A Quantitative Assessment of the Return on Investment of Research England's Higher Education Innovation Fund (HEIF)

A technical report for Research England

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1 Introduction

This report aims to assess the economic impacts arising from the Higher Education Innovation Fund (HEIF). HEIF is managed by Research England and in 2022/23 allocated £280 million via a formula to English Higher Education Providers (HEPs) to build their capacity and capabilities to support and develop knowledge-based interactions with external partners to deliver economic and societal gains. These *knowledge exchange* (KE) interactions are known to deliver a wide range of benefits to partners in the private, public and third sectors (see e.g. Hughes et al., 2022; PACEC/CBR, 2009), and generated £4.5 billion for HEPs in receipt of HEIF in 2022/23.

Evaluating the impacts of HEIF is challenging, not least because most HEPs receive at least some funding. This precludes traditional control group analyses to gain insights into the counterfactual; a critical question of any evaluation that seeks to understand what have happened in the absence of funding. To overcome key challenges, the study built on previous assessments of HEIF impacts (Ulrichsen, 2015a, 2020), and deployed multiple quantitative methods to investigate the fund's impacts and return on investment (ROI), including:

- An assessment based on the expert insights of senior KE leaders on the attribution of KE outcomes to HEIF investments;
- The construction of 'quasi-control groups' based on differences in the amounts and changes to HEIF received by HEPs over time to examine whether KE performance is systematically different between groups; and
- The development of regression models to explore the relationship between KE performance and HEIF investments.

Through this mixed quantitative approach, the study sought to triangulate evidence on the strength of the economic impacts of HEIF, and increase the robustness of its conclusions.

The study focuses primarily on the period 2017/18 – 2022/23. This period marked the beginning of a period of significant increases in HEIF, from around £160 million per annum across the period 2014/15 to 2016/17, to £210 million in 2018/19, and £280 million in 2022/23. This period saw significant and growing turbulence and uncertainty in the Higher Education (HE) sector, not least from the aftermath of the decision to leave the European Union, the Covid-19 pandemic, the cost of living crisis, wars in Ukraine and the Middle East, and rising geopolitical tensions.

The report is structured as follows. Section 2 first sets out a conceptual framework for investigating the impacts and ROI for HEIF. Section 3 then turns to setting out the overall approach to assessing these impacts and ROI, and the specifics of the various methods and data used. Section 4 begins the presentation of the empirical evidence by investigating key trends in both KE income and HEIF. Section 5 then presents the findings from each of the key approaches on the impacts and estimated ROI of HEIF. These include a method leveraging expert insights from senior KE leaders; a method that attempts to build quasi-control groups; and a series of regression models. Section 6 extends the impact analysis to investigate the more

specific policy performance measure of private leverage. Section 7 undertakes a deep dive into the impacts of HEIF on, and through, student and learning-focused KE, reflecting the significant contributions made by the Department for Education to the HEIF budget. Section 8 summarises the key findings and concludes.

2 Conceptual framing

Before diving into the empirical evidence on the impacts and ROI of HEIF, it is important to first understand how HEPs fit into the wider innovation and socio-economic systems, the role of KE in enabling benefits to be realised, and how HEIF acts, often alongside other resources, to support the KE process.

2.1 Situating higher education providers within the innovation system

To guide our thinking about how HEIF invests into HEPs and delivers impact through KE, it is helpful to first situate HEPs within the system formed around the purposeful development, exchange, diffusion and deployment of knowledge to deliver economic and societal gain. Innovation systems frameworks provide a valuable lens through which to examine this.

At the core of the innovation systems approach are processes of knowledge generation, diffusion and deployment. This process is shaped by the systems 'structure', which typically distinguishes three core elements. The first element consists of the *actors* whose behaviour takes place within the system. 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, community groups and individuals, and many others.

The second element is the *institutional architecture* within which activities occur and which shapes agent choices and behaviours. This encompasses 'hard' institutional elements such as contract, labour, and intellectual property law, and standards and regulation, as well as 'softer' informal norms and rules of the game governing interactions such as culture. The third element is the set of *interactions* between agents that take place within the institutional framework. These interactions go beyond arms-length market interactions 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 knowledge-based infrastructures provided by private and public sector agents.

Innovation systems frameworks also emphasise the importance of the interdependence between the supply side of the system in generating new knowledge (dominated in the UK by HEPs) and the demand-side. Strengthening the system requires not just attention on the supply side, but also efforts to ensure the incentives, resources, and capabilities of knowledge users (e.g. companies, public sector agencies, hospitals etc.) enable them to effectively with knowledge producers to exchange, co-develop, and exploit emerging knowledge and ideas to solve problems that deliver impact.

Within this broad innovation systems framework, English HEPs form a core part of the critical knowledge infrastructure of our nation (Edquist, 1997). They are one of the primary actors in our system creating the variety of underpinning knowledge and technological alternatives from

which actors operating in competitive markets can select and further develop. They are also typically very stable organisations, and relatively neutral environments. This has been shown to help create 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).

Academic and practitioner studies examining how universities contribute to innovation through KE have identified a variety of areas where they impact. Through more direct linkages with HEPs, organisations may be able to develop and enhance *technologies and capabilities* that feed into different stages of their innovation processes, from early stage technology development to scale-up, production, logistics, marketing and sales (Bercovitz & Feldman, 2007; Cohen et al., 2002; Hughes et al., 2022; Lee, 2000). These interactions are also known to touch many sectors of the economy, stretching well beyond manufacturing and product driven sectors to include service-based and public sectors (Cohen et al., 2002; Hughes et al., 2022; Laursen & Salter, 2004; Salter & Martin, 2001).

HEPs also have a role to play in strengthening the *conditions and capabilities* of the wider system that are important for enabling innovation and the diffusion and exploitation of ideas and knowledge for productive uses (Breznitz & Feldman, 2012; Gunasekara, 2006; Ulrichsen, 2015b; Uyarra, 2010; Youtie & Shapira, 2008). Examples here include providing strategic insights and intelligence to inform regional and national sector and technology strategies; providing regional leadership alongside key stakeholders; building skills of the workforce, locally and nationally; 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.

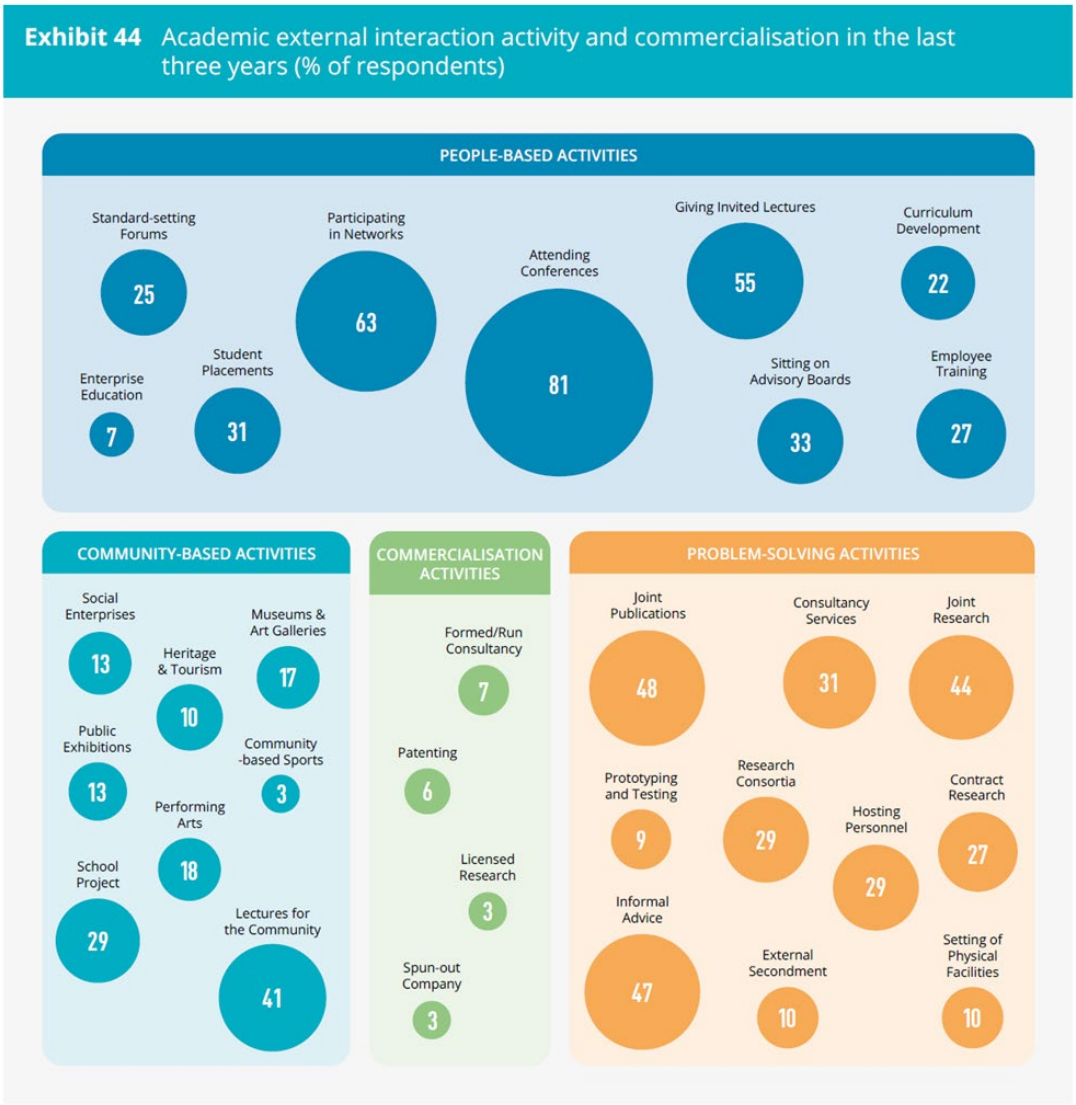
2.2 The role of knowledge exchange

The past twenty-five years or so have seen HEPs become more strategically active in working directly with partners in the private, public and third sectors to deliver impacts on innovation and the economy and society. This has been facilitated by a significant increase in policy focus on, and public resources devoted to, helping HEPs build up their KE capacity, capabilities, and infrastructures. These developments have seen HEPs move well beyond their traditional knowledge diffusion mechanisms through scholarly publication and the movement of students into the labour market and dramatically expand their more *direct* interactions with partners to purposefully exchange, co-develop, diffuse and exploit knowledge for socio-economic gain. Importantly, these KE interactions are fundamentally shaped by the type of knowledge generated and held by HEPs, or accessible through them (e.g. through collaborations).

Studies have also frequently highlighted the many *mechanisms* through which knowledge is exchanged between HEPs and externa partners (see e.g. Hughes et al., 2016; Hughes & Kitson, 2012; PACEC, 2012; PACEC/CBR, 2009; Philpott et al., 2011). The volume and value of common KE mechanisms – collaborative and contract research, consultancy, continuing professional

development, new venture formation and IP licensing, regeneration and development programmes, and the provision of facilities and equipment services – are captured annually for all UK HEPs in the Higher Education Business and Community Interaction (HE-BCI) survey. However, these form a subset of a wider range of formal and informal KE mechanisms that have been identified that often involve academics, although may also be driven by other communities within the HEP (e.g. students, professional services staff, university leaders). Figure 1 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).

Figure 1 Coverage of HE-BCI survey metrics across the variety of KE mechanisms



Source: Hughes et al. (2016)

Some of these KE mechanisms emerge through what one might term *'KE-push'* engagements; opportunities that emerge as a result of the research activity undertaken within the HEP that seek out opportunities for real world application. 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 (co-)develop, access, acquire, and exploit 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 HEPs and non-academic organisations, for example co-investing in collaborative research projects.

2.3 Recognising the diversity of higher education providers in the system

It is also important to recognise that HEPs 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. HEPs are also home to 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.

Opportunities for KE are also shaped by the needs, capabilities, and conditions of the wider innovation, industrial, and socio-economic systems within which HEPs are based and 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 HEP (or group of HEPs).

HEPs 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 on different projects at the same time.

This diversity of institution is important, with HEPs 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.

An attempt to identify and cluster English universities into similar types was undertaken by the author (Ulrichsen, 2018, 2023). 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. A statistical cluster analysis was then applied to broad discipline HEIs and resulted in five clusters of HEPs which had broadly similar structural characteristics within each cluster that are likely to affect how they engage with external

partners to develop, exchange and deploy knowledge. These clusters now underpin the English Knowledge Exchange Framework (KEF) for English universities.

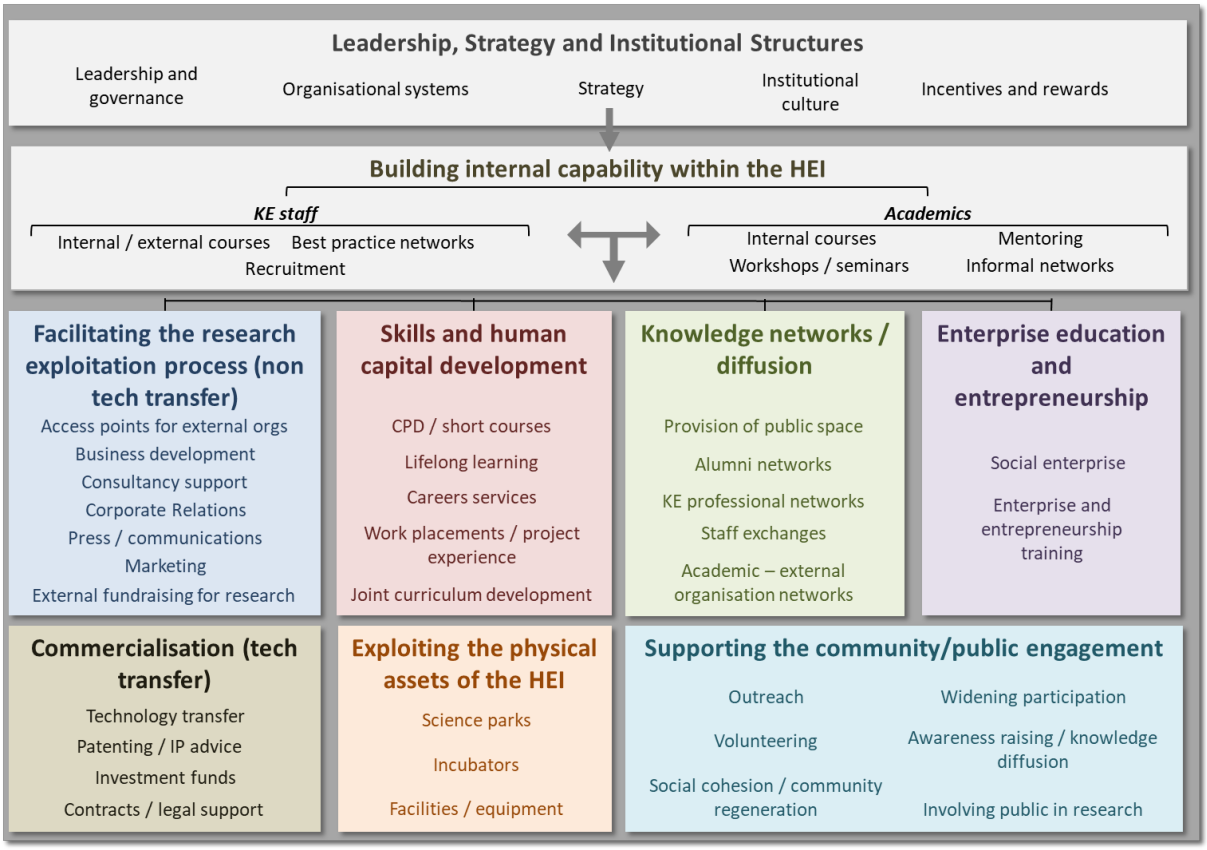
2.4 The function of HEIF in enabling knowledge exchange

The past few decades have seen many HEPs – often backed by HEIF in English HEPs – invest in building up their capacity and capabilities to engage in KE. The systems of support being put into place typically cover a wide range of types of KE, well beyond technology transfer. There is mounting evidence – from academic studies, funding programme evaluations, and practitioner experiences – that suggests that these efforts to better support KE are having some effect (Galán-Muros et al., 2017; Galán-Muros & Davey, 2017; PACEC/CBR, 2009; Perkmann et al., 2013; Ulrichsen, 2015a).

Figure 2 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 HEPs looking at the system of KE 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 2 Framework capturing the types of support for KE being developed within English HEPs



Source: Ulrichsen (2020)

HEIF is one of the core sources of funding for many English HEPs for building up their long-term capacity and capabilities to support and enable KE. A distinguishing feature of this funding is that it is provided to HEPs as institutions to allocate flexibly based on their strategic priorities and local needs and within broad government priority areas.

However, the role of HEIF must not be seen in isolation from other policy instruments aimed at accelerating the translation, exchange and exploitation of knowledge generated and stored within HEPs. This includes, for example, funding programmes explicitly aimed at supporting KE projects and the translation of ideas from research into applications; incentives (e.g. the Research Excellence Framework and grant award criteria) aimed at shaping the behaviours of both individual academics and HEP leadership; and funding programmes (e.g. those distributed by Innovate UK such as Knowledge Transfer Partnerships) aimed at stimulating the demand side and providing resources to businesses and others to engage with HEPs.

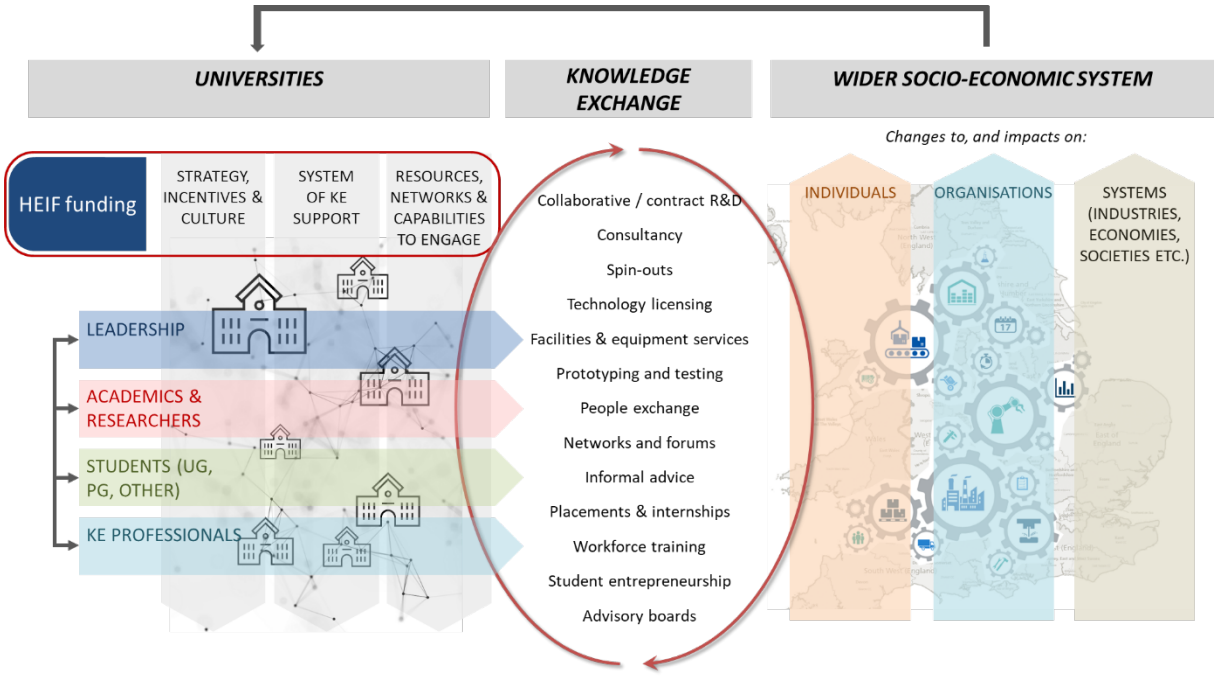
In effect, a key role of HEIF in providing resources to HEPs to build up their core infrastructure and capabilities to deliver KE, is to make specific KE interactions – often funded by other resources – more efficient and effective.

2.5 Analytical framework

These various insights are brought together in the analytical framework for thinking about how investment in HEIF can support HEPs to deliver KE that delivers positive socio-economic impacts (Figure 3). It positions HEPs as one of the organisations in a wider socio-economic system built up of individuals and organisations operating in different private, public and third sectors and based in specific local socio-economic contexts. These organisations and individuals are confronted by different opportunities and challenges. HEPs and partners (organisations and/or individuals) in the wider socio-economic system interact to (co-)develop, exchange, deploy and exploit knowledge aimed to pursuing these opportunities or addressing challenges that result in impacts variously on individuals, organisations and potentially at the system level. These KE interactions can take many forms and provide the channels through which knowledge flows between knowledge producers and knowledge users.

HEPs themselves have multiple internal communities that either engage directly in, support, or influence the KE process. These variously include the HEP leadership, academics and researchers, students, and KE professionals. KE activities and support require resourcing, with HEIF funding providing important resources to HEPs at the organisation-level to invest based on strategic priorities and local needs to build up their capacity and capabilities to support and deliver KE that results in positive economic and societal benefits.

Figure 3 Analytical framework



3 Approach, methods and data

3.1 Overall assessment approach

Logic model frameworks have been developed to provide guide and structure these types of assessments, capturing different stages of the journey from investment to impacts. A generic evaluation logic model for KE depicted in Figure 4 distinguishes between the ***inputs*** into the process of forming and delivering ***KE activities*** that seek to exchange knowledge with the aim of delivering positive gains to the economy and society; the ***KE outputs*** that directly emerge from these activities often in the form of goods and services delivered (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) I refer here to direct benefits realised by those engaged in the KE process, and longer term, cumulative and systemic benefits accumulating in the system, rather than immediate and intermediate outcomes and final impacts; labels which are frequently used in evaluation logic models. I believe this can provide a more intuitive understanding of the development and realisation of positive changes resulting from KE rather than trying to disentangle benefits based on specific time points in their emergence and accumulation.

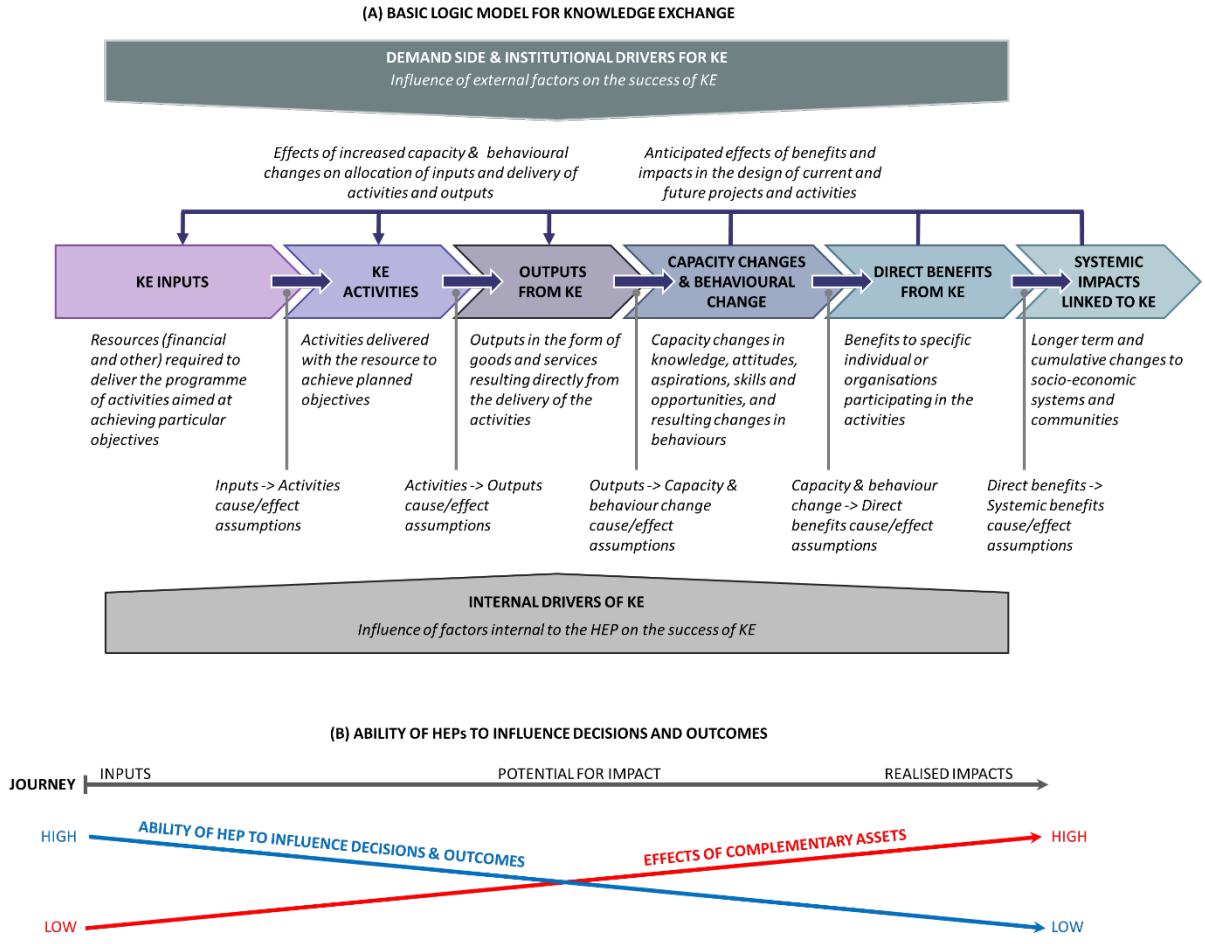
Note also that the logic model is depicted in a sequential, linear manner for simplicity. Although there is naturally some logical progression from inputs to impacts, there are many interdependencies and overlaps between different stages. Crucially, given the nature of HEIF funding, there are important feedback loops between the effects of HEIF on capacities, capabilities and behaviours of HEPs, staff and students on their ability to deliver KE more effectively and efficiently in the future.

We must also recognise that, as with any investments in public R&D and early stage innovation, there are typically long time lags between investing in the KE activities that work to translate, exchange and deploy ideas and knowledge assets from the university base in the real world, and impacts being realised (Hughes & Martin, 2012). Furthermore, for KE projects to realise actual real world impacts, they will typically require investments of time and effort by others, integration with other pieces of knowledge and assets, and may be shaped and constrained by wider forces outside the influence of the HEP (e.g. market forces, company decisions, government policies, legal systems etc.) (Hughes & Martin, 2012). 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 the further the journey progresses.

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.

Figure 4 Framework for investigating the success of KE for performance optimisation



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

Given these significant challenges, evaluations of research and early stage innovation funding programmes, including previous evaluations and assessments of the impacts of HEIF have focused on 'trajectory measures' that capture whether knowledge is being exchanged efficiently and effectively, and whether there is evidence that it is being productively used (Hughes & Martin, 2012; Molas-Gallart et al., 2016; Ulrichsen, 2015a).

At the heart of any evaluation of impacts realised from public investments and interventions is an assessment of the extent to which the realised benefits and impacts would have happened in the absence of the investment or intervention; i.e. that they are additional to what would have happened anyway. This is known as the *counterfactual*. Realised gross impacts therefore have

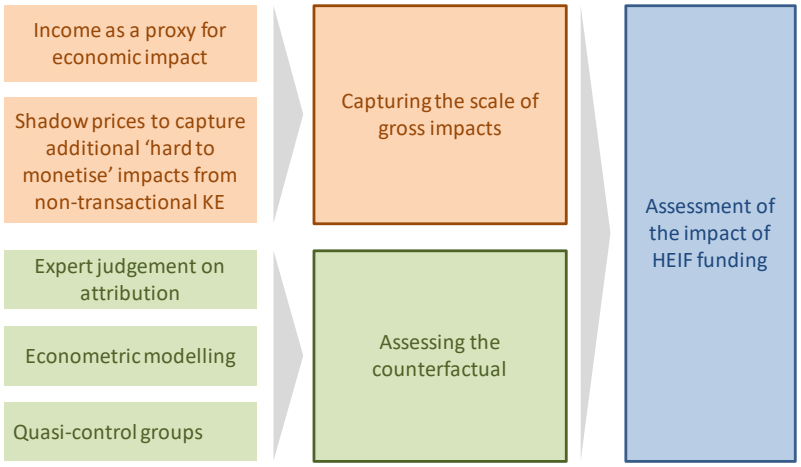
to be adjusted for this to estimate the *gross additional* impacts. Furthermore, any displacing effects of the intervention on private sector activity also needs to be estimated, resulting in an understanding of *net additional* impacts realised. In addition, in estimating an ROI for HEIF, there is a need to monetise impacts realised, in order to compare against investments made.

Both of these tasks present significant challenges (Hughes et al., 2011; PACEC/CBR, 2009; Ulrichsen, 2015a). Core to the first of these challenges is findings ways to assess what would have happened in the absence of the policy investments. This presents particular challenges in the case of HEIF funding, not least because most HEPs receive at least some funding meaning that there are no natural 'control groups' against which to compare a 'target' group for the policy investments. HEIF also typically provides investments into HEP KE capabilities and capacity that help to seed KE projects that may well secure additional financial and other resources from other sources. Furthermore, realising the impacts of KE activities enabled and supported by HEIF will likely require investments and actions of others well beyond the HEP. All of these factors make disentangling the effects of HEIF from other factors incredibly difficult.

Core to the second of these challenges is both in understanding the nature of the impacts arising on different groups (including internally within the HEI, and externally on the economy and society) *and* in estimating the monetary value of impacts to allow for comparison and aggregation between and across impact types and HEIs.

The paper has therefore deployed multiple methods to triangulate towards a robust assessment of the impact and ROI of HEIF. The different methods are shown in Figure 5 and are discussed below.

Figure 5 Mixed method approach for exploring the impacts of HEIF



Source: Ulrichsen (2015a)

3.2 Measuring gross impacts arising from knowledge exchange

This paper follows previous studies evaluating and assessing the impacts of HEIF (e.g. PACEC/CBR, 2009; Ulrichsen, 2015a) and uses the KE income generated by HEIs as a *proxy* for the gross economic impacts derived by users from their KE engagements with HEPs. This reflects the challenges highlighted in the previous section, not least relating to the significant time lags between investment and long-term systemic impacts; the importance of factors well beyond the control of HEPs in shaping and influencing the process; and the many and varied impacts realised through KE the specific nature of which will vary from one HEP to another, and many of which will lack any monetary values attached to them.

I have argued previously (Ulrichsen, 2016) that the income realised through KE provides an important indication that valued linkages are forming between the university base and the wider economy to diffuse and exchange knowledge. The core assumption here is that, if reasonably well governed and accountable organisations in the private, public and third sectors willing to pay for a service (here KE-related), they must believe they are deriving value from it in some way. At minimum therefore, KE income represents implied demand for the capabilities and expertise available within universities.

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.

Importantly, assuming that the extent to which the price paid for different types of KE is at least proportional to its economic value, KE income can also be aggregated across different mechanisms and, importantly, compared across institutions.

Of course, this approach has its challenges, including not least:

- It struggles to give any significant insights into the nature of the impacts realised;
- There are KE activities for which no monetary transaction takes place, and that the price paid may not even reflect the full economic costs of delivering them; and
- Income-based measures as proxies of KE impacts may also vary across disciplines, reflecting not least the differences in costs in delivering KE between disciplines.

3.2.1 Capturing the impacts from non-transactional knowledge exchange activity

A common critique of using KE income as a proxy for the economic impact of HEIF is that it fails to capture the effects KE activities that do not involve monetary transactions. This may be, for example, due to the well-known market failures associated with some organisations (e.g. SMEs, charities) being able to access the necessary resources to invest in innovation resulting HEPs providing services at lower prices (or for free) to this community.

Following previous assessments of the impacts of HEIF by this author (Ulrichsen, 2015a, 2020), this study attempts to confront this issue by exploiting evidence assembled in a 2015 study exploring the extent to which hard-to-monetize benefits were being realised from HEIF-funded KE activities (PACEC, 2015). It showed that while some KE activities of a particular type (e.g. contract research or consultancy) involve monetary transactions (and hence generate income based on a negotiated price for the services provided), others do not. Helpfully this study provided information on the proportion of different types of KE activities that do not involve monetary transactions. By assuming that partners would pay a similar price if markets were working well, we can treat the monetary value of those KE activities of a particular type that do involve priced transactions as a quasi 'shadow price' for those of the same type that do not.

Replicating the methods developed in Ulrichsen (2015a), this allows an approximate estimation of an additional component of the ROI due to this subset of KE activities that do not involve monetary transactions. This additional component can be added to the ROI estimated using the core income-based method.

3.2.2 Capturing the impacts of spinouts and startups

The income-based approach of assessing the economic impacts of HEIF is also particularly weak in capturing the effects of new ventures emerging from HEPs (either to commercialise intellectual property in the case of spinouts, or startups resulting from academic and student entrepreneurship). Helpfully, additional information is available across all English HEPs that can be leveraged to inform an improved assessment of the economic impacts resulting from this type of KE activity. Note that student startups are included here only if they have had some form of support from the HEP.

The 2020 study assessing the economic impacts of HEIF (Ulrichsen, 2020) developed a method to more explicitly capture the value realised through spinouts and startups. This leveraged data available on the amount of external investment raised by these companies. It builds on insights from the evaluation of Innovate UK's ICURe programme (Ipsos Mori et al., 2018) that argued that the amount the market is willing to invest in these companies provides a useful proxy for the benefits that are likely to flow from commercialising ideas and technologies through spinouts and startups. It assumes that the price the investor is willing to pay reflects the net present value of the future profits that the investor expects to earn (the economic rent) from their investment in the company over and above the amount they would expect to earn by placing their money in a risk-free asset. It assumes that their valuation is able to account for the expected future technological and commercial risks. It also assumes that the technology is being commercialised for productive gains rather than as a defensive measure. This is a

reasonable assumption for IP being commercialised through a spinout, although may not be for IP transferred to existing companies who may be acting defensively.

3.3 Assessing the counterfactual

Estimating the counterfactual represents a core part of any evaluation. This is particularly challenging in the case of HEIF not least due to the lack of any strong control groups as well as the fact that HEIF is often used in combination with other sources of funding that are deployed at different points in the KE project lifecycle to impact.

The study follows the mixed-methods approach developed in previous assessments of the impacts and ROI of HEIF (Hughes et al., 2011; PACEC/CBR, 2009; Ulrichsen, 2015a). This helps us to triangulate to a conclusion on the impacts realised as a result of HEIF. It deploys a combination of sources of information and analytical techniques to investigate the counterfactual, including:

- Leveraging the expert insights of senior KE leaders on the attribution of KE outputs to HEIF (similar to insights that would be gathered through a programme of interviews in an evaluation study).
- Developing 'quasi-control groups' that exploit differences in the changes to the amounts of HEIF received by HEPs during its significant expansion period from 2017/18 to 2022/23.
- Developing statistical regression models to investigate the relationship between KE income and HEIF, controlling for a range of university characteristics and local socio-economic conditions.

Each of the methods is described in more detail in the appropriate section.

3.4 Types of higher education provider

It is important to recognise that the English HE sector brings together a diversity of HEPs with different structural characteristics and contexts that will shape their set of viable opportunities for KE. To examine differences in the impacts realised through HEIF for different types of HEP, the study leverages the KE clusters developed for the Knowledge Exchange Framework (Ulrichsen, 2023). These isolate five clusters of broad discipline-based HEPs using a statistical clustering technique that seeks to create groups of HEPs with similar structural characteristics but maximises differences between groups. In addition to these five clusters, two clusters of specialist HEPs are identified in the KEF; that of specialist biomedical, science, technology, engineering and mathematics (STEM) institutions, and specialist arts and design institutes.

The characteristics of each of the clusters, and cluster membership is provided in Appendix A.

3.5 About the data

A comprehensive dataset was assembled to underpin this study of the economic impacts of HEIF. This brought together information on the KE performance of HEPs, HEIF funding, structural characteristics of HEPs, and the external context within which the HEP is situated. All income-based data converted to constant 2023 prices, adjusting for inflation using the GDP deflator

provided by HM Treasury (based on the March 2024 release). The database also adjusts for HEP mergers and de-mergers over time.

The database draws on the following data sources:

- **KE activities and performance**: HESA Higher Education Business and Community Interaction (HEBCI) surveys. This includes:
    - Income secured through seven different KE mechanisms: collaborative research, contract research, consultancy, continuing professional development and continuing education, regeneration and development programmes, provision of facilities and equipment services, and intellectual property commercialisation (through spinouts and licensing)
    - Income secured from a subset of these mechanisms (contract research, consultancy, continuing professional development and continuing education, provision of facilities and equipment services, and intellectual property commercialisation through licensing) from different types of partners: SMEs, non-SME commercial organisations, and non-commercial organisations (largely public and third sector)
    - Numbers of spinouts and staff and student startups created in each year, and the external investment, employment, and turnover of spinouts and startups active in each year
- **HEIF expenditures (scale and focus)**: internal data supplied by Research England on the actual HEIF expenditures of HEPs reported through their Annual Monitoring Statements; publicly available data on HEIF allocations
- **HEP characteristics**: HESA staff, student and finance surveys, Research Excellence Framework
- **HEP types**: KE clusters underpinning the Knowledge Exchange Framework
- **Local context**: Office for National Statistics (ONS) on local economic prosperity (gross value added per job), employment rate, local skills levels, employment in different industries. UK Government data on the index of multiple deprivation (IMD)

Where possible, data on the local context was collected at the Travel to Work Area (TTWA). The TTWA represents the spatial area within which "*at least 75% of an area's resident workforce work in the area and at least 75% of the people who work in the area also live in the area*"[1]. It provides a useful sub-national geography around HEPs to capture the influence of local factors. Data collected at the TTWA level includes gross value added per job, and employment by industry sector. Data collected at the local authority level includes employment rate, skills level, and index of multiple deprivation. Local data was matched to HEPs using the postcode of their main campus.

The dataset brings together data over the period 2003/04 to 2022/23 (although not all variables are available over this long time period).

[1] Definition obtained from: http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/other/travel-to-work-areas/index.html, accessed on 12th August 2015

4 Key trends in HEIF funding and knowledge exchange performance

The first section looks at key trends in both KE performance – measured here by the income secured by HEPs through their KE activities – and HEIF funding. Understanding these trends is a crucial first step in assessing the economic impact and ROI of HEIF.

Given the focus of this report on the impacts of HEIF, our various analyses, including of trends, are limited to those English HEPs that received at least some funding over the core period of interest, 2017/18 – 2022/23. This reduces the number of English HEPs in our population from 143 to 111.

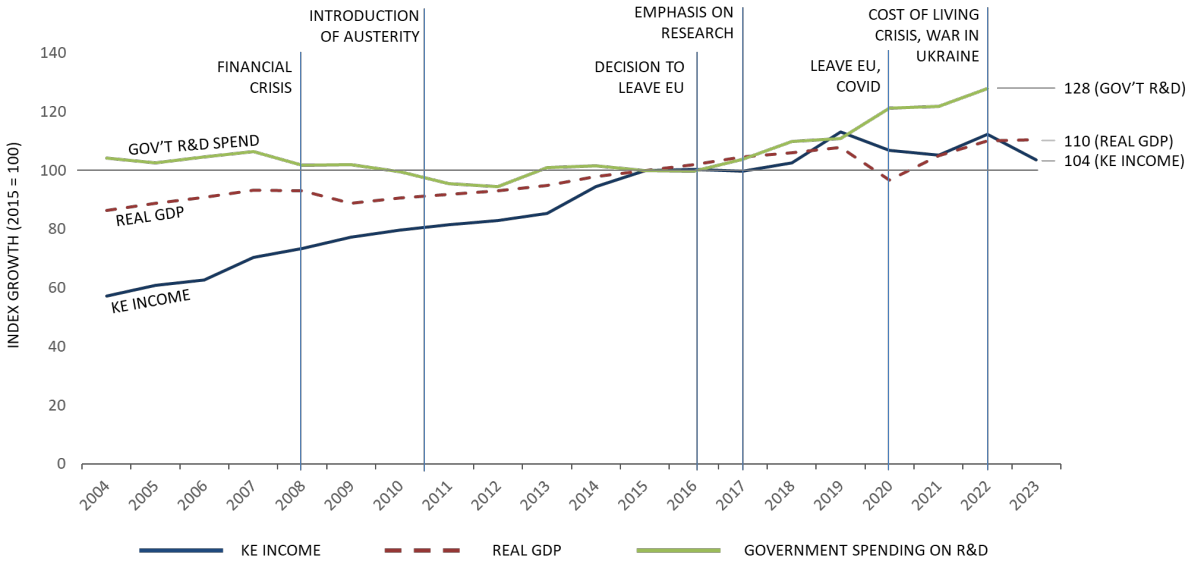
4.1 Trends in knowledge exchange income for HEPs receiving HEIF

The long-term trends in KE income (in constant 2023 prices) are shown in Figure 6. It covers the 20-year period 2003/04 – 2022/23. This chart also presents the trends in real gross domestic product (GDP) which provides a measure of the size of the economy, and the total government spending on R&D[2]. It also overlays a number of key major events that are known to have affected the HE sector, including not least the global financial crisis in 2008 and resulting economic downturn; the introduction of a policy of austerity by the UK Coalition Government in 2010/11; the decision to leave the EU in 2016 and the subsequent period of negotiation culminating in the UK's actual departure in January 2021; the decision to significantly increase public spending on R&D as part of the UK Government's target for R&D to hit 2.4% of GDP; and of course, most recently since 2020/21, the Covid-19 pandemic and its aftermath, wars in Ukraine and the Middle East, rising geo-political tensions, and high inflation and the cost of living crisis.

The trends show KE income growing relatively strongly during the first decade to 2015, with growth overall (controlling for inflation) stronger than the economy as a whole. From 2015 onwards, however, we appear to have entered a period of limited growth in KE income apart from one significant step-change following the introduction of the industrial strategy in 2017 and the emphasis of the government on increasing spending on R&D. This may reflect the multiple crises and shocks the UK has faced since then, not least with the Covid-19 pandemic, cost of living crisis, and departure from the European Union and the effects of this on R&D (research grants and contracts income to HEPs from European sources declined almost 30% in real terms between 2015/16 and 2022/23).

[2] Based on the total net expenditure of UK government expenditure on R&D. Data for 2011-2022 provided by the Office for National Statistics Research and Development (R&D), by the UK government, 2022 Datasets, published on 30th April 2024. Data for 2004-2010 provided by the Organisation for Economic Cooperation and Development (OECD) Data Explorer, available at https://data-explorer.oecd.org/

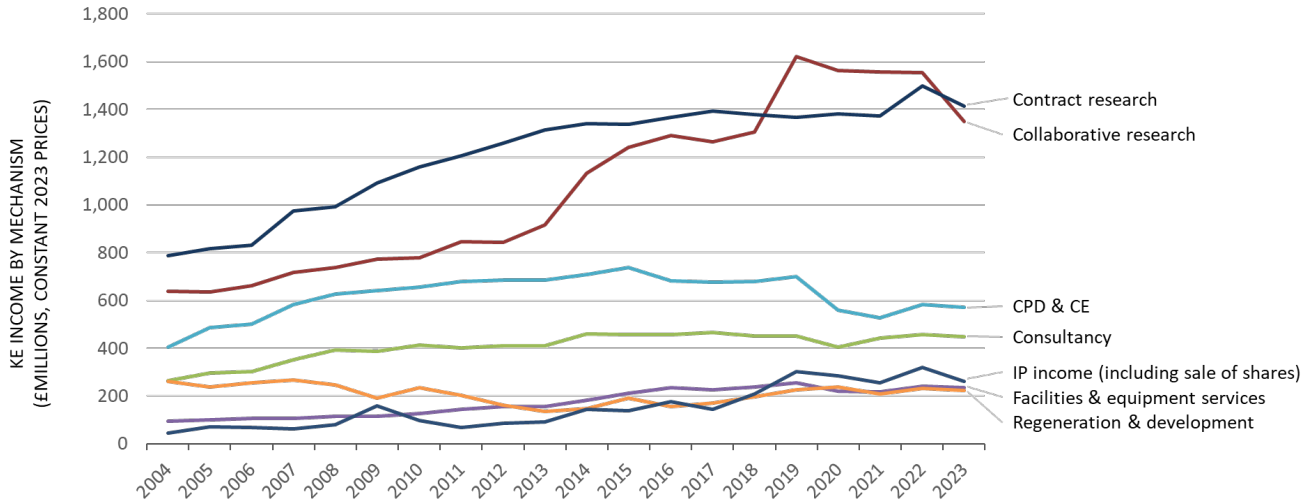
Figure 6 Trends in knowledge exchange income for HEPs receiving HEIF



Sources: HESA HEBCI records, ONS GDP quarterly national accounts, UK (April to June 2024), ONS Research and Development (R&D), by the UK government (2022 Datasets), and OECD data on Government budget allocations for R&D (for UK Government spending pre-2011) available via the OECD Data Explorer.

Figure 7 presents long-term trends in KE income secured through different types of mechanisms. Most forms of KE have seen their income stagnate over the past 10 years, with continuing professional development (CPD) and continuing education (CE) experiencing a significant drop over this period. Collaborative research – which appears to be behind the significant jump in overall KE income between 2017/18 – 2018/19, has dropped significantly in the latest year. This could reflect growing economic and investment uncertainties affecting collaboration partners and their ability to invest in these engagements with HEPs.

Figure 7 Trends in income generated through different types of KE mechanisms



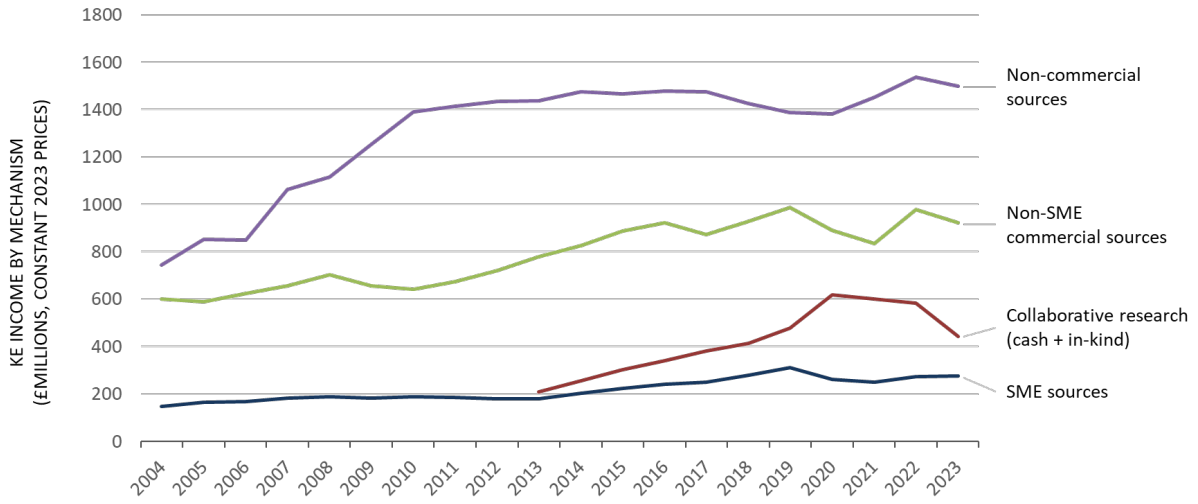
Source: HESA HEBCI records

Turning to the long-term trends in KE income secured by HEPs from different types of KE partners, Figure 8 shows that income from non-commercial sources (e.g. from the public sector

and charities) saw big growth in prior to 2009/10, but has largely flatlined since the introduction of austerity. We must recognise that innovation and capability building in the public sector to improve how we deliver public services is as important as innovation in the private sector. HEPs, through their KE interactions with government departments and agencies nationally and locally, have much to contribute here.

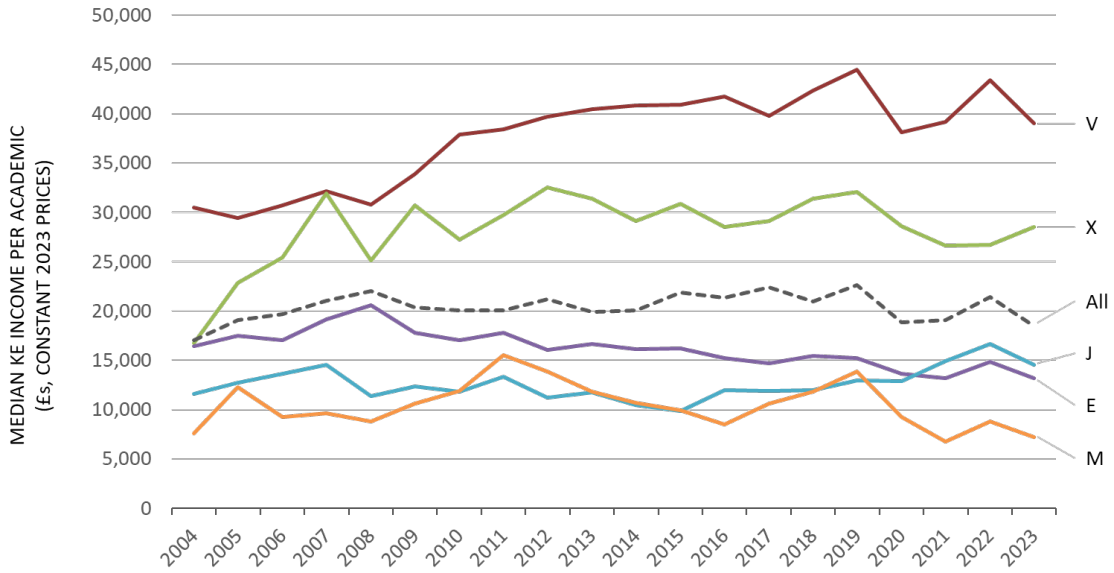
Income from non-SME commercial sources (which includes large companies), and with SMEs, grew steadily during the 2010s, but has stagnated since 2016, possibly reflecting the increasingly difficult and uncertain economic landscape. Work with SMEs mirrors the trend with non-SME commercial organisations. Excluding public funding, contributions by partners (cash and in-kind) to collaborative research grew significantly until 2019/20 at which point it stagnated and has fallen in the most recent year. This inflection point is coincident with the onset of the Covid crisis and subsequent crises (including not least cost of living, wars in Ukraine and the Middle East).

Figure 8 Trends in income generated through from different types of KE partners



Source: HESA HEBCI records

Figure 9 Trends in median KE income per academic FTE for each KE cluster of non-specialist HEPs

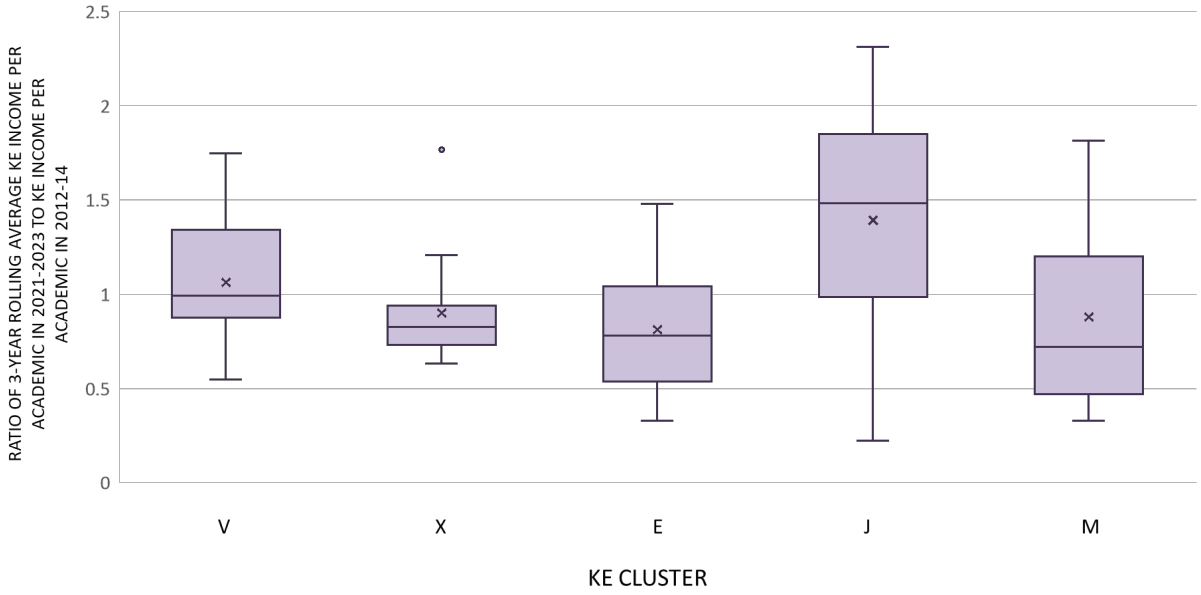


Source: HESA HEBCI and staff records

Normalising KE income by the number of academic full time equivalent (FTE) staff, while not perfect, provides an initial insight into the overall 'productivity' of the academic base in engaging in KE. Figure 9 suggests that KE 'productivity' has seen little growth for many years , and in many cases has declined. Diving into different types of HEP (captured here by the KE cluster to which they belong), this stagnation or decline is seen, on average, across most clusters. Cluster J appears to be an exception with KE income per academic growing over the past decade.

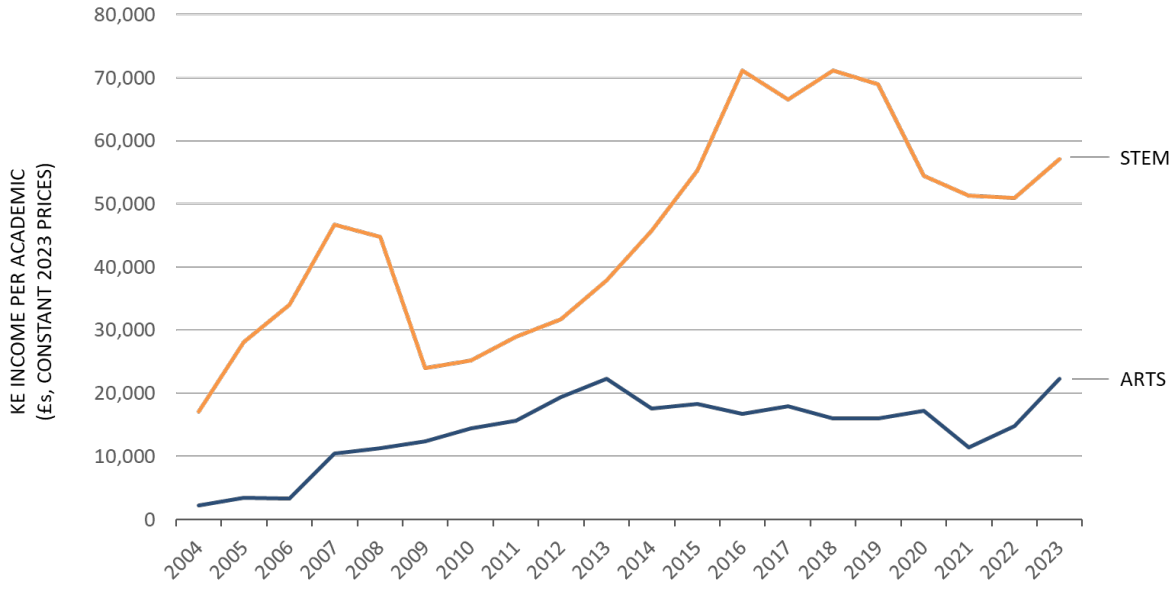
Figure 10 digs into this finding further. It presents the ratio of KE income per academic FTE for the period 2020/21 – 2022/23 to their KE income per academic over the period 2011/12 – 2013/14. The boxplot allows us to explore not just the median ratio for each cluster, but also what the distribution around the median looks like. It shows that for cluster V, around half of HEPs experienced a growth in their KE income per academic during this period, while for clusters X, E and M, many HEPs within the cluster experienced declines. Most HEPs in cluster J experienced an increase.

Figure 10 Distributions in the ratio of the average KE income per academic over the period 2020/21 – 2022/23 to KE income per academic over the period 2011/12 – 2013/14 for different KE clusters



Source: HESA HEBCI and staff records

Figure 11 Trends in median KE income per academic FTE for each specialist HEP KE cluster



Source: HESA HEBCI and staff records

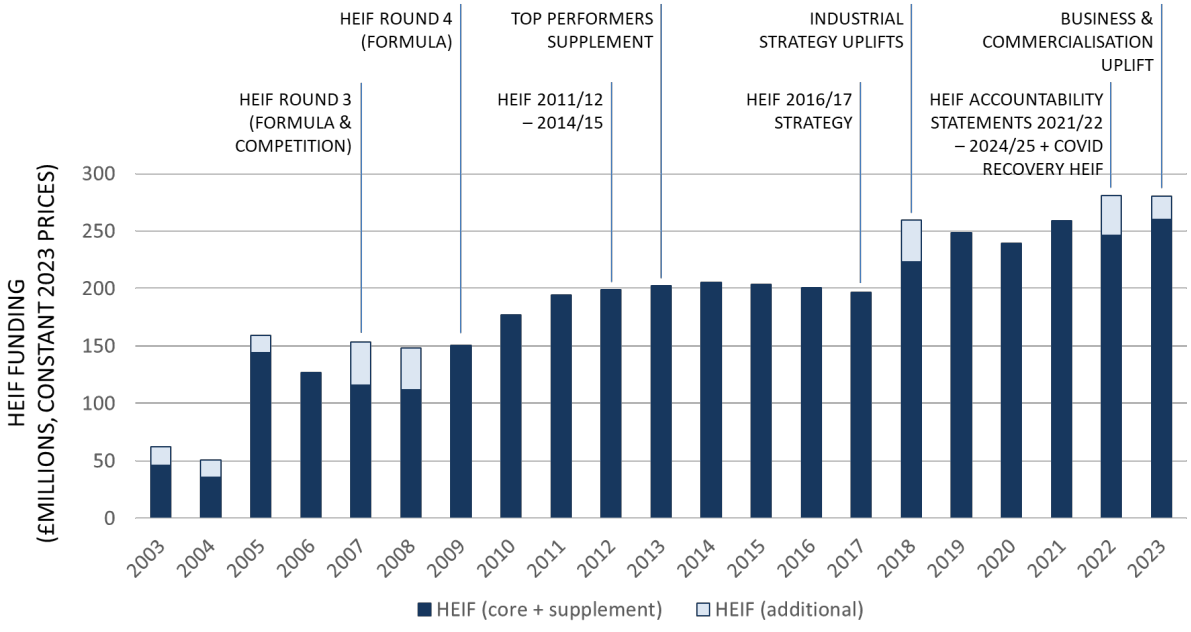
4.2 Trends in HEIF funding

HEIF is one of the main funding sources available for English HEPs to invest in building up their long-term capacity and capability to deliver KE. It has seen significant expansion in real terms

over the past twenty years, from around £150 million during the late 2000s to around £200 million between 2011/12 to 2016/17, to £280 million in 2022/23 (Figure 12). The sustained increases from 2017/18 onwards were initiated by the 2017 industrial strategy and its ambition to increase R&D spending to 2.4% of GDP. During this time, the core funding programme has been augmented with additional components, including not least the 'top performers supplement' in 2012/13, recognising that those HEPs constrained by the maximum cap on HEIF funding received significantly less funding per academic than others; a one-off industrial strategy uplift in 2017/18; additional funds in 2021/22 to support HEPs in navigating the Covid-19 pandemic; and most recently in 2022/23 an additional component to support business and commercialisation through KE.

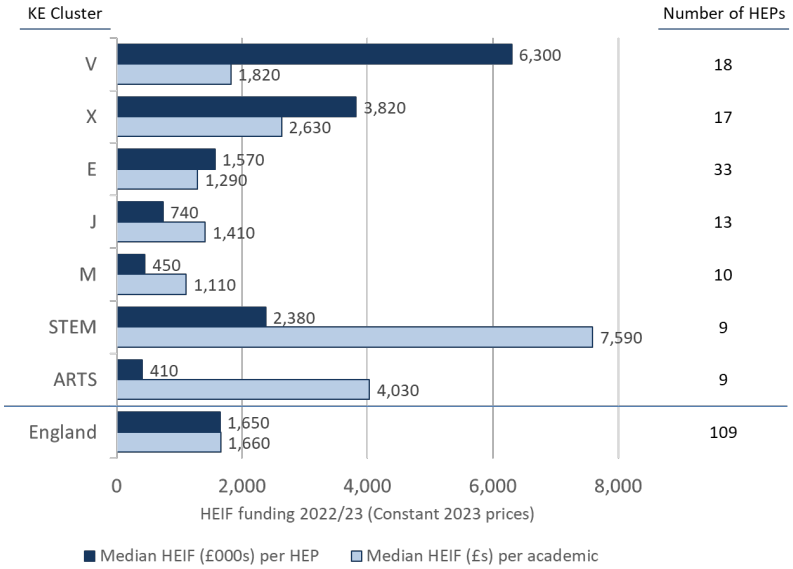
In 2022/23, 109 HEPs received HEIF funding, with a median average allocation of £1,650 million per HEP. This equates to £1,660 per academic FTE staff (Figure 13). The amount received by HEPs varies considerably across different types of HEPs, ranging from a median average £6.3 million per institution for HEPs in cluster V, to around £450,000 for HEPs in cluster M. When normalising by the number of academic staff, there is less variation across different types of HEPs, with those in cluster V receiving on average £1,820 per academic, those in cluster E receiving £1,290 per academic, and those in cluster J receiving £1,410 per academic. For broad discipline-based HEPs, institutions in cluster X received on average the most per academic, with a median of £2,630 per academic.

Figure 12 Trends in HEIF funding



Sources: HEFCE and Research England circulars, internal Research England data

Figure 13 Median HEIF allocations in 2022/23 across different types of HEP



Note: Analysis of HEIF in this chart includes all pots of HEIF distributed in 2022/23, including the core formula allocation, the supplement for top performers, and the business and commercialisation pot.

Sources: Internal Research England data, HESA staff records

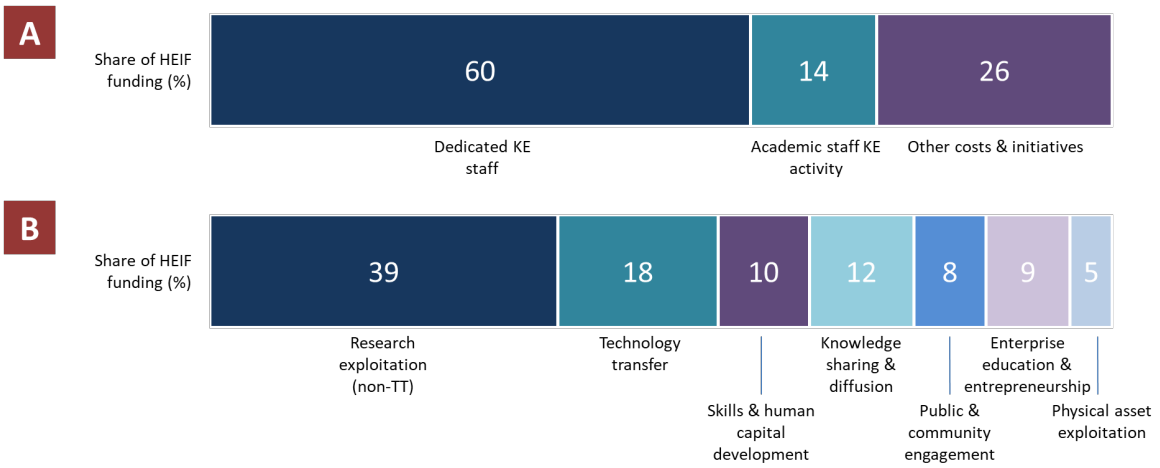
4.3 Knowledge exchange support funded by HEIF

As part of the allocation and monitoring processes for HEIF, Research England collects information from HEPs on the types of KE being supported by the funding. The categories are guided by the framework presented in Figure 2, focusing on seven key types of KE: facilitating research exploitation (non-technology transfer); commercialisation through technology transfer; skills and human capital development; exploiting physical assets; knowledge networks and diffusion; entrepreneurship and enterprise education; and supporting the community and public engagement. For each of these categories, HEIF expenditures is further broken down by spending on dedicated KE staff, academic staff KE activity, and other costs and initiatives.

Focusing on spending of recurrent HEIF (i.e. excluding the various additional pots of funding distributed to HEPs through HEIF), an analysis of the Annual Monitoring Statements submitted by HEPs for the year 2022/23 as part of the monitoring process shows that 60% of the funds received were spent on dedicated KE staff, 14% on academic staff KE activity, and 26% on other costs and initiatives (chart A, Figure 14).

When looking at expenditures on support infrastructure for different types of KE, Chart B of Figure 14 shows that 39% of HEIF was spent on supporting research exploitation (non-technology transfer); 18% on technology transfer; 10% on skills and human capital development; 12% on knowledge sharing and diffusion; 8% on supporting public and community engagement; 9% on enterprise education and entrepreneurship; and 5% on exploiting the HEP's physical assets.

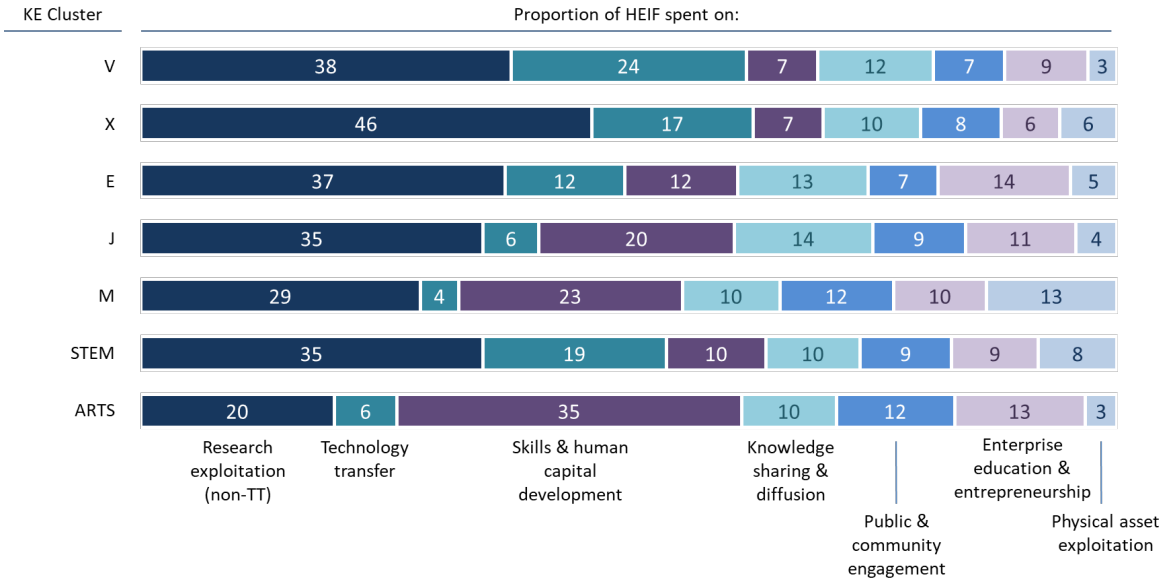
Figure 14 HEIF expenditures in 2022/23 on different types of KE (chart A) and areas of KE support (chart B)



Source: Research England HEIF Annual Monitoring Statements

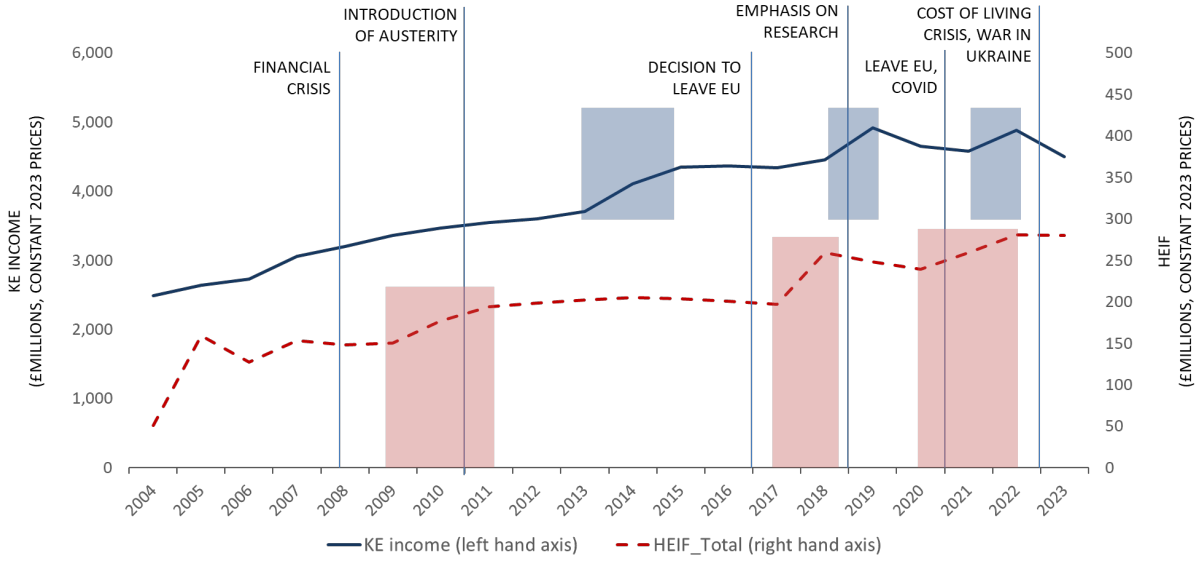
The patterns of spending from recurrent HEIF on different types of KE varies considerably for different types of HEP. Perhaps unsurprisingly the larger research universities spend a greater proportion on research exploitation and technology transfer, while the more teaching-focused institutions in clusters J and M typically spend relatively more on skills and human capital development.

Figure 15 HEIF expenditures in 2022/23 on different areas of KE for different types of HEP, by KE cluster



Source: Research England HEIF Annual Monitoring Statements

Figure 16 Comparing trends in knowledge exchange income and HEIF for HEPs receiving HEIF



Sources: HEBCI records, HEFCE and Research England circulars, internal Research England data

Figure 16 compares the trends in KE income secured by HEPs with the trends in HEIF funding they received over the past 20 years. While purely descriptive and correlative, it suggest that step-change increases in HEIF are followed a number of years later by a step-change in KE income. The step-change in HEIF from around £150 million pre-2008/09 to £195 million in 2010/11 and around £200 million in subsequent years was followed by a jump in KE income between 2012/13 – 2014/15 to a new steady-state level. The increase in HEIF from £196 million in 2016/17 to £260 million in 2017/18 was followed by a jump in KE income between 2017/18 and 2018/19, which then fell back, tracking a real terms decrease in HEIF for the following two years. Increases in HEIF from £240 million in 2019/20 to £260 million in 2020/21 and £280 million in 2021/22 onwards, was followed by an increase in 2021/22 in overall KE income generated by the HE system in England (although this fell back in 2022/23). We wait to see for 2023/24 whether this decrease in KE income will be sustained or reversed.

5 Assessing the impacts of HEIF

The report now turns to the assessment of the economic impacts of HEIF. As set out in section 3.1, the study deploys three different methods to investigate the effects of the funding: the first based on expert judgements of the attribution of KE outputs to HEIF made by senior KE leaders; the second based on constructing quasi-control groups; and the third developing statistical models to determine the relationship between HEIF and KE income and other performance measures. Following arguments made in section 3.2, KE income is used as a proxy measure (and likely a lower-bound) for the economic impacts of HEIF.

5.1 Estimating the impact of HEIF through expert judgement

The first of the assessment methods focuses on leveraging information provided by senior KE leaders of 79 HEPs in receipt of HEIF to Research England capturing their insights on the extent to which KE outputs and incomes are attributable to HEIF – i.e. their views on the extent to which KE outputs and incomes could have been generated in the absence of HEIF investments. This information was gathered through an information request made by Research England to HEPs in July 2024.

While subjective judgements, it has merits given the very complicated, nuanced and in many cases, underpinning effects that HEIF has on the KE process. This attribution information is captured for each of the seven KE support categories. This is then combined with KE income and outputs data available from HEBCI and information on HEIF spending to estimate the ratio of KE income generated (as a proxy for impacts) to HEIF spending; a measure of the return on investment of HEIF.

The analysis is based on the six-year period 2017/18 – 2022/23, with KE outputs and income, and HEIF funding entering the calculations as averages for each HEP over the period.

5.1.1 Association of KE outputs with different types of KE infrastructure

To begin we first have to map KE outputs and incomes to each of the seven KE support categories that HEIF funds. This mapping is enabled by information provided by HEPs as part of the information request made by Research England to HEPs for their estimates of attribution. Table 1 shows how different KE incomes are distributed across each of the KE support categories. For many KE income streams, there is a relatively strong alignment to a particular KE support category – these are highlighted in darker green in the table. A key exception here is regeneration and development funding, which appears to be distributed across multiple categories, highlighting how it likely draws upon multiple mechanisms to deliver on objectives. The lighter green shaded cells in the table highlight secondary areas, identified by more than 10% of KE income being mapped to the support category. It reveals the importance of, for example, knowledge networks, sharing and diffusion for collaborative and contract research; exploiting physical assets for contract research; the link between skills and human capital

development in consultancy, and the importance of licensing of IP in broader research exploitation efforts beyond pure technology transfer.

Table 1 Distribution of income-based KE mechanisms across KE infrastructure categories

Income-based KE metrics	% income in each KE support category							Average over period 2017/18 – 2022/23 (£ millions)
	Research exploitation (non-TT)	Commercialisation (TT)	Skills & human capital development	Knowledge sharing & diffusion	Community & public engagement	Enterprise education & entrepreneurship	Exploiting physical assets	
Collaborative research	57	10	2	13	9	1	7	1,310
Contract research	61	10	3	14	0	0	11	1,201
Consultancy	50	8	14	12	6	3	7	370
Facilities and equipment-related services	19	4	2	9	5	1	61	191
Continuing professional development	4	1	69	9	3	12	2	475
Regeneration and development programmes	33	4	17	18	14	6	8	136
Licensing and intellectual property	23	70	2	4	0	1	0	255
KE income	47	12	12	12	5	2	10	3,939

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

Table 2 Distribution of key commercialisation metrics across KE infrastructure categories

Key commercialisation metrics		% income in each KE infrastructure category							Average over period 2017/18 – 2022/23
		Research exploitation (non-TT)	Commercialisation (TT)	Skills & human capital development	Knowledge sharing & diffusion	Community & public engagement	Enterprise education & entrepreneurship	Exploiting physical assets	
Number of companies established	IP-based spinoffs (HEI owned & formal)	4	85	3	3	0	4	2	113
	Staff start-ups	4	48	5	6	1	34	3	40
	Graduate start-ups	2	8	8	2	1	75	4	2,349
External investment (total in £ millions)	IP-based spinoffs (HEI owned & formal)	2	75	7	7	0	8	1	7,773
	Staff start-ups	1	59	9	18	0	13	0	96
	Student start-ups	2	37	6	3	1	46	5	699
Licensing (total in £ millions)	Licensing and intellectual property	23	70	2	4	0	1	0	255
Process metrics	Invention disclosures	8	85	2	1	0	4	0	2,602
	Patent applications	7	85	3	1	0	5	0	1,473
	Patent portfolio	9	83	2	1	0	5	0	1,387

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

Table 2 focuses on the non-income based commercialisation-focused outputs and how they map onto the seven KE support categories. While unsurprisingly most of these outputs map strongly to the commercialisation (technology transfer) support category, graduate startups are the exception and map largely to the enterprise education and entrepreneurship category. Staff start-ups (not based on university IP) are also spread more evenly across both these two categories.

5.1.2 Estimates of the attribution of KE outputs to HEIF

Table 3 provides the estimated attribution of KE incomes and outputs across different KE mechanisms to HEIF based on the expert judgements of senior KE leaders. It shows that, overall, 38% of KE income is believed to be attributable to HEIF. This increases to 43% for both collaborative research and regeneration and development programmes. Attribution estimates for IP revenues and consultancy are 36%, and for contract research is 35%. Attribution is lowest for facilities and equipment service provision (at 28%). For non-income based measures, 44% of spinouts founded are believed by senior KE leaders to be attributable to HEIF, rising to 58% of staff startups and 53% of student startups. This suggests a perceived significant importance of HEIF in enabling these types of activities; activities which do not generate much, if any, income at the outset, and for staff and student startups, will likely lead to no (direct) financial benefits to the university.

Table 3 Attribution of different KE outputs to HEIF (2024 assessment, %)

KE mechanism	Attribution to HEIF funding (%)
Collaborative research	43
Contract research	35
Consultancy	36
Facilities and equipment-related services	28
Continuing professional development	33
Regeneration and development programmes	43
IP revenues	36
KE income	38

KE mechanism	Attribution to HEIF funding (%)
Disclosures	49
Patent applications	49
Spinouts (number)	44
Staff start-ups (number)	58
Student start-ups (number)	53
Spinouts (external investment)	45
Staff start-ups (external investment)	51
Student start-ups (external investment)	55

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

Using the mapping of KE incomes to KE support categories (aggregated linkages provided in Table 1), the attribution of HEIF impacts related to each of the seven KE support categories can be estimated (Table 4).

Table 4 Attribution to HEIF for different types of KE support infrastructure (2024 assessment, %)

KE support infrastructure category	Attribution to HEIF funding (%)
A1. Facilitating the research exploitation process (non-technology transfer)	44
A2. Commercialisation (technology transfer, including spin-outs and licensing)	41
B. Skills and human capital development	31
C. Knowledge sharing and diffusion	29
D. Supporting the community and public engagement	36
E. Enterprise education and entrepreneurship	40
F. Exploiting the HEI's physical assets	25
All	38

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

5.1.3 Assessing gross additional impacts of HEIF

Taking the above estimates of attribution allows us to construct a measure of the gross additional impact of HEIF and calculate a 'return on investment' for the fund. Accepting that KE income as a proxy for the impact of KE realised by the partner (acknowledging the caveats outlined earlier), then a measure of the ROI for the fund is a ratio of the additional KE income enabled by HEIF relative to the investments made through the funding.

As discussed earlier, it is highly likely that impacts arising from the investments made through HEIF take time to feed through the system. As little is understood on the lag structure, which is likely to be highly complex and varied depending on the type of investment being made, the analysis focuses on comparing the KE outputs and incomes realised over a relatively long period of time to the investments made during that period.

Table 5 Estimates of the gross additional impact of HEIF

KE support infrastructure category	KE income* (£ millions) Average, 2018-23	Attribution to HEIF funding (%)	KE income attributable to HEIF (£ millions) Average, 2018-23	HEIF expenditure* (£ millions) Average, 2018-23	Ratio of additional KE income to HEIF funding)
A1. Facilitating the research exploitation process (non-technology transfer)	1,821	44	793	76	10.4
A2. Commercialisation (technology transfer, including spin-outs and licensing)	477	41	196	33	6.0
B. Skills and human capital development	473	31	145	20	7.1
C. Knowledge sharing and diffusion	483	29	141	23	6.1
D. Supporting the community and public engagement	184	36	67	14	4.9
E. Enterprise education and entrepreneurship	96	40	38	19	1.9
F. Exploiting the HEI's physical assets	380	25	95	9	11.1
All	3,914	38	1,475	194	7.6

*: KE income reported here is limited to the sample of HEPs providing information to Research England on their HEIF attribution.

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

Table 5 performs this calculation. It applies the attribution estimates to calculate the KE income attributable to HEIF over the period 2017/18 – 2022/23. Comparing this to the HEIF expenditure over the same period results in the ratio of gross additional impacts from HEIF to the expenditure invested.

The analysis suggests that, over this period, HEIF generated a return on investment of 7.6. However, this is likely to represent an underestimate of the total benefits to the economy and society not least due to the potentially large impacts that are very hard to capture, likely spillover and multiplier benefits, and the long-term benefits arising from the positive behavioural and attitudinal changes it has had on academics towards engaging in KE.

Based on the KE income approach to creating a proxy for the impact of HEIF, the ROI is highest for KE focused on exploiting the HEP's physical assets (11.1) and facilitating research exploitation (10.4), followed by skills and human capital development (7.1). The low ROI estimate for enterprise education and entrepreneurship is likely due to this category being dominated by staff and student startups, which will typically generating little by way of income for the HEP but are likely to have important positive socio-economic impacts.

As the following section highlights, caution is advised in overly interpreting differences in ROIs by KE infrastructure category as differences in performance of HEIF in these different areas. The robustness of using income as a proxy for impact will vary considerably by category, and be particularly weak for categories such as *community and public engagement* and *knowledge sharing and diffusion*, which are typically much less transactional.

5.1.4 Incorporating impacts realised through spinouts and startups in the return on investment estimates

As set out in section 3.2.2, assessing the ROI of HEIF based on KE income to the HEP as a proxy for the impacts realised through KE poorly captures the value created by spinouts and staff/student startups. This is because the only representation of their effects in these data is through the income realised through sales of shares and any licence-based royalties and fees, and this will typically only apply for spinouts based on university-owned IP.

To overcome this, the study follows the methodology set out in section 3.2.2 and leverages increased data available through HEBCI on the amounts of external investment raised by these companies to provide an improved proxy for the benefits that are likely to flow from commercialising ideas and technologies through spinouts/startups. In doing so, IP income secured by the HEP in the core income-based assessment of the economic impacts of HEIF is adjusted to exclude any income received by HEPs through the sale of shares in their spinouts. Table 6 presents the results, comparing them with the base estimates of the purely KE income-based approach.

Table 6 Capturing returns to spinouts & startups through external investment

KE support infrastructure category	Ratio of gross additional impacts to HEIF		
	Base estimate	Including spinout impacts based on investment secured	
		Excluding Cambridge	*Including Cambridge*
A1. Facilitating the research exploitation process (non-technology transfer)	10.4	10.2	10.9
A2. Commercialisation (technology transfer, including spin-outs and licensing)	6.0	27.3	98.9
B. Skills and human capital development	7.1	7.3	18.9
C. Knowledge sharing and diffusion	6.1	6.6	16.1
D. Supporting the community and public engagement	4.9	4.9	5.0
E. Enterprise education and entrepreneurship	1.9	13.1	19.9
F. Exploiting the HEI's physical assets	11.1	14.1	14.5
All	7.6	12.4 (+4.8)	27.8 (+20.2)

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

The data is complicated by a dramatic increase in external investments secured by active spinouts from the University of Cambridge from 2020/21 onwards, particularly for those companies where they did not have any ownership links. This appears to be due to improved data collection efforts by Cambridge in this area. Given the significant effects it has on the results, Table 6 presents the revised ROI capturing the effects of spinouts and startups both excluding and including Cambridge.

By more explicitly including the effects of spinouts and staff/student startups in the assessment of gross additional impacts of HEIF, the estimated ROI increases from 7.6 (base estimate) to 12.4 (+4.8 over the baseline) if Cambridge is excluded from the analysis, and to 27.8 (+20.2 over the baseline) if Cambridge is included.

All of these estimates represent a significant increase compared with the 2020 estimate of an additional +1.8 over the baseline estimate, suggesting the growing importance of spinouts and startups in the commercialisation of ideas and IP from universities. Diving into the data, the substantial increase in spinout/startup-related ROI appears to be due to the significant increase in external investment being secured by these companies in recent years compared with previously. For example, the total external investment into HEP-owned spinouts rose from £677 million in 2015/16 to £1.7 billion in 2018/19 to £4.5 billion in in 2020/21, before falling back to £2.2 billion in 2022/23. Some of this is due to significant increases reported by the University of Cambridge, although increases are also seen in other large, research universities producing spinouts (e.g. Oxford, UCL, Manchester, Bristol etc.).

Furthermore, by including an improved estimate of the impacts from spinouts and startups in the method, the ROI for commercialisation KE support category increases significantly, from 6.0 to 27.3. Crucially, the ROI for the enterprise education and entrepreneurship category increases from 1.9 to 13.1. This reflects the effects of capturing a monetary estimate of the likely impacts of staff and student startups in a category that does not otherwise generate much income to the HEP.

5.1.5 Capturing the hard-to-monetise impacts of HEIF in the return on investment estimates

Another common critique of using KE income as a proxy for the economic impacts of KE is that the price paid by the partner to the HEP fails to adequately capture the full impacts of the activity. This is most acutely felt when KE activities incur no monetary transactions. This study replicates the approach taken in previous studies (Ulrichsen, 2015a, 2020) and set out in section 3.2.1. It leverages information provided in the 2015 study commissioned by HEFCE on the non-monetised benefits arising from HEIF (PACEC, 2015). This which estimates of the proportion of KE activities of different types that involve monetary transactions and hence generate income to the university. Assuming that partners would pay a similar price if the markets were working optimally, we can treat the monetary value of those KE activities of a particular type that do involve priced transactions as a quasi 'shadow price' for those of the same type that do not.

Table 7 Capturing the impacts of hard-to-monetise KE outcomes in the return on investment estimates

HEBCI KE stream	PACEC equivalent	% involving transaction	Estimated non-monetised KE income component Average, 2018-23 (£millions)	Attribution to HEIF (%)	Non-monetised KE income attributable to HEIF Average, 2018-23 (£millions)
Contract research	Contract research	0.87	209	35	73
Collaborative research	Collaborative research	0.87	223	43	97
CPD and CE	Training/CPD	0.5	590	33	194
Consultancy	Consultancy/research	0.87	65	36	23
Facilities and equipment related services	Premises	0.5	232	28	65
Regeneration and development programmes	Business advice/enterprise	0.5	215	43	93
IP (including sale of shares)	Licensing IP	0.87	41	36	15
KE income			1,574	38	593

Source: PACEC (2015), HESA HEBCI records, responses to Research England request for information on HEIF attribution (July 2024)

Table 7 presents the data points and results. For each of the core KE mechanisms reporting income in HEBCI, it provides the relevant estimate of the proportion of activity involving transactions provided in PACEC (2015). Using this information it estimates the additional KE income that would have been secured had all activity involved a transaction at the same price as those that do. The estimates of the attribution of each KE income stream to HEIF are then applied to estimate the value of the additional non-monetised KE component that is attributed to HEIF – i.e. an additional gross additional impact component resulting from hard-to-monetise KE.

This additional non-monetised KE component is then compared to the HEIF funding distributed over the same period (2017/18 – 2022/23). Table 8 presents the result, and suggests that the baseline ROI of 7.6 calculated using the KE income method would increase by 2.4.

Table 8 An estimate of the additional return on investment due to hard-to-monetise KE outcomes

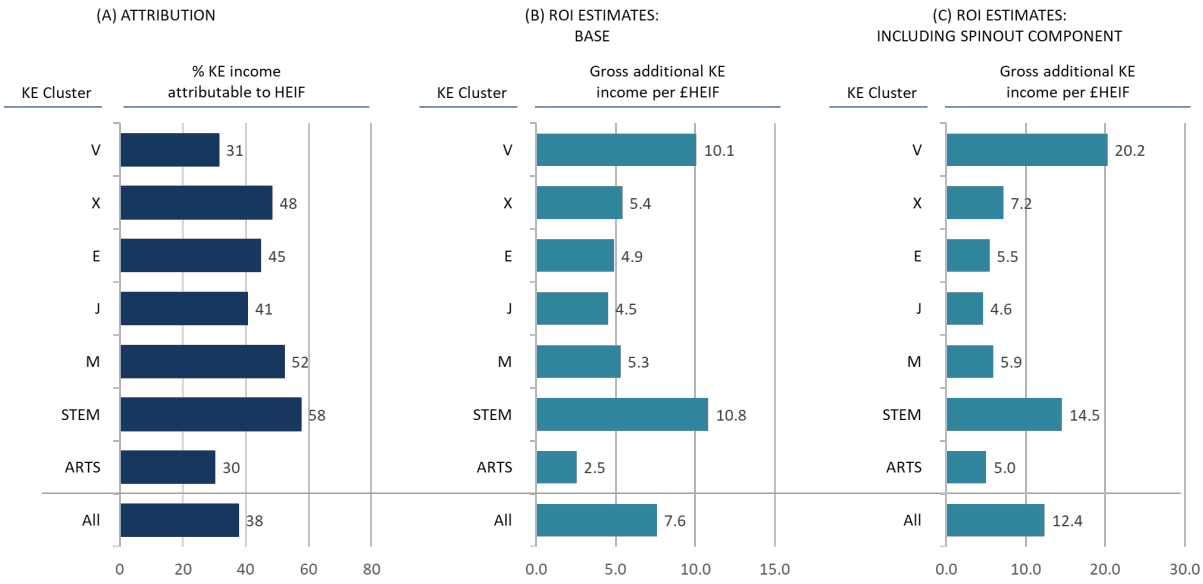
Additional non-monetised KE income 2018-23 (£ millions)	593
HEIF funding 2018-23 (£ millions)	252
Ratio of additional non-monetised KE income to HEIF funding 2018-23	2.4

5.1.6 Variations in HEIF attribution and return on investment across KE clusters

The estimated attribution of KE outputs and incomes to HEIF, and the return on investment of the fund, varies across KE clusters (Figure 17). In particular, while the attribution of KE outputs to HEIF is lower in cluster V (very large research intensive HEPs), the significant scale of KE outputs generated compared with other types of HEPs results in a much higher return on investment, particularly when including the revised method for capturing the effects of spinouts and startups. By contrast, HEIF is important for underpinning a larger proportion of KE outputs in KE cluster M (52%) and in cluster X (48%) and E (45%) although their return on investment is lower. HEIF is also very important for underpinning KE activities across STEM specialist HEPs (58%).

Excluding the effects of spinouts and startups, the ROI for different types of HEPs outside cluster V and the specialists appears to be relatively similar, at around 5. By including these effects, the ROI estimate increases significantly for cluster V and to a lesser extent for cluster X. It also increases significantly for the specialist arts cluster, bringing it broadly in-line with the estimates for clusters E, J and M.

Figure 17 Variation in attribution and gross additional impacts of HEIF by KE cluster



Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

Table 9 provides a cross-tabulation of the estimated attribution rates for different types of KE outputs and incomes to HEIF with different types of HEPs. Among other things, it emphasizes the importance of HEIF for student and staff entrepreneurship, across most HEPs. Other standout findings include that HEIF is particularly important for collaborative and contract research, and for IP-related activities and outputs across many HEPs, particularly those outside the largest research universities of cluster V.

Table 9 Variation of estimates of the attribution of KE outputs to HEIF by KE cluster

KE mechanism	Attribution of KE income to HEIF (%) by KE cluster						
	V	X	E	J	M	STEM	ARTS
Collaborative research	37	51	55	62	59	58	48
Contract research	30	59	51	49	42	58	49
Consultancy	23	46	49	53	54	50	25
Facilities and equipment-related services	24	35	30	21	42	34	30
Continuing professional development	33	35	31	32	53	29	27
Regeneration and development programmes	27	49	50	43	61	56	33
IP revenues	26	63	31	50	..	91	29
Disclosures	41	59	75	37	..	41	40
Patent applications	43	73	71	36	..	57	40
Patents granted	32	84	75	32	..	46	..
IP-based spinouts (number)	39	61	69	36	..	66	40
Staff start-ups (number)	54	74	63	54	..	..	66
Student start-ups (number)	51	55	47	78	61	..	61
KE income	31	48	45	41	52	58	30

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

5.1.7 A comment on net additionality

It is important that evaluations of the impact of policies attempt to move beyond gross additionality to assess the effects on substitution and displacement of private sector activity – (known as net additionality). This paper does not develop further insights into this issue, but argues that the nature of the KE services provided suggests that there is a strong presumption of high net additionality. In particular, where KE activity is based on original research or know-how, training and expertise emerging from this research, it is unlikely that the private sector would be able to easily replicate the cumulative knowledge that underpinned the research in the first place. Some activities, such as regeneration and development-focused KE may be high in principle but in some local economies there may be a dearth of private sector partners able or willing to deliver such services.

5.1.8 Comparing current and previous estimates of HEIF attribution

Table 10 compares the estimates of the attribution of KE outputs and incomes to HEIF based on the expert insights of senior KE leaders made in 2024 and applied to KE data covering the period 2017/18 – 2022/23, with previous estimates using insights from these leaders in 2016 and applied to the period 2015/16 and 2018/19 (Ulrichsen, 2020). Note that although the request for information from KE leaders by HEFCE/Research England was similar, the individuals completing the request may have changed and the methods used by these individuals to assess

attribution may not be the same. The comparison, while informative, should therefore be treated with some caution.

Comparing the two estimates suggests that senior KE leaders believe HEIF to be more important now compared with previously, with attribution of KE income overall now standing at 38% compared with 30% based on 2016 estimates. In each category of KE, the estimates of attributions have increased. This is consistent with evidence emerging from studies during the pandemic and looking towards the pandemic recovery period that suggested that during this time of ongoing crisis, flexible funding (including not least HEIF) were particularly important for enabling HEPs to continue to deliver KE and adapt to the increasingly uncertain landscape (Ulrichsen, 2021; Ulrichsen & Kelleher, 2022).

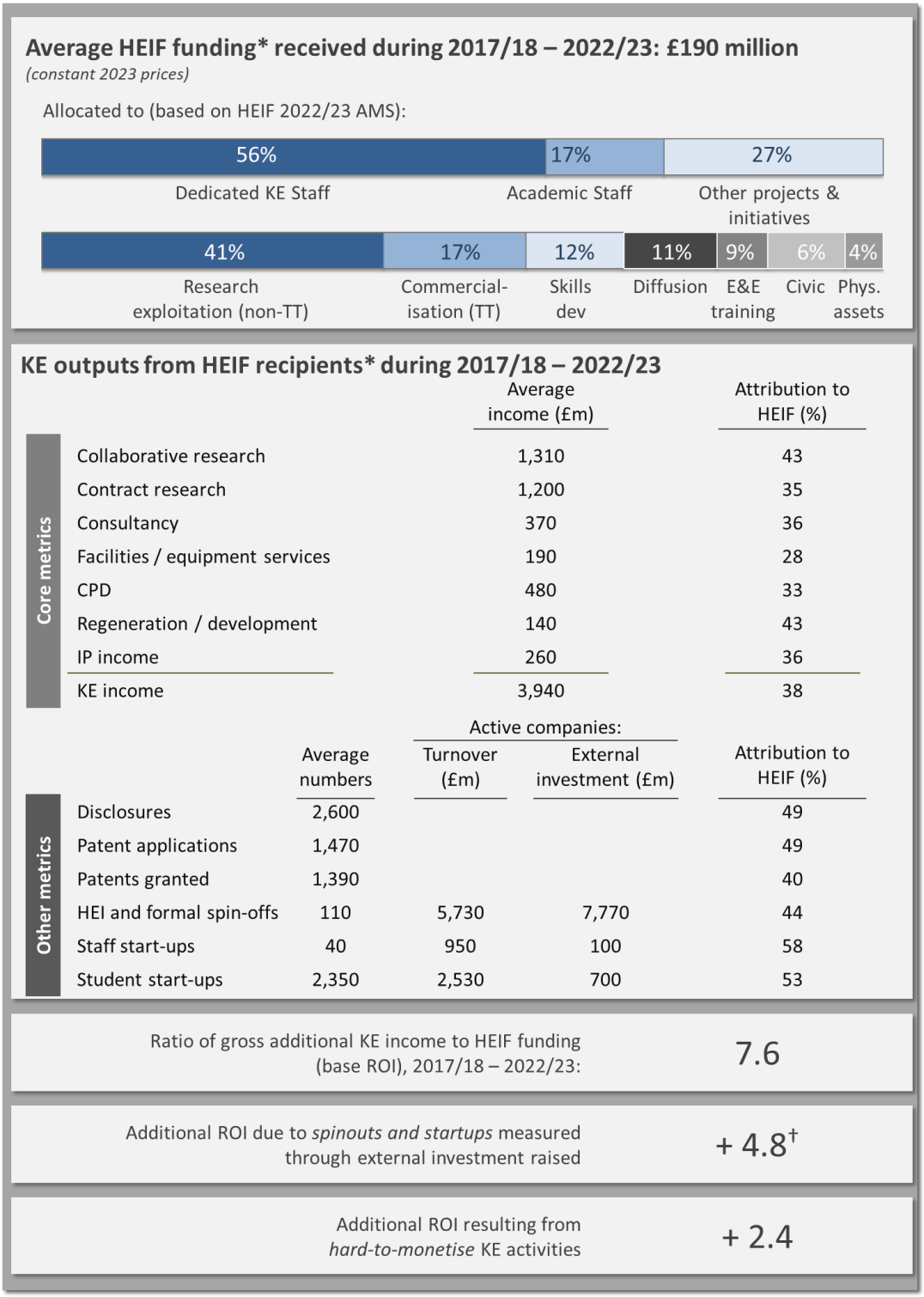
Table 10 Comparison of HEIF attribution estimates based on insights from senior KE leaders in 2016 and 2024

KE mechanism	2024 estimate of attribution assessed over the period 2017/18 – 2022/23	2016 estimate of attribution assessed over the period 2015/16 – 2018/19
Collaborative research	43	32
Contract research	35	31
Consultancy	36	31
Facilities and equipment-related services	28	21
Continuing professional development	33	22
Regeneration and development programmes	43	31
IP revenues	36	43
KE income	38	30
Disclosures	49	35
Patent applications	49	35
Formal (HEI's IP-based) spin-offs (number)	44	22
Start-ups (new enterprises not based on formal IP) (number)	58	38
Student start-ups (number)	53	35

5.1.9 Summary cost-benefit balance sheet capturing the impacts of HEIF

The various results emerging from the expert-judgement based approach to assessing the impacts and ROI of HEIF are brought together in Figure 18. This provides a 'cost-benefit-balance sheet' comparing the investments into the KE process, and the emerging KE outputs and impacts (proxied by the income received by HEPs) attributable to the investments.

Figure 18 Summary cost-benefit balance sheet capturing the impacts of HEIF



**Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding*

† This estimate excludes the University of Cambridge spinouts and startups data. Including the University of Cambridge, the additional ROI rises to +20.2.

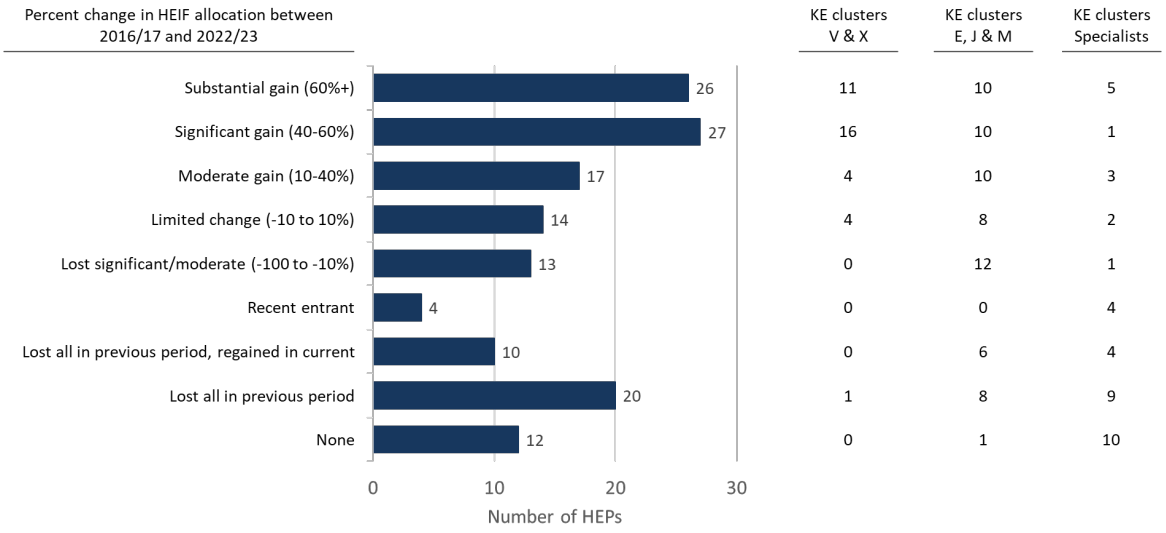
5.2 Exploring the impacts of HEIF using a quasi-control group approach

The second approach to assessing the impact of HEIF attempts to construct quasi-control groups to drive the analysis.

A common approach to assessing the impact of a policy intervention is to identify and compare the performance of the group benefiting from the intervention against a control group that is unaffected by it. Given that most English HEPs receive at least some HEIF – and indeed – receive roughly similar levels of HEIF based on the scale of their institutions – a traditional control group method is not possible. That said, as previous evaluations and assessments of the impacts of HEIF have demonstrated (PACEC/CBR, 2009; Ulrichsen, 2015a), it is possible to leverage differences in how different HEPs have experienced changes in their HEIF allocations to construct 'quasi-control groups' from which to examine whether this has led to differential effects on their KE performance.

This study exploits the significant expansion of HEIF from 2017/18 to 2022/23 to construct these quasi-control groups. HEPs were affected very differently by the expansion of funding, with some gaining significantly, while others saw their funding decline. Using this approach, the study segmented the 111 English HEPs receiving HEIF during the period 2017/18 – 2022/23 into groups based on the percent change in HEIF between the year preceding the expansionary period (2016/17) and the most recent year (2022/23). Should HEIF have a positive effect on KE, we should expect the change in KE performance of a HEP to be positively correlated with the change in HEIF received; i.e. if a HEP sees an expansion in their HEIF allocation, we would see an expansion in the KE outputs and impacts realised (proxied here by the income secured).

Figure 19 Constructing quasi-control groups to investigate the impacts of HEIF



* 109 HEPs received HEIF in 2022/23. Over the period 2017/18-2022/23, 111 HEPs received HEIF.

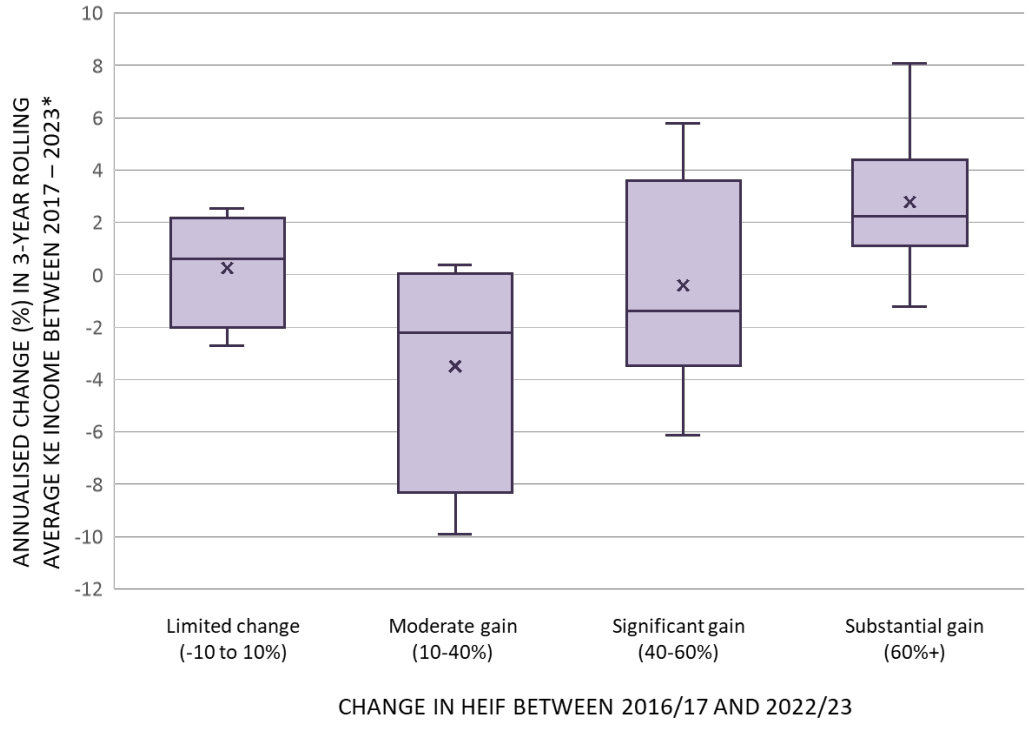
Sources: Research England funding data, HEIF Annual Monitoring Surveys

The groups are shown in Figure 19. To control for the significant differences in scales of HEIF received in the base period the analysis looks separately at HEPs in clusters V and X and those in clusters E, J, and M. Figure 13 shows that the former typically receive significantly more HEIF per institution than the latter (although the amounts per academic show much less variation).

Figure 20 compares the KE performance – measured as the compound annual growth rate in KE income – for HEPs in KE clusters V and X experiencing different levels of change in HEIF between 2016/17 and 2022/23. Boxplots are used to visualise the data as they are able to exhibit both the median average, *and* the distribution of KE performance around the median, for each of the quasi-control groups.

The analysis shows that HEPs seeing a greater increases in their HEIF allocations over the period 2016/17 and 2022/23 experienced greater KE income growth than those that saw less big increases in their allocations. One exception to this is the 4 universities in clusters V and X that saw limited change in their HEIF funding saw relatively stable KE income growth during this period. Of course, this analysis does not control for other factors – this will be explored in the regression modelling presented in the next section.

Figure 20 Change (% per annum) in the 3-year rolling average KE income between 2016/17 and 2022/23 for HEPs in KE clusters V and X with different levels of change in HEIF



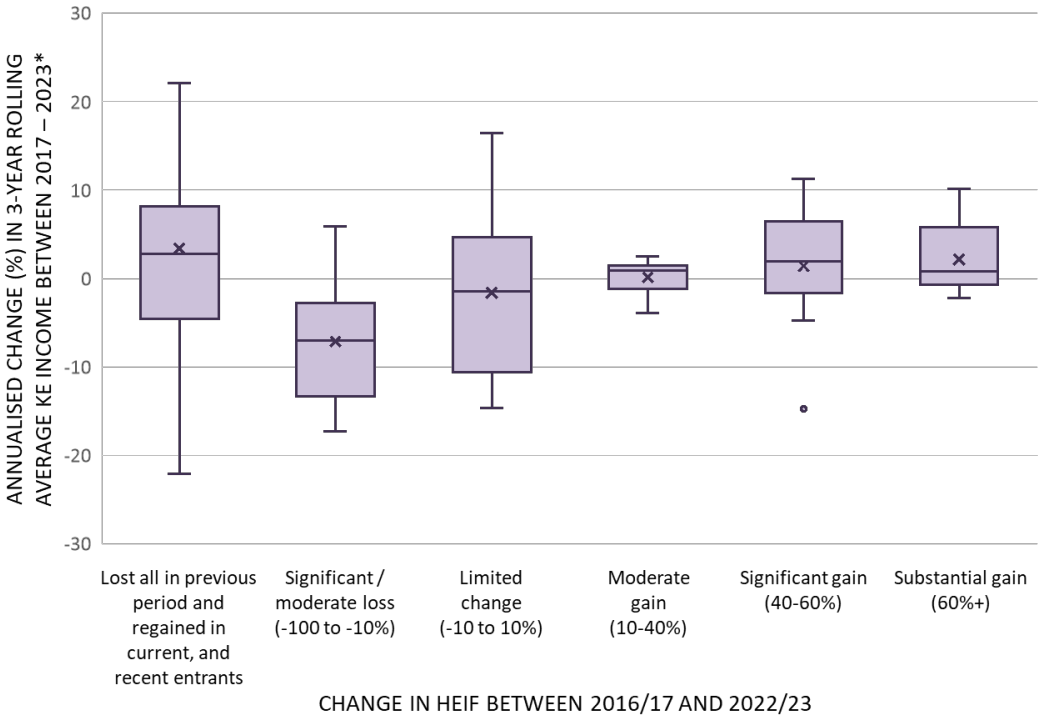
* Annual change (%) calculated using the compound annual growth rate (CAGR) on the 3-year rolling average KE income with averages taken over the period 2014/15 to 2016/17 and 2020/21 to 2022/23

Sources: HESA HEBCI, Research England funding data, HEIF Annual Monitoring Surveys

Figure 21 presents the results for HEPs in clusters E, J & M. Here the picture is more mixed. It suggests that HEPs that saw their HEIF allocations increase over the period mostly experienced stable or positive KE income growth. However, there was limited difference between HEPs receiving different levels of HEIF increases. By contrast, those that saw their allocations decrease over the period experienced a decline in their KE income, in some cases significantly. More than half of those that saw limited change in their HEIF allocations also experienced declines in their KE income over the period. Note that this period includes the Covid-19 pandemic. A study into the effects of the pandemic on KE showed that HEPs in these KE

clusters were more adversely affected during this period than those in clusters V and X (Ulrichsen & Kelleher, 2022). The study also showed the importance of HEIF in helping HEPs navigate the turbulence of the pandemic.

Figure 21 Change (% per annum) in the 3-year rolling average KE income between 2016/17 and 2022/23 for HEPs in KE clusters E, J and M with different levels of change in HEIF



* Annual change (%) calculated using the compound annual growth rate (CAGR) on the 3-year rolling average KE income with averages taken over the period 2014/15 to 2016/17 and 2020/21 to 2022/23

Sources: HESA HEBCI, Research England funding data, HEIF Annual Monitoring Surveys

5.3 Estimating the impact of HEIF using econometric modelling

The final approach to estimating the impact of HEIF focuses on developing an econometric model that seeks to examine why HEPs across the English HE sector experience different levels of KE performance and impacts, and the extent to which the amount of HEIF they receive can, at least in part, explain these differences.

These types of econometric models allow us to move beyond the more descriptive analyses presented thus far in this report, to explore in more detail how multiple factors influence the outcome variable. Through such techniques it is also possible to estimate the marginal effects of a change in funding on KE performance, controlling for wider explanatory and contextual factors, and produce an estimate of the ROI for the fund.

5.3.1 An econometric model for explaining KE performance and the role of HEIF

The model developed in this study builds on the work done in previous assessments of the impacts of HEIF by the author (in particular Ulrichsen, 2015a). It attempts to determine the influence of HEIF in explaining differences in the impacts arising from KE activities across

different HEPs, controlling for a range of internal and external factors. Building on previous evidence and insights, the development of the model is guided by the following function:

$$KE\ impacts = f(Funding, Prior\ experience, Scale, Internal\ capabilities\ and\ resources, Local\ context)$$

The impacts realised by HEPs through their KE activities is proxied here by the KE-related incomes secured by HEPs, based on the arguments set out in section 3.2. In developing econometric models that examine the effects of HEIF on KE performance, it is instructive to **look both at differences in the scale of KE impacts realised by HEPs, as well as their productivity in doing so**. Institution-level productivity in KE can be thought of as the amount of KE outputs and impacts produced per unit of knowledge input. With KE drawing on not just research but also the knowledge held by academics, this can be usefully proxied by the KE income generated normalised by the number of academic FTE staff. There is then a question as to whether the support and activities enabled by HEIF are able to increase not just the scale of KE, but also institution-level KE productivity.

The model builds on evidence that suggests that the potential for HEPs to contribute to the economy and society through KE depends critically on its **internal capabilities and available resources**, its **strategic ambitions and culture**, and viable external opportunities. This approach underpins the development of the KE clusters used in the KEF, and as such, membership of the KE clusters provide a useful tool to capture such differences (Ulrichsen, 2018, 2023).

Previous evaluations and assessments of the impact of HEIF also suggest that the **dedicated KE funding** has a positive and significant effect on KE outputs and impacts (PACEC, 2015; PACEC/CBR, 2009; Ulrichsen, 2014, 2015a). This funding invests to build up the capabilities and capacity to support deliver KE and create a conducive organisational environment, which wider evidence has shown to benefit KE activities (see e.g. Galán-Muros et al., 2017).

Furthermore, research has also shown that the **local socio-economic context** also plays an important role in shaping the KE activities of HEPs (e.g. Huggins et al., 2012; Lester, 2005). Different aspects of the local socio-economic context are captured here, including the overall level of economic prosperity, local industrial structure, local employment rate, local skills levels, and levels of local deprivation (based on multiple dimensions including not least health, crime, barriers to housing, and the living environment)[3].

Evidence also suggests that HEPs **benefit from the scale of their institutions**, with previous studies suggesting that the relationship between the size of HEP and both KE income *and* KE income per academic is positive and statistically significant. This tentatively suggesting that economies of scale and scope may be at play (Ulrichsen, 2014, 2015a). Conceptually, one might expect such a result due to economies of scale in supporting KE e.g. large fixed costs associated with the necessary supporting KE infrastructure. In addition, network effects could be important, for example, as the number of academics engaging in KE increases, it may become easier to convince the additional academics that it is of value. There may also be informal learning effects and mentoring through larger numbers of academics engaging, which

[3] Further detail on the Index of Multiple Deprivation can be found here: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019, accessed 10th November 2024.

lead to increases in KE income per academic. Critical mass effects may also emerge with the larger and more valuable partnerships seeking out larger university partners that can meet a wider range of knowledge needs (e.g. because of the diversity of disciplines or types of research and training available).

Evidence also points to KE being **strongly path dependent** (Thune & Gulbrandsen, 2014; Ulrichsen, 2015a), with the scale and nature of current activity and outputs shaped very much by that in the previous period. In essence, KE typically evolves through incremental change rather than disruptive junctures.

This leads to the general regression equation:

$$KEImpacts_{i,t} = \alpha + \beta_1 HEIF_{i,t-1} + \beta_2 PriorExp_{i,t} + \beta_3 UniScale_{i,t} + \beta_4 UniCapabilities_{i,t} + \beta_5 LocalProsperity_{i,t} + \beta_6 LocalIndustry_{i,t} + \beta_7 LocalEmpl_{i,t} + \beta_8 LocalSkills_{i,t} + \beta_9 QualArea_{i,t} + \varepsilon_t$$

Given the availability of a longer time series, this study also investigated whether the *changes* in KE impacts realised by the HEP (proxied by KE income) are related to the changes in HEIF expenditure, and changes to other key variables. In this model, the general regression equation was:

$$KEImpact\ Growth_i = \alpha + \beta_1 HEIF\ Growth_i + \beta_2 LocalProsperity\ Growth_i + \beta_3 LocalEmpl\ Growth_i + \beta_4 LocalSkills\ ChangeGrowth_i + \beta_5 QualArea\ Improvement_i + \beta_6 Univ\ Capabilties_i + \varepsilon_t$$

5.3.2 Conceptual and econometric challenges

There are a number of conceptual and econometric challenges that need to be addressed in the econometric modelling of the economic impacts of HEIF funding. First, the dependent variable (KE income) and several key explanatory variables are heavily skewed, with a small number of HEPs securing large proportions of the total HE system share. To overcome this, the model follows standard practice and transforms the data into logarithms. This transformation has the additional benefit in leading to a convenient interpretation of the regression coefficient: that a 1% change in the explanatory variable (e.g. HEIF funding) leads to a x% change in the dependent variable (e.g. KE income), i.e. the elasticity of KE income on HEIF funding.

Second, the English HE system is characterised by HEPs of vastly different scales. To control for this, the study adopts different approaches, not least: incorporating a scale variable (number of academic FTEs employed at the HEP) in the regression model; and normalises key variables by the scale of the institution (number of academic FTE staff). In the latter, the key performance indicator then becomes a measure of institution-level KE productivity. Importantly, the model retains the scale variables in the regression to test the effects of scale on productivity.

The third key challenge relates to the time lags associated with the economic impacts arising from KE (see section 3.1). To overcome this, the model focuses on the cumulative period 2017/18 – 2022/23). All dependent and explanatory variables, where possible, are assessed over this period. This helps to internalise the time lags involved. However it is inevitable that

some impacts will take longer to materialise than others, particularly for KE building on more fundamental research outputs. In addition, the use of KE income as a proxy for economic impact also helps to overcome some time lag issues. Because firms (and other users) are paying for the service in advance of its deployment, it reflects a *perceived* impact rather than a realised impact. The one exception here is income from licensing royalties which are secured based on sales.

Another challenge for econometric analyses is coping with outliers. This is particularly relevant here as the English HE sector is diverse as highlighted by the KE clusters developed for the KEF (Ulrichsen, 2023). Key sources of this heterogeneity include not least the breadth of disciplines, the type of research activity (from fundamental to more applied; from curiosity-driven to user-driven), the balance between research and teaching, and the type of teaching activity. Furthermore, while many HEPs cover a broad range of disciplines, the sector also includes specialist institutions focusing on particular disciplines (e.g. biomedicine, arts, science and engineering, or social sciences). An exploration of outliers in initial regressions revealed that many were specialist HEPs. There are different econometric techniques to control for outliers, such as running models such as robust regression that are less sensitive to extreme values; excluding outliers from the sample; or including a dummy variable to identify them in the model. These options were all investigated.

A fifth key challenge revolves around *collinearity* amongst the explanatory variables. This arises when different variables 'move' closely together. This can make separating the relative effects of each factors difficult, although their omission can also be conceptually questionable. In our models, collinearity starts to become a problem in a number of areas. This includes the inclusion of prior experience based on KE income in the previous period. To overcome this, the prior experience is entered into the model as different KE mechanism rather than the aggregate total. A second area is amongst the 'control' variables attempting to capture the resources and capabilities of HEPs. To overcome this, the core models use the membership of different KE clusters as a proxy to capture the different structural characteristics of HEPs.

Lastly, previous work highlights the existence of heteroskedasticity in the data – i.e. non-constant variances in the error term of the regressions. While the presence of heteroskedasticity will not lead to biases in the coefficient of the variable, it will lead to biases in the variance. This will cause problems in interpreting whether or not the coefficient is truly statistically significant or not. To help address this, regressions are run with robust standard errors.

5.3.3 Variables and data sources

Guided by the general model, variables were identified to capture each of the key concepts. These are presented in Table 11, along with data sources.

Table 11 Variables and data sources underpinning the econometric models

Category	Variable	Measure	Data sources
Dependent variables			
KE performance	Overall KE performance in the current period	Natural logarithm of KE income, averaged over the current period (2017/18 – 2022/23)	HESA HEBCI records
	Institution-level KE productivity in the current period	Natural logarithm of KE income per academic FTE, averaged over the current period (2017/18 – 2022/23)	HESA HEBCI and staff records
	KE performance growth between the previous and current periods	Percent change in KE income between the average income for the previous period (2011/12 – 2016/17) and the current period (2017/18 – 2022/23)	HESA HEBCI records
	KE performance with different types of partners (SMEs, non-SME commercial, non-commercial) in the current period	Natural logarithm of KE income from each type of partner (SMEs, non-SME commercial, and non-commercial) normalised by the number of academic FTEs, based on the average for the current period (2017/18 – 2022/23)	HESA HEBCI and staff records
Policy intervention variables			
Funding	HEIF expenditure	HEIF (recurrent) expenditure, averaged over the current period (2017/18 – 2022/23)	Internal Research England HEIF annual monitoring survey (AMS), publicly available data on HEIF allocations
Control variables – internal to university			
Prior experience	Institution-level KE productivity in the previous period	Natural logarithm of KE income from each KE mechanism normalised by academic FTE staff, average over the previous period.	HESA HEBCI and staff records
University capabilities	Membership of KE clusters underpinning the KEF	Dummy variable (1/0) capturing the membership of the HEP in one of the KE clusters that were developed to underpin the KEF. These clusters created groups to capture structural similarities between HEPs that are likely to shape KE opportunities. They capture differences in both scale and focus of HEP activity.	Ulrichsen (2023)
	Disciplinary portfolio in the current period	Share (%) of academics in clinical medicine and STEM disciplines, averaged over the current period (2017/18 – 2022/23). This reflects evidence that the types and scale of KE opportunities are known to different between science and engineering-focused disciplines and the arts, humanities and social sciences.	HESA staff records
	Balance between research and teaching in current period	Ratio of research income to tuition income, average for the current period (2017/18 – 2022/23). This seeks to capture HEPs that are more or less research- and/or teaching-driven.	HESA finance records
	Teaching focus in current period	Share (%) of postgraduate students in the total student population, average for current period (2017/18 – 2022/23).	HESA student records
	International research links in current period	Share (%) of research grants and contracts from non-UK sources as a share of total research grants and contracts income, average for the current period (2017/18 – 2022/23)	HESA finance records
	Quality of research impacts in the current period	Proportion (%) of Units of Assessment submitted to the Research Excellence Framework 2021 in the top quartile for impact excellence	REF 2021 data

Scale	Academic staff in the current period	Number of full time equivalent academic staff, average for the current period (2017/18 – 2022/23)	HESA staff surveys
Control variables – local context			
Local socio-economic context	Local economic prosperity in the current period	Gross value added in the travel-to-work-area (TTWA) in which the HEP is based, average for the current period (2017/18 – 2022/23)	Office for National Statistics Gross value added (GVA) and productivity statistics for other geographical areas[4].
	Local industrial strengths in high-tech manufacturing	Concentration of high-tech manufacturing jobs in the local area compared with nationally (local quotient) in the travel-to-work-area (TTWA) in which the HEP is based, average for the current period (2017/18 – 2022/23)	Business Register and Employment Survey (open access), available through Nomisweb
	Local industrial strengths in high-tech knowledge intensive services	Concentration of high-tech knowledge intensive services jobs in the local area compared with nationally (local quotient) in the travel-to-work-area (TTWA) in which the HEP is based, average for the current period (2017/18 – 2022/23)	Business Register and Employment Survey (open access), available through Nomisweb
	Local employment rate	Percentage of people aged 16 to 64 in employment in the local authority in which the HEP is based, average for the current period (2017/18 – 2022/23)	Office for National Statistics Local Indicators[5]
	Local skills level	Percentage of people aged 16 to 64 with Level 3 or above qualifications in the local authority in which the HEP is based, average for the current period (2017/18 – 2022/23)	Office for National Statistics Local Indicators[6]
	Local deprivation	Proportion of lower super output areas in the local area that are in the most deprived 10% nationally, based on the 2019 Index of Multiple Deprivation for England	UK Government data[7]

The regression were focused on the sample of non-specialist HEPs in England that had received at least some HEIF during the period 2017/18 – 2022/23. The specialist institutions were excluded both on conceptual and empirical grounds; both because, as argued, their specialisation results in much more targeted KE opportunities and impacts resulting in a number of them being clear outliers in the data. This final core sample consisted of 89 HEPs.

A number of diagnostic tests were undertaken on each regression to test their robustness. Among others, this included an examination of the normality of residuals, and tests for heteroskedasticity (including White's general test for heteroskedasticity and Cameron-Trivedi's decomposition to examine heteroskedasticity, skewness and kurtosis, and Breusch-Pagan / Cook-Weisberg tests for heteroskedasticity); normality (Shapiro –Wilk W test); collinearity (variance inflation factors); model mis-specification (linktest); omitted variables (Ramsey RESET test); normality (Shapiro-Wilk test); and outliers (analysing residuals, interquartile ranges).

[4] Available at https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/ukgvaandproductivityestimatesforothergeographies, accessed on 10th November 2024

[5] Office for National Statistics Local Indicators available at https://explore-local-statistics.beta.ons.gov.uk/, accessed on 10th November 2024

[6] Ibid.

[7] Index of Multiple Deprivation data for England available at https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019, accessed on 10th November 2024

5.3.4 Models and results

Four key models were developed and run using the statistical software package Stata. They investigated the relationship between HEIF and: institution-level KE productivity (KE income per academic) (model 1); scale of KE income (model 2); KE income growth (model 3); and KE income from different types of partners (model 4).

Model 1: Institution-level KE productivity (KE income per academic)

The first model (model 1.1) examines the relationship between the amount of HEIF a HEP receives per academic FTE and the amount of KE secured by the HEP per academic FTE – a measure of institution-level KE productivity – controlling for internal university characteristics, local external conditions, scale, and path dependence. The model was run using Ordinary Least Squares with robust standard errors to help correct for issues of heteroskedasticity. Most variables were entered as their natural logarithm to help control for heavily skewed distributions, and university characteristics were captured by entering a dummy variable (1/0) for membership of their KE cluster.

Table 12 Model 1.1 regression results – institution-level KE productivity and HEIF

VARIABLES	DV: Ln(KE Income per academic, 2018-23) OLS
Ln(HEIF (recurrent) per academic, 2018-23)	0.437***
	(0.000)
Ln(Collab. research income per academic, 2012-17)	0.064**
	(0.039)
Ln(Contract research income per academic, 2012-17)	0.016
	(0.687)
Ln(Consultancy income per academic, 2012-17)	-0.017
	(0.645)
Ln(Facilities & equipment income per academic, 2012-17)	0.035**
	(0.024)
Ln(CPD income per academic, 2012-17)	0.067
	(0.232)
Ln(Regeneration income per academic, 2012-17)	-0.000
	(0.988)
Ln(IP income per academic, 2012-17)	0.049**
	(0.023)
Ln(Academic FTEs, 2018-23)	0.149
	(0.246)
KE cluster = V	0.610***
	(0.007)
KE cluster = X	0.177*
	(0.099)
KE cluster = J	0.466**
	(0.023)
KE cluster = M	0.187
	(0.424)
Ln(GVA per job, 2018-23)	-0.704**
	(0.014)
Location quotient, high-tech manufacturing	-0.083
	(0.175)
Location quotient, high-tech knowledge intensive services	0.188*
	(0.077)
Employment rate 2018_23	-0.023†
	(0.102)

Skills (level 3 plus) 2018_23	0.002
	(0.795)
IMD 2019 - Proportion of LSOAs in most deprived 10% nationally	-0.586*
	(0.085)
Constant	13.099***
	(0.000)
Observations	89
R-squared	0.803
r2_a	0.749

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1, † p<0.15

The results for model 1.1 are shown in Table 12. It shows that the amount of HEIF expenditure per academic FTE is statistically significant and positively associated with the amount of KE income secured per academic FTE, controlling for variety of university characteristics, path dependence, scale, and local socio-economic characteristics. Interpreting the coefficient suggests that a 1% increase in HEIF per academic associated with a 0.44% increase in KE income per academic. **Assessing this effect at the mean of all variables, this implies a ratio of increased KE income related to increased HEIF funding of 5.9.**

Other important findings from this regression include that there is some path dependence at play here, with the level of KE income per academic in a number of key areas in the previous period positively and statistically significantly related to the amount secured in the current period. One striking finding is that the scale variable (proxied by the number of academic FTEs) appears to have little statistically significant effect on the KE productivity of an institution. This compares to the 2014 study which found a positive and statistically significant effect of the number of academic FTEs on KE income per academic FTE. One possible explanation for this could be that scale effects are captured by the KE cluster dummies. However, as shown in model 1.2 below, this does not appear to be the case.

Furthermore, HEPs in areas where economic prosperity (proxied by GVA per job) was lower are associated with generating more KE income per academic FTE. Those based in less deprived areas were also linked with generating more KE income per academic FTE, as were HEPs in areas with a greater concentration of high-tech knowledge-intensive services (which includes R&D companies focused on biotechnology, science and engineering).

To test the robustness of using membership of a HEP's KE cluster to capture university characteristics, an alternative regression model (model 1.2) was run where key characteristics were entered as variables, including their scale, quality of their research, balance between science and engineering disciplines and arts, humanities and social sciences, balance between research and teaching, focus of teaching on postgraduates, and international research links.

The results of are shown in Table 13. The coefficient on HEIF per academic FTE is very similar to the primary model 1.1, with a 1% rise in funding per academic FTE linked to a 0.42% rise in KE income per academic FTE. HEPs generating more high quality research impacts (based on REF 2019 assessments) were also linked with higher KE income per academic FTE, as were those with a more research focus, and those with a greater share of postgraduates in their student population. As with model 1.1, the scale variable (number of academic FTEs) remains

statistically insignificant, controlling for other factors, suggesting little additional effect of the scale of HEPs on their institution-level KE productivity.

Once again, being located in areas with lower GVA per job, and in less deprived areas, is associated with higher KE income per academic FTE.

Table 13 Model 1.2 regression results – institution-level KE productivity and HEIF (alternative specification)

VARIABLES	DV: KE Income per academic (2018-23) OLS
Ln(HEIF (recurrent) per academic, 2018-23)	0.423***
	(0.000)
Ln(Collab. research income per academic, 2012-17)	0.037†
	(0.142)
Ln(Contract research income per academic, 2012-17)	-0.020
	(0.720)
Ln(Consultancy income per academic, 2012-17)	-0.054
	(0.196)
Ln(Facilities & equipment income per academic, 2012-17)	0.043**
	(0.014)
Ln(CPD income per academic, 2012-17)	0.009
	(0.847)
Ln(Regeneration income per academic, 2012-17)	-0.014
	(0.509)
Ln(IP income per academic, 2012-17)	0.019
	(0.444)
Ln(Academic FTEs, 2018-23)	0.049
	(0.646)
REF 2021 - Share (%) of UoAs in top 25 impact	0.008**
	(0.050)
Share of academics in clinical medicine and STEM, 2018-23	0.323
	(0.428)
Ratio of research income to tuition income, 2018-23	0.004*
	(0.076)
Share of postgraduate students in total student population, 2018-23	1.492*
	(0.061)
Share of overseas research income in total, 2018-23	-0.085
	(0.819)
Ln(GVA per job, 2018-23)	-0.664**
	(0.044)
Location quotient, high-tech manufacturing	-0.114†
	(0.115)
Location quotient, high-tech knowledge intensive services	0.129
	(0.306)
Employment rate 2018_23	-0.013
	(0.334)
Skills (level 3 plus) 2018_23	-0.014
	(0.154)
IMD 2019 - Proportion of LSOAs in most deprived 10% nationally	-0.542†
	(0.150)
Constant	14.781***
	(0.000)
Observations	89
R-squared	0.792
r2_a	0.731

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1, † p<0.15

Model 2: Scale of KE income

Model 2 enters the key variables in levels rather normalised by the number of academics. One challenge of this approach is that the distributions of key variables such as KE income and HEIF are more skewed which can cause issues with the regression. The model was run using an Ordinary Least Squares regression with robust standard errors. Diagnostic tests suggest few issues with regards to normality assumptions, collinearity, mis-specification, or outliers. We can therefore have some confidence in the results emerging from this model.

The results for model 2.1 are presented in Table 14. The coefficient on HEIF expenditures is once again both positive and statistically significant. It suggests that a 1% increase in HEIF is associated with a 0.45% increase in KE income secured by the HEP. **Assessed at the mean of variables, this suggests a ratio of increased KE income from a 1% increase in HEIF of 8.6.**

As with model 1, there is evidence of path dependence, with the higher previous levels of KE income is associated with higher KE income in the current period. Here, the scale of HEP is strongly positively associated with higher KE income; perhaps unsurprising given the outputs are not normalised by the number of academics – i.e. it merely finds that larger institutions generate more KE income. The findings on the local context are similar to model 1.

Table 14 Model 2.1 regression results – scale of KE income

VARIABLES	DV: Ln(KE income, 2018-23) OLS
Ln(HEIF (recurrent), 2018-23)	0.446***
	(0.000)
Ln(Collab. research income, 2012-17)	0.071**
	(0.038)
Ln(Contract research income, 2012-17)	0.015
	(0.700)
Ln(Consultancy income, 2012-17)	-0.027
	(0.455)
Ln(Facilities & equipment income, 2012-17)	0.037**
	(0.026)
Ln(CPD income, 2012-17)	0.062
	(0.248)
Ln(Regeneration income, 2012-17)	-0.001
	(0.969)
Ln(IP income, 2012-17)	0.054**
	(0.019)
Ln(Academic FTEs, 2018-23)	0.529***
	(0.001)
KE cluster = 1	0.544**
	(0.016)
KE cluster = 2	0.153
	(0.162)
KE cluster = 4	0.471**
	(0.019)
KE cluster = 5	0.184
	(0.458)
Ln(GVA per job, 2018-23)	-0.680**
	(0.017)
Location quotient, high-tech manufacturing	-0.087
	(0.151)
Location quotient, high-tech knowledge intensive services	0.172
	(0.100)

Employment rate 2018_23	-0.023*
	(0.086)
Skills (level 3 plus) 2018_23	0.001
	(0.831)
IMD19 - Proportion of LSOAs in most deprived 10% nationally	-0.609*
	(0.064)
Constant	10.305***
	(0.003)
Observations	89
R-squared	0.948
r2_a	0.934

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1, † p<0.15

Model 3: KE income growth

Models 1 and 2 focus on exploring differences in KE performance in the current period (assessed over a relatively long period of time between 2017/18 and 2022/23) and the amount of HEIF spent on supporting these activities over the same period (to help internalise lags between investment and impacts), and controlling for initial conditions (path dependence). Model 3 exploits the increasingly long and stable (in terms of definitions) time series we have for the key variables, to investigate the relationship between the percentage change in HEIF allocations received by HEPs, and the percentage change in their KE income, between the previous period (measured as the averages over the period 2011/12 – 2016/17) and current period (measured as the averages over the period 2017/18 – 2022/23). Here the variables are not log-transformed, and hence the coefficients are interpreted as a 1 unit change in the explanatory variable is linked with an x unit change in the dependent variable.

The results are shown in Table 15. The coefficient on the HEIF growth variable is positive and statistically significant. It suggests that a 1 unit change in percentage growth in HEIF is linked to a 0.42 unit change in the percentage growth in KE income between the two periods. This implies that those HEPs that saw their HEIF allocations grow faster than those than didn't, on average saw their KE income also growth faster. This is consistent with the findings of the more descriptive quasi-control group analysis presented in 5.2.

Furthermore, controlling for other factors including the growth in HEIF received, HEPs in cluster V appear to experience a significantly higher KE income growth rate between these periods compared with cluster E (the baseline cluster), as do those in cluster J. Growth rates in KE income for HEPs in clusters X and M appear to be similar to those in cluster E. This is consistent with insights from the descriptive analyses presented in Figure 9.

Assessed at the means of the variables over the periods and converting the growth rates into changes in levels of HEIF and KE income, suggests that a **£1 increase in HEIF is linked to an increase in KE income of £8.6.**

Table 15 Model 3 regression results – KE income growth

VARIABLES	DV: KE income growth (%), 2012-17 to 2018-23 OLS
HEIF growth, 2012-17 to 2018-23 (%)	0.416***
	(0.000)
KE cluster = V	20.780***
	(0.006)
KE cluster = X	1.466
	(0.810)
KE cluster = J	23.887*
	(0.063)
KE cluster = M	1.713
	(0.925)
GVA per job growth, 2012-17 to 2018-23 (%)	-0.174
	(0.801)
Change in employment rate, 2012-17 to 2018-23	-0.363
	(0.801)
Change in proportion of skills level 3+, 2012-17 to 2018-23	2.578**
	(0.038)
IMD Change - Proportion of LSOAs in most deprived 10% nationally	31.784
	(0.658)
Constant	-24.175*
	(0.076)
Observations	86
R-squared	0.447
r2_a	0.381

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Model 4: KE income from different types of partners

Model 4 dives into the KE income secured from different types of partners, covering SMEs, non-SME commercial organisations (likely dominated by large companies), and non-commercial organisations (public and third sectors). It normalises the core variables by the number of academic FTEs to control for the scale of the institution. Note here, however, that unlike aggregate KE income analysis where we assume that KE income per academic can be thought of as the institution-level productivity in KE, this is not the case for the KE income with different types of partners. This is because the number of academics in this case does not necessarily represent the relevant base for KE engagements with each type of partner.

The results are presented in Table 16. Controlling for other internal and external factors, the amount of HEIF received by HEPs per academic FTE is statistically significant and positively related to the amount of KE income per academic FTE secured from each type of partner. This suggests that the funding is playing an important role in enabling productive engagements with SMEs, non-SME commercial partners, and non-commercial partners. The results also suggest that HEPs located in areas with higher concentrations of high technology knowledge intensive services companies are likely to generate greater KE income per academic FTE from SMEs. This does not appear to be the case for engagements with non-SME commercial partners or non-commercial partners. This could perhaps reflect a greater importance of geographic proximity

for small, knowledge-intensive services companies in their engagements with HEPs compared with larger companies.

Table 16 Model 4 regression results – KE income per academic with different types of partners

VARIABLES	(1) SMEs OLS	(2) Non-SME Commercial OLS	(3) Non-Commercial OLS
Ln(HEIF (recurrent) per academic, 2018-23)	0.548*	0.971**	0.343**
	(0.054)	(0.012)	(0.044)
Ln(Collab. research income per academic, 2012-17)	0.038	-0.043	-0.170***
	(0.684)	(0.558)	(0.002)
Ln(Contract research income per academic, 2012-17)	-0.027	0.022	0.248***
	(0.826)	(0.912)	(0.001)
Ln(Consultancy income per academic, 2012-17)	0.003	-0.188	0.128†
	(0.978)	(0.155)	(0.137)
Ln(Facilities & equipment income per academic, 2012-17)	0.218***	0.046	0.007
	(0.000)	(0.449)	(0.827)
Ln(CPD income per academic, 2012-17)	-0.037	0.192†	0.364***
	(0.752)	(0.139)	(0.000)
Ln(Regeneration income per academic, 2012-17)	0.043	-0.030	-0.050†
	(0.457)	(0.618)	(0.106)
Ln(IP income per academic, 2012-17)	0.065	0.158***	0.002
	(0.274)	(0.004)	(0.953)
Ln(Academic FTEs, 2018-23)	0.233	0.376	0.124
	(0.579)	(0.279)	(0.542)
KE cluster = V	-0.020	1.074**	0.791*
	(0.970)	(0.023)	(0.051)
KE cluster = X	-0.330	0.133	0.083
	(0.333)	(0.657)	(0.691)
KE cluster = J	-0.212	-0.342	-0.132
	(0.689)	(0.498)	(0.669)
KE cluster = M	0.185	-0.217	-0.504
	(0.691)	(0.748)	(0.159)
Ln(GVA per job, 2018-23)	-0.242	-0.142	-0.575
	(0.707)	(0.863)	(0.213)
Location quotient, high-tech manufacturing	0.037	0.221	0.058
	(0.844)	(0.161)	(0.555)
Location quotient, high-tech knowledge intensive services	0.550**	-0.068	-0.177
	(0.047)	(0.878)	(0.439)
Employment rate 2018_23	-0.004	0.008	0.039*
	(0.910)	(0.740)	(0.057)
Skills (level 3 plus) 2018_23	-0.004	0.013	0.009
	(0.844)	(0.516)	(0.470)
IMD 2019 - Proportion of LSOAs in most deprived 10% nationally	-0.317	0.621	0.611
	(0.781)	(0.551)	(0.302)
Constant	2.158	-3.302	3.667
	(0.795)	(0.758)	(0.484)
Observations	89	89	89
R-squared	0.525	0.701	0.692
r2_a	0.394	0.618	0.607

Dependent variable is the natural logarithm of KE income per academic from each type of partner, 2018-23
Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1, † p<0.15

6 HEIF and private sector leverage

The report has so far attempted to estimate the scale of the impacts arising from HEIF and a return on investment for the fund. Crucially, following the analytical framework set out in section 2, it recognises that HEPs work with many types of partners not just in the private sector, but also across the public sector – including, for example, central government, local government, public health and social care, defence – and the third sector and local communities. As with the private sector, partners in the public and third sectors also need to innovate to open up new ways of delivering services, tackle problems in the services they provide, and create new services to help address existing or emerging challenges.

The use of income as a proxy for impact, as argued in section 3.2, still holds for these non-private sector partners, and provides a useful estimate of the minimum-bound for the likely value of the KE services to the partner. As such, the income received by HEPs through their KE activities with private, public and third sector partners, provides a proxy measure of the impact realised through KE across the economy, public and third sector.

Another key measure of policy performance is the ability of public funding to leverage private sector investment. Given the UK's difficulties in stimulating private sector R&D investment compared with key comparator nations (such as the US, Germany, Switzerland, Japan, Korea, and China[8]), the ability of public investments to crowd-in private sector investment is critically important for our future competitiveness and economic growth.

The private sector leverage measure of policy performance therefore restricts our attention specifically to effects on the private sector, and thus excludes KE activities with the public and third sectors. The analyses that follow adopt the definition for private sector leverage used in a report for the then UK Department for Business, Innovation and Skills (Economic Insight, 2015):

> *Private sector leverage is the amount of private sector funding that arises as a result of public sector funding, and that otherwise would not have occurred*.

Note in the definition above that, as with our assessments of impacts and overall ROI for HEIF, the assessment of private sector leverage must also account for additionality (the extent to which the private sector investments would have happened anyway).

In considering private sector leverage, we adjust our use of KE income from being a *proxy* for the impact realised, to being a *measure* of the investment made by the KE partner in the KE project which, by definition, is aimed at leveraging HEP-based knowledge to deliver socio-economic benefits for the partner, the UK, and the world.

[8] Based on an analysis of the OECD Main Science, Technology and Innovation Indicators 2024, business expenditure on R&D, constant 2015 prices, purchasing power parity US dollars time series (B_PPPCT)

6.1 Empirical findings on private sector leverage

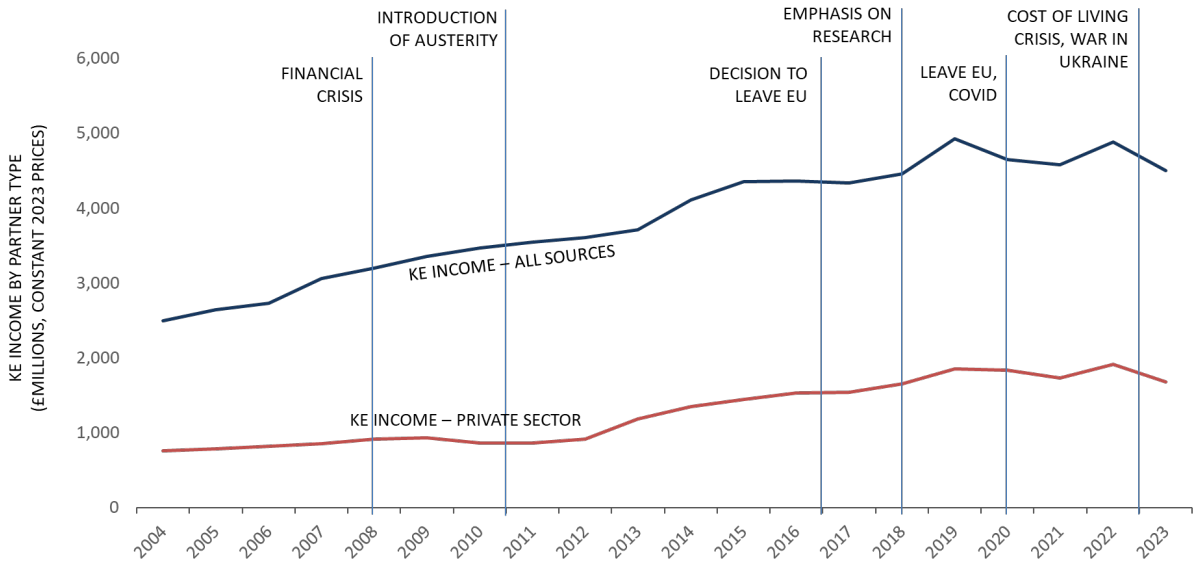
To get an estimate of private sector leverage for HEIF, we can exploit the methods and data set used for the wider assessments of impact and overall ROI for the fund but limit our attention to KE activities with private sector partners.

A measure of the scale of investments by private sector partners into KE with HEPs is developed using data available from the HEBCI records, and aggregates the following elements of KE:

- Collaborative research cash and in-kind income
- Contract research with SMEs and non-SME commercial partners
- Consultancy with SMEs and non-SME commercial partners
- Continuing professional development with SMEs and non-SME commercial partners
- Provision of facilities and equipment services with SMEs and non-SME commercial partners
- Intellectual property income from SMEs and non-SME commercial partners
- Income from the sale of shares in spinouts

The long-term trend in private sector investment into KE (as measured by the income received by HEPs) is shown in Figure 22. In 2022/23, private sector partners invested £1.7 billion in KE with HEPs, down from a long-term peak in the previous year of £1.9 billion.

Figure 22 Long term trends in income to HEPs from KE with all types of partners and from private sector partners



6.1.1 Private sector estimates based on expert insights from senior KE leaders

These data on private sector KE investments into different areas of KE are combined with expert insights on the attribution of KE outputs and incomes to HEIF provided by senior KE leaders to a request for information from Research England in July 2024. This leads to an estimate that, at least based on the views of KE leaders, over the period 2017/18 to 2022/23, HEIF leveraged

average annual private sector investments for KE totalling £582 million (i.e. this level of private sector investment in KE would not have happened in the absence of HEIF) (Table 17). Comparing this to HEIF investments made over the same period **suggests that £1 of HEIF results in £3 of private sector investment in KE.**

Table 17 Estimates of private sector leverage based on expert insights on attribution from senior KE leaders

KE support category	HEIF investment (£ millions) Average over 2017/18 – 2022/23	Private sector KE income attributable to HEIF (£ millions) Average over 2017/18 – 2022/23	Ratio of HEIF-enabled private sector KE income to HEIF	Ratio of HEIF-enabled private sector KE income & investment into spinouts / startups to HEIF*
A1. Facilitating the research exploitation process (non-technology transfer)	76	315	4.1	4.2
A2. Commercialisation (technology transfer, including spin-outs and licensing)	33	99	3.0	22.8
B. Skills and human capital development	20	38	1.9	2.3
C. Knowledge sharing and diffusion	23	53	2.3	2.9
D. Supporting the community and public engagement	14	29	2.1	2.2
E. Enterprise education and entrepreneurship	19	9	0.5	11.5
F. Exploiting the HEI's physical assets	9	38	4.4	7.7
All	194	582	3.0	7.6

* Excludes the University of Cambridge for reasons set out in section 5.1.4.

Although not perfect, the KE income secured by HEPs from private sector partners invested can be thought of as a more direct leverage effect of the fund, allowing more direct investments into KE projects. Following the rationale set out in section 5.1.4 allows us to expand this assessment to include a more indirect leverage effect of the fund, by capturing the investments into spinouts and startups that were founded and enabled / support in some way by HEIF. I refer to this an indirect because, beyond the initial investment into the venture at the deal stage, it is ultimately the actions and success of the company that secures subsequent investments.

Table 17 presents an assessment of the private sector investment leveraged by HEIF that includes the external investments secured by spinouts and startups. Once again, the University of Cambridge is excluded from the analysis due to likely changes in the way their data was collected over this period. **This expanded assessment suggests that £1 of HEIF is linked to £7.6 of leveraged private sector investment.**

6.1.2 Private sector leverage estimates based on regression models

The extent to which HEIF has leveraged private sector investment in KE was also examined through a regression model, building on the models from section 5.3.4 looking at the effects of

HEIF on KE income more generally. Two models are run; the first with key variables normalised by the number of academic FTE staff and transformed using their natural logarithm, and the second with key variables transformed using their natural logarithm but not normalised (i.e. entered as the scale of income secured). Each model for two dependent variables. The first is the amount of KE income secured by the HEP from private sector sources. The second adds the amount of external investment secured by spinouts and startups. This follows the arguments made in the previous section with the latter component representing a more *indirect* leverage effect of HEIF compared with the more *direct effect* of securing direct investment from the private sector in KE projects.

Table 18 presents the results for model 5 looking at the amount of private sector income secured by HEPs normalised by the number of academic FTE staff. The regressions pass the various diagnostic tests set out in section 5.3.3 suggesting we can have some confidence in the results. Model 5.1 shows that the coefficient on the HEIF per academic variable is positive and statistically significant controlling for other factors including internal and external conditions and prior experience. It suggests that a 1% increase in HEIF per academic is associated with a 0.59% increase in private sector investment in KE projects per academic. Assessed at the means of the variables suggests that £1 of HEIF is associated with leveraging an additional £2.5 of private sector investment in KE projects (direct leverage effect).

Model 5.2 includes the external investment into spinouts and startups, which adds a more indirect component to private sector leverage estimates. Once again, the coefficient on the HEIF per academic variable is positive and statistically significant controlling for other factors and conditions, and suggests that a 1% increase in HEIF per academic is associated with a 0.49% increase in private sector investment in KE projects and investment into spinouts and startups per academic. Assessed at the means of the variables suggests that £1 of HEIF is associated with leveraging an additional £4.5 of private sector investment in KE projects (direct and indirect leverage effect).

Table 18 Model 5 regression results – KE income per academic from commercial sources

	(5.1) Private sector income per academic	(5.2) Private sector income & external investment into spinouts/startups per academic†
VARIABLES	OLS	OLS
Ln(HEIF (recurrent)per academic, 2018-23)	0.588**	0.487*
	(0.023)	(0.075)
Ln(Collab. research income per academic, 2012-17)	0.129**	0.162**
	(0.011)	(0.010)
Ln(Contract research income per academic, 2012-17)	-0.066	-0.140
	(0.626)	(0.320)
Ln(Consultancy income per academic, 2012-17)	-0.121	-0.087
	(0.254)	(0.435)
Ln(Facilities & equipment income per academic, 2012-17)	0.101***	0.095**
	(0.001)	(0.018)
Ln(CPD income per academic, 2012-17)	-0.079	-0.121
	(0.307)	(0.232)
Ln(Regeneration income per academic, 2012-17)	-0.020	0.017

	(0.607)	(0.721)
Ln(IP income per academic, 2012-17)	0.061	0.071
	(0.148)	(0.173)
Ln(Academic FTEs, 2018-23)	0.207	0.215
	(0.237)	(0.367)
REF 2021 - Share (%) of UoAs in top 25 impact	-0.002	0.001
	(0.847)	(0.947)
Share of academics in clinical medicine and STEM, 2018-23	1.100	1.360
	(0.237)	(0.202)
Ratio of research income to tuition income, 2018-23	0.004	0.012**
	(0.372)	(0.027)
Share of postgraduate students in total student population, 2018-23	0.957	1.519
	(0.551)	(0.426)
Share of overseas research income in total, 2018-23	-0.153	-0.507
	(0.851)	(0.561)
Ln(GVA per job, 2018-23)	-0.137	-0.111
	(0.804)	(0.857)
Location quotient, high-tech manufacturing	0.034	0.086
	(0.788)	(0.515)
Location quotient, high-tech knowledge intensive services	0.114	0.116
	(0.645)	(0.689)
Employment rate 2018_23	-0.005	-0.009
	(0.818)	(0.761)
Skills (level 3 plus) 2018_23	0.009	0.026
	(0.577)	(0.111)
IMD19 - Proportion of LSOAs in most deprived 10% nationally	0.111	0.210
	(0.878)	(0.798)
Constant	3.343	3.130
	(0.624)	(0.697)
Observations	89	88
R-squared	0.748	0.779
r2_a	0.674	0.713

† Excludes the University of Cambridge from the analysis due to likely changes to their data collection practices resulting in challenges with interpreting their spinout and startup investment data over time.
Robust p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19 presents the results of model 6 which examines the association of HEIF with the two key dependent variables without normalising key variables by the number of academic FTE staff. The regressions pass the various diagnostic tests set out in section 5.3.3 suggesting we can have some confidence in the results. The coefficient on HEIF for model 6.1 is both positive and statistically significant, controlling for other factors. It suggests that a 1% increase in HEIF is associated with a 0.57% increase in private sector KE investment into KE projects. Assessed at the means of the variables suggests that a £1 increase in HEIF is linked with an additional £4.0 increase in private sector investment into KE projects (direct leverage effect).

Model 6.2 adds the external investment into spinouts and startups to the direct KE investments made by the private sector. Once again, the coefficient on HEIF is positive and statistically significant, controlling for other factors and conditions. It suggests that a 1% increase in HEIF is linked with a 0.49% increase in the combined private sector investment into KE projects and investments into spinouts and startups. Assessed at the means of the variables suggests that £1 of HEIF is associated with leveraging an additional £10.0 of private sector investment in KE projects (direct and indirect leverage effect).

Table 19 Model 6 regression results – scale of KE income secured from private sector sources

VARIABLES	(6.1) Private sector income OLS	(6.2) Private sector income & external investment into spinouts/startups† OLS
Ln(HEIF (recurrent), 2018-23)	0.572**	0.486*
	(0.018)	(0.061)
Ln(Collab. research income, 2012-17)	0.141**	0.171**
	(0.011)	(0.013)
Ln(Contract research income, 2012-17)	-0.063	-0.138
	(0.636)	(0.323)
Ln(Consultancy income, 2012-17)	-0.118	-0.091
	(0.201)	(0.359)
Ln(Facilities & equipment income, 2012-17)	0.108***	0.098**
	(0.000)	(0.022)
Ln(CPD income, 2012-17)	-0.070	-0.108
	(0.321)	(0.256)
Ln(Regeneration income, 2012-17)	-0.020	0.016
	(0.622)	(0.762)
Ln(IP income, 2012-17)	0.070	0.078
	(0.110)	(0.160)
Ln(Academic FTEs, 2018-23)	0.608**	0.738**
	(0.017)	(0.023)
REF 2021 - Share (%) of UoAs in top 25 impact	-0.002	0.000
	(0.822)	(0.977)
Share of academics in clinical medicine and STEM, 2018-23	1.032	1.338
	(0.292)	(0.240)
Ratio of research income to tuition income, 2018-23	0.003	0.011**
	(0.412)	(0.037)
Share of postgraduate students in total student population, 2018-23	0.920	1.481
	(0.552)	(0.435)
Share of overseas research income in total, 2018-23	-0.104	-0.454
	(0.893)	(0.584)
Ln(GVA per job, 2018-23)	-0.100	-0.093
	(0.852)	(0.880)
Location quotient, high-tech manufacturing	0.033	0.083
	(0.793)	(0.530)
Location quotient, high-tech knowledge intensive services	0.104	0.105
	(0.677)	(0.723)
Employment rate 2018_23	-0.006	-0.010
	(0.766)	(0.723)
Skills (level 3 plus) 2018_23	0.008	0.025
	(0.593)	(0.122)
IMD19 - Proportion of LSOAs in most deprived 10% nationally	0.048	0.124
	(0.946)	(0.877)
Constant	0.190	-0.691
	(0.976)	(0.927)
Observations	89	88
R-squared	0.895	0.891
r2_a	0.864	0.858

† Excludes the University of Cambridge from the analysis due to likely changes to their data collection practices resulting in challenges with interpreting their spinout and startup investment data over time.
Robust p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.2 Summary of private sector leverage estimates

The assessment of private sector leverage follows the overall approach taken for this study, whereby the impacts of HEIF are examined using different methods and data sources to increase confidence in the results. Each method estimates first a *direct* private sector leverage effect (based on the amount of investment private sector partners make into KE projects that can be attributed to HEIF). It then attempts to add a more *indirect* leverage component by including the investment secured into spinouts and startups. The findings are brought together in the following summary tables. Each table also presents the average across each of the methods, reflecting that each method has advantages and disadvantages. **Averaging across the different methods suggests that HEIF has a direct private sector leverage effect of 3.2, and a combined direct and indirect leverage effect of 7.4.**

Table 20 Summary of direct private sector leverage of HEIF

Method	ROI estimate	Method details
Expert assessment	3.0	Ratio of additional private sector investment into KE projects to the amount of HEIF invested by HEPs, with values based on averages over the period 2017/18 – 2022/23. Attribution estimates based on the expert insights of senior KE leaders of 79 HEPs responding to a request for information from Research England in July 2024.
Regression model 5.1 (normalised per academic)	2.5	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF per academic and the natural logarithm of private sector investment into KE projects normalised by academic FTE staff (over the period 2017/18 – 2022/23). The direct private sector leverage effect is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Regression model 6.1 (levels)	4.0	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF and the natural logarithm of private sector investment into KE projects without normalising by the number of academic FTE staff (over the period 2017/18 – 2022/23). The regressions pass the various diagnostic tests. The direct private sector leverage effect is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Average of methods	**3.2**	**Averaging across the three methods above.**

Table 21 Summary of direct and indirect private sector leverage of HEIF

Method	ROI estimate	Method details
Expert assessment	7.6	Ratio of additional private sector investment into KE projects (direct leverage) and investment into spinouts and startups (indirect leverage) to the amount of HEIF invested by HEPs, with values based on averages over the period 2017/18 – 2022/23. Attribution estimates based on the expert insights of senior KE leaders of 79 HEPs responding to a request for information from Research England in July 2024.
Regression model 5.2 (normalised per academic)	4.5	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF per academic and the natural logarithm of the combined private sector investment into KE projects and investment into spinouts and startups normalised by academic FTE staff (over the period 2017/18 – 2022/23). The University of Cambridge is excluded from the analysis due to likely changes in their data collection practices. The private sector leverage effect (direct + indirect)

		is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Regression model 6.2 (levels)	10.0	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF and the natural logarithm of the combined private sector investment into KE projects and investment into spinouts and startups without normalising by the number of academic FTE staff (over the period 2017/18 – 2022/23). The University of Cambridge is excluded from the analysis due to likely changes in their data collection practices. The private sector leverage effect (direct + indirect) is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Average of methods	**7.4**	**Averaging across the three methods above.**

7 A deep dive into the impacts of HEIF on and through student and learning-focused KE

7.1 Introduction

This final section undertakes a deep dive into what we currently know about the impacts and ROI of HEIF on, and through, student and learning-focused KE.

The Department of Education (DfE) contributes £48 million annually to the HEIF budget, with the remainder drawing from Department for Science, Innovation Technology (DSIT). This joint funding of HEIF from both an education and science perspective enables it to cover both KE that draws from the full breadth of assets and capabilities HEPs hold across their research and education portfolios and activities. There is therefore an interest in whether the fund is having a positive and significant impact on areas of interest to the DfE, for example on the student journey and outcomes, and on skills development, particularly in the local economy.

Investigating the impacts and ROI on student and learning-related KE (henceforth KE-S/L) is challenging not least due to the lack of any comprehensive datasets on how KE engages students, and the extent to which HEIF is focused on these areas. The HEBCI survey, while having national coverage is primarily focused on the activities of KE rather than the delivery agents (e.g. staff and/or students). Furthermore, while it identifies the scale of activities with different types of partners (SMEs, non-SME commercial organisations, and non-commercial organisations) and the income received from them which we then use as a proxy for the impact realised through KE, it does not capture how staff or students themselves benefit from KE. That said, HEBCI does provide insights on some areas of KE relevant to the DfE, notably student entrepreneurship. It also provides insights on the skills development and upgrading work of HEPs through CPD and CE.

There are also ad hoc large-scale, UK-wide surveys of academics and businesses (Hughes et al., 2016, 2022) that provide some further insights into how academics, students, and businesses benefit from KE in areas relevant to the DfE.

To make progress in this area, this section first sets out a conceptual framing for considering the impacts realised from investments of HEIF impacts on, and through, KE-S/L. It then looks at data availability and key limitations, before presenting the evidence of impacts and an estimate of the ROI for student entrepreneurship.

7.2 Conceptual framing

One of the biggest challenges to assessing the impacts and ROI realised from investments of HEIF on, and through, KE-S/L is being clear about the eligibility of different types of KE activities and target groups being supported by, or benefiting from, the funding.

Attempts to understand and investigate KE have traditionally focused on the nature of the interactions, the types of non-academic partners involved and how they benefit. They also typically assume the primary delivery agent for KE within the HEP is the academic. The role of the student in delivering KE historically received little attention.

One notable exception is **student entrepreneurship**, which is more visible and distinct, and likely helped by the national annual collection of data on the scale and impacts of this activity through HEBCI (Figure 23). This figure shows that, for HEPs in receipt of HEIF funding between 2017/18 and 2022/23, students (including graduates within 2-years of graduation), had set up almost 4,000 startups that had received some form of business / enterprise support from their institution. This was approximately 500 more than in 2017/18. The portfolio of active student startups increased by over 3,800 over this period, with the employment generated by active companies rising to over 50,000 in 2022/23 from just under 20,000 in 2017/18. The ratio of turnover to employment increased from around £35,400 to £93,800, and the amount raised per startup increased from just under £52,000 in 2017/18 to just over £332,000 in 2022/23.

Figure 23 Student startup activity and impacts in 2017/18 and 2022/23

	STUDENT START-UPS 2017/18	STUDENT START-UPS 2022/23
Number of student start-ups newly registered	3,368	3,924
Number of active student start-ups	10,652	14,496
Estimated employment of active student start-ups	19,832	50,597
Estimated turnover of active student start-ups	£702mn	£4,746mn
Estimated external investment received into student start-ups	£175mn	£1,303mn

Note: to be classed a 'student startup', venture has to have been founded by a students currently registered with HEP or by graduates within 2 years of graduation, and have received some form of business/enterprise support from the HEP

Source: HESA HEBCI records

Table 22 Broad project typologies and common activity types identified by SQW

Area	Description
Employer-set project delivery	Where KE activity is led by employers e.g. employers proposing challenges which students are asked to solve
Student-led project delivery	Where issues or challenges are identified by students, who then provide solutions through KE
Entrepreneurship schemes	With activities focused on entrepreneurship and/or the implementation of new ideas within organisations (intrapreneurship)
Training delivery	Providing training activities to students to support the development of KE skills
Research/evaluation	Undertaking research or evaluation on existing activity, to expand the KE evidence base (but not the 'delivery' of KE activities specifically)

Source: reproduced from SQW (2023)

The growing importance of student-focused KE was being highlighted in analyses of HEIF strategies from the early 2010s (PACEC, 2012; Ulrichsen, 2014). It noted other forms of student-driven KE beyond student entrepreneurship, for example students delivering consultancy projects for local small companies, and student placements and internships. A more recent study by SQW for the Office for Students highlighted student-centric KE activities in a bit more detail, as captured in Table 22.

In addition to students becoming the primary delivery agent for KE, some academic-driven KE activities may involve students in delivery, for example in research-focused or training-focused KE projects. Furthermore, a few HEPs as far back as the early 2010s, were also looking at how they could create work experience / internship opportunities for students to *support* the KE activities of the institution (PACEC, 2012). Unfortunately, there is little information on the prevalence of these activities amongst the student body.

We have also long-known from surveys of academics investigating their KE motivations and activities that their teaching and student-focused activities benefit from their KE interactions (Abreu et al., 2009; Hughes et al., 2016; PACEC/CBR, 2009). The most recent survey of academics (Hughes et al., 2016) showed that:

- Over 50% of all academics engaging in KE were motivated to do so because they gained knowledge about practical problems that could be used in the teaching; and around half were motivated by the potential to create student placements and job opportunities.
- Over 50% cited that their KE interactions led to changes to the way in which they present teaching material, and over 40% said it led to changes in their course programmes. 22% of academics engaged in KE specifically to support curriculum development.
- Over 30% of academics engaging in KE believed that their interactions led to an increase in employability of their students; and around 18% believed it led to an increase in entrepreneurial skills of their students.

What we do not yet know is whether the ways in which KE benefits the teaching and learning of academics, and through this, their students and their outcomes, varies based on the type of KE undertaken, or by the balance of research/teaching responsibilities of the academic.

Beyond the link between KE and students, there are then KE activities that focus on driving education and learning outcomes in non-academic partners, for example through CPD with small companies. We know from HEBCI that HEPs in receipt of HEIF over the period 2017/18 – 2022/23 generated £571 million in income from the provision of continuing professional development and continuing education courses to organisations in the private, public and third sectors and to individuals. The academic survey of Hughes et al. (2016) showed that 27% of academics engaged in KE focused on providing 'employee training' (40% for academics in engineering and materials science).

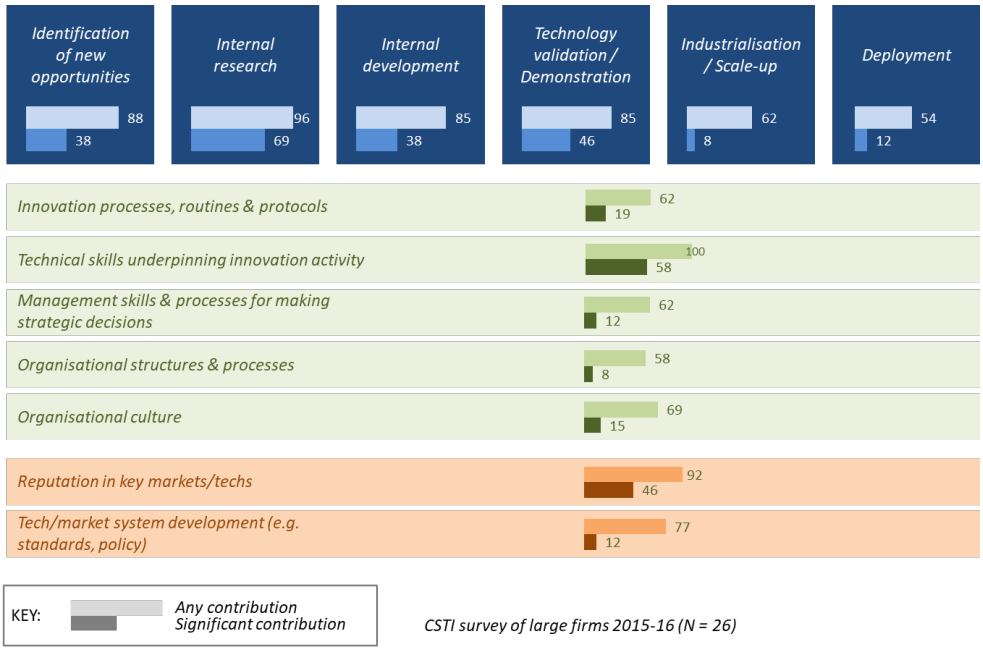
A more recent survey of businesses exploring their KE interactions with UK-based HEPs provides further insights on the how KE engages both the student body and learning agendas of HEPs (Hughes et al., 2022). These are highlighted in Exhibit 20 from their report. Engagement in many of these activities rises with the size of company, for example:

- Student projects / placements (16.9% of companies; 27.8% of large companies)
- Training employees (15.4% of companies; 31.1% of large companies)
- Studentship sponsoring (9.6% of companies; 23.0% of large companies)

This business survey also found that 16% of companies responding were motivated to engage with HEPs to support human resource management efforts, rising to 31% of large companies (more than 250 employees) and 22% in ICT, professional and scientific services sectors (which typical includes R&D-focused companies in biotechnology/engineering, technical and management consultancies, legal, accounting and other professional services companies).

We must also recognise that organisations engaging with HEPs through KE mechanisms that are not explicitly centred on training and learning, may also see benefits to their skills base, particularly where interactions involve close, person-based interactions between individuals. For example, research collaborations or longer-term strategic partnerships, while research-driven, are likely to involve elements of skills development and learning (both informal and perhaps more formal). A survey of some of the world's largest R&D intensive companies undertaken in 2015 looking at their strategic partnerships with universities highlights this the many areas they believed these types of interactions contributed to their innovation endeavours (Ulrichsen & O'Sullivan, 2018) (Figure 24). This includes many citing technical skills as an area of significant contribution. The same survey also found that many respondents also saw these partnerships as helping to build up their collaboration skills, and help to recruit students and researchers into their companies.

Figure 24 Areas where large companies perceive their strategic partnerships with universities contribute (any contribution and significant contributions, percent of respondents)

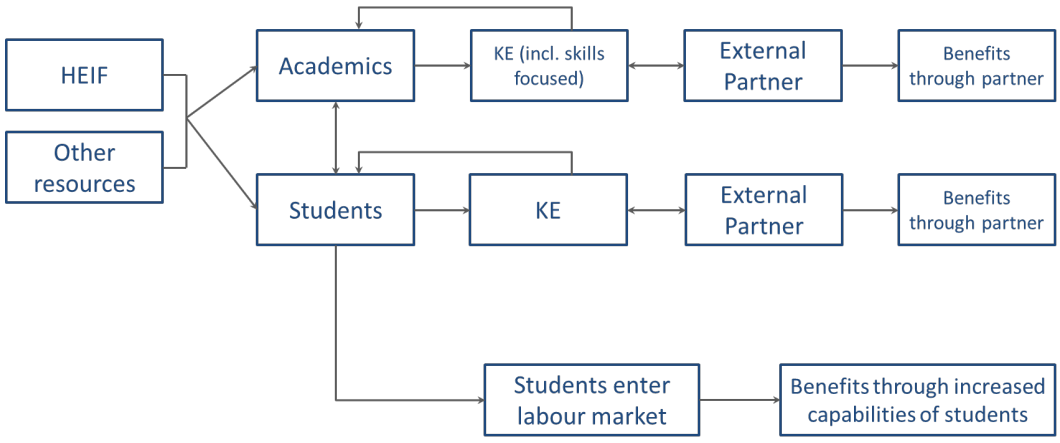


Source: Ulrichsen and O'Sullivan (2018)

Bringing these various insights together suggests the following simplified analytical framework for thinking about how KE – supported and enabled by HEIF and other resources – can deliver benefits through different channels (Figure 25), covering:

- **Students as KE delivery agents** (alone, or with academics, and for any type of KE) leading to short and longer term benefits to the external partners and through them, the wider economy and society. This would include student entrepreneurship.
- **Students, through delivering or supporting KE, realise benefits in terms of the development of their own capabilities**, experiences and employability. When they enter the labour market, these bring benefits that would otherwise be realised; to themselves (e.g. through higher wages, better job opportunities including starting new ventures), and their employers (e.g. through higher productivity) with consequences for the economy (e.g. greater innovation, improved products / services, higher profitability etc.).
- **Academics delivering KE (of any form) which results in benefits through feedbacks to their student and learning** focused activities at the HEP (e.g. more relevant, targeted teaching material, placement / job opportunities for students), which then results in benefits to the student who enters the labour market.
- HEPs delivering **KE (by academics, students or others) that seeks to develop and upgrade the skills of the workforce**.

Figure 25 Simplified framework for exploring the impacts of HEIF on, or through student and learning-focused KE



7.3 Evidence on the impacts of HEIF through student and learning-focused KE

Building on this analytical framing, the section now turns to investigating and assessing, where possible, the impacts of HEIF realised through its investments in KE-S/L and its ROI. While the analytical framework outlined in Figure 25 suggest multiple routes through which students can benefit through KE, and through which skills-focused KE can deliver benefits to the economy, given significant data limitations, efforts are limited to two types of KE activities which are clearly in scope of KE-S/L, namely: the effects of HEIF on student entrepreneurship, and on the delivery of CPD/CE.

7.3.1 HEIF expenditure on student and learning-focused KE

The difficulties in identifying the scope of student and learning-focused KE, coupled with data capture systems not set up to capture KE activities and investments that underpin them that are within scope, makes it is very difficult to determine a precise amount of HEIF that is invested to support KE-S/L activities. There are two exceptions. The framework used by Research England to track HEIF expenditures isolates two relevant categories: enterprise education and entrepreneurship, and skills and human capital development (Figure 2). Note that the first of these categories will likely also capture some level of academic entrepreneurship support as well as support for students. While not perfectly aligned, these provide a first indication of the quantum of HEIF invested in KE-S/L-relevant areas.

Information from Figure 14 shows that, in 2022/23, 9% (£24.4 million) was spent on supporting and enabling enterprise education and entrepreneurship, and a further 12% (£26.5 million) was spent on supporting KE focused on developing and upgrading skills and human capital in the wider economy and society. This equates to a total of £50.9 million in that year. This compares to £41.8 million across these two categories in 2017/18.

7.3.2 Impacts of HEIF through student entrepreneurship

To explore the impacts and ROI of HEIF on student entrepreneurship, we deploy similar methods to those used to assess the fund more broadly.

Estimates based on expert insights from senior KE leaders

Leveraging expert insights from senior KE leaders, Table 23 presents key estimates of the attribution of student entrepreneurship-related KE outputs and outcomes to HEIF investments, and an estimate for the ROI of HEIF in this area. It suggests that **53% of student startups created (involving some formal support from the HEP) were attributable to HEIF**. This is noticeable higher than for KE activities overall (38%). Table 9 in section 5.1.6 shows that this attribution is high across all types of HEPs, including for the very large research intensive institutions in cluster V (55%), and is particularly high for those in clusters J (78%) and M (61%).

The attribution of KE outputs and outcomes to HEIF for the KE support category of enterprise education and entrepreneurship was 40% (noting that this will include some activities beyond those that are student-focused). **This results in an estimated ROI for HEIF for this category of 13.1.** This is based on all the KE outputs and incomes associated with this category, as it is not possible to isolate those that are focused on students), and includes the improved estimate for the impacts realised through startups based on the external investments raised by these ventures.

Table 23 Key measures of attribution of HEIF and ROI for student entrepreneurship, based on expert insights from senior KE leaders

Key measures	Value
Attribution of student startups to HEIF: based on numbers of new ventures created	53%
Attribution of KE outputs related to enterprise education and entrepreneurship (which includes staff as well as student startups):	40%
Estimated ratio of additional monetised value of KE outputs to HEIF investments in the area of enterprise education and entrepreneurship (including the external investment raised by startups in the measure – see section 5.1.4, Table 6):	13.1

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

A simple regression model for linking HEIF to student entrepreneurship outcomes

A simple regression model (model 7) was also developed to explore the relationship between HEIF investments in student entrepreneurship and key measures of success. Key success measures (dependent variables) include:

- Model 7.1: the natural logarithm of the number of student startups created normalised by the number of students (averaged over the period 2017/18 – 2022/23)
- Model 7.2: the natural logarithm of the employment generated by the portfolio of active student startups (averaged over the period 2017/18 – 2022/23)
- Model 7.3: the natural logarithm of the external investment secured by the portfolio of active student startups (averaged over the period 2017/18 – 2022/23)

These data were sourced from HEBCI. Note that for a student startup to be reported in HEBCI, it has to have received some level of formal business or enterprise support from the HEP.

In these regressions, HEIF is limited to the amount invested into the enterprise education and entrepreneurship support category. While not perfectly aligned to student enterprise and education activities it provides a more targeted proxy for the amount of HEIF dedicated by HEPs to student entrepreneurship activities than focusing on all HEIF expenditure.

A dummy variable was used to capture the different types and scales of HEPs (using the KE clusters), and the number of student startups per student for the previous period (2011/12 – 2016/17) was included as a measure of prior experience.

Table 24 presents the results. It shows that, for each of the models, the amount of HEIF spent on enterprise education and entrepreneurship is statistically significant and positively related to the performance measure (number of student ventures created, employment generated by their student venture portfolio, and the external investment raised by this portfolio). The results suggests that a 1% increase in a HEP's HEIF investments in enterprise education and entrepreneurship (per student) are associated with a 0.2% increase in the number of student ventures founded per student (model 5.1); a 0.53% increase in the employment generated by the active student venture portfolio per student; and 0.59% increase in the investment secured by these companies per student.

Table 24 Regression results exploring the relationship between HEIF (enterprise education and entrepreneurship) and student entrepreneurship outcomes

VARIABLES	(7.1) Student startups (number) OLS	(7.2) Student startups (employment) OLS	(7.3) Student startups (investment) OLS
Ln(HEIF(Ent. education & entrepreneurship) per student, 2018-23)	0.201*	0.563**	0.593**
	(0.054)	(0.034)	(0.050)
Ln(Number of student startups per student, 2012-17)	0.408***	0.386**	-0.018
	(0.000)	(0.042)	(0.926)
KE cluster = V	-0.274	0.855	2.784***
	(0.300)	(0.173)	(0.003)
KE cluster = X	-0.775**	-0.950**	0.382
	(0.011)	(0.041)	(0.590)
KE cluster = J	-0.098	0.153	-1.393*
	(0.775)	(0.865)	(0.072)
KE cluster = M	0.437	0.826	-0.275
	(0.374)	(0.363)	(0.785)
Constant	-0.138	-5.894***	0.923
	(0.663)	(0.000)	(0.171)
Observations	84	84	84
R-squared	0.377	0.420	0.318
r2_a	0.329	0.375	0.265

Dependent variable is the natural logarithm of the variable, normalised by the number of student FTEs at the HEP
Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1, † p<0.15

By leveraging the results from regression model 7.2 on the employment generated by the active student startup portfolio, we can estimate a 'cost per job' measure for the ROI of HEIF for this type of KE – i.e. how much HEIF it costs to generate the jobs created by student startups. Assessed at the means of the variables, the regression modelling suggests **a 'cost per job' of £1,200**.

By leveraging the results from regression model 7.3 on the external investment raised by the active student startup portfolio, we can estimate a monetised ROI for HEIF for this type of KE. This makes the same assumption as in section 5.1.4 looking at using external investments into spinouts and startups as a measure of the minimum bound of their predicted market value. This is based on the assumption that investors (at least across their portfolio of investments) will be seeking to make positive returns on their investments and making investments based on the likelihood of the startup in delivering (financial) returns greater than the investment made. Assessed at the means of the variables this would suggest that **a £1 increase in HEIF into enterprise education and entrepreneurship is associated with an increase in external investments secured by student startups of £18.0.**

7.3.3 Impacts of HEIF through skills upgrading

Estimates of the impacts of HEIF realised through KE focused on skills development and upgrading in the economy, based on the expert insights of senior KE leaders, are captured in Table 25. Based on this method, 31% of the KE incomes generated by HEPs through their skills and human capital development-focused KE is attributable to the HEIF invested in this category.

This suggests that £1 of HEIF invested to support this type of activity is associated with £7.1 of impacts from skills and development-focused KE (assuming that the income from KE provides a useful proxy for impacts realised, and likely represents a minimum bound).

Table 25 Key measures of attribution of HEIF and ROI for skills and human capital development, based on expert insights from senior KE leaders

Key measures	Value
Attribution of KE incomes related to skills and human capital development category of KE support:	31%
Estimated ratio of additional KE income to HEIF investments, in the area of skills and human capital development:	7.1

Source: Based on 79 HEPs in receipt of HEIF submitting responses to a request from Research England in July 2024 for expert assessments of attribution of KE outputs to HEIF funding. HESA HEBCI records.

8 Summary and conclusions

This report presented key evidence on the impacts emerging from HEIF investments in HEPs to enable and support knowledge exchange. It also leveraged different methods to assess the ROI of HEIF. By drawing on different sources of information and using different approaches, **the report finds that HEIF continues to have a strong impact on the ability of English HEPs to deliver value from their KE activities.**

The past two decades has seen KE income secured by English HEPs grow significantly in real terms, with KE income 81% higher in 2022/23 than in 2003/04 for HEPs in receipt of HEIF during the period 2017/18 – 2022/23 (the vast majority of HEPs in England). However, what is clear is that this twenty-year period is characterised by two very different decades. While KE income grew strongly – and faster than the economy as a whole – during the first decade, the past ten years has seen this growth largely stagnate. The limited growth in KE income may well reflect the multiple crises and shocks the UK has faced since then, not least with the Covid-19 pandemic, cost of living crisis, and departure from the European Union and the effects of this on R&D with research grants and contracts income to HEPs from European sources declining almost 30% in real terms since the EU referendum in 2016. KE income now appears to track trends in the economy more widely (as measured by the UK's GDP). This is perhaps unsurprising given that KE involves HEPs working with partners in the private and third sectors that will be impacted by economic conditions.

Of course, not all HEPs are affected equally. A deeper dive into how KE income per academic over the past decade across English HEPs shows that growth is largely concentrated within clusters V (where approximately half of HEPs experienced some growth), and cluster J (where most experienced growth). Most other HEPs across the other clusters experienced declines.

At the mechanism level, collaborative research income exhibited strong growth, well after growth in other forms of KE had plateaued. However, this now appears to have stagnated and fell in the most recent period. This is particularly concerning given the emphasis on the importance long-term and effective partnerships between the research base and industry in driving innovation in the government research and innovation strategies past and present.

The overall impacts of HEIF

Overall, evidence from the various methods used – based on insights from senior KE leaders, a quasi-control group analysis, and regression modelling – suggests that HEIF makes a positive and significant contribution to securing impacts through KE (proxied in this study by the amount of income from these activities).

Based on insights from senior KE leaders, across all forms of KE, approximately 38% of KE outputs and incomes can be attributable to HEIF – i.e. they would not have happened in the absence of HEIF. This varies for different types of KE, with the attribution estimates noticeably

higher from collaborative research, spinouts and IP commercialisation, academic and student entrepreneurship, and regeneration and development.

Insights from the different approaches were also used to estimate a 'return on investment' (ROI) for HEIF, proxied here by measures of the ratio of the gross additional KE income attributable to HEIF to the amount of HEIF invested. Overall, the evidence suggests a strong return on investment from HEIF, with ROI estimates ranging from 5.9 to 8.6 (Table 26). Encouragingly all the approaches suggests return on investment figures within a reasonable range. Note that a variation in estimates is to be expected given the different methods and data sources used. **Averaging across the different approaches would suggest an ROI of 7.7**.

Table 26 Summary of base return on investment estimates for HEIF

Method	ROI estimate	Method details
Expert assessment	7.6	Ratio of the KE income attributable to HEIF received by HEPs over the period 2017/18 – 2022/23 to the amount of HEIF spent during this period. Attribution estimates are based on the expert judgements of senior KE leaders of 79 HEPs responding to a request for information from Research England in July 2024.
Regression model 1 (normalised per academic)	5.9	Regression model estimating the relationship between the amount of HEIF received and the amount of KE income generated (over the period 2017/18 – 2022/23), with values normalised by the number of academics (FTEs). ROI based on coefficients and values assessed at the mean average of the variables.
Regression model 2 (levels)	8.6	Regression model estimating the relationship between the level of HEIF received and the KE income generated (over the period 2017/18 – 2022/23). In this model the variables were entered without normalisation. Collinearity between explanatory variables was higher but within acceptable limits and regressions passed diagnostic tests. ROI based on coefficients and values assessed at the mean average of the variables.
Regression model 3 (growth)	8.6	Regression model estimating the relationship between percentage change in KE income and percentage change in HEIF between the previous period (average over 2011/12 – 2016/17) and the current period (average over 2017/18 – 2022/23). ROI based on coefficients and values assessed at the mean average of the variables.
Average of methods	7.7	Averaging across the four methods above, with impact proxied by the income secured by HEPs from their KE activities.

The main approaches used to estimate the impacts and ROI of HEIF focused on using income from KE as a proxy for the impacts it generates. This assumes that partners investing in KE activities must perceive that they derive at least that amount of value from the investment – i.e. it sets a minimum bound on the impacts realised. Of course, this has its limitations, particularly where we know that certain types of KE do not involve priced transactions that lead to income to the HEP. One such example is spinouts and startups, where any financial rewards back to the HEP are typically through the sale of any shares the university holds in the company, and any financial payments through the license of any IP. However, we have additional information on the external investments raised by these companies that can be used to inform an assessment of their impacts. Doing so raises the baseline ROI estimate of HEIF from 7.6 (the baseline for the expert assessment method) to 12.4, i.e. +4.8 due to better capturing impacts of spinouts and startups (Table 27). Note that, for consistency, this table limits our attention to ROI estimates based on expert assessments.

We also know that there are KE activities that do not involve priced transactions and hence would not be captured in any income-based measures of impact. Leveraging information on the proportion of such KE activities within different types of KE allows us to estimate an additional component to the ROI of HEIF that assumes that KE activities of similar types that do not involve monetary transactions would be valued at a similar price to those that do. This 'non-monetised' component is estimated to raise the baseline ROI by +2.4 (Table 27).

Table 27 Summary of additional ROI components based on improving estimates of the impacts of spinouts and startups and capturing hard-to-monetise KE

Method	ROI estimate	Method details
Baseline ROI (expert assessment method)	7.6	Estimated ROI of HEIF based on the expert assessment of senior KE leaders of the attribution of KE outputs and incomes to HEIF. Analysis limited to the KE income secured by HEPs as a proxy for KE impacts.
+ *Additional component due to spinouts & startups*	*+4.8* *(see comments)*	Utilising a method that more explicitly captures the impacts of spinouts and startups by using the external investment they raise as a proxy for impact, the ROI based on expert assessments increases from 7.6 (the baseline for the expert assessment method) to 27.8 (+20.2). This substantial increase appears to be driven largely by increased reporting by the University of Cambridge of their non-HEP owned formal spinouts since 2020/21. If we exclude Cambridge from this analysis, the ROI increases from 7.6 to 12.4 (+4.8).
+ *Additional non-monetised ROI estimate*	*+2.4 additional to above*	While income provides a valuable proxy for the impact of KE, it will not fully capture the total impact realised. A 2015 evaluation of the non-monetisable benefits arising from HEIF (PACEC, 2015) showed that while some KE activities involves a monetary transaction, others do not. Leveraging information from this study on the proportion of different types of KE that involve monetary transactions, and assuming that interactions that do not involve monetary transactions deliver similar benefits to those that do, we can estimate an additional element to the ROI that is not captured by income. This results in an additional ROI element of +2.4

Note: the ROI estimates provided in this table are limited to those emerging from the analysis based on the expert assessments of attribution by senior KE leaders.

The evidence also suggests that HEPs in cluster V appear to generate greater ROI from HEIF compared with HEPs in other clusters, although a greater proportion of KE outputs and incomes are perceived to be attributable to HEIF in other clusters. This possibly suggests a tension between allocating HEIF to areas where is particularly important given the availability of other sources of funding and areas where it can deliver greater ROI.

The estimates of attribution of KE outcomes to HEIF funding and the ROI are higher than the previous assessments for the period 2015/16 – 2018/19 (Ulrichsen, 2020). This is despite increased turbulence and uncertainty in the KE landscape. One possible explanation for this is that this increased uncertainty and turbulence in the landscape is making stable and predictable public funding for KE particularly important for maintaining KE activities in HEPs. A recent study on the effects of the Covid-19 pandemic on universities'' KE activities suggested that flexible and predictable sources of funding such as HEIF were becoming increasingly valuable for HEPs as they navigated periods of significant uncertainty (Ulrichsen & Kelleher, 2022).

HEIF and private sector leverage

The assessment of private sector leverage follows the overall approach taken for this study, whereby the impacts of HEIF are examined using different methods and data sources to increase confidence in the results. Each method estimates first a *direct* private sector leverage effect (based on the amount of investment private sector partners make into KE projects that can be attributed to HEIF). It then attempts to add a more *indirect* leverage component by including the investment secured into spinouts and startups. The findings are brought together in the following summary tables. Each table also presents the average across each of the methods, reflecting that each method has advantages and disadvantages. **Averaging across the different methods suggests that HEIF has a direct private sector leverage effect of 3.2, and a combined direct and indirect leverage effect of 7.4.**

Table 28 Summary of direct private sector leverage of HEIF

Method	ROI estimate	Method details
Expert assessment	3.0	Ratio of additional private sector investment into KE projects to the amount of HEIF invested by HEPs, with values based on averages over the period 2017/18 – 2022/23. Attribution estimates based on the expert insights of senior KE leaders of 79 HEPs responding to a request for information from Research England in July 2024.
Regression model 5.1 (normalised per academic)	2.5	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF per academic and the natural logarithm of private sector investment into KE projects normalised by academic FTE staff (over the period 2017/18 – 2022/23). The direct private sector leverage effect is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Regression model 6.1 (levels)	4.0	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF and the natural logarithm of private sector investment into KE projects without normalising by the number of academic FTE staff (over the period 2017/18 – 2022/23). The regressions pass the various diagnostic tests. The direct private sector leverage effect is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Average of methods	**3.2**	**Averaging across the three methods above.**

Table 29 Summary of direct and indirect private sector leverage of HEIF (including external investment into spinouts and startups)

Method	ROI estimate	Method details
Expert assessment	7.6	Ratio of additional private sector investment into KE projects (direct leverage) and investment into spinouts and startups (indirect leverage) to the amount of HEIF invested by HEPs, with values based on averages over the period 2017/18 – 2022/23. Attribution estimates based on the expert insights of senior KE leaders of 79 HEPs responding to a request for information from Research England in July 2024.
Regression model 5.2 (normalised per academic)	4.5	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF per academic and the natural logarithm of the combined private sector investment into KE projects and investment into spinouts and startups normalised by academic FTE staff (over the period 2017/18 – 2022/23). The University of Cambridge is excluded from the analysis due to likely changes in

		their data collection practices. The private sector leverage effect (direct + indirect) is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Regression model 6.2 (levels)	10.0	Estimate based on regression model investigating the relationship between the natural logarithm of HEIF and the natural logarithm of the combined private sector investment into KE projects and investment into spinouts and startups without normalising by the number of academic FTE staff (over the period 2017/18 – 2022/23). The University of Cambridge is excluded from the analysis due to likely changes in their data collection practices. The private sector leverage effect (direct + indirect) is based on the coefficient on HEIF and values assessed at the mean average of the variables.
Average of methods	**7.4**	**Averaging across the three methods above.**

HEIF and student and learning-focused KE

The study also examined the effects of HEIF on, and through, student and learning-focused KE. The importance of this dimension of HEIF reflects the significant contribution to the HEIF budget made by the DfE. The section presented a simplified logic model to help guide our thinking on the routes through which HEIF can impact on students (directly and indirectly), through the KE that students help to deliver that lead to benefits for the external partners involved, and through the teaching and learning-focused mechanisms of KE that result in skills and human capital development-related benefits to partners, with a particular interest in those in the local economies of HEPs.

While data availability greatly hampers delivering a wide-ranging analysis of the impacts of HEIF on students and learning, and on skills and human capital development in the economy, the report presented evidence that hopefully makes some initial progress. It highlights that:

- Many academics engaging in KE believe their interactions with non-academic partners benefit their teaching and student-focused activities, including by helping to create student placements and job opportunities, changing the ways in which they present teaching material, and changing their course programmes.
- 30% of academics engaging in KE believe their interactions helped to increase the employability of their students.
- HEPs in receipt of HEIF during 2017/18 – 2022/23 secured £571 million in income from the provision of continuing professional development and continuing education courses to partners in the private, public and third sectors, and to individuals.
- In 2022/23, students and graduates within two years of leaving the HEP started almost 4,000 new ventures that had benefited from some formal business or enterprise support provided by the HEP. The population of active student startups employed almost 50,600 people in 2022/23, and these active startups raised £1.3 billion in this year.

On the impacts of HEIF, the various analyses suggest that:

- Accepting data limitations, HEIF invested £50.9 million in 2022/23 on enterprise education and entrepreneurship (which includes much of student entrepreneurial activities as well as some academic entrepreneurship support) and on skills and human capital focused KE.
- 53% of student startups in receipt of some formal business/enterprise support from the HEP can be attributable to HEIF. This suggests an important role for the funding programme in supporting and enabling student entrepreneurship. The importance of HEIF is seen across the different types of HEP, and is particularly so for the HEPs outside the biggest research intensive institutions.
- Through regression modelling that looked specifically at the **relationship between HEIF investments into enterprise education and entrepreneurship and student startup outcomes suggests a cost per job created for of £1,200**; i.e. an additional job created through a student startup receiving some support from the HEP would cost an additional £1,200 of HEIF invested in enterprise education and entrepreneurship.
- Based on the regression model and looking at the external investment raised by these student ventures as a proxy for their likely impact suggests that a £1 increase in HEIF invested in enterprise education and entrepreneurship is associated with £18.0 of additional investment secured by student startups that received some support from their HEPs. Based on the expert insights of senior KE leaders suggests a return on investment from investing HEIF in this area of 13.1. **Averaging across these methods suggests at return on investment into this area of HEIF of 15.6.**

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Appendix A KE clusters and cluster membership

Table A.1 KE clusters and their characteristics

Cluster	Characteristics
Cluster E	• Large universities with broad discipline portfolio across both STEM and non-STEM excellent research across all disciplines. • Many academics have both a teaching and research focus or teaching only focus • Significant amount of research funded by government bodies/hospitals (cluster average 45%); 9% from industry and 12% from charities. • Large proportion of part-time undergraduate students. Smaller postgraduate population dominated by taught postgraduates.
Cluster J	• Mid-sized universities with a more teaching focus (although research is still in evidence). • Academic activity across STEM and non-STEM including other health, computer sciences, social sciences and humanities • Research activity funded largely by government bodies/hospitals (41%) and charities (20%); 9% from industry. • Smaller postgraduate population dominated by taught postgraduates.
Cluster M	• Smaller universities, often with a teaching focus. Few research-only academics • Academic activity across disciplines, particularly in other health domains, social sciences and humanities. • Research activity typically funded by non-UKRI sources, covering government bodies/hospitals (38%) and industry (27%); 14% from charities.
Cluster V	• Very large, very high research intensive and broad-discipline universities undertaking significant amounts of excellent research. • High proportion of research-only academic staff • Research funded by range of sources including UKRI (34%), other government bodies (26%), charities (24%) and industry (11%). • Significant activity in clinical medicine and STEM disciplines • 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. • High proportion of research-only academic staff • High proportion of research funded by UKRI (45%); 29% from other government bodies; 8% from industry and 12% from charities. • Discipline portfolio balanced across STEM and non-STEM although less or no clinical medicine activity. • Large proportion of taught postgraduates in student population

Source: Ulrichsen (2023)

Figure A.1 Cluster membership

(A) Clusters of broad discipline-based HEPs

Cluster E	Cluster J	Cluster M	Cluster V	Cluster X
Anglia Ruskin	Bath Spa (M)	UC Birmingham	Birmingham	Bath
Aston	Bedfordshire (E)	Bolton (J)	Bristol	Birkbeck
B'ham City (J)	Canterbury	Buck's New	Cambridge	Brunel
Bournemouth	Chester	Chichester	Exeter (X)	Durham
Bradford	Derby	Cumbria	Imperial	East Anglia
Brighton	East London	Falmouth	King's College	Essex
Central Lancs	Edge Hill (M)	Leeds Trinity	Leeds	Hull
City University	Gloucestershire	Liverpool Hope	Liverpool	Keele
Coventry	Northampton	London Met (J)	Manchester	Kent
De Montfort	Roehampton	Newman	Newcastle	Lancaster
Goldsmiths	SOAS (X)	St Mary Tw'ham	Nottingham	Leicester
Greenwich	Staffordshire	Solent	Oxford	LSE
Hertfordshire	Sunderland	Marjon	Queen Mary	Loughborough
Huddersfield	Worcester	Suffolk	Sheffield	Reading
Kingston		West London	Southampton	Royal Holloway
Leeds Beckett (J)		Winchester	UCL	Surrey
Lincoln		York St John	Warwick	Sussex
John Moores				York
South Bank (J)				
Manchester Met				
Middlesex				
Northumbria				
N'ham Trent				
Open				
Oxford Brookes				
Plymouth				
Portsmouth				
Salford				
Sheffield Hallam				
Teesside (J)				
UWE				
Westminster				
Wolverhampton (J)				

(B) Clusters of specialist HEPs

Specialists: STEM *		Specialists: Social sciences & humanities	Specialists: Arts & design		
BIO/VET	AECC	Bishop G'teste (*manual assignment to cluster M*)	Arts B'mouth	Cen Sch of Ballet	*HEPs are eligible for KE funding but lack sufficient data. Given sufficient evidence of specialist arts focus, suggest manually assigning to this cluster*
	Brit Osteopathy	L'don Business (*manual assignment to cluster V*)	Courtauld	Nat Cen for Circus Arts	
	ICR		Creative Arts	Contemporary Dance	
	Liver Trop Med		National Film	Rambert School	
	Sch of Hygiene		Guildhall	Northern School of Contemporary Dance	
	Royal Vet Coll		LAMDA		
	St George's		Leeds Art		
ENG	Cranfield		Leeds Conservatoire		
AGR	Harper Adams		Liver Perf Arts		
	Hartpury Uni		Arts London		
	Royal Agr Coll		Norwich Arts		
	Writtle		Plymouth Art		
			RADA		
			Ravensbourne		
			Rose Bruford		
			Royal Ac Music		
			Royal Coll Art		
			Royal Coll Mus		
			Speech & Drama		
			RNCM		
			Trinity Laban		

Source: Ulrichsen (2023)

Appendix B How to read a boxplot

In our analysis, we employ 'box-and-whisker plots' as a powerful tool for data visualisation. These plots serve as a valuable tool to illustrate not just the median average of a variable but also the extent of variability surrounding the median. In this way, it provides a visual summary of the distribution and central tendencies of a dataset while also identifying potential outliers or extreme values. This allows for much more meaningful comparisons between different groups.

Interpreting a box plot involves understanding the key components and features it represents.:

1. **Box**: The box in the plot represents the interquartile range (IQR), which includes the middle 50% of the data. **The left (or bottom) edge of the box represents** the first quartile (Q1) or the 25th percentile, and the right (or top) edge represents the third quartile (Q3) or the 75th percentile. The height of the box, therefore, shows the spread of the middle 50% of the data.
2. **Line inside the box**: This line represents the data's median or the 50th percentile. It shows the midpoint of the dataset.
3. **Cross inside the box**: Where represented, this indicates the mean average of the distribution.
4. **Whiskers**: The whiskers extend from the edges of the box and reach the minimum and maximum data values within a defined range.