards; or targeted funding for R&D and demonstration projects/infrastructures to support development/diffusion of emerging technologies
- Demand articulation failures arising from an absence of signals of public demand; insufficient spaces for anticipating/learning about user need; and demand articulation competencies
- *Policy coordination failures* arising from a lack of coordination across different levels, temporal dimensions and areas of policy relevant to transformative change
- Reflexivity failures arising from insufficient system monitoring and anticipation mechanisms or self-governance processes; insufficient spaces for experimentation and learning; and an absence of adaptive policies to facilitate parallel developments as a mechanism to deal with uncertainty

Proactive policy approaches would, for example, support increasing involvement of HEPs in anticipation of innovation's societal and ecological consequences (e.g. through technology assessment); encouraging deliberation and reflexivity on the direction of research (e.g. informing development of mission-oriented innovation policy, engaging in breakthrough R&D around specific challenges, convening public dialogues on the direction of science and technology for societal gain); and broadening participation in innovation processes and benefit sharing (e.g. through open innovation and place-based approaches).

2.9 Types of funding programmes to enable effective knowledge exchange

The framework set out in Figure 9 and the many and varied drivers of KE captured in Figure 12, provides a useful way of conceptualising the different types of policy interventions aimed at strengthening the KE links between HEPs and non-HEP partners to accelerate the delivery of socio-economic benefits. These are captured in Figure 13.
Figure 13 Different types of policy instruments aimed at delivering more effective KE



Alignment of KE funding programmes with success drivers in KE and government priorities

3 Alignment of KE funding programmes with success drivers in KE and government priorities

We now turn to investigating the extent to which the KE funding programmes managed by Research England are aligned with the success drivers of KE, and with key government priorities.

We focus specifically on the main KE funding programmes that Research England manages or is significantly involved in delivering, notably:

- Higher Education Innovation Funding (HEIF)
- Connecting Capability Fund (CCF)
- UKRI Strength in Places Fund (UKRI SIPF) (delivered by Research England and Innovate UK working in partnership, on behalf of UKRI)

We also look briefly at the following RE-managed funds that have a KE component:

- UK Research Partnership Investment Fund (UKRPIF)
- University enterprise zones (UEZ) (expansion of the original BEIS pilot scheme, delivered by Research England with funding contribution from BEIS)

In addition, in order to explore how RE funds work alongside wider public investments in KE and as part of a wider system of support, we look briefly at selected funding instruments delivered by the UKRI Research Councils. In particular we look at:

- Impact Acceleration Accounts (IAA), managed by AHRC, BBSRC, EPSRC, MRC, and STFC
- ESRC Impact Acceleration Accounts (ESRC IAA), managed by ESRC
- Place-based Impact Acceleration Accounts (PBIAA), managed by EPSRC
- Follow-on funding (FoF) and translational funding, including general FoF (AHRC, BBSRC, STFC), proof of concept/commercialisation focussed FoF (AHRC, BBSRC), early and late stage R&D funding schemes (STFC) and the Developmental Pathway Funding Scheme (MRC)

We also briefly cover other selected instruments managed by Innovate UK that directly support and facilitate KE or may indirectly create demand for it, including:

- Knowledge Transfer Partnerships (KTP)
- Innovation Vouchers (IV)
- Investor partnerships
- Small Business Research Initiative (SBRI)¹
- Smart grants
- Catalyst funding (Biomedical, Energy, Creative Catalysts)²

¹ SBRI is also delivered by other government departments

² ESRC and AHRC have recently launched the Social science, Humanities and Arts for People and the Economy (SHAPE) Catalyst programme

Finally, given its historic importance in funding KE and innovation infrastructure connected to HEPs, we also include the outgoing European Regional Development Fund (ERDF), managed by DLUHC in the UK.

It is important to recognise, however, that this list is by no means exhaustive but rather selected to highlight how key RE-managed schemes operate alongside schemes that are likely to target different parts of the innovation system and process. Some other schemes not included in our analysis include:

- The Innovation-to-Commercialisation of University Research (ICURe) and BBSRC-focussed ICURe are pre-accelerator programmes designed to support, train and fund research teams in exploring the commercial application and potential of their research and technologies
- The UK Innovation and Science Seed Fund (UKi2S) is an early-stage venture capital fund intended to build and grow technology companies stemming from the UK's research base
- Research Council Prosperity Partnerships fund early-stage research collaborations between businesses and academic partners which are on their way to becoming strategic partnerships and which target specific challenges

3.1 Addressing key success drivers of knowledge exchange

To explore how these funding programmes may act to help strengthen the KE system, we sought to characterise each programme along a number of key dimensions, including:

- The types of mechanisms they target
- The primary organisation responsible for delivery
- The geographical focus of the targeted impacts
- Any targeting of specific parts of the knowledge base (e.g. disciplines)

We then further characterised each funding instrument based on how they seek to strengthen the KE system, drawing on the categories emerging from the conceptual framework developed in section 2.7 and presented in Figure 13, namely:

- HEP organisation-level incentives, support, infrastructure, capabilities & resources for KE
- HEP individual-level KE opportunities & capabilities
- Collaborative capabilities & resources of HEPs (new category added to distinguish between those funds focused on building capabilities & resources of specific HEPs and those focused on building collaborative capabilities and resource
- Functioning of KE interactions
- Opportunities & capability needs of specific knowledge partners
- Strengthening the wider supply-side conditions for KE
- Strengthening demand-side conditions
- Strengthening the institutional framework for KE

In characterising the various programmes we drew a mix of publicly accessible literature describing the funding instruments, evaluations and other documents capturing the focus of the funds, and our own understanding and knowledge of the functioning of the funds.

Table 2 presents the findings. Crucially it highlights how different funding programmes are targeted at different parts of the KE system. Note that we are not commenting here on whether each funding programme is/has been effective in strengthening the drivers of KE; rather we focus on whether the funding programmes individually and collectively cover different known drivers.

Given the focus on funding instruments primarily managed by Research England and other parts of UKRI, it is perhaps not surprising that few of those studied focus on strengthening the demand conditions of the system and the institutional framework for KE. Examples of policy instruments focused on the latter two areas could include:

- Policy instruments (funding or otherwise) aimed at reducing barriers to innovation and raising the innovativeness of specific sectors
- Tax policies relating to e.g. R&D expenditures, patent activity
- IP policies and other policies and regulations shaping the distribution of IP rights

Responsible funding body:		UKRI								
		Research England (RE)			RE with Innovate UK			Research Councils (RC)		
	Funding instrument:	HEIF	CCF	UKRPIF	UEZ	UKRI SIPF	IAA	ESRC IAA	PBIAA	FoF
Targeted mechanisms:		Any KE aligned with HEP strategy	Inter-HEP collaborations HEP-business / investor collaborations System KE capability	HEP & system research infrastructure HEP-research org. partnerships System resources (private investment)	HEP local partnerships System capabilities, network links, infrastructure	HEP-local business consortia Emerging clusters	Translation of specific innovation opportunities Strategic HEP- knowledge user partnerships HEP culture & capability	Translation of specific innovation opportunities Strategic HEP- knowledge user partnerships HEP culture & capability	System resources and capabilities (private investment, infrastructure, clusters & links, capacity/ leadership) Demand conditions (innovation trajectory)	Translation of specific innovation opportunities
Primary mode of operationalisation:		Single HEP	Multi-HEP	Single / multiple HEPs	Single HEP	Multi-partner consortium (HEP/non-HEP, business)	Single HEP	Single HEP	Multi-HEP / Multi- partner consortium (HEP/non-HEP)	Single or multi HEP / non-HEP
Geographical focus of targeted impact:		Any	Any	Any	Local	User-defined geography local to consortium	Any	Any	Defined cluster (could be multiple locations)	Any
Knowledge focus		Any	Any	Any	Any	Any	Discipline-specific based on RC	Economic & social sciences	Engineering & physical sciences	Discipline- specific based on RC
	Individual HEP org-level incentives, support, infrastructure, capabilities & resources for KE	***	** (through best practice sharing)	***	***	*	*	*		
	HEP individual-level opportunities & capabilities	*	*			*	***	***	***	***
Drivers of KE ¹	Collaborative capabilities & resources of HEPs		***	* (where collaborative)		***			**	
	Functioning of KE interactions	***	***		*	***	*	*	*	
	Opportunities & capability needs of specific knowledge partners	*	*		*	***				
	Strengthening wider supply-side conditions		*	***	***	***			***	
	Strengthening demand-side conditions				**					
	Strengthening the institutional framework for KE				**					

Table 2Characteristics of key KE funding instruments managed by Research England and selected other programmes managed by others

1 *** : strong primary focus of funding programme on this driver; ** moderate focus of funding programme on this driver; * some, or more indirect focus of funding programme on this driver.

Table 2 continued...

Responsible funding body:		UKRI						Other
		Innovate UK						
Funding instrument:		КТР	Innovation vouchers	Investor partnerships	SBRI ²	Smart grants	Catalyst funding ³	ERDF
Targeted mechanisms:		Knowledge user-HEP partnerships to solve specific business & technical problems	Expert advice to SMEs	Leverage of Innovate UK funding by business to secure equity investment from private investors	Pre-commercial public procurement mechanism to stimulate & de-risk innovation	Partnerships between knowledge users and others, including HEPs	Translation of specific innovation opportunities	Entrepreneurship HEP-local business collaborations System resources and capabilities (private investment, network links, infrastructure, entrepreneurial ecosystems, capabilities)
Primary mode of operationalisation:		Business	Business	Business (SMEs)	Business	Business / non-HEP	Business, RTOs (but can involve HEPs)	Regional bodies
Geographical focus of targeted impact:		Any	Any	Any	Any	Any	Any ⁴	Region
	Knowledge focus	Any	Any	Future economy	Public sector challenges	Cross-sectoral breakthrough innovation	Biomedicine; energy; creative	Any
	Individual HEP org-level incentives, support, infrastructure, capabilities & resources for KE							***
	HEP individual-level opportunities & capabilities	***	**				*	
	Collaborative capabilities & resources of HEPs							* (where collaborative)
Drivers	Functioning of KE interactions	***						*
of KE ¹	Opportunities & capability needs of specific knowledge partners	***	***		***	***	***	***
	Strengthening wider supply-side conditions			***		***		***
	Strengthening demand-side conditions				***			*
	Strengthening the institutional framework for KE							

1 *** : strong primary focus of funding programme on this driver; ** moderate focus of funding programme on this driver; * some, or more indirect focus of funding programme on this driver.

2 Also run by other government departments

3 ESRC and AHRC have recently launched the Social science, Humanities and Arts for People and the Economy (SHAPE) Catalyst programme

4 Energy Catalyst is specifically focused on Sub-Saharan Africa, South Asia and the Indo-Pacific regions

3.2 Alignment of KE funding programmes with government priorities

We now turn to the question of how key KE funding instruments enable the HE sector and their KE activities to deliver on key UK Government priorities, focusing on:

- The UK Government's ambitions to raise the R&D intensity of the UK economy to drive increased economic growth³
- The UK Government's ambitions around levelling up and reducing the substantial disparities in socio-economic prosperity observed across the regions and nations of the UK
- The extent to which KE helps Research England to deliver on its research funding and policy objectives
- The extent to which KE helps to deliver benefits to students (reflecting in part the contribution of the Department for Education to HEIF)

3.2.1 Delivering the 2.4% R&D target to drive economic growth

The UK Government's 2021 Innovation Strategy set out its plans to make the UK a global hub for innovation by 2035 and create a robust and agile national economy that works for everyone and is fit for future generations (BEIS, 2021a). The strategy was designed around four pillars of action:

- Unleashing business fuelling those businesses who want to innovate. This included committing to a target of increasing public and private sector R&D expenditure to 2.4% of GDP by 2027
- People making the UK the most exciting place for innovation talent
- Institutions and places ensuring UK research, development and innovation institutions serve the needs of businesses and places across the UK
- Missions and technologies stimulating innovation to tackle major challenges faced by the UK and the world and drive capability in key technologies.

The strategy sees HEPs as home to a world-leading research base and emphasises particular types of KE – including the commercialisation of ideas via academic/student entrepreneurship, and partnerships with business, public sector and others – as key to delivering on its ambitions.

How can HEPs, through their KE efforts, support the delivery of the UK Government's ambitions to raise the R&D intensity of the UK economy, and through this its innovation and economic growth potential?

Given the breadth of the pillars for action set out in the R&D Roadmap, it is clear from the evidencebased framework presented in section 2 that HEPs, through their KE activities, have the potential to contribute to the delivery of the R&D intensity target in many ways. However, our systems-based approach set out in Figure 9 and Figure 10 highlights how the impacts of HEP KE efforts aimed at

³ The UK Government set a R&D spending target of reaching 2.4% of GDP (the average for advanced economies in the OECD) as part of the 2017 industrial strategy. Changes to the methodology used by the ONS to estimate gross domestic expenditure on R&D (GERD) suggest the UK has higher levels of R&D spending as a share of GDP than previously thought, and suggest that this target has already been met. There are now calls for the target to be raised.

strengthening the R&D potential of the economy may be rate-limited by barriers elsewhere in the system, not least the capabilities of companies in investing in R&D to drive innovation and in identifying, acquiring, absorbing and deploying knowledge developed outside their organisation to do so ('absorptive capacity').

Below we set out some of the main ways through which HEPs can contribute to strengthening the amount of R&D being undertaken in the economy.

First, HEPs invest in developing ideas emerging from research into functional prototypes and applications that have commercial potential and are able to attract investment and partners interested in developing them further into products and services generating economic and societal value. Fully commercialising these opportunities will likely require additional investments in R&D.

Beyond R&D-enabled technological inventions and innovations, KE linked to research can also help to unlock new business models and organisational practices to create and capture value; develop new ways of producing and supplying products and services more efficiently and sustainably; improve individual- and population-level behavioural insights concerning responses and adaptation to new technologies; and strengthen public policies, standards and regulations; and ethical frameworks that guide the development and diffusion of innovations.

HEPs also work with partners in industry, charitable and public sectors to undertake collaborative R&D programmes or contract R&D aimed at tackling specific R&D / innovation challenges. They also work through KE mechanisms such as fee-for-service work and facilities and testing services) to help partners advance their own internal R&D efforts. Evidence also shows that HEPs work with partners to help them identify new opportunities for R&D and innovation.

Indeed, a recent survey of businesses by University of Cambridge Centre for Business Research in 2021 (Hughes et al., 2022) showed that such KE interactions help businesses to sustain and, in a quarter of cases (consistent across all company size bands) even increase private sector investment in R&D, with little evidence of any crowding-out effects.

Through their KE activities, HEPs engage with companies in a wide range of sectors, well beyond those that traditionally invest heavily in R&D. Delivering the R&D target will likely require not just these sectors to increase their R&D investments in the UK, but also sectors that have historically not invested significantly in R&D to do so (e.g. construction, traditional manufacturing sectors etc.). Backed by public funds, examples such as the Centre for Digital Built Britain are helping the construction industry to become more innovative.

HEPs also invest effort and resources, deployed through KE, to help develop and strengthen the resources and capabilities available within the innovation system that underpin the ability of companies to invest in, and successfully deliver R&D and innovation. This includes, for example, investing in the R&D and innovation-related skills base available; strengthening relevant networks and alliances that improve the connectedness of the R&D and innovation system; and investing in, and making available, specialist facilities and equipment that can help them develop, test and demonstrate the commercial potential of their products. It also includes investing effort and resources to make locations attractive places to invest, live and work.

HEPs work with policymakers, regulators, standards-setting bodies and others to ensure the institutional framework develops in positive ways alongside the emergence and evolution of technologies and industries to facilitate and accelerate innovation while mitigating negative consequences (e.g. the ethical consequences of the deployment of artificial intelligence-driven software in healthcare).

These efforts in building the capabilities of the economic system to undertake R&D and improve the institutional framework should result in more effective R&D investments and help to attract greater investments in R&D.

In 2021 we surveyed UK university leaders with strategic responsibility for KE looking at the effects of the Covid-19 pandemic on their institutions and priorities for the recovery. Figure 14 presents the findings. Crucially, for the UK Government's R&D target, most research-intensive HEPs (proxied here by membership of the Russell Group) see significant and viable opportunities for their institutions in developing and commercialising research to open up new opportunities for wealth creation, in contributing to specific societal missions and major innovation challenges, and in addressing the innovation needs of specifically targeted sectors. One major area of concern highlighted by this survey was that worryingly few of these institutions saw *viable and significant* opportunities for building international collaborations to drive innovation. Given that international collaborations and attracting inward R&D investments will be important for delivering the R&D target, this should raise significant concerns.

Figure 14 University KE leaders views on viable and significant strategic opportunities for their institutions to contribute to the post-Covid-19 recovery, for university respondents from the Russell Group and non-Russell Group



Source: Ulrichsen and Kelleher (2022)

Are key KE funding instruments aligned with helping to deliver the UK Government's R&D target? As discussed in section 2, it is important to take a systems-based approach to tackling this question that looks at how different funding programmes explicitly and implicitly target this objective, and that directly and indirectly support HEPs to engage in activities that will raise the R&D intensity of the

economy. A systems-approach also allows us to identify how other factors and funding programmes might rate-limit the potential of KE funding programmes to deliver against an R&D-intensity target. It is also worth noting that the R&D Roadmap which set out plans to deliver this target identifies a broad range of objectives.

HEIF and the importance of flexible funding for KE

HEIF has been instrumental over the past two decades in providing HEPs with university-level resources to invest in KE in a more strategic and coherent way to deliver locally-defined strategic KE objectives than would be possible through more targeted national schemes. Evaluations of HEIF suggest the fund has delivered significant value for money in helping HEPs build the capacity and capabilities (including driving culture change) to deliver effective KE (PACEC/CBR, 2009, Ulrichsen, 2015).

The last major evaluation of HEIF (PACEC/CBR, 2009) emphasised the importance of its flexibility and long-term stability in driving its significant and positive impacts on the system. This has allowed HEPs to move towards greater long-term planning in building KE capacity and capability, as well as providing them with resources to respond more rapidly to emerging opportunities and threats. It has also enabled HEPs to experiment with new approaches to how they deliver KE, enabling more innovative approaches to be developed. A recent survey of HEP leaders responsible for KE looking at the effects of the pandemic on their institutions' KE and innovation focused activities found that core KE funding programmes (and other flexible funding sources and rapid response grants) were seen as significantly positive in enabling their institutions to adapt and respond to the challenges of the pandemic.

The fund is also deliberately broad in scope allowing HEPs to invest in a very wide range of KE with any type of external (non-academic) partner aimed at delivering economic and societal benefits. It also requires HEPs to utilise the funding to deliver key Government priorities. Given the formula nature of the fund and its longevity, these priorities have naturally changed over time. In recent years this has included delivery of the UK Government's R&D Roadmap to 2.4% and the Industry Strategy. Previous years have emphasised the National Productivity Plan (including the spatial dimensions to productivity), and the sub-national growth agenda.

Absent of further evidence, it is difficult to determine whether HEPs are responding to these signals and shaping their HEIF investments to more deliberately pursue KE activities that will help to deliver the R&D Roadmap and 2.4% R&D target. Furthermore given the breadth of ways through which HEP KE activities can contribute to this Government priority, for many HEPs – particularly the more research-intensive institutions – the pursuit of this target may not significantly change what they would do anyway in the absence of such a target.

Changes made to the allocation in the 2010s (the raising of the maximum cap, removal of a capacity element etc.) and the introduction of various pots of HEIF funding since (e.g. the supplement for those at the maximum cap, the Industrial Strategy uplifts) have in effect provided greater resources to larger, more research-active HEPs. This may have helped to increase the likelihood of KE efforts relevant to the 2.4% R&D target being delivered.

UKRI Strength in Places Fund and Connecting Capability Fund

While HEIF focuses on enabling individual HEPs to build up internal and long-term capacity and capabilities to deliver KE based on HEP-specific objectives, both the UKRI Strength in Places Fund (UKRI SIPF) and the Connecting Capability Fund (CCF) tackle challenges in building large-scale interinstitutional collaborations between HEPs, businesses, and other key partners to pool expertise around KE and pursue more targeted and systemic innovation and growth challenges (whether they be driven by regional needs, sectoral innovation challenges or emerging technology opportunities).

The Connecting Capability Fund was introduced to support the delivery of the UK Government's Industrial Strategy (in which the UK Government's R&D target was formalised). It aimed to do so by stimulating "strategic collaborations between universities... to pool expertise, build connecting capacity and share good practice" to strengthen the commercialisation of research⁴. Evaluations of CCF found that the fund has helped to drive the development of innovation infrastructures, networks, and capacities to deliver KE, as well as the sharing of effective KE practices between HEPs. These developments have enabled new technologies to be developed, diffusion of technologies to SMEs with associated productivity improvements, and the founding of high-potential spinouts with associated job creation. CCF has also catalysed spillovers in the form of sectoral- and regionalfocused innovation partnerships and activities which have continued outside of CCF projects.

The UKRI Strength in Places Fund was announced as part of the Industrial Strategy White Paper in 2017 and aimed to address significant regional disparities across the UK that hamper the ability of the whole nation to work towards delivering the UK Government's R&D intensity target by 2027. It recognised that science, research and skills play an important role in raising productivity and economic growth at the regional level. In incentivising this type of collaborative capacity, a unique and important feature of UKRI SIPF is that it very explicitly requires the building of consortia involving both research organisations, and business or other partners that assemble the range of local ecosystem partners required to invest in developing and harnessing local research and innovation strengths for local benefit. As such it is concerned more broadly than building KE capacity to include considerations of how the wider ecosystem needs to be developed to unlock new opportunities for R&D and growth.

Other funding programmes and incentives

In addition to these core Research England funding programmes for KE it is important to recognise the role of other funding programmes in addressing other drivers and barriers for KE, not least:

- In strengthening the business pull for KE (e.g. what role for Innovate UK's Innovation Vouchers, Knowledge Transfer Partnerships, Catalyst funding, SBRI)
- In helping to de-risk technologies to accelerate the commercialisation process and attract external partners and investors (e.g. Research Councils' follow-on and translational funding)
- In creating demand for challenge-led research-to-innovation efforts where the active integration of KE alongside the research efforts is crucial for delivering success
- In strengthening cultures within HEPs that see KE as a more legitimate activity (including the role of the wider research impact agenda)

⁴ HEFCE (2017) Higher Education Innovation Funding: Connecting Capability Fund, HEFCE circular 2017/03

- In enabling HEPs to deliver targeted projects in supporting local SMEs and in building up the innovation infrastructures in their regions (e.g. ERDF).
- In strengthening the ability of businesses (including spinouts) to raise equity investment by de-risking the process (e.g. through Innovate UK's Investor Partnerships)

Interdependencies between funding programmes

With KE-related funding programmes focusing on stimulating different parts of the R&D and innovation system (Table 2), there are likely important interdependencies between them. In particular, previous evaluations of HEIF have highlighted its *enabling function*, allowing HEPs to not just build up the foundational capacity and capabilities to engage in KE, but its high degree of flexibility allows HEPs to cultivate and secure other funding opportunities for specific KE projects and initiatives.

Conditioning expectations of the ability of HEPs to contribute to the UK Government's R&D target through KE

We have emphasised in this report that the ability of HEPs to deliver impact on the economy and society through KE will be conditioned strongly by external factors and forces. Hence the ability of KE funding instruments to impact on the R&D intensity target will be limited by the effectiveness of efforts to tackle wider barriers to R&D and innovation elsewhere in the system. This includes not least known challenges on the demand-side of the economy around the ability and willingness of companies to invest in R&D in the UK and build up the capabilities to interact and partner with HEPs to co-produce, exchange, and exploit knowledge.

3.2.2 Strengthening places and driving levelling up across England

The UK has struggled with low productivity growth since the 2008 Global Financial Crisis and significant and growing disparities in economic and societal prosperity across the UK. The Government's levelling up white paper sets out a strategy to tackle these regional disparities in productivity, pay, educational attainment and health across the UK (HM Government, 2022).

Recognising this decoupling between the UK's high and low productivity regions, recent work has recommended a number of features of a modern, place-based innovation policy in a UK context (Hughes and Ulrichsen, 2019; Kitson, 2019; McCann, 2019; and Ulrichsen and O'Sullivan, 2019):

- Adopt an outcomes-focus by identifying the needs of specific places to deliver improved local economic outcomes, and understanding the theory of change – the pathway from the status quo to achieving the desired outcomes and how policy interventions and investments will facilitate this journey
- Focus not just on R&D, knowledge generation, and frontier, but also on incremental innovation and knowledge diffusion as essential features for regions to grow. Poor diffusion of productivity-enhancing innovations between London and its hinterland, and the rest of the UK, and insufficient incremental innovation within low-performing companies across all sectors are both regarded as particularly problematic in the UK
- Focus not just on technological innovation but also the local sets of capabilities and conditions (e.g. skills development, supply chain development, capital infrastructure

investments) to ensure that the capabilities necessary to develop, diffuse and deploy innovations for local value capture are being developed alongside the technology

- Design locally-tailored regional policies which bring together the necessary stakeholders (i.e. not only HEPs but also private, public and civil society actors) to work together to unblock local development traps and unlock local development potential.
- Strengthen local governance institutions so that policies can be locally designed and tailored to meet local needs, and implemented effectively

Within this context, how then can HEPs contribute to the levelling up agenda through their KE activities? Universities have the potential to contribute to the regions in multiple ways. This includes both through the potentially significant spillover effects arising from their wider investments in research, education, and KE, as well as through the deliberate targeting of their assets and capabilities to deliver regional impacts (see e.g. Uyarra, 2010).

Figure 15 Marshalling university expertise and resources to contribute to regional challenges



Many of the pathways through which HEPs contribute to innovation through their KE activities identified in section 2 can be brought to bear in addressing regional innovation goals (Figure 15, (building on arguments made in Hughes and Ulrichsen, 2019; Ulrichsen, 2015; Gunasekara, 2006; Lester, 2005; Power and Malmberg, 2008 and elsewhere). Examples of how they can work to deliver regional impacts through innovation include:

- Help local companies and other organisations solve specific problems and increase their productivity through technology, process and skills upgrading, through for example their consultancy, contract research, and training provision
- Support the development and growth of nationally and globally competitive sectoral and technology-driven clusters through their efforts to commercialise frontier research and seed

new companies as well as through their partnerships with existing companies and efforts to develop local ecosystems around specific technologies and sectors

- Work to address key skills shortages in the area both by helping to upskill the local workforce and through efforts to align the education curriculum more closely with the future skills needs of local employers. This should have consequent impacts on local wage growth as workers become more highly skilled and productive
- Investing in the physical and virtual innovation and entrepreneurial infrastructures and in initiatives to strengthen the local innovation and entrepreneurial culture and dynamism
- Work with partners to attract inward investment into the area, including providing support for companies looking to establish new sites and grow in the area, and crucially, investing effort and resources to improve the quality of life and 'local buzz' of the area making it a more attractive place to live and work
- Work with local partners to set the strategic direction of the local economy, for example by providing strategic insights and intelligence and support with foresight exercises to shape and coordinate future investments in the area
- Providing 'public' and neutral convening spaces that can help to catalyse new and valuable network linkages between actors operating in different parts of supply chains, across industries, and across academia, companies and the public / third sectors. These new and often informal links can open up new opportunities for innovation

The actual role HEPs play in place-based development varies, and will in part depend on the types of industries which make up the local economy, and on the nature of industrial transformation occurring (Lester, 2005). Insights from Lester's research on how universities can contribute to local industrial innovation are captured in Figure 16.

Figure 16 How universities contribute to innovation in local industries undergoing different types of industrial transformation



Source: Lester, R. (2005) Universities, Innovation, and the Competitiveness of Local Economies: summary report from the local innovation project — phase I, Cambridge, MA: Industrial Performance Center, MIT.

Returning to the findings from our recent 2021 survey of university KE leaders (Figure 14), we found that most HEPs – across different types – see significant and viable strategic opportunities for working with their local economies to increase innovation and economic prosperity locally.

Furthermore, many also see important opportunities for working to support SMEs, many of which will likely be in their local economies.

Finally, we must not ignore the fact that many HEPs are powerful actors in their local and regional economies. They are often one of the largest employers in the area employing a highly-skilled workforce. Combined with their distinctive features as knowledge producers and diffusers and their typically strong links with local government bodies and local industry, they are uniquely placed to convene the local ecosystem to help shape the strategic direction of the places where they are based.

Many of the key KE funding instruments play an important role in enabling HEPs to contribute to the levelling up agenda either by supporting innovation partnerships with local businesses or regional government, or by strengthening their role in building regional capacity to innovate, e.g. through infrastructure developments (e.g. clusters, networks, facilities); scientific, entrepreneurial and leadership capacity of innovation ecosystems; or attracting regional investment.

Funds such as the UKRI Strength in Places Fund, university enterprise zones, and place-based IAAs, have been designed to explicitly focus on delivering place-based outcomes. This reflects the need to address regional divergence in the geographic distribution of innovation opportunities and benefits:

- The £315 million UKRI Strength in Places Fund provides funding to help areas of the UK build on existing strengths in research and innovation to deliver benefits for their local economy, building on local collaborations between HEPs and other core ecosystem partners.
- The £25 million Place-based IAAs seek to complement Research Councils' institution-focused IAAs to focus efforts of HEPs working in collaboration with local partners to further leverage and develop engineering and physical sciences research being undertaken locally to enhance the capabilities of local clusters and drive regional growth.
- The £21 million University Enterprise Zones (UEZs) scheme created specific geographical sites around universities "to encourage clusters of high-tech firms to locate near and engage with universities, as well as encouraging universities to cooperate with local businesses and Local Enterprise Partnerships to foster innovation and local economic growth"⁵. The scheme sought to encourage universities to strengthen their roles as strategic partners in driving the local growth agenda, and stimulate the development of incubator or 'grow-on' space for small businesses in locations that encourage businesses to interact with universities and to innovate.

Other funding instruments such as HEIF and CCF are not explicitly place-based and regionally focused, but evidence from studies examining how these funds are deployed show that they provides important foundational resources to enable HEPs to deliver regionally focused KE initiatives and activities.

For example, an analysis of the latest HEIF accountability statements found that 82% of HEPs in receipt of the funding discuss levelling-up, regional inequality, disparity, or development in their plans (Technopolis, 2022). For CCF, a number of the funded projects are explicitly focused on

⁵ Ward (2022) Enterprise Zones, House of Commons Library report, available at <u>https://researchbriefings.files.parliament.uk/documents/SN05942/SN05942.pdf</u>

addressing key regional challenges such as the lack of venture capital funding and support for research commercialisation in the North of England (e.g. the Northern Triangle Initiative and the Northern Accelerator). Other projects assembled geographically proximate partners around a common and strategically important sector for the UK (e.g. the MedTech SuperConnector in London). By contrast some projects such as the SPace Research & Innovation Network for Technology (SPRINT) brought HEPs together from across the country to support SMEs in the UK's nascent space sector.

Those instruments designed to explicitly focus on delivering place-based outcomes typically emphasise local or regional partnerships as geographic proximity of the HEP and partner organisations is seen as a key driver of KE. Further, spillover effects are also often local. For example, the relationships between HEPs and external partners which CCF have enabled have also catalysed regional-focused innovation activities which have continued outside of CCF projects.

3.2.3 Improving student outcomes

UK policy documents variously see students as a global resource to be attracted to the UK (HM Government, 2021); a source of human capital to be developed via clear progression pathways (BEIS, 2021a) and a talent pool to be retained in order to contribute to the country's R&D and innovation needs (HM Government, 2020). In addition, with funding for HEIF drawing from both the science budget and the education budget through the Office for Students, there are pressures on this particular funding programme to deliver specific benefits to the student population.

There are a number of ways through which KE can improve not just student outcomes but also address critical skills-related issues hampering the UK economy. Successfully deployed, KE activities that create closer connections between employers in the economy and higher education providers can help to address key mismatches between the skills needs and education provision and the responsiveness of the system to changing needs. This includes not just specific technical skills, but also the broader sets of skills and capabilities that are believed to underpin creativity, innovation and entrepreneurship (OECD, 2012), and the ability of agents in the system to adapt to changing technological and innovation regimes.

In addition, we know that significant search costs are incurred by recipients of education in identifying potential employers, and by employers in identifying potential employees. Closer ties through KE can help to reduce these costs. Furthermore, there has historically been a cultural aversion within the student population coupled with other barriers (e.g. availability of finance and support) to more entrepreneurial career pathways. The emerging support for student-focused KE support and training can help to increase the employment opportunities for students. Furthermore, student engagement in KE can deliver valuable work experiences that increase their employability and career development opportunities.

In addition to these more direct potential benefits of KE on student outcomes (students as the beneficiary from KE), there is growing evidence that HEPs are increasingly involving students in the delivery of a range of KE activities leading to positive KE outcomes. As such, students have a potentially important role to play as a 'conduit' of effective KE.

In terms of 'student as the beneficiary from KE', we are increasingly seeing the emergence of funding instruments explicitly designed to target key student outcomes through KE. For example, one priority of the RED fund was that funding should improve outcomes for postgraduate students, and secure postgraduate research opportunities or work experience for under-represented groups at that level. The Office for Students and Research England introduced a £10 million KE funding competition aimed at increasing the impact of student involvement in KE.

Second, some funding instruments are not explicitly designed to target the delivery of student benefits but are nevertheless used in ways that do so (i.e. the benefits to students are indirect). For example, HEIF, while partly funded by the Department for Education. Historically, HEIF did not mandate that part of the funding had to be targeted at students. With the separation of HEFCE into Research England and the Office for Students, stronger signals are provided to HEPs in using HEIF in ways that deliver benefits to students. Nevertheless, evaluations and reviews of HEIF have shown an increasing involvement of students in KE over the years (including not just through student entrepreneurship but also through e.g. consultancy and advisory work alongside academics). The most recent accountability statements for HEIF (2020-21) include a much more explicit requirement for HEPs to consider the interplay between KE and student benefits.

Many CCF projects also included mechanisms to develop students' commercial & entrepreneurial skills, with good practice being described as spilling over to other non-CCF initiatives (Eggington and Osborn, 2020). Increases in PhD students/postdoctoral associates have been linked to the prevalence of industry sponsorship in UKRPIF facilities (Hall et al., 2018). The UEZ has funded 4 student/graduate incubators (Hatch, 2020).

Third, some instruments such as IAA and PBIAA preclude the use of funding to support certain types of student-related activities such as undergraduate or doctoral activities.

In terms of student as conduit of KE, UKRI SIPF has an expectation for involvement of students and graduates in enterprise activities, while 52% of HEIF accountability statements describe instances where students act as agents of KE (Technopolis, 2022).

3.2.4 Research funding and policy

Part of Research England's mission is to support the continuation of a world-class, dynamic, responsive research base across the full academic spectrum within UK higher education. In this section we consider how well their KE funding align with and reinforce this mission.

To examine this we look at the known synergies between KE and research. The following two figures present the findings of a 2015 survey of over 18,000 UK academics examining their motivations and experiences in engaging in KE over the three preceding years.

Figure 17 presents the important motivations for academics in engaging in KE with external partners. It shows that many academics are motivated to engage in KE because of the benefits it can bring to their research endeavours, for example by gaining insights in the area of the research, keeping up-to-date with research being undertaken outside the academic community, and testing the practical applications of their research. Figure 18 asks academics about the impact KE has had on their research activities. For many it led to new contacts in the field and has given them new insights that has shaped their work. For just under 60% it also led to new research projects.



Figure 17 Important motivations for academics in engaging in KE with external partners

Source: Hughes et al. (2016)





Source: Hughes et al. (2016)

Overall, the evidence suggests that KE has a range of positive effects on the research of academics, not least by strengthening the feedback loop between industrial and societal needs and the direction of research. It also provides a vehicle for academics to explore and test the application of their research in practice, likely accelerating the process of realising tangible economic and societal impacts from the research. It is therefore likely that funding instruments that invest in KE and help academics to build links with external partners will also have positive effects on the research they undertake.

In addition to this, a number of developments in recent years are more explicitly seeking to strengthen link between KE and research. The rise of the impact agenda (including both pathways to impact and the inclusion of impact as part of research assessments) has created more positive incentives for academics to consider how their research can be developed and applied in the real world. For many, active engagement in KE will provide the necessary conduit for realising this impact. In addition, the rise of more challenge-led and mission-oriented funding programmes encourages reflection by academics and their partners on how to:

- More closely integrate their research and KE activities within overarching missions/challenges
- Identification of wider needs and capability gaps that need to be addressed if the research is to be successfully commercialised (including e.g. skills, facilities and funding gaps)
- Foster direct and tangible linkages for working with partners to further develop and apply the knowledge to deliver real-world solutions that deliver on key mission/challenge goals.

Within this context, challenge-led funding programmes are emerging to enable this type of activity. It is likely the case that the KE support HEPs draw upon to support these programmes is underpinned by programmes such as HEIF.

3.2.5 Alignment of KE funding and selected other programmes with government priorities

Figure 19 attempts to visualise how the various funding programmes touch the four key UK Government priority areas. It distinguishes between primary impacts that are explicitly targeted as part of the funding programme design (solid lines), and the more indirect or secondary impacts that are either anticipated at the design phase or emerge through how the funding is deployed by HEPs.



Figure 19 Funding programmes touching key UK Government priority areas (programmes investing in HEPs or explicitly targeting HEP-business interactions)

— Primary impacts targeted at policy design

---- Indirect or secondary impacts anticipated at policy design or observed at project level

3.2.6 KE funding programmes and HEP strategic agility

In our 2021 survey exploring the effects of the Covid-19 pandemic on the innovation-focused activities of HEPs and their strategic priorities for the recovery, we asked UK HEP leaders to reflect on the value of different types of funding programmes in enabling them to adapt and respond to the challenges of the pandemic, opening up new opportunities for KE and overcoming significant threats. The results highlighted how funding programmes that enabled flexibility and decentralised decision-making at the university or department level – such as HEIF, QR and IAA funding – were regarded as being most effective for helping HEPs to respond and adapt in this very challenging period (Figure 20).

Figure 20 UK university perceptions of the effectiveness of government funding programmes on their ability to adapt and respond to the pandemic



Source: Ulrichsen and Kelleher (2022)

In this study we also sought views from UK HEP KE leaders on the scale of resource gaps (financial and otherwise) that hampered the ability of HEPs in pursuing what they saw as viable strategic opportunities around key government priorities (Figure 21). We separated results into the more research intensive HEPs (proxied here by membership of the Russell Group) and others. While most research intensive HEPs see significant viable opportunities in contributing to specific societal and innovation missions, supporting their local economies, and in commercialising emerging technologies, these were also area where many identified significant resources gaps. For non-Russell Group HEPs, significant resource gaps also exist for their efforts to contribute to their local economy.

Figure 21 UK university KE leaders views on resource gaps hindering pursuit of viable and significant strategic opportunities, for universities in the Russell Group and others







The survey also sought views on what more government action could be taken to help HEPs play a more active and strategic role in helping to drive an innovation-led recovery from the pandemic (*note, the study was undertaken before the cost-of-living crisis took hold*). Key findings are shown in Figure 22.

Reflecting on their perceived value of funding programmes like HEIF in helping them to respond to the pandemic, university leaders called for higher levels of flexible funding to enable them to become more responsive to long-term opportunities in both research and KE. Additional resources were also requested to better enable HEPs to actively engage in innovation-related activities to tackle major societal problems, exploit technological opportunities and contribute to local and regional development.

They also highlighted the need for improvements in the coordination across different funding instruments. Specific issues related to 'time-related coordination' such as the short notice of funding calls, extended duration of HEIF allocation decisions in recent years, mismatched funder/university expectations for the time needed for impact realisation, and funding sequencing issues. There were also calls for improved coordination across different areas of policy and across different government departments, as well as between the *strategic intention* of policies and their *implementation*.

These KE leaders also called for additional support to build capabilities to collaborate and innovate within the innovation system. This included help with tackling the challenges within the HE system of recruiting and retaining highly skilled professionals to support KE, and on the demand side to build entrepreneurial and workforce skills within the wider economy that is able to work more effectively with HEPs to co-innovate.

Finally, HEP KE leaders called for greater support for building and strengthening networks to facilitate innovation and platforms to drive collaborations (e.g. pre-competitive R&D consortia, regional technology clusters, platforms to facilitate international research and innovation collaborations).

Measuring and demonstrating success of knowledge exchange

4 Measuring and demonstrating success of knowledge exchange

This section turns to the question of how success in knowledge exchange is measured and demonstrated to drive improvements in performance and increased impacts from KE. At the outset of this chapter is it important to recognise that KE is in effect a suite of mechanisms for improving the flow of knowledge between HEPs and non-academic partners to enable knowledge generated and held within HEPs to be used to drive socio-economic impacts. The impacts arising through KE, while inevitably overlapping with those linked to research, are much broader.

Policies and interventions to incentivise knowledge exchange between HEPs and non-academic partners aimed to accelerating socio-economic impacts from HEP resources and expertise have become globally ubiquitous with widespread acceptance of the value of science and innovation-led economic growth and development. This, in turn, has created a strategic imperative for policymakers, as well as HEP leaders, to understand whether their strategies and interventions are having the desired effects. This requires access to relevant data and information to enable (Campbell et al., 2020):

- Making decisions on policy, funding and operations in England this critically includes allocating funding for KE via a metrics-driven formula
- Tracking the developmental status of KE performance and practices
- Benchmarking against comparable institutions
- Reporting on return on investment

More broadly, insights from the field of performance measurement and management (see e.g. Neely, 1998) suggest three main ways in which performance measurement systems can be used:

- As a means of **control** i.e. measures are used as a warning system to check positions and monitor progress over time against benchmarks, targets or critical, non-negotiable performance parameters
- As a means of **checking health** i.e. measures are selected to confirm organisational priorities, and to communicate progress towards strategic goals to external audiences as a regulatory/legal requirement or because it is expected/desirable to do so
- As a means of **challenging assumptions** i.e. measures are used to compel progress by encouraging HEPs/others to test the validity of cause-and-effect assumptions underpinning strategic planning, and search for ways to improve performance.

Historically national performance measurement systems for KE have largely centred on the first two of these uses, with efforts to challenge assumptions relying more on periodic evaluations of major interventions such as HEIF (e.g. PACEC/CBR, 2009 evaluation of HEIF, IP Pragmatics evaluation of CCF). This is changing, however, with the emergence of Research England's Knowledge Exchange Framework (KEF) for English universities, and the sector-led, UK-wide Knowledge Exchange Concordat. Used in combination, these have the potential to strengthen the framework for enabling

HEPs and policymakers to challenge key assumptions on cause-and-effect relationships. This use is believed to be very important for helping the system to learn, adapt, and continuously improve.

We also know that collecting, integrating, and curating data in this area is very challenging for several reasons, not least:

- The significant variety of mechanisms formal and informal for exchanging KE between academics and non-academic partners. Information is more readily available for some of these KE mechanisms (e.g. spinouts) than others (e.g. research partnerships funded by companies, or academic engagements with policymakers).
- The significant variety in the types of knowledge being exchanged, from highly codified to highly tacit.
- The significant time lags between investment in KE and realised outcomes and impacts, with impacts the result of many other actions and efforts making attribution back to the initial KE activity very difficult to trace let alone determine with any accuracy.

4.1 Frameworks for measuring and demonstrating success in KE

In thinking about measuring success for performance optimisation it is important to be very clear about *whose* success we are seeking to measure. Given the focus of Research England's funding programmes, we focus in this section on the HEP as our primary unit of analysis and how we can capture its overall success in enabling and facilitating KE linkages between knowledge producers and knowledge users that lead to positive socio-economic impacts. We also comment on measuring the success of different forms of KE mechanisms. Different stakeholders may also be interested in looking at, for example, the performance of specific KE offices (e.g. the Technology Transfer Office, a Corporate Partnerships Office or a CPD Office) or specific KE projects in delivering positive outcomes from their particular inputs.

Frameworks from evaluation practice can help in thinking about how to measure success for performance optimisation. This generic evaluation logic model for KE (Figure 23) attempts to distinguish between the *inputs* into the process of forming and delivering *KE activities* that seek to exchange knowledge with the aim of delivering benefits to the economy and society; the 'goods and services' that directly emerge from these activities (e.g. courses provided, consultancy projects delivered, sponsored research projects delivered, patents granted, spinouts created etc.); the effects these have on the changes in the knowledge, attitudes, aspirations, skills and opportunities of individuals and organisations (e.g. academics, students, KE professionals, recipients of KE, as well as HEPs as organisations) to deliver KE; the direct benefits on the individuals and organisations engaging in the KE activities (i.e. new or improved functionality of the products or services, new ways of working, changes in their capabilities and capacities to deliver on their organisations objectives etc.); and the *longer term, cumulative and systemic benefits* arising from these direct individual-level benefits.

Following insights from Mayne (2015) we refer to individual direct benefits and longer term, cumulative and systemic benefits rather than immediate and intermediate outcomes and final impacts, labels which are frequently used in evaluation logic models. This can provide a more intuitive understanding of the development and realisation of positive changes resulting from KE rather than focusing specifically on the temporal evolution of benefits.

Note that the logic model is depicted in a sequential, linear manner for simplicity. It is decidedly not linear in reality, with many interdependencies between different stages and different and stages overlapping.



Figure 23 Framework for investigating the success of KE for performance optimisation

Source: Building on Hughes and Martin (2012), Mayne (2015) and the framework presented in Figure 12.

It is crucially important to understand how external and internal drivers affect the KE process and its journey from engagement to impacts. As captured by Hughes and Martin (2012) in their study looking at measuring the value of publicly funded R&D, the vast literature on innovation processes and innovation systems would suggest that for KE projects to realise actual impact, they will typically require investments of time and effort by others, integration with other pieces of knowledge, and may be shaped and constrained by wider forces outside the influence of the HEP (e.g. market forces, government policies, legal systems etc.). As such the ability of HEPs to influence the decisions and outcomes of the KE journey becomes harder and more reliant on the actions and choices of others and forces out of their control.

We also know that KE activities and outputs are shaped by a range of factors internal to the HEP (e.g. local incentives for KE, HEP strategic priorities, resources and support available to academics engaging in the process etc.). It is important to understand how these internal and external drivers

shape KE success to ensure we appropriately condition expectations on what success can and should be expected.

Lastly, in addition to understanding the various linked inputs, outputs and impacts, it is as important to understand the 'arrows' between the different boxes, i.e. the cause/effect assumptions and relationships that get you from inputs to activities; from activities to outputs; from outputs to capacity and behavioural changes and direct benefits; and from direct benefits to systemic impacts. It is these in understanding these arrows that will identify key obstacles that hamper the ability of potential impact enabled by KE to be translated into real-world impact.

4.2 Current information sources for measuring the success of knowledge exchange

The realisation of systemic, socio-economic impacts of KE investments and activities relies heavily on the actions and efforts of others, the availability of complementary assets, and on external forces outside the control of HEPs, with often long time-lags between inputs and outcomes / impacts. As such, the attribution of realised impacts to KE investments is incredibly difficult.

Scholars and evaluation experts have therefore increasingly focused their attention on 'trajectory measures' rather than attempting to capture the long-term systemic impacts linked to the investments. In doing so they focus on determining the ability of knowledge users and HEPs to develop and nurture effective interactions to exchange and diffuse knowledge and whether the knowledge exchanged is being utilised by partners in productive ways that will likely deliver socio-economic impacts (Hughes and Martin, 2012; Molas-Gallart et al., 2016; Ulrichsen, 2015). The focus is therefore increasingly on understanding whether KE-focused interventions and investments are alleviating barriers and strengthening enablers of KE, whether there is demand for KE, and on whether partners are utilising the knowledge they acquire in productive ways.

That is not to say that efforts should not be made to understand the scale and nature of long-term and systemic economic and societal impacts arising through KE. Rather, due to the difficulties, cost and burden of undertaking robust analyses of this type, they may be more appropriately delivered through in-depth studies of specific areas on a more periodic basis.

Reflecting these challenges, when seeking to compare *relative* KE performance across HEPs policymakers have, for many years, gravitated towards using the income that HEPs receive from their KE activities as a signal that their activities are being valued by external partners. The advantages and challenges of this approach are discussed fully in section 4.3.2. What this approach cannot easily provide is insights into the full variety of socio-economic impacts that arise from KE, and insights into the scale of impacts in specific areas where transactions are not common or are known to poorly reflect the nature and scale of activity. This may become a significant issue if there is particular interest in understanding the reach and impacts of KE into a specific type of target community (e.g. public policy or with local communities.

It is also important to note here that studies of the KE system and its impacts rarely rely on a single source of information (e.g. data on KE income). They often combine evidence sources bringing secondary data with additional primary data gathering efforts such as surveys and case studies of those involved with, and benefiting from KE. It is therefore important to not consider each

information source in isolation, but as part of a system of information that can be gathered, integrated, and analysed. The question then is whether the full suite of information sources can provide us with the evidence needed to measure and demonstrate KE performance, and whether we can integrate different sources to underpin the analyses required.

It should also be noted that while this chapter reflects critically on current datasets, the past two decades has seen the UK develop databases on KE that are held up as global best practice by other countries and organisations, not least in a 2010 US National Academies review of managing intellectual property in the public interest, and more recently in a major review of knowledge transfer metrics published in 2020 by the European Commission.

With this in mind and taking the framework presented in Figure 23 as a guide, we set out in Table 3 a number of key information sources currently available that may be able to inform our understanding of KE performance.

Information source	Details	KE performance evaluation system insights	Advantages & disadvantages	
Higher Education Business and Community Interaction (HE-BCI) survey	 Statutory data collection exercise managed by HESA HEP-level data collected annually since early 2000s Structure of initial database informed by academic work from the University of Manchester Captures quantitative (transactional) information on volume of, and income from, of range of KE mechanisms well beyond technology transfer Some variables disaggregated by partner type (SME, non-SME commercial partner, public & third sector partners Until recently sought more qualitative information on the strategic focus and context of HEPs for KE. Often cited internationally as a world-leading KE-focused dataset in terms of its breadth of KE mechanisms covered and completeness across the HE sector (Campbell et al., 2020; National Academy of Sciences, 2010) 	 Nature & scale of KE activities Evidence on willingness to pay for KE by partners (income measures) Enables long-term trends to be analysed 	 Advantages: Consistency across years allows for long-term trends to be identified Complete coverage across UK HEPs Metrics are comparable across HEPs Income metrics for KE give indication that partners are willing to pay for KE services (see comment below on use of income as a measure of KE performance) Can be easily linked at the HEP-level to other data sources Disadvantages: Income-based and transaction metrics will not capture the full range of valuable KE activities undertaken by HEPs Weaknesses in variable definitions and guidance weakens comparability between individual HEPs Variability across HEPs in terms of data collection weakens comparability between individual HEPs 	
HEIF accountability statements (previously HEIF institutional strategies)	 Qualitative and quantitative information provided by HEPs to Research England as part of accountability requirements for receiving HEIF Statements detail institutional strategic objectives relating to KE, intended use of HEIF allocations to achieve these objectives (including estimated spend on different activities), and performance monitoring arrangements (RE and OfS, 2022). This data has been used to provide thematic analyses of HEIF funding (Technopolis, 2022, PACEC, 2012) Collected and curated by Research England 	 Nature & scale of KE inputs, activities, and anticipated effects Insights on emerging trends and experiments in how HEPs are delivering, supporting, and seeking to improve KE Strategic priorities & HEP context for KE 	 Advantages: Detailed insights on how HEPs are seeking to delivery, support and strengthen KE Thematic analyses can reveal emerging trends and new experiments Disadvantages: Subjective information provided by HEP leadership to secure access to KE funding Can be hard to verify claims made by HEPs 	
Knowledge Exchange Framework narrative statements	 Institutional context statement: Describes the contextual factors that shape KE activities in order to support interpretation of performance metrics, enable cross-institutional comparison and potentially enable identification of future metrics. Perspective narrative statements for local growth and public and community engagement: Provide a qualitative assessment of performance in KE in key areas 	 HEP context for KE (in all its forms) Qualitative information on KE activities and assessments of outcomes linked to the HEP in these KEF perspectives (local growth, and public / community engagement) 	 Advantages: Valuable insights into institutional context for KE Qualitative insights into nature of the strategy, activities and results linked to KE in local growth/public & community engagement areas Disadvantages: Likely partial information rather than comprehensive insights Variable quality of information across HEPs Hard to test robustness of information provided 	

Table 3Different data sources relevant to measuring and demonstrating the success of KE

Knowledge Exchange Concordat evaluation assessments and HEP action plans	 where quantitative metrics are lacking across the HE sector. Collected and curated by Research England Provide assessments of a HEP's approach to KE and its plan for continuous improvement within KE (McMillan, 2020). Offers insights on future KE performance. Plans to share assessment and action plan data between HEPs to drive organisational learning are currently under consideration by Research England 	 Clarity of HEP's mission and priorities for KE Insights into efforts to change in the capacities and behaviours of HEPs to engage effectively in KE Insights into what HEPs are doing to strengthen movement along pathway from inputs to realising impacts (i.e. their understanding of cause/effect relationship) 	 Advantages: Clarity on what constitutes KE within HEPs Detailed insights into KE performance improvement, shared among HEPs Disadvantages: Likely partial information rather than comprehensive insights Hard to test robustness of information provided Difficulties in linking Concordat to other information sources e.g. insights from KEF
REF	 Institutional environment statement: describe the environment of each discipline-based 'unit of assessment' as an enabler for research quality & impact. This may provide KE-relevant insights Impact case studies: describe project-level narratives of the reach and significance of impacts underpinned by research, which may include insights on how impacts were achieved 	 Insights into the nature of impacts arising from research-related KE activities if it is possible to identify particular KE channels used as part of impact journey 	 Advantages: Insights into the variety of impacts linked with research-related KE Disadvantages: Difficult to identify specific KE mechanisms used as part of impact journeys Limited to insights arising from research-related KE activities
Bibliometrics	 The Knowledge Exchange Framework and other KE-related measurement frameworks (e.g. the CWTS Leiden Ranking⁶) use co-authorships between academics and non-academic partners as a measure of the strength of knowledge interactions between universities and knowledge users. 	 Detailed insights into collaborations between academics and non-academic partners, with the ability to drill down into different sub-HEP categories and issues Insights on what academics and non-academic partners are working on together and emerging trends Growing attempts to links between academic outputs and policy documents (Overton) and other non-academic outputs (e.g. Altmetrics, patent databases) 	 Advantages: Relatively comprehensive databases for specific types of documents indexed (e.g. Leiden/Overton) Diverse range of policy material indexed (Overton) Disadvantages: Bibliometrics will bias towards disciplines and sectors/partners who are motivated to co-author publications with academics and have the resources to do so. Known biases towards English-speaking journals and materials, although advances in technology are tackling this Non-academic publications vary significantly in the quality of referencing external work making it hard to robustly trace links between academics and non-academic partners through these documents
Patent, trademark and design datasets	• The European Patent Office's patent dataset (PATSTAT) and the UK Intellectual Property Office's trademark,	 Insights on nature and scale of selected KE outputs (trademarking, 	Advantages: • Comprehensive databases

⁶ CWTS Leiden Ranking is available at <u>https://www.leidenranking.com/</u> (accessed on 6th December 2022).

	design, and patent datasets have been used to provide bespoke deep dive assessment of UK HEP intellectual property filing habits, including patent volumes, collaboration trends, patent coverage, and technological specialisms (IPO, 2020)	 design, and patenting activity) with ability to undertake much more detailed analyses than is possible through HEP-level reporting of aggregate totals in these areas Insights into emerging technology trends linked to academic research 	 National/supranational curation Disadvantages: Significant challenges with inventor name harmonisation, patent family definition, and technological classifications Hard to link patents to impacts, although efforts are increasingly looking at how to address this
Research and innovation grants databases	 Databases of publicly funded research and innovation projects (e.g. Gateway to Research) often provide information on partners involved in projects and the activities of projects 	 Information on research and innovation-focused activities More detailed insights in variations in this form of KE by discipline, location and other structural factors When linked to other information can potentially yield information on direct benefits to partners resulting from engagement in specific R&I projects Insights on the demand conditions for R&I projects 	 Advantages: Can identify specific partners involved in publicly funded research and innovation grants Can link these partners to other datasets (e.g. company financials, investment deals, patents etc.) Can link to other information available on the web capturing what partner is doing and what people are saying about partner Opens up significant potential for more detailed analyses of interactions between HEPs and partners including network analyses Ability to explore variations in these forms of KE by discipline Disadvantages: Databases only provide information on publicly funded projects. No comparable datasets for privately funded research and innovation projects Focus is on funded projects rather than wider KE activities Typically cannot determine planned contributions of extent of involvement of partners in projects Limited to partners involved at proposal stage with little information on partners ioning projects as they evolve
Investment & company- level datasets	 Proprietary (and often expensive) databases are emerging that compile information on investment deals secured by companies (e.g. Beauhurst, PitchBook, CB Insights, Crunchbase) These and other proprietary (sometime public) databases assemble information on company financial performance and business activities (e.g. Bureau van Dijk FAME database, Companies House). These datasets can be linked to companies with some KE connection to HEPs (e.g. identified through research and innovation grants, spinouts and start-ups etc.) to add important contextual information about who is working with HEPs and capture insights on their financial performance. 	 Assessments of UK academic spinout trends and outcomes Assessments of the outcomes of companies involved in research and innovation KE projects 	 Advantages: Ability to undertake detailed assessments of landscape, key trends and outcomes of spinouts ONS databases provide comparable and largely complete insights on the employment and turnover of UK VAT-registered companies that cannot be gathered through financial accounts. Disadvantages: Relies on accurate lists of spinouts and companies linked to HEPs. Currently no publicly available and robust list of spinouts – have to rely on criteria used by companies developing these datasets to include / exclude companies as HEP-linked spinouts and start-ups. Can also be very difficult to access these lists even where available to drive analyses for the public good (including public policy and university practice development)

	 Office for National Statistics makes available micro-level (company) data through its Secure Lab for the purpose of research for the public benefit (including policy development). This includes data available to the UK Government on the employment and turnover of all VAT-registered companies in the UK. 		 Investment datasets will typically miss companies that seek non-venture capital investment to drive their growth. This may bias against spinouts and startups emerging from certain disciplines e.g. the social sciences. Use of ONS data is heavily restricted to preserve confidentiality (i.e. significant limits on what data you can publish)
Regular national / global surveys	 A number of regular surveys are undertaken nationally and internationally that have some touchpoints with KE. For example, the UK Innovation Survey is conducted by BEIS every 2 years and includes a measure of cooperation arrangements between UK businesses and HEPs in comparison with other innovation system actors (BEIS, 2022). The World Economic Forum (WEF) executive opinion survey, conducted annually across 140 national economies, includes the same datapoint. 	 Assessments of the impacts of HEP cooperations on measures of company innovation performance (e.g. example use of UK Innovation Survey) National-level comparisons of cooperation strength and wider supply-side conditions and contexts 	 Advantages: Regular assessments of scale of overall links between HEPs and innovating companies Ability to set this in context of wider innovation performance measures to examine effects of overall links on company performance Disadvantages: Lack any significant detail on KE other than generic 'cooperation' between business and HEP question
Bespoke surveys and studies	 Bespoke surveys have been undertaken to gather perspectives from both academics and businesses on knowledge exchange. Some aim to generate insights at the national system level (e.g. the CBR surveys of academics and businesses in 2008/09, and more recently in 2015 and 2021 respectively). Focused studies are also commissioned to explore specific topics related to KE and understanding its journey, drivers, and impacts. These may involve deep-dive case studies, surveys and other data collection techniques. 	 Investigations of full range of KE, motivations, barriers/enablers, conditions for KE, how academics & partners benefit from KE etc. Deep dives into understanding nature of direct benefits and wider impacts arising from KE, pathways to realising this impact etc. gathered through qualitative casebased research 	 Advantages: Detailed insights into KE, impacts realised, pathways to impact, factors influencing process etc. Disadvantages: Can be very costly in both money and time burden on the system

Taking the insights from this table, we have then positioned different data sources back on our framework (Figure 24) to explore the coverage of the system of information that might collectively be able to give us insights into the 'health' and performance of the HEP KE system. Obviously, the ability to deliver insights into the performance of particular 'unit of analysis' (e.g. an individual HEP) will depend on the ability to secure access to robust data at that level of analysis in each of the elements of the framework, be able to link it together, and be confident of the attribution of any changes (positive or negative) to the original KE activity and investments.

Figure 24 Mapping of existing data sources onto the framework for measuring and demonstrating the health and performance of knowledge exchange



INTERNAL DRIVERS OF KE

Influence of factors internal to the HEP on the success of KE

- KE Concordat action plans and evaluations
- Bespoke surveys and targeted studies on KE
- Analyses of HEIF accountability statements
 KEF narrative statements on institutional context

4.3 Challenges and opportunities in KE data measurement and integration

4.3.1 Being clear on the purpose of KE measurement

In developing KE performance measurement systems it is important to be clear about its purpose. As mentioned at the beginning of this chapter this could include funding allocations, revealing and demonstrating value, individual-HEP or national KE system optimisation and improvement. These will each have different requirements on the features and qualities of the data we need to have in place to underpin metrics and analytical exercises.

For example, if used for funding allocations and individual-HEP benchmarking data needs to be complete (across all eligible HEPs), robust, and reliable as well as being meaningful. Transparency is

also important for ensuring trust in the process. This places additional burdens on the quality of data required. By comparison if we are interested in understanding the outcomes and impacts of the system as a whole we may be able to relax some of these requirements, for example regarding the completeness of data availability across all HEPs.

4.3.2 Ability to integrate different data sources

Superficially, Figure 24 suggests that we have data sources that can inform our understanding of the KE journey from inputs to activities to benefits to impacts. However, this is far from possible at the moment.

One of the biggest challenges in leveraging data from a variety of sources to explore the success of KE is the interoperability of the different datasets to allow us to develop robust analyses, either at the HEP-level or HE system level (looking at the portfolio of KE mechanisms) or at a KE mechanism level looking at how investments into specific KE mechanisms feed into benefits and impacts. This is made harder not least because of:

- Lack of common identifiers across datasets making it harder to integrate different datasets
- Datasets focusing on different parts of the system and different units of analysis leading to difficulties in linking inputs to activities to benefits and systemic impacts
- Incomplete coverage across the range of KE inputs, activities, and partners, with more micro-data typically available in STEM disciplines and R&D-intensive partners in more regulated sectors (e.g. life sciences). This can lead to a disproportionate focus on specific types of KE with certain parts of the economy purely because of data availability
- Reliance on proprietary datasets can limit ability to link data with other sources and run own analyses

As mentioned earlier, improving KE performance also requires a good understanding of the processes by which inputs are invested into activities, how activities are translated into outputs, how outputs result in capacity and behavioural change, how this then leads to direct benefits and ultimately how these translate into systemic long term impacts (i.e. the arrows between boxes). Information on these translation processes is very hard to source.

4.3.3 Using income as a proxy for KE success and impact

With performance being a multi-dimensional and often ambiguous concept, perfect measures of performance are unlikely to exist (Jensen and Meckling, 1976). Because of this, organisations and policy makers tend to use proxy measures – i.e. quantitative measures that approximate or serve as surrogates of performance – in the absence of perfect measures (Franco-Santos, Rivera and Bourne, 2014).

In the context of KE, this has seen policymakers and others gravitate towards using the income that HEPs receive from their KE activities as a **proxy** for the impact realised, particularly when focused on revealing *relative* KE performance across HEPs and in estimating sector-wide and monetised return on investment to KE funding. This reflects the significant challenges faced in measuring the impacts linked to KE in a systematic and comparable way across all HEPs, and with monetising impacts to inform cost-benefit analyses that meet the needs of HM Treasury in spending reviews.

What does KE income tell us about KE outcome performance?

KE income provides an important indication that valued linkages are forming between the university base and the wider economy to diffuse and exchange knowledge. If reasonably well governed and accountable organisations are willing to pay for KE, they must believe some value is being derived (financial or otherwise). At minimum therefore, **KE income represents an implied demand** for the capabilities and expertise available within HEIs.

Standard economic theories of the firm would also suggest that the price paid for a good or service reflects the marginal (the additional benefit the consumer receives from one additional unit) contribution of that good or service to their organisation. KE is also believed to lead to complex spillovers, multiplier effects, supply chain effects, and unexpected benefits emerging through both the deployment of the acquired knowledge and through the KE process itself (for example, learning by doing and interacting). This suggests that the price paid does not fully capture the additional socio-economic benefits of the consumption of KE.

Other economic theories posit that the value of a good or service is dependent on the subjective assessment of its value by buyers and sellers and the ability to come to an agreement on a price that satisfies the value assessments of the different parties, i.e. the value realised by the buyer has to be greater than the price paid.

One could therefore argue that KE income represents a minimum bound on the monetary value of the impacts KE delivers into the economy and society.

Other benefits of using income in measuring KE performance

A significant benefit of using KE income to measure and explore relative differences and trends in KE performance is that it is easily aggregated across different KE mechanisms and levels of the system (e.g. specific disciplines, individual HEPs, groups of HEPs, whole system etc.). This is much harder for non-monetary-based KE measures that currently exist (e.g. volumes of KE activities).

Furthermore:

- It is more easily auditable than other measures of implied demand for the capabilities and expertise available within HEPs.
- It is more likely than other datasets available in England (e.g. bibliometrics, research & innovation grants, investment datasets) to be complete in terms of coverage across HEPs and the range of KE mechanisms

Issues in using income as a proxy for measuring KE impacts

This approach to measuring KE impacts and success has its challenges, with KE income neither a perfect nor comprehensive indicator.

First, income struggles to give any significant insights into the nature of benefits and impacts arising from KE which may be important for understanding *how* the KE activities of different HEPs or from different KE activities benefit the society and the economy. For this we have historically resorted to the use of commissioned studies and academic research,
Second, we also know from the evaluation of the hard-to-monetise benefits linked to HEIF funding (PACEC, 2015) that the price paid for KE services do not always even reflect the full economic costs of delivering them (e.g. with small businesses and charities). This reflects in part to the public-good nature of the KE services and the need for the public sector to co-invest alongside the private sector to address the key market and system failures that are known to hinder the ability of certain types of partners to engage through KE with HEPs for the benefit of the economy and society.

Third, the value of an income-based approach to measuring KE may vary across disciplines. For example, KE from the life science, engineering and other STEM disciplines often require access to labs and expensive facilities, which will cost more than KE from the social sciences and arts and humanities. These structural differences in the nature of KE between disciplines need to be acknowledged in any attempts to use income to capture KE performance. This is hampered, however, by the lack of KE data below the HEP-level.

An income-based approach to KE measurement will therefore bias towards the dynamics of the forms of KE with certain types of partners and from certain disciplines that have the greatest income-generating potential. It may therefore be harder to pick-up signals on emerging pressures and opportunities of working with other types of partners and disciplines.

Finally, feedback in the stakeholder engagement exercise in Research England's review of KE funding raised the issue that the use of income as a KE performance measurement tool (and to allocate funding) can send confused signals to HEP leaders, particularly those not heavily engaged in the KE agenda, which may result in prioritisation of higher income generating KE activities over those that generate little income but may nevertheless deliver significant value. This will likely be more pronounced for HEPs that are not safely within the maximum cap for HEIF, where additional income generated through KE may lead to additional HEIF funding in subsequent years.

On this point, we need to be very careful not to promote a message that income generation through KE is at odds with impact maximisation. Ulrichsen (2016) argued that in many cases generating income through KE should be expected as part of the process of delivering valuable KE services into the economy and society; in the interests of the taxpayers funding much of the activities within HEPs, those organisations that benefit privately from the knowledge they access and acquire from HEPs should be expected to pay unless there are failures in the market and system which hinder valuable interactions from forming due to the lack of financial resources within organisations to pay.

Moving forward in the use of income as a proxy for KE performance and impact

Moving forward, the critical question is whether additional information would lead to changes in the relative positions and movements of HEPs in their KE performance, or can reveal, in a comparable way across all eligible HEPs, new or better information on the nature and scale of success in KE. It is important that we continue to test the assumptions underpinning an income-driven approach, and as new sources of information become more readily available, whether they can add new or improved insights.

4.3.4 Contextualisation and participation in the development of KE measurement systems

The contextualisation of measurements systems and participation of those impacted (e.g. knowledge providers as well as knowledge users and funders) in co-developing metrics systems have emerged as key issues in the field of science and technology (S&T) metrics development.

Scholars and experts in the broader S&T metrics (e.g. Barré, 2019; Ràfols, 2019) field have argued that the selection of specific metrics and their use for performance optimisation are often political, value-laden choices influenced both by the principles of New Public Management and the linear, science-push model of innovation, yet are not explicitly acknowledged as such. These choices have led to S&T indicators that are overly reductionist and isolated from their *contexts* of use – termed 'secluded metrics' (Ràfols, 2019) – with confusion over their objectives. Furthermore, these indicators are sometimes used even when they lack analytical validity or social robustness. This has prompted efforts to develop more explicitly context-specific S&T metrics, for example around specific issues such as sustainability and social justice (e.g. STRINGS, 2022).

The real value of S&T metrics, according to these scholars lie in their ability to facilitate debate *in specific contexts* and enable collective learning in policy arenas and priority-setting in research strategies (Ràfols, 2019). Therefore, both learning and priority-setting should also be considered as objectives in developing performance measurement systems, in addition to rewarding and incentivising performance optimisation.

To this end, effort should be made to develop indicators that enable knowledge users to tailor their own context-specific perspectives of data. This can be achieved through, for example, fine-grained topic classifications (Gläser, Glänzel and Scharnhorst, 2017; Klavans and Boyack, 2017), seductive visualisations (Chen and Leydesdorff, 2014), statistical methods to reveal uncertainty (Schneider, 2015), and functionalities to enable investigation of underlying data and algorithms.

On *participation* in the development of metrics systems, increasing involvement of the range of key stakeholders likely to be affected and/or targeted by the metrics can help to drive the development indicators that are meaningful for stakeholders operating in very different contexts. Combined with increased contextualisation of metrics, this should lead to improvements in the ability of organisations to make better decisions leading to greater realisation of value through KE in their particular context.

Moving forward, as HESA progresses the major review of HE-BCI, Research England evolves the KEF, and the sector-led KE Concordat continues to develop we should reflect on how we can strengthen the contextualisation of KE metrics and provide information that can be customised to different contexts, as well as ensure wide participation in the development of these performance optimisation and learning systems.

4.3.5 Potential for international comparisons in KE

International comparisons and benchmarking efforts around KE have the potential to create a valuable source of evidence for driving improvements to national KE systems (National Academy of Sciences, 2010) at different levels, from the national system to sub-groups of HEPs such as those with certain research profiles or in certain types of regions, and individual HEPs. Such comparisons can reveal differences in KE levels and trends that then prompt questions about whether these

reflect structural factors (for example the sectoral composition of the economy, the structure of the research and innovation base which may lead to specialisation effort along the KE journey) or genuine performance differences in how resources for KE are allocated and used. They can also prompt a search for emerging experiments and practices around KE that could inspire UK-specific learning aimed at improving KE performance.

HE-BCI is considered to be one of the most robust and best longitudinal datasets for KE globally, due to its breadth, the mandatory nature of the return, and data audit procedures (Campbell et al., 2020; National Research Council, 2011). It has been influential in the development of national performance measurement systems in other countries, with HE-BCI data being shared with the EC, AUTM and Japan's University Network for Innovation and Technology Transfer (UNITT) (McMillan, 2016).

However, international comparisons are both limited and challenging because of varying degrees of alignment between national data collection methods and nomenclatures/terminologies. Furthermore, as discussed, contextual information is critically important for adjusting for structural difference between nations and HEPs (e.g. local and national socio-economic contexts, availability of other research and innovation organisations that shape the specialisation of effort by HEPs along the KE journey, HEP characteristics such as scale and discipline portfolios, and approaches to national and local funding of KE).

Currently, there is a drive for greater alignment between countries' KE measurement systems, particularly across the EU with the development of harmonised KE metrics (Campbell et al., 2020). This represents an opportunity for a distinct effort with international partners to converge on an agreed approach to KE performance measurement.

4.3.6 Pressures to reduce burden

Collecting, curating and analysing data and information to underpin effective performance measurement systems inevitably incurs a burden on the system. As the demand for KE performance measurement systems grows, it is important to consider what level of burden is acceptable to ensure good public accountability and policy insight.

4.3.7 Indicator 'lock-in'

A challenge currently levelled at broader field of S&T indicators is that of 'lock-in' (Barré, 2019) – i.e. indicators which have been used for years, have significant associated sunk costs, and have become integrated within social, professional, and cultural norms, become the indisputable reality of the object or phenomenon. However, potential gaming of the indicator over time, coupled with a lack of critique and contextualisation, may result in differences emerging between what is purported to be measured and what happens on the ground. In addition, over time policy objectives may change compared with those set when the indicator system was established leading to a potential misalignment of incentives.

The extent of lock-in within KE measures is currently unknown.

However, two notes of caution must be raised before any changes to existing suites of KE measures is considered. First, there are significant benefits from having a long time-series of data on selected KE metrics to enable long-term trends to be studied. Such analyses provided valuable insights into

the long-term consequences of the 2008 financial crisis and how different parts of the sector were affected. It also allows analysts to probe how changes in the funding regimes are affecting patterns of KE activity and outcomes.

Second, HE-BCI is considered to be the most robust and best longitudinal dataset for KE globally and has informed the developments of other countries' KE data collection efforts. As efforts grow to try and standardise data collection efforts across countries, people are looking to the UK for insights on metrics and definitions.

As we look forward, we should ask whether the current set of KE metrics are well aligned with delivering performance optimisation in its different desired forms, from control, health-checking, as well as for challenging assumptions and driving learning.

4.3.8 Emerging datasets and tools

Within the broader field of research impact assessment, a wide range of datasets, platforms and tools have emerged in recent years aimed at developing new S&T indicators. The potential in this area has been accelerating with rapid advancements in data science, machine learning and natural language processing technologies (NLP) tools and techniques.

Many 'structured' datasets have emerged in recent years, including commercial bibliometric databases, national performance-based research funding datasets, commercial spinout/start-up datasets, and institutional repositories (Mahieu, Arnold and Kolarz, 2014). There is also a trend of increasingly comprehensive open-access datasets, including lens.org for patent and scholarly data, 1finder for scholarly journal outputs, and dimensions.ai for linked research to impact data.

Other efforts relate to leveraging 'unstructured' data from alternative sources, such as social media like Twitter and web-scrapped data. Areas of potential interest include developing network-level insights from altmetrics (Robinson-Garcia, van Leeuwen and Ràfols, 2018), sector-specific innovation maps (Mateos-Garcia, Stathoulopoulos and Thomas, 2018) and semantic analysis from website text scrapes (Gok, Waterworth and Shapira, 2015), or combining S&T data and sectoral data (e.g. health data, Yegros et al., 2019). NLP methods to process and analyse unstructured data have been developed, including topic modelling, text categorisation and clustering, information extraction, named entity recognition, relationship extraction and sentiment analysis (Deloitte, 2019).

These emerging datasets and tools have yet to be used in KE performance measurement and represent a *potential* opportunity for the development of new metrics for KE as means to gain additional insights over what is currently possible, and provide more contrasting results to enable greater *contextualised* learning and debate on KE performance.

However, each of these emerging datasets comes with important caveats. For example, datasets may not be complete. In the area of spinouts, a number of commercial datasets have emerged in recent years. However, there is no way of currently establishing how complete they are due to the lack of curated registry of spinouts developed for public policy design and evaluation. As such we have to rely on lists assembled by others for other purposes, which may or may not align with the needs of policymakers. Further, they typically struggle to capture certain types of investments at the very-early stage of spinouts; a point where market and system failures may be particularly pronounced. At the same time, they may also systematically cover spinouts in certain fields (e.g.

technology) to a greater extent than others (e.g. spinouts in the creative industries and social enterprises).

Other issues are around *disambiguation* of names and recognising the *nature of the information being gathered*. For example, the platform Overton links academic outputs to policy documents. Overton, as reported on their website, does not disambiguate authors. This means that if an author has a middle initial in the author list of one paper and not in another, they will appear as two different authors. Web scraped data is also *self-reported*; it may represent what organisations choose to promote rather than technological achievements.

Though these types of data can be easily accessible if the lists of the target data sample are provided, linking various data sources, disambiguating entries and cleaning them is not without a burden.

In addition to the completeness, there are other considerations regarding the use of emerging data sets and machine learning methods:

- **Data quality**: Is the data reliable, timely, accurate, representative, and impartial? Do the datasets cover all HEPs, or are some not represented? Do they cover all the different variations of a KE activity? For example, do they cover all types of spinouts including social enterprises and spinouts that grow through non-VC backed routes?
- **Fairness**: Are the proposed data and systems fair and aligned to human-centred values in allocating resources, such as equity and fairness? Do they reinforce existing biases?
- When extracted from unstructured sources, what **accuracy** of the methods used is required to provide assurance to the public and stakeholders that the data can be used to provide robust insights?
- Explainability: how do we understand and explain the results of a machine learning system to improve transparency in decisions?⁷ Many machine learning approaches act like "black" boxes, and their choices cannot be explained. This issue might amplify for 'off-the-shelf' solutions, with no access to training data and methods, if the provider offers no means for ensuring explainability. Unless tackled, the use of such tools could reduce the transparency of KE funding allocations.
- Accountability: When allocating funding, funders will need to ensure that any datasets and AI systems used in decision-making are in accordance with regulatory frameworks, and be able to explain how decisions are made by providing related documentation. For example, any automated assessments and decisions and the systems and tools that underpin them would have to comply with the UK GDPR and the Data Protection Act 2018⁸

The challenges, risks, and biases of using AI, machine learning and natural language processing in decision-making in policy have been widely discussed. The risks have been manifested in practice, in areas other than KE performance assessment, but lessons learnt are transferrable. For example, a

⁷ See e.g. Government Digital Service (GDS) and the Office for Artificial Intelligence (OAI) guidance on how to build and use artificial intelligence in the public sector, available at:

https://www.gov.uk/government/collections/a-guide-to-using-artificial-intelligence-in-the-public-sector ⁸ Ibid.

British medical school rejected qualified female and minority applicants because it was trained on the previous biased decisions made by the admissions board (Buchanan and Miller, 2017)⁹.

UK Government and other institutions have recently provided guidelines, frameworks and principles for the use of data and AI for policy¹⁰. An increased level of data quality and trust in the data's **completeness, validity and representativeness** is needed if AI/machine learning is used directly in policymaking. This would include for example if used to allocate KE funding.

The use of emerging datasets and tools for policy unlocks great potential but also a great responsibility.

4.4 Contemporary performance measurement design

The last couple of years have seen the emergence of performance measurement systems intended to strengthen the link between financial/non-financial performance measures and organisational strategies to encourage performance improvement. Such systems are known as 'contemporary performance measurement' (CPM) systems within the field of performance measurement and management (Franco-Santos, Lucianetti and Bourne, 2012).

Element of CPM	Control System (CS)	System of Systems (SoS)
Autonomy: the ability of sub-systems to pursue goals independently without external control within a broader system	CS emphasises high levels of external control and alignment	SoS emphasises managerial/operational independence and the freedom to learn and adapt within the system
Belonging : the relationship between sub-systems and the system as a whole	CS emphasises high centrality with information cascading out to sub-systems	SoS sub-systems are seen to have a choice whether or not to address system challenges, and how to address them in terms of orchestrating links to other sub- systems (e.g. via partnerships, supply chain links)
Connectivity : the relationships between sub-systems	CS emphasises tight coupling so that system-level performance measures map directly onto those of sub- systems	SoS emphasises loose coupling, involving continuous evidence-based performance dialogue to support contextualised interpretation of system performance measures
Diversity : the level of heterogeneity of sub- systems	CS emphasises homogeneity as this facilitates centralised strategic planning and selection of performance targets	SoS emphasises heterogeneity as this captures greater diversity within complex systems and supports system- level synergies and performance evaluation
Emergence: the developments of the system which cannot be causally linked to individual sub-systems	CS emphasises prediction and optimisation of measures as ultimate goals	SoS emphasises continuous improvement, which is dependent on an ability of sub-systems to navigate through options and evaluating small- scale experimentation

Table 4Elements of contemporary performance measurement in two types of system: 'controlsystems' and 'system-of-systems'

⁹ Buchanan and Miller (2017) Machine learning for policymakers

¹⁰ See e.g. OECD AI Principles, available at <u>https://oecd.ai/en/ai-principles</u>, UK Government Digital Service (GDS) and the Office for Artificial Intelligence (OAI) guidance on how to build and use artificial intelligence in the public sector, available at <u>https://www.gov.uk/government/collections/a-guide-to-using-artificial-intelligence-in-the-public-sector</u>; UK Government's Data Ethics framework, available at <u>https://www.gov.uk/government/publications/data-ethics-framework</u>

Two approaches to CPM design are distinguished, the 'control systems' (CS) and 'system-of-systems' (SoS) approaches (Bourne et al., 2018). While the former predominates, its appropriateness for complex, volatile and uncertain environments is being challenged, leading to the growing influence of the latter. The main differences between the two are summarised in Table 4.

In addition, when creating effective performance measurement systems, it is important that we develop robust analytical frameworks that can guide our understanding of how the system works, where we are able to collect robust data and where key gaps in our understanding remain. The latter is critically important as it can help to condition our interpretation of the results of the data and metrics we can gather.

Comparing two KE-focused contemporary performance measurement systems: the combined KEF & KE Concordat, and EU harmonised metrics

Using these dimensions of CPMs, we compare two recent KE performance measurement systems: the combined KEF and KE Concordat in England, and the European Commission's plans for harmonised knowledge transfer (KT) metrics.

In 2009, an EU expert review of knowledge transfer (KT) highlighted the need for a systemic policy and suitable indicators (Finne et al., 2009). This recommendation has been realised within the EU knowledge valorisation policy (EC, 2022) and the development of a set of harmonised metrics and higher-level composite metrics for KT by an Expert Group on Knowledge Transfer Metrics (Campbell et al., 2020, 2022).

Figure 25 Framework adopted in the development of a European-wide set of harmonised indicators for knowledge transfer



Figure 1: Knowledge Transfer: from research to impact

Figure 26 Set of harmonised indicators proposed by European Commission's expert group



Figure 2: Input and Output KT Indicators: the four quadrants

Their work was guided by the conceptual framework illustrated in Figure 25 and Figure 26. It led to a set of metrics being proposed that captured information on the internal context and external environment of public research organisations (including HEPs), their KT activities, and the impacts of these activities. Financial and non-financial KT measures are included for disclosures; licences & agreements; spin-offs; research contracts and collaborations; and consultancies.

In the UK, the McMillan Review made a number of recommendations for the improvement of KE practice (McMillan, 2016). From this emerged two initiatives of note: the Knowledge Exchange Concordat and Knowledge Exchange Framework (KEF). The Concordat is a community-led initiative to set KE standards across UK HEPs and facilitate a long-term programme of continuous learning (McMillan, 2020). Research England have developed the KEF as a metrics-led approach to KE performance measurement in English HEPs, intended to sit alongside the KE Concordat (RE, 2020a). Thus, the KEF and the KE Concordat combined are intended to operate as a CPM. KEF metrics cover a broader range of KE activities than the EC harmonised metrics, including financial and non-financial measures for research partnerships; working with business; working with the public/third sector; skills, enterprise & entrepreneurship; local growth & regeneration; IP and commercialisation; public & community engagement.

The EC and UK approaches have similarities and differences which reflect the influences of CS and SoS approaches to CPM design. The main differences are summarised in Table 5.

CPN	1 systems	
CPM element	EC harmonised KT metrics	KEF/Concordat
Autonomy	Control and alignment : Single set of harmonised KT metrics, with adoption across all member states recommended.	Control and alignment : Single set of KE metrics adopted across the English HE sector.
		Learning and adaption: The Concordat emphasises the use of KEF metrics for benchmarking purposes to support continuous improvement in KE.
Belonging	Centralisation and cascading : Central database for EU public research organisation KT data (the KT Metrics Platform), with publication of regular reports.	Centralisation and cascading : Central database for KE data (KEF), with annual reports cascaded to HEPs through online dashboards.
		Localisation and orchestration: KEF measures intended to enable orchestration, including external stakeholder engagement and relationship management.
Connectivity	Tight coupling : Governments, Ministries and Departments to encourage and incentivise the adoption of harmonised metrics across their public research organisations.	Loose coupling : KEF informs KE performance review and Concordat action plans for KE improvement, as well as proactive best practice sharing between peer HEPs.
Diversity	Heterogeneity: Metrics for internal contexts and external environment of public research organisations are provided. Heterogeneity is addressed through use of core and supplementary metrics, the latter providing greater granularity for the former.	Heterogeneity : HEPs are categorised within KE clusters, differentiated by knowledge base; knowledge generation; and physical asset investment (Ulrichsen, 2018). Contextual information is also provided through KEF narrative statements to support metrics interpretation.
Emergence	Prediction and optimisation : Harmonised metrics designed to meet country and institution requirements to track KT performance and practice development; benchmark against comparable institutions; inform decisions on policy/funding/operations; report return on investment.	Prediction and optimisation : KEF metrics aim to provide comparable, benchmarked and publicly available performance information to allow providers to better understand and improve their own KE performance and provide external organisations with more information to help them access knowledge within HEPs.
	Navigation and improvement : Harmonised indicators are seen to offer a window on progress in KT which can inform policy and practice. Achievements against indicators to be assessed holistically, while simple benchmarking of outputs is considered dangerous and unhelpful.	Navigation and improvement: HEPs free to develop enablers to improve KE performance best suited to their own KE strategy. Regular institutional/collective self-assessments to evaluate success, supported by benchmarking measures, partner feedback and best practice sharing.

Table 5Comparison of EC harmonised metrics and KEF/Knowledge Exchange Concordat as

This analysis suggests three significant differences in the approaches to CPM design taken by the UK and EC. First, the UK approach has more hallmarks of the system-of-systems perspective than the EC approach, particularly concerning the attributes of connectivity, belonging and autonomy.

Second, while the scope of the EC harmonised KT metrics is narrower than KEF, with a smaller set of KE activities being measured, it is broader than the KEF in that it explicitly brings together in one place information on the internal and external contexts as well as more explicitly presenting measures of KT inputs, activities, and impacts. This could, potentially, facilitate the challenging of cause-and-effect assumptions.

Third, the EC approach seeks to gather information on the longer term impacts arising through KT. However, in doing so, it recognises that many impact indicators will have to be gathered *on an occasional basis* through more costly and burdensome methods such as evidence-based case studies and externally commissioned expert assessments and support.

4.5 KE-level performance measurement systems

Developing effective KE performance measurement systems is arguably easier at the level of specific KE mechanisms (e.g. technology transfer, research partnerships, public and community engagement) rather than at the HEP-level looking at whether their portfolios of KE are optimised for delivering greatest potential economic and societal benefit.

Advances have been made in recent years in understanding the theories of change for specific KE mechanisms, capturing how investments within HEPs feed through into activities, outputs, benefits and impacts in the economy and society. The most notable effort here is the work by SQW (2020) in a project for Research England looking at determining logic models and detailed theories of change 'wire diagrams' capturing how inputs are translated into outputs, outcomes, and impacts for each of six key forms of KE (technology transfer, knowledge sharing and diffusion, supporting the community and public engagement, facilitating the research exploitation process, exploiting the HEP's physical assets, and skills and human capital development. An example for technology transfer is provided in Figure 27 below. For each theory of change element, they highlight where HESA's Higher Education Business and Community Interaction (HE-BCI) survey provides data and information.



Figure 27 Framework for investigating the success of KE for performance optimisation

SQW

Knowledge Exchange Funding: Novel Evaluation Methodologies

These insights can provide a starting point from which to explore how data could be more systematically collected and integrated from different sources to provide an understanding of the success of HEPs in delivering a specific form of KE. As discussed in this chapter, insights will inevitably

come from different data sources, where valuable insights will only emerge if we are able to link different datasets together. Key issues in doing so are discussed in section 4.3.2.

Theories of change frameworks such as those set out in Figure 23, customised for a specific type of KE, can provide an important strategic framework for guiding systematic data collection and reporting to drive improved strategic intelligence on the health and performance of the system and opportunities for learning. This both helps to reveal where we have decent coverage of information, and to highlight clearly and transparently where key gaps in evidence remain. This is critically important as it helps to condition our interpretation of the data and explore potential biases that may exist (e.g. towards a certain type of institution). It also provides an important device for integrating quantitative and qualitative evidence drawn from different sources to inform an overall assessment of KE performance at a particular level of the system.

It may also be the case that some metrics should be collected on an annual basis, providing more of a monitoring function, while other insights are collected less frequently (particularly if the object of study is relatively stable over time). Furthermore, it is likely that while some evidence may be in the form of quantitative data, other information may be more qualitative (particularly when we move beyond outputs and tangible benefits. This may include information gathered and analysed through more automated techniques such as AI and machine learning, subject to the challenges identified in section 4.3.8.

Finally, we must better understand how the actions and decisions of HEPs might shape the KE journey at different points not least the ability of partners to realise benefits and impacts from their interactions with the process. This is critically important to ensure we are setting appropriate performance expectations when factors well outside the control of HEPs will ultimately determine whether the knowledge is able to deliver realised socio-economic benefits at the system level.

Example: measuring HEP performance in generating spinouts

Efforts of this type are looking promising in some areas, particularly those where the object of KE is relatively tangible and identifiable, such as spinouts.

At UCI we have been investigating whether we could improve our understanding of KE performance in this area if we had access to disaggregated data on spinouts rather than the current HEP-level reporting. We have been developing analytical frameworks that capture the journey of spinouts from HEP to impact, and are investigating how we might assemble information from different data sources that can be linked together to provide more systemic and granular insights on the trajectories and outcomes of spinouts.

For example, we are exploring what is possible if we have access to spinout company names and selected details about their origins that would enable us to link information into wider datasets and information available on the web regarding their research origins as well as their post-foundation development journey towards successful growth (or failure). We are also finding that in doing so we are able to identify how their geographic footprint is evolving (important for levelling up and regional/national value-capture discussions). We are now beginning to explore how to secure insights on the product/service mix of the company.

Further linking into government-owned data would then allow us to access key information for example on employment and turnover growth of these companies which can be difficult to obtain robustly through company accounts-based databases. These can complement measures capturing the investment journeys of these companies, although it is critically important to recognise that not all spinouts will grow through venture capital-backed investment, and that proprietary databases in this area may result in structural biases towards certain types of company and sector.

Much of this information could be updated on an annual basis. In addition, the micro-level nature of the data means that we could much better control for structural differences that shape KE opportunities and performance (e.g. biotech spinouts versus software-based spinouts).

These insights could then be supplemented by further information on the context of the spinout company's emergence (HEP conditions, local economic and investment environment, demand conditions etc.) collected through other data sources.

More detailed insights into the variety and scale of direct benefits and systemic impacts could be gained through more periodic data collection efforts, including through more qualitative approaches such as surveys, case studies, and other, perhaps more automated, techniques that leverage unstructured information on the web capturing the spinout's impact on society. In exploring the use of the latter to inform KE policy, we will be investigating the opportunities and limitations as discussed in section 4.3.8.

Enabling continuous learning and innovation in HEP knowledge exchange

5 Enabling continuous learning and innovation in HEP knowledge exchange

For an organisation to improve, it must learn something new. For an organisation to continually improve, it must commit itself to learning systematically. This section examines the question of how public policy interventions can be used to incentivise and enable continuous innovation by HEPs in their KE activities.

The section first reflects on the different mechanisms through which policy interventions can incentivise and enable continuous improvements within HEPs (drawing on insights from work research and innovation assessment systems). It then turns to what is known about the drivers of organisational learning drawing on models developed in the organisational learning and knowledge management fields. These provide a framework for reviewing comments from the KE review consultation exercise to examine whether HEIF, the KEF and Concordat are acting in ways to reinforce the key drivers of learning within organisations.

5.1 Policy mechanisms for incentivising continuous improvement in KE within HEPs

We know from a recent major EU-wide study and related work on research and innovation (R&I) assessment and performance-related funding systems that there are four main categories of policy instruments targeted at improving the quality and performance of R&I systems (Debackere et al., 2018, p.40; Mahieu and Arnold, 2015):

- Instruments to enhance R&I quality and the country's research competitiveness
- Instruments to steer behaviour to tackle specific failures in the R&I system
- Instruments to strengthen accountability in the use of public money in strengthening the R&I system
- Instruments to provide strategic information (quantitative and qualitative) to inform R&I strategies and policies being developed by policymakers in government as well as by institutional management of HEPs and other research and innovation actors. This includes insights to improve our understanding of the structure, function and evolution of the R&I system, key barriers and enablers, emerging practices, international trends and developments etc.

The Technopolis study (Mahieu and Arnold, 2015) argued that international experiences in developing performance-related funding systems have led to improvements in the quality of outputs from research organisations. However, the European Commission 'mutual learning exercise' (Debackere et al., 2018, p.31) concluded that it is not currently possible to determine whether an optimal balance between these types of incentives can be achieved. No clear theory exists concerning how individual instruments, the policy mix or changes within the policy mix relate to

overall performance. Nor have simple relationships been demonstrated based on robust evidence. Policymaking therefore depends strongly on contextual knowledge and judgement rather than hard evidence.

With this in mind, we examined whether key Research England policy instruments (HEIF, KEF and KE Concordat) exhibit some or all of these mechanisms for strengthening the performance of the English KE system (Table 6).

Mechanism for		Policy instrument	
improving performance of KE system	HEIF	KEF	KE Concordat
Improve quality of KE and competitiveness of KE system	The allocation of HEIF based on a formula driven by past KE performance creates an incentive for HEPs to seek ways of improving their competitiveness in attracting and nurturing KE partners. The maximum cap may reduce this incentive for those not at risk of falling below this threshold.	Vision for KEF was to create public framework to reveal performance differences in order to improve English HEP competitiveness in KE	KE Concordat identified key components of well- functioning KE system within HEPs, assess maturity of each component, and develop an action plan for how to improve it with a view to raising performance in KE
Steer behaviour	HEIF provides HEPs with strategic resources to improve capacity and capability to deliver KE that has benefits for the economy and society and helps HEPs to meet key Government priorities. The emergence of specific pots of formula-allocated HEIF to tackle key government priorities (productivity, commercialisation, industrial strategy) provides a more direct steer to adapt	KEF has helped to further elevate status of KE within English HEPs alongside research and teaching, further legitimising KE amongst senior leaders	In doing so, KE Concordat should help HEPs to create strategies and structures to steer behaviours within their institutions towards a more enabling environment for KE
	behaviours to meet key Government priorities.		
Increase accountability	The formula allocation of HEIF is supplemented with a requirement for HEPs to produce an accountability statement setting out the HEP's strategic objectives for KE and how HEIF will enable their delivery. These statements are assessed by Research England to ensure appropriateness of spending given HEIF objectives.	KEF aimed to provide a more visible and public benchmarking of KE in English HEPs to increase public accountability for increasing levels of investment in KE	
Provide strategic information	Information gathered in the HEIF accountability statements is in part used to identify sector-wide spending intentions of HEIF and information on activities to inform policy development and provide feedback to Government. These insights are published publicly. Most recently they included the collection of case studies of the socio- economic benefits arising from HEIF- funded activities.	KEF aimed to identify performance differences between English HEPs to help them identify peers that may be doing something innovative	The KE Concordat creates a platform for effective practice sharing and peer learning

Table 6Examples of how Research England policy instruments seek to improve the
performance of the English KE system

5.2 HEPs as learning organisations and continuous improvement in knowledge exchange

To understand how public policy can incentivise continuous learning within HEPs around KE, it is helpful to understand key drivers of learning at the organisation-level in knowledge-based organisations.

HEPs as learning organisations

To inform our exploration of how continuous improvement in HEPs' KE activities can be incentivised, we need a process model of how HEPs learn and improve. To do this we draw on one of the most established concepts in the fields of organisational learning and knowledge management – the 'learning organisation' (Senge, 1990). Note that the application of this concept to HEPs is complicated because they differ significantly from commercial businesses in a number of important ways (Bui and Baruch, 2013; White and Weathersby, 2005), not least:

- Stability: HEPs are typically very stable structures and tend to be slow to change
- **Loose coupling**: Rather than hierarchal organisations, HEPs can be thought of as 'looselycoupled' systems made up of parts that are weakly attached to each other, while simultaneously holding independent identities and partial separation (Weick, 1976)
- **Domain-specific knowledge**: Academics traditionally create knowledge within specific knowledge domains of a scientific field rather than on behalf of their institutions
- **Knowledge volume**: The volume of knowledge created and transferred within HEPs is massive compared to commercial organisations
- **Governance**: There may be incompatibilities between the consensual governance structures traditionally found within HEPs and those of learning organisations
- **Social learning**: Social learning within the HEP may be an espoused ideal rather than actual practice
- **Resource conflicts**: Collaboration within the HEP can be impacted by self-interested behaviour and competition for internal/external resources
- **Risk aversion**: HEPs may be risk averse at individual, group, department and university levels.

Nonetheless, HEPs have experimented with learning organisation principles to improve performance. Additionally, the concept has been extended to a university context from the perspective of employees, managers and society, albeit with a scope covering all HEP activities rather than KE specifically (Örtenblad and Koris, 2014).

Örtenblad's (2004) model sees the integration of four distinct aspects of how the learning organisation is both conceptualised in the literature and understood by practitioners (Figure 28):

 Organisational learning: This includes two types of individual learning – error identification/correction ('single-loop' learning) and critical reflexivity ('double-loop' learning) to question current courses of action (Argyris and Schön, 1974). It also includes the incorporation of individual knowledge into organisational memory – i.e. the organisation's rules, routines and practices. Organisational memory regulates behaviour and directs learning.

- Learning at work: This includes both formal courses and feedback-driven on-the-job learning. Learning at work and organisational learning are integrated in three ways – (i) organised knowledge management processes to refine/remove existing rules and routines in order to embed individual knowledge within organisational memory; (ii) performance and strategic performance management processes to ensure organisational memory is being used in practice; and (iii) shared mental models which shape group interpretation of events and directs attention towards selective learning.
- Learning climate: This is the extent to which the organisational atmosphere facilitates and encourages experimentation. The organisational climate is integrated with organisational learning through (i) modification of organisational norms and values to ensure that even failed experiments that prompt learning and reflexivity are viewed positively; and (ii) knowledge sharing between individuals and teams. The organisational climate is integrated with learning at work through processes to encourage experimentation.
- Learning structure: This includes both team- and organisational-level structures. Flexible, organic and decentralised organisational structures are preferred as these may enable the organisation to constantly adapt. Team structures should be empowered with meaningful authority to make changes based on learning. Learning structure and climate are integrated through the provision of space for experimentation and purpose for learning. Structure and organisational learning are integrated through shared visions so that decentralised and empowered teams are aware of overall strategic direction; and 'who knows what' mapping so that knowledge can be located within the organisation. Structure and learning at work are integrated through both learning from environmental information and intra-team learning opportunities, such as job rotation, which create shared understandings.

Successfully implementing these four key aspects of the learning organisation should result in flexible action that drives continuous improvement and adaption to changing environmental conditions and improved KE performance.



Figure 28 Process model of the HEP as a learning organisation

Source: adapted from Örtenblad, 2004

Having developed this model, we reflect on key insights emerging from Research England's KE review engagement exercise in terms of how well the Concordat, KEF and HEIF are shaping the development of HEPs as learning organisations undertaking continuous improvement in KE (Table 7).

	Aspect of learning organisation ¹²				Implication for HEIs as learning
Issues identified ¹¹	Organisational learning	Learning at work	Learning climate	Learning structure	organisations and continuous improvement in KE
		Concordat an	d KEF		
Concordat enabled useful self-reflection for HEPs concerning longstanding issues	+				Single-loop (error correcting) and double-loop learning (critical reflexivity and course correcting) are being enabled
Concordat brought fundamental/ longstanding issues forward to be addressed at a senior level	+	+			The Concordat is enabling shared mental models to emerge between leaders and staff, however this may be hampered by complexity (see below)
The Concordat and KEF have raised the profile of KE within institutions and facilitated the emergence of a common understanding of KE. Significant quantities of KE activity not previously being captured were surfaced during the Concordat exercise		+		+	The Concordat and KEF are enabling emergence of shared understandings of what activities constitute KE
Concordat has encouraged senior buy in and starting discussions on where to focus in future	+			+	The Concordat and KEF have enabled the emergence of shared visions for KE
KEF has encouraged senior management to think about opportunities in KE, complexity of the KE agenda, and has started discussions on where to focus in future. Concerns that this focus on areas of strategic importance may not happen if a link to funding was introduced					
Concordat brought a level of coordinated activity via action plans to address issues, notably in areas of governance, accountability, and staff development.	+	+			The Concordat is enabling knowledge management processes to refine/remove existing rules/routines
Concordat is too complex and difficult to explain to those working outside of KE, particularly to vice chancellors. Action plan form too long and complex	-	-			Complexity may be hampering the ability to develop shared mental models
Involvement in the Concordat exercise varied: only one person was involved in some HEPs, while a team was involved in others		+/-		+/	There is an issue with intra-team learning in some HEPs where only one person is involved in the Concordat exercise

Table 7Implications of stakeholder feedback on the Concordat, KEF and HEIF for HEPs as
learning organisations

¹¹ Data extracted from notes taken at 11 stakeholder engagement events undertaken between May-July 2022 as part of the Research England KE review.

¹² '+' indicates progress towards development of HEPs as learning organisations; '-' indicates issues impeding progress

Some saw evaluator feedback to the Concordat as polarised and could not be fully unpacked. Others viewed evaluators as overreaching on their feedback and possessing varying levels of ability/quality. Strong endorsement of ideas sharing from communities of practice/action learning sets rather than evaluator (peer) feedback		-		-	Evaluator feedback may not be an effective method of learning from environmental information . Community-organised knowledge sharing may provide a better alternative
There could be better opportunities in the Concordat for HEPs to articulate how their 'enablers' have helped them to improve performance in specific KEF categories, and for outcomes of Concordat initiatives to be evidenced in the KEF	-	-			There may be a performance management issue where cause-and- effect relationships between KEF measures and Concordat initiatives are not made explicit
KEF metrics do not align with the broader definition of the Concordat. Strong support for greater alignment between the Concordat, KEF and content required in HEIF eligibility, e.g. use of similar headings		-		-	There may be a learning from environmental information issue , caused by a lack of alignment between KEF, HEIF and the Concordat
Some believe that the KEF and Concordat should be kept separate, with the Concordat used for continual improvement and reflection, and KEF for KE performance/benchmarking. However, practices vary across HEPs, with some using Concordat/KEF to inform each other, while others just using HE-BCI data. The Concordat/KEF split is confusing to many non-KE personnel, contributing to perception of burden	-	_			There may be a performance management issue if the link between the KEF's retrospective measures and the Concordat's forward-looking measures is not recognised and used to drive improvement
KEF is difficult to understand and does not currently meet external partners' objectives, e.g. providing context- relevant rather than broad insight Concordat should be used for internal purposes within HEPs	-	-			There may be a performance management issue in that neither KEF nor the Concordat facilitate participation of a diverse set of external stakeholders in KE performance management and continuous improvement
Purpose of KEF for RE or Government is no longer clear, though there is a view that it should be the vehicle to support KE performance/ benchmarking		-		-	There may be a learning from environmental information issue , with KEF not signalling Government priorities
		HEIF			
RE's focus on Government priorities are sufficiently broad to use HEIF in flexible and tailored ways to meet HEP strategy, strengths, and capabilities. General support for priorities being set by RE and Government to direct HEIF funding if needed		+		+	HEIF enables flexibility to address Government/RE priorities, suggesting no issue with learning from environmental information
Flexibility, relative stability, and broad scope of HEIF enables HEPs to respond rapidly to new opportunities and experiment with new ways of working			+		HEIF encourages experimentation in approaches to KE

Scope of HEIF feels generally appropriate. There were some calls for capacity building funding for those HEPs who don't currently receive a HEIF allocation; funding to pump prime activity; small allocations of ongoing funding rather than one-off allocations; and expansion of HEIF to support capital expenditure, such as incubators		+	+		The suggested changes to HEIF allocation would represent a way of encouraging experimentation and boosting on the job learning
HEIF cap is a successful element of the allocation formula but can inhibit those HEPs at the cap from growing their activity		+/-		+/-	There may be a learning from environmental information issue , with HEIF not incentivising continuous improvement for HEPs at the cap
HEIF approach is sufficiently broad to align with breadth of activity across a broad sector. However, the use of income as a proxy for impact can lead to signals that income-generating activities should be prioritised over other KE		+/-		+/-	There may be an issue with learning from environmental information , with the use of KE income in allocating HEIF steering leaders focus towards income generating activities. However, the rise of the KEF has helped to balance this
KEF has encouraged senior management to think about the value of the breadth of KE and complexities of the agenda					effect
Need for greater financial incentivisation of collaboration to maximise existing capacity to address the Levelling Up agenda was flagged by some HEPs		-		-	There may be a learning from environmental information issue , as there is insufficient signalling of certain Government priorities via HEIF
Others noted that some Government priorities, e.g. student enterprise, are not sufficiently incentivised by the HEIF allocation method					
Delays in annual HEIF allocations, the dynamic nature of the formula leading to annual revisions, and the lack of inflation linked funding raises challenges for many HEPs in making strategic investment decisions, supporting ongoing supply/continual contracts for staff, and ensuring sustainability of KE activities	-			-	There may be an issue establishing shared visions where delayed HEIF allocations and real-term allocation reductions affect strategic investment and staff/activity continuity

It was clear from the engagement exercise data that stakeholders regard the Concordat as the main driver of continuous improvement in KE. Our analysis shows how the Concordat, KEF, and HEIF all influence the development of HEPs as learning organisations to enable continuous improvement. The Concordat is perceived as enabling (i) single- and double-loop learning; (ii) the emergence of shared mental models between staff and leaders concerning issues to be addressed; (iii) shared understandings of what activities constitute KE; (iv) knowledge management processes to refine/improve existing rules/routines; (iv) shared strategic visions for KE. KEF has also enabled shared visions for, and understanding of KE. HEIF provides critical resources that enable flexible responses to address Government/RE priorities, aligned with HEP strategies.

Stakeholders also identified a number of issues with the Concordat and the KEF, that are likely to hamper the movement of HEPs towards continuous learning and improvement, in particular:

- Lack of alignment between the Concordat and KEF for example in how forward looking measures in the former will lead to improvements in measured performance in the latter (i.e. the cause-and-effect relationship between enablers and performance)
- The complexity of the Concordat can make it hard to socialise it beyond those directly engaged in the process, making it harder to developed shared mental models for KE
- Both the Concordat and KEF are difficult to understand by those outside the KE system. This
 makes it harder to develop more inclusive approaches to learning and performance
 improvement
- It is hard to see how KEF creates links with key Government priorities, which reduces its potential to create signalling effects that shape the development of HEPs
- The nature of the feedback process for the Concordat could be improved and strengthened to promote action and community learning between HEPs.

HEIF is very positively viewed by HEPs overall, not least its breadth in scope, flexibility, and relative stability over the past decade. This has allowed HEPs to become more responsive to emerging opportunities (including Government priorities) and, crucially, experiment with new ways of working and delivering KE. That said, the following key issues were raised by HEPs in the engagement exercise which could dampen the incentives on HEPs to continuously learn and improve in KE:

- The cap, while broadly welcomed by HEPs reduces incentives on those institutions that are safely above it to continuously improve and innovate in how they deliver KE. The emergence of the KEF, which very publicly revealed performance differences amongst this group of HEPs (primarily those in cluster V), will likely have introduce a new incentive for this group of HEPs to learn and improve.
- The use of income as proxy for impact can create signals to senior leaders of HEPs (particularly those that are less engaged with the KE agenda) that are below the maximum cap to focus their KE efforts on income-generating activities at the expense of other valuable interactions. Again, the KEF may help to rebalance this effect for this group of institutions.
- While HEIF has been very stable over the past 15 years, the delays to annual allocations in recent years coupled with dynamic allocations and the lack of inflation-linked funding are creating strategic challenges for some HEPs with recruitment and retention as well as with strategic investments; both of which could dampen the ability of HEPs to pursue continuous learning strategies.

Contextualisation of KEF metrics

Stakeholders regarded KEF metrics as offering a broad oversight of KE activities within a HEP rather than providing insights relevant to the context of specific stakeholders. This is part of a wider issue with the field of scientometrics, where the choice and interpretation of science and technology (S&T) metrics in general, made via value-laden and political processes, emphasise a purpose of driving efficiency over facilitating debate in specific contexts or enabling collective learning in policy arenas (Barré, 2019; Ràfols, 2019).

Progress in improving the contextualisation of S&T metrics is limited, though a number of mechanisms have been identified that may help (Ràfols, 2019). Stakeholder engagement exercises can be used to achieve agreement between knowledge creators, users and beneficiaries on sets of *locally meaningful* indicators. Changes in indicator design – e.g. fine-grained topic classifications;

functionalities to enable digging into underlying data and algorithms to enable users to explore the robustness of descriptions, show contrasting dimensions, engage in critical reflexivity upon options against their values – can also help users choose and interpret forms of quantitative evidence relevant for their specific contexts.

Incorporating KEF and the Concordat into HEP performance management processes

Evidence from the stakeholder engagement exercise suggests significant variation across HEPs in the extent to which the KEF and Concordat have been incorporated into HEP performance management processes. Both instruments have facilitated the emergence of shared visions for KE, which ideally will inform the development or modification of KE strategies. However, while some HEPs report that KEF and the Concordat significantly inform each other, others report that KEF is not used in internal performance management processes. Further, some stakeholders favour maintaining a split between the KEF and Concordat as policy instruments – for performance measurement/benchmarking and continuous improvement proposes respectively – and it is not known whether this split is maintained at HEP level.

Literature from the field of performance management suggests that there are three modes in which performance measurement is used within organisational performance management processes (Neely, 1998):

- As a means of control versus critical, non-negotiable performance parameters. This broadly translates to the need for HEPs to demonstrate accountability for public funding
- As a means of checking health. This mode sees organisational strategy as a series of assumptions about cause-and-effect relationships intended to achieve organisational goals. The choice of metrics is intended to convey to internal and external audiences the extent to which these goals are being achieved
- As a means of challenging assumptions. In this mode, the validity of cause-and-effect assumptions are challenged, and changes made where necessary.

The extent to which the three modes are employed is linked to the maturity of performance management within an organisation. For example, while a less mature organisation may use measures linked to strategy as a means of control, a more mature organisation may have explicit cause-and-effect relationships established between the measures to facilitate health checking and assumption challenging (Franco-Santos, Lucianetti and Bourne, 2012).

What 'good' KE performance looks like

6 What 'good' KE performance looks like

This section examines what 'good' KE performance looks like, including the balance between HEPs investing in supporting and enabling a broad range of KE activities versus specialising in specific areas. In looking into these issues, we draw upon insights and information provided in previous chapters.

6.1 What 'good' KE performance looks like

In considering what 'good' KE performance looks like it is critically important to recognise that HEPs are not a homogeneous set of organisations. Evidence presented in the development of the KE clusters that currently underpin the KEF shows that they are a diverse group with very different knowledge bases from which to draw upon for the KE, different levels of resources and capabilities available to invest in and support KE, different strategic ambitions and particular history and evolution, and are based in very different local socio-economic contexts. All of these factors – some structural, others more easily changed – will shape 'viable KE opportunities' available to them and their staff/students, i.e. the types of partners they work with and the types of challenges and opportunities they work on together.

As discussed in section 2.7 we must also recognise the importance of capabilities of partners and wider supply-side and demand-side conditions in shaping the viable KE opportunities available to a HEP, and whether the *potential* for positive direct benefits and impacts on society and the economy are able to be translated into actual *realised* impacts.

Given this diversity of HEPs in the system it is widely accepted in both the academic literature and practitioner space that **there is no one-size-fits-all model for delivering effective KE** (see e.g. Allen and O'Shea, 2014; Baglieri et al., 2018; Benneworth et al., 2016; Kitagawa et al., 2016; McMillan, 2016; Philpott et al., 2011; Sánchez-Barrioluengo, 2014; Schoen et al., 2014), even for specific forms of KE such as technology transfer, research and innovation collaborations, or working with SMEs.

In considering what 'good' looks like at the level of the HEP we must also improve our understanding of how the actions and decisions of HEPs taken might shape and condition the KE journey at different points not least the ability of partners to realise benefits and impacts from their interactions with the process. This is critically important to ensure we are setting appropriate performance expectations when factors well outside the control of HEPs will ultimately determine whether the knowledge is able to deliver realised socio-economic benefits at the system level.

The lack of easily identifiable 'best' solutions to delivering high-impact, effective KE, coupled with the many issues identified in section 4 around how to measure the success of KE, suggests that we need to rethink what we mean by 'good' performance in KE. Building the evidence and insights presented in this report, we suggest that a 'good' and 'healthy' KE system is one that:

- Has in place key building blocks known to support different forms of KE this includes many of the 'ordinary' operational capabilities emphasised in the Concordat. While many of these building blocks will need to be delivered within HEPs, others may be best delivered through collaboration with others, or through purchasing or accessing the services of others.
- Is able to adapt and respond effectively to emerging opportunities and threats what academics refer to as 'dynamic capabilities' at the organisation level that enable HEP leadership (at relevant levels of the organisation) to identify emerging opportunities and threats, respond to them and develop / reconfigure organisational structures and resources to pursue them successfully. We know from our study of the effects of Covid pandemic on universities' innovation-focused that it is these capabilities that are important for strategic adaptation (Ulrichsen and Kelleher, 2022). This area is less well understood, less well incentivised, and less well captured in current performance measurement approaches (e.g. in the Concordat or by metrics)
- Is continuously learning and actively investing in seeking out ways to improve. This includes
 incentives and spaces (organisational and cultural) for sharing approaches, experiences, and
 learning. Note that this should not just be limited to KE professionals, but extended to
 university leaders, academics and their partners involved in the KE process. Insights from
 modern innovation policy research emphasise the importance of experimenting with new
 approaches coupled with deliberate efforts to learn from these experiences and share
 learnings and insights across the system.
- Is actively seeking to reduce barriers and strengthen enablers to exchanging knowledge effectively with partners in the economy and society to unlock additional socio-economic benefits. This will involve more active learning and reviews about obstacles and the root causes of these, adopting a systems-approach to identifying why these exist, who is causing them (looking beyond HEPs) and what can be done to alleviate them. Note this needs to be done in a fair and balanced way that *maximises societal benefits* from knowledge transfers and exchanges rather than a sole focus on the maximising the private benefits to individual or group.
- That sees the **knowledge assets generated and held within HEPs being utilised by partners** in the economy and society to deliver positive economic and societal benefits. An important question here is whether there should be an incentive for at least part of the benefits to be realised in the UK.
- That enables and incentivises HEPs to **develop locally relevant and appropriate strategies and approaches** to delivering KE.

The above should be considered at different levels: from the operation of the national KE system as a whole, specific regions, groups of HEPs, or at the individual HEP and even sub-HEP levels.

6.2 Balancing breadth versus depth in KE

The KEF review highlighted a perceived issue where the approach of allocating HEPs a position across the sector based on performance on a wide range of KE metrics, could unintentionally incentivise HEPs towards pursuing a strategy of delivering across the breadth of KE activities rather than specialising in those areas most relevant and strategically important to them (Research England, 2022b, p.78).

In considering this issue we need to reflect on what drives decisions of partners to engage in KE with a particular HEP. This will likely be shaped by the desire to access **specific sets of knowledge and expertise to solve a particular problem** they face or open up a new opportunity for delivering some benefit to their stakeholders. This in turn will likely be shaped by the **type of partner** (e.g. large companies, SMEs, public sector organisations, charities, government departments, and their capabilities/innovation ambitions etc.) and the **sectors they operate within** (which will shape the nature of the innovation challenges and opportunities faced). Collectively, these factors will shape the appropriate KE mechanisms that need to be established to deliver the opportunity (e.g. whether through a piece of collaborative research or consultancy, or by providing training etc.).

As such it perhaps unsurprising that most HEPs have some level of activity across most KE mechanisms, and most disciplines have some level of activity across the breadth of KE mechanisms. There are obvious exceptions, for example, with spinouts and IP licensing, where these are (currently) much more strongly linked with certain the impact journey of certain types of knowledge bases (often in the STEM disciplines) (Hughes et al., 2016a). Where we see greater variation with the types of partners and sectors HEPs work with through KE.

Given this, the specialisation of HEPs is perhaps better considered through the lenses of knowledge and expertise, partner type, and sector, rather than a KE mechanism lens. This implies that most HEPs could be expected to deliver excellent and effective KE across a wide range of mechanisms, with the exception of certain specific channels e.g. spinouts and IP licensing. Deploying funding to reward and incentivise effective knowledge exchange

7 Deploying funding to reward and incentivise effective knowledge exchange

In this final section we reflect on the following key questions with respect to how Research England funds KE:

- 1. Are there objectives other than rewarding/incentivising performance that UKRI should consider in devising a model for institution-level KE funding?
- 2. Are there better means to align allocations and evidence of success of the programme?
- 3. Income is the best proxy UKRI has for the impact of KE activities on the economy and society. However, it has a downside that it might appear to incentivise HEPs to focus on income not outcomes. What means are there to increase focus on measurable outcomes?

In addressing these questions we draw upon insights and evidence presented throughout this report.

7.1.1 Objectives for institution-level KE funding

Research England's funding for KE can broadly be separated into funds allocated by formula (e.g. HEIF) requiring periodic accountability statements to be produced, and those allocated on a timelimited project basis (CCF, UKRI SIPF, RED Fund etc.) following a competitive process and/or expert panel review. In addition the KEF and Concordat provide wider framework focused on performance measurement and improvement.

Rewarding performance in ways aligned to Government priorities

The current method for allocating HEIF in particular focuses on awarding funding based on realised KE performance, making an adjustment for the amount of activity undertaken by a HEP with SMEs (reflecting the particular value of such engagements but significant additional challenges in doing so). It requires HEPs to produce accountability statements which include requiring them to invest HEIF funds in line with key government priorities. This method attempts to incentivise 'performance' in KE with HEPs performing better than their peers over the preceding three years rewarded with a greater allocation of HEIF, with signals provided to HEPs to align efforts around key government and RE/OfS priorities.

There are several limitations to this approach that are worth bearing in mind.

First is that effect of the maximum cap on HEIF on incentives for HEPs to improve performance in KE (as measured by KE income) is significantly reduced for those institutions safely above the cap with little risk of falling below it.

Second, the sole focus on past KE performance may struggle to accommodate large and uneven system-wide shocks, such as the financial crisis and the most recent Covid-19 pandemic. These are increasingly recognised as becoming non-negligible forces shaping the environments in which

different actors and innovation systems operate (Li et al, 2021). We know from a recent study by UCI (Ulrichsen and Kelleher, 2022) that the ongoing effects of the pandemic on universities and their innovation-focused KE activities have been uneven across HEP-types, with large, research-intensives HEPs recovering much faster than smaller, more teaching-focused institutions. Similar effects were seen after the financial crisis. Certain sectors (e.g. aerospace, creative industries and hospitality) and types of partners (SMEs and charities) have been more negatively affected by the pandemic. The onset of austerity following the financial crisis saw public and third sector demand for KE reduce significantly. HEPs heavily exposed to these types of partners and sectors will be facing much greater pressures to adapt and find new opportunities for KE. As we suggested in Ulrichsen and Kelleher (2022) there is a danger that capacity and capability to deliver KE is lost during this process of adjustment and is hard to rebuild.

Third, the focus on performance coupled with the minimum qualifying KE income to secure HEIF means that some HEPs do not receive any HEIF at all. If effective KE requires some level of KE support, a question emerges regarding how such HEPs are able to invest in order to improve their KE performance to reach the qualifying income threshold.

Fourth, while we are not aware of research that has established differences in the cost-base of delivering effective KE it is possible that HEPs located at significant distance from natural partners for their knowledge (e.g. HEPs located at distance from major industrial, innovative and entrepreneurial hotspots) may experience greater challenges and incur greater costs associated with searching for, securing, and delivering effective KE opportunities. While such costs are likely to be reducing due to the increased use of virtual collaboration tools, they are likely not eliminated. This may be offset due to increased costs typically associated with operating in dynamic economies. If this is shown to be an issue, a pure income-based approach to allocating funding would not account for the different 'input costs' for delivering KE.

Fifth, we know that certain types of KE activities are less likely to generate income, or generate income significantly less than full economic costs reflecting market and system failures that result in partners being unable to pay full costs for services that would otherwise lead significant benefits to society (key rationale for government intervention). Such activities may be more common if HEPs pursue certain types of strategic objectives, such as local economic renewal in areas that are heavily dominated by SMEs. In such cases an income-based approach to allocating funding may struggle to create alignment between a government priority (e.g. around levelling up) and incentives for HEPs to prioritise such effort.

Finally, as discussed earlier, the government priorities around which HEPs are required to invest HEIF around are relatively broadly defined. It is likely that much of a HEP's KE activity could be justified as aligned to at least one of these priorities. As such, it is not clear, *a priori*, whether these priorities would have much effect on the behaviour of HEP KE leaders in how they are allocating their funds. The introduction of specific pots of HEIF tied to specific priorities (e.g. the uplift specifically focused on delivering the industrial strategy) will likely create a much stronger effect on internal priorities and resource allocation decisions.

Overcoming these limitations could be tackled in different ways. While some could feasibly be tackled through adjustments to formula funding for KE, we should not expect to solve all through this single funding scheme. For example:

- Adjustments could be made to the formula to attempt to account for some of these challenges such as incentivising greater challenges of operating far from key markets or to address place-based priorities
- The signals for HEPs at the maximum cap to improve performance could be addressed through the KEF, which introduces (potentially significant) reputational risk to these HEPs, that may compensate for the weak signals from HEIF for these institutions to innovate and improve in how they deliver KE
- Absent of changes to the formula behind KE funding or the introduction of new funding schemes directly tied to Government priorities, signals to HEPs on the importance of investing aligned with delivering key Government priorities could be strengthened through more targeted periodic reporting requirements either through the Annual Monitoring survey or other efforts such as the KEF.
- Other competitive, project-focused funding schemes could be created aimed at providing HEPs without HEIF access to resources focused on getting them to the qualifying income threshold for regular HEIF allocations

Incentivising and rewarding learning to drive KE improvements

We have suggested through this report that there are number of purposes to KE performance measurement. This includes using measurement systems to as a means of 'control', monitoring progress and checking positions against benchmarks and targets, and as a means to check on the 'health' of the system, for example confirming organisational priorities are aligned with wider system goals and communicating progress and developments.

Often overlooked, yet critically important, is the role of performance measurement systems in providing insight and intelligence to drive learning aimed at improving continuous improvements. A healthy KE system will be one in which HEPs are able to identify and respond effectively to emerging opportunities and threats.

The current set up of funding and KE performance measurement systems is fragmented, with HEIF, KEF and the Concordat only weakly linked, which weakens the cumulative effect of the incentives each one is able to create around learning and improvement.

Further the Concordat is focused primarily on the development of the operational capabilities of HEPs to deliver effective KE. Equally important are the strategic 'dynamic' capabilities that allow HEP leaders – at different levels of the organisation – to identify emerging opportunities and threats, seize them, and (re-)configure their organisations to go pursue them successfully. These capabilities were shown to be very important in enabling HEPs to adapt to the Covid crisis. Overall we need to think further about how the system of funding and incentives can help HEPs to continue to develop and improve these sets of capabilities as well their ability to deliver existing opportunities.

7.1.2 On income as a proxy for impact and alternatives

The advantages and limitations of using income as a proxy for impact in KE are discussed in some detail in section 4.3.3. In summary, KE income-based measures have a number of advantages not least of being comparable across HEPs, providing a measure of 'implied demand' for those activities for which there is a monetary transaction. It follows a growing trend in the research and innovation

evaluation literatures in focusing on monitoring 'trajectory' measures rather than final impacts reflecting the many challenges in measuring the latter.

Nevertheless, income-based measures suffer from some important limitations. This includes not capturing valuable KE activities where there is no monetary transaction but nevertheless value is realised by those engaging with the HEP (e.g. an SME receiving a free training course). This can be a significant issue if the object of the performance measurement exercise is to examine KE performance in that particular area. The use of income-based measures also has the potential to send confused signals to HEP leaders regarding the prioritisation of high income-generating KE activities over others. The latter is likely more pronounced for those HEPs not safely within the HEIF maximum cap, where prioritising KE activities with potentially lower socio-economic value but higher income-generating potential could lead to an increased funding allocation.

Once again, it is important to consider the purpose of KE performance measurement. For allocating funding, one needs a robust *proxy* measure for success that allows for the distribution of performance across of HEPs to be estimated. Additional information should be included if it would alter in some way the distribution of HEPs. The potential for mixed signals could be combated through other elements of the funding allocation method, such as information required in the accountability statements, or through other incentive systems such as the emergent KEF and Concordat.

If the purpose is evaluating and *demonstrating* KE success, it may be important to move beyond the primary focus on income-based metrics. Here it may be as important to reveal not just relative differences in aggregate performance across HEPs, but also to provide an understanding of the types of direct benefits and longer-term systemic impacts arising from KE (at the system-level or individual HEP-level).

As discussed in section 4, a clear and transparent framework can help guide additional data collection efforts to create a *system* of evidence and insight capturing and tracing the KE journey from investment to impact able to inform our understanding of KE performance and success. It can help to position income-based metrics alongside a wider range of metrics and information (quantitative and qualitative). This system of evidence should also include efforts to enable greater contextualisation of data. Furthermore, the system should be designed not just to monitor progress and demonstrate success, but also to provide a vehicle to enable and incentivise organisational learning and continuous improvement.

Furthermore, we must recognise that not all data and information need to be collected on the same timescale (e.g. annually). As we move further away from the outputs to examining the direct benefits and wider impacts of KE, and for areas where the object of study is known to be very stable over time, it is likely sufficient that data is collected only periodically. Such studies could focus more on understanding in depth the journeys from activities to changes in capacities and behaviours, direct benefits and impacts, providing evidence on the how the 'trajectory' measures (captured more regularly) lead to realised benefits and impacts, and what factors enable and condition success. These studies would in effect assess whether the trajectories remain valid. This would likely provide greater assurance to Government that impacts will continue to be realised if the various trajectory measures continue to be maintained. Such studies could draw on more traditional data

collection methods such as surveys and case studies as well as exploring more emergent methods such as AI and machine learning tools applied to novel data sources.

While all data and information points do not need to be collected on the same timescales, the data collection *cycle* (e.g. 5 years) should be regular and set out clearly how and when different types of data will be collected and updated. In addition, different data collection exercises need to be designed to allow for integration with each other to enable an overall assessment of KE performance over the data cycle.

Currently there are some concerns that the various activities that involve the gathering of KE data, from HE-BCI to the KEF, KE Concordat, HEIF accountability statements and annual monitoring statements, REF impact case studies, commissioned evaluations etc. are effectively standalone exercises with little interoperability between them to enable a wider and strategic system of intelligence for capturing and demonstrating the performance of KE (whether at the system or HEPlevel). Given this, it would be useful to first examine how these various data collection systems could be better integrated to enable a more holistic assessment of KE performance.

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Appendix A: Illustrative examples of KE initiatives

KT organisational factor targeted		Illustrative examples of types of initiatives by primary organisational factor targeted and KE focus						
		Technology transfer only	Academic engagement only	Combinations of specific academic engagement <i>and</i> transfer mechanisms	Breadth of KE or mechanism agnostic	KE opportunity driven		
Leadership and strategy		Insufficient examples	Identify strategic, user-relevant and engaged research and innovation challenges Adopt new leadership roles in regional innovation system	Strategic priorities incorporate multiple KE pathways combining both commercialisation and other mechanisms Prioritise building longer term, multi- faceted strategic partnerships	Create KE leadership roles	Become more strategically		
					Foster research-KE synergies	responsive to user needs		
					Engage with external stakeholders to inform strategic decisions	Systematically map internal capabilities to external opportunities to guide strategic priorities		
					Consultative KE strategy development process			
Culture and incentives		More generous royalty sharing schemes	Insufficient examples	Insufficient examples	Introduce KE into promotion	Insufficient examples		
		Introduce funds to huy out academic			Account for KE in workload planning			
		time to start new ventures and exploit			Clear statements of expected values			
		research outcomes Reduce transaction costs facing			Efforts to raise awareness and legitimacy of KE			
		academics engaging in			Create awards for impact through KE			
		commercialisation Introduce commercialisation prizes			Establish or strengthen performance targets & strategic oversight for KE			
Structures and programmes	Dedicated support units and enabling infrastructure	Strengthen commercialisation offices and support functions	Establish dedicated support functions for specific KE mechanisms	Integrate commercialisation and other KE support offices into single structure to better coordinate support	Develop offices to internationalise delivery of KE	Create sector-focused units to bridge needs with academic expertise and tailor KE to opportunities		
		Develop wider commercialisation			Establish clear access portals and signposting into the university for potential users (e.g. identifying available expertise, resources and IP, and suitable mechanisms)			
		infrastructure (e.g. science parks, incubators, accelerators)	Develop dedicated support for large- scale research and KE initiatives					
		Provide dedicated support units for student entrepreneurs						
	Institution-wide centres & uni level KE collaborations	Multi-university collaborations to deliver technology commercialisation infrastructure and support	User-engaged research centres and institutes focusing on advancing technologies towards application	User- engaged and challenge-driven research and innovation centres and institutes involving both research and commercialisation activities	Build multi-university collaborations for delivering KE and support functions (including shared services)	Major redevelopment of university campuses to foster translational research and KE		
			Regional multi-university collaborations to support SMEs					
			Multi-university consortia focusing on translating research into applications					

Table 8Illustrative examples of types of organisational initiatives

	Dedicated funding and linkage-building	Provide funding for the commercial development of research (e.g. proof-of- concept, funding for early stage ventures	Establish industry-academic fora and networks	Develop industry-specific networks to facilitate access to research and intellectual property	Programmes to engage alumni to support KE Dedicated funding for pilot experiments exploring routes to commercial application	Rapid reaction funds to respond to new opportunities in KE
Dedica fundir linkag			Provide more flexible resources to work with industry			
		Develop networks of business angels and mentors	Embed Professors-of-Practice amongst academics			
		Embed Entrepreneurs-in-Residence	Foster staff exchange between universities and firms			
Ot	Other KE programmes	Insufficient examples	Programmes to support regional SMEs' access to overseas markets and firm competitiveness	Fixed-term, internationally focused translational research and technology transfer programmes	Insufficient examples	Insufficient examples
pr			Co-locate economic development partners and other innovation support providers on campus	Fixed-term programmes to address specific opportunities in industry (particularly SMEs) through multiple KE pathways		
	pproaches		Strengthen dialogue with users to inform research, teaching and KE	Introduce holistic approaches to develop partnerships and progress	Standardisation of interaction processes with business across breadth of KE to make university 'easy to do business with' Improve management information across range of KE Improve processes for reviewing grant applications to incorporate KE element	Work closely with users to shape KE products and services
		Streamline commercialisation processes		relationships to become strategic Streamline processes across research- translation-commercialisation		Improve management tools to signpost target users to relevant KE opportunities based on needs
		Outsource of commercialisation	Streamline academic engagement processes			
Practices and appro		other universities	Develop flexible approaches to working with industry Proactively engage students in other KE mechanisms	Strengthen feedbacks and synergies between commercialisation and		Improve processes to link KE opportunities to relevant internal expertise and resources
		More systematically engage students in commercialisation				
				Establish clear university-wide framework and guidance for KE		Establish processes for KE pilot programmes to become mainstream
	lity development	Provide formal enterprise and entrepreneurship training for staff,	Provide formal training programmes, seminars and workshops for academics looking to engage through other KE mechanisms	Establish professional development courses for academics to develop their capabilities to engage in	Embed KE champions and mentors within academic body	
Internal capability d		Provide informal mentoring for staff,			Provide training and workshops for academics to support pathways to	Insufficient examples
, ,r -		Students seeking to start new ventures	Provide formal training programmes for different types of professional	different types of KE (e.g. developing	impact from their research	
		commercialisation support staff to professionalise and improve their skills	support staff to professionalise and improve their skills	su arcgic hai mersinihsi	Establish KE networks supporting peer learning	





Policy Evidence Unit for University Commercialisation and Innovation

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