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# The impact of teaching on third mission activities of higher education institutions: evidence from the UK

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## ABSTRACT

This study analyses the effect of a change of focus in a traditional mission (teaching) of higher education institutions (HEIs) on the variety and intensity of knowledge exchange (KE) activities. In doing so, it bridges two partially disconnected streams of the literature in science and innovation focusing on HEI missions and heterogeneity in HEI KE activities. The work relies on a longitudinal dataset from UK Research and Innovation (UKRI) comprising information on publicly funded research projects over the 2006–2013 period. Our identification strategy exploits the change in tuition fees following a 2012 reform to proxy for the increased attention to the teaching mission of English and Welsh HEIs compared to other HEIs in the UK. Results show a strong negative effect of the increase in tuition fees on the variety and intensity of KE activities by English and Welsh HEIs. Following the reform, applications for competitive research funding by English and Welsh HEIs did not change in terms of grant length, value and the number of collaborating partners.

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Higher education institutions; teaching; third mission; university; knowledge exchange

## Introduction

The term ‘entrepreneurial university’ has gained momentum recently, characterising the role higher education institutions (HEIs) play in the economic development of their region via knowledge exchange (KE) with the external environment (Etzkowicz 2003). In an attempt to systematise the variety of channels available to HEIs through which to interact with the external environment, recent works in the science and innovation literatures have proposed looking at both the variety of the forms of external engagement (the breadth of KE) and the intensity of collaboration (the depth of KE) (Hughes and Kitson 2012; Iorio, Labory, and Rentocchini 2017). Most of the existing literature on academic engagement has focused on the implications of the increased interaction of HEIs with the external environment for just one of the traditional missions of HEIs, namely, research activity (Perkmann et al. 2013; 2021). Little research is currently available on the relationship between the teaching commitment of HEIs and third mission activities (Marzocchi, Kitagawa, and Sánchez-Barrioluengo 2019).

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Drawing on and extending the points highlighted above, this study aims to investigate the impact that an increased focus of HEIs on the teaching mission has on their 'third mission' activities, focusing on the variety (breadth) and intensity (depth) of HEI knowledge exchange activities. This work bridges the gap between the literature relating HEI missions and strategies (Laredo 2007; Sánchez-Barrioluengo 2014) and that stressing the importance of variety in activities, stakeholders and outputs in HEI KE (Rossi and Rosli 2015). The value added this work offers is based on three main aspects: (i) it reports evidence on the rather under-investigated link between teaching and third mission activities in HEIs; (ii) it makes use of fine-grained data from a rich dataset containing detailed project-level information on competitive research funding obtained by UK HEIs and (iii) it adopts an identification strategy based on a reliable exclusion restriction that allows us to pin down causality in the relationship of interest.

The empirical analysis builds on information provided by Gateway to Research (GtR), a website developed by UK Research and Innovation (UKRI) – a public funding agency for science and research – with the purpose of disclosing information on UK Research Council – funded research projects. The study uses information on research grants awarded to HEIs in the UK (England, Scotland and Wales): the final dataset consists of 89 HEIs observed between 2006 and 2013 and comprises over 26,000 funded research grants. The work exploits the change in tuition fees following a 2012 reform to proxy for the increased attention on the teaching mission by English HEIs compared to other HEIs in the UK and estimates the effect of this increase on the variety and intensity of outcomes from KE activities by UK HEIs.

Our results show a negative and significant effect of the increase of tuition fees on the variety and intensity of KE activities by English and Welsh HEIs. After the reform, English and Welsh HEIs shift away from a broader set of knowledge-transfer activities relating to competitive research funding (less breadth and depth of KE outputs). Reassuringly, the above effect is not driven by the characteristics of research grants HEIs apply for before and after the reform.

The paper is structured as follows. Section 2 provides a review of the relevant literature and presents our main hypothesis; Section 3 describes the identification strategy, while Section 4 presents the data and methodology. Section 5 discusses the results, and Section 6 offers some concluding remarks.

## Background and research question

Within the broad area of research on higher education, recent decades have witnessed strong interest in the social responsibility of higher education institutions (Larrán Jorge and Andrades Peña 2017; Godonoga and Sporn 2022). This literature draws heavily on neo-institutional and corporate social responsibility theoretical approaches (in particular, stakeholder and legitimacy theories) and highlight (i) how HEIs build up legitimisation subject to pressure from the institutional environment (Lounsbury and Zhao 2013) and (ii) the factors shaping their legitimacy and accountability to multiple stakeholders (Suchman 1995). According to the above framework, the implementation of social responsibility in higher education institutions is shaped by pressure from the institutional environment and organisational factors. HEIs are expected to 'incorporate ethical, social and environmental principles and values within their main functions and this must be achieved from a perspective based on satisfying the needs and expectations of stakeholders.' (Larrán Jorge and Andrades Peña 2017, 304) Scholars have been increasingly referring to the social responsibility of HEIs in relation to (i) the engagement between these and the external environment (Godonoga and Sporn 2022) and (ii) the mission and impact of HEIs (Phillips, Moutinho, and Godinho 2018). This study takes the perspective above and focuses on aspects of HEI engagement and mission orientation.

Notably, recent work on HEI engagement has highlighted the importance of taking into consideration the variety of activities, stakeholders and impacts of HEI knowledge exchange. An increasing number of studies have considered a broader set of KE activities, looking at the main predictors

of engagement in KE activities by individuals (Landry et al. 2010; D'Este and Perkmann 2011) and the impact of this engagement (D'Este, Guy, and Iammarino 2013; Rentocchini et al. 2014; Sánchez-Barrioluengo 2014). Hughes and Kitson (2012) highlight the importance of the breadth and depth of HEI KE activities in terms of the mechanisms, disciplines and stakeholders involved. Rossi and Rosli (2015) point to the variety of activities and outputs arising from HEI KE, calling for a more careful investigation of the available indicators. Iorio, Labory, and Rentocchini (2017) draw an empirical distinction between the variety (breadth) and intensity (depth) of KE activities and show how these are associated with altruistic and pro-social behaviours. The current work builds upon this recent stream of the literature and characterises the rich set of KE activities coming from collaborative research according to two main dimensions. First, the average number of different KE activities (KE breadth) carried out by a HEI is important: a higher number of different activities implies a greater effectiveness of KE. Notably, a reliance on different channels for KE activities has been shown to increase the ability to convey complex ideas to diverse audiences and to tap into diverse and richer knowledge (D'Este and Patel 2007). Second, the depth of KE activities (KE depth) also matters for the effectiveness of KE. This refers to the relative importance of each activity in the basket of available KE activities (intensity of KE). Depth implies stronger ties, which have been shown to be more likely to ease the transfer of complex and tacit knowledge compared to weak ties (Uzzi, 1999).

Taking into consideration the heterogeneity (in terms of mechanisms, stakeholders and outputs) of KE activities is particularly important when looking at the specific mix of functions that might characterise a HEI (Laredo 2007). After all, HEIs need to position and differentiate themselves in a competitive environment, and in order to do so, they need to find the most appropriate balance between the three missions (Kitagawa, Sánchez Barrioluengo, and Uyarra 2016). The existing literature agrees that when looking at the heterogeneous set of activities comprising the three core missions of HEI (research, teaching and the third mission), 'one size does not fit all' because HEI external engagement is highly context-dependent (Sánchez-Barrioluengo 2014; Benneworth, Pinheiro, and Sánchez-Barrioluengo 2016).

Recent developments in institutional theory have pointed to the existence of simultaneous competing logics within organisations, which contribute to defining an organisation's identity (Greenwood et al. 2011). The literature on the missions of HEIs has examined how their core missions (research and teaching) have been expanded to incorporate a third mission more oriented towards industry and society at large (Morphew, Fumasoli, and Stensaker 2018). However, the study of the tensions generated among the different logics/missions is a comparatively under-investigated topic in science and innovation studies (Shields and Watermeyer 2020). Industry and academia are characterised by conflicting institutional logics: an academic logic focused on research freedom, a reward system based on peer recognition and open disclosure of research findings and a commercial logic (mostly introduced into HEIs via increased interest in the third mission), which entails different practices such as a higher hierarchy, secrecy and the private appropriation of financial returns (Sauer mann and Stephan 2013). Evidently, this broad theoretical separation is subject to different teaching-related nuances that depend on a number of features characterising the organisation: nature of the work (basic vs applied research, focus on teaching), workplace characteristics (teaching- vs research-focused organisation) and scientists' individual preferences (Sauer mann and Stephan 2013).

Although considerable effort has been put into understanding the complementarity/substitutability relationship between 'third mission' activities and research productivity (Perkmann et al. 2013; 2021) and between teaching and research missions (Reymert and Thune 2022), comparatively less effort has been devoted to studying the relationship between teaching and engagement in KE activities (Sánchez-Barrioluengo 2014; Bianchini et al. 2016). Existing evidence on the relationship between third mission activities and the teaching mission is clustered around three different approaches. First, some studies analyse the moderating effect of teaching activities on the relationship between the third mission and research performance in HEIs. The evidence is mixed, with positive (Freel, Persaud, and Chamberlin 2019), negative (Degl'Innocenti, Matousek, and Tzeremes 2019)

and inconclusive results (Landry et al. 2010). A second set of studies has focused on the role that specific third mission activities can have on teaching quality. For instance, Bianchini et al. (2016) find a positive correlation between consulting activities by Italian engineering faculties and teaching quality, but only for senior scholars with a scientific reputation. In all other cases, the relationship is negative and significant. Similarly, Wang et al. (2016) finds a non-linear relationship between third mission activities and teaching performance in Chinese HEIs, with an inverted U-shaped relationship for academic commercialisation (patents and licensing) and a U-shaped relationship for collaborative research. Vorley and Nelles (2008) discuss how the third mission can positively reinforce teaching and research activities, while the third mission has been found to affect teaching through its impact on research units and university management (Koryakina, Sarrico, and Teixeira 2015). The last piece of evidence pertaining to the relationship between teaching and third mission activities shows a direction of causality that goes from the teaching of entrepreneurship topics to specific instances of academic commercialisation. The literature is concord in finding a positive association between entrepreneurship training in HEIs and the creation of academic and graduate start-ups (Ramaciotti, Muscio, and Rizzo 2017; Marzocchi, Kitagawa, and Sánchez-Barrioluengo 2019).

This work builds upon the different streams of the literature highlighted above, focusing on the impact generated by a surge of interest in teaching activities in HEIs on the variety and intensity of HEI KE activities. Notably, we focus on the effect of the increase in tuition fees on the variety (breadth) and intensity (depth) of HEI KE activities. We use the change in tuition fees taking place following the 2012 reform in the UK to proxy for an increase in focus on the teaching mission compared to other missions by HEI managers and faculty. Our conjecture is that this increased focus on teaching-related activities has decreased specific instances of HEI KE, namely KE outputs from publicly funded collaborative research. Our main expectation is that the impact of an increased focus on teaching activities in HEIs leads to a lower engagement in KE activities, both in terms of the variety (KE breadth) and intensity (KE depth) of the KE activities carried out. Two main mechanisms are put forward to explain the negative relationship highlighted above: (i) attention bias and (ii) individual attitudes and incentives.

As for the former, past research shows that individual cognitive abilities are bounded when evaluating the ability to process and respond to information (Conlisk 1996). Hence, information processing is often susceptible to heuristics, including attentional bias (Gabaix 2019). In the case at hand, recent years have seen increasing pressure towards teaching-related activities in HEIs: increasing teaching loads (Schimank and Winnes 2000); increased 'micro-management' of teaching-related activities by HEI senior managers (Teelken 2012); the implementation of routines and formal processes at the administration level to address teaching-related issues (Locke 2014); greater scrutiny on teaching quality by students, student unions, students' families and other formal and informal organisations (Huisman and Currie 2004); the introduction of incentives for faculty strongly biased towards teaching (e.g. alternative career paths that are more teaching-oriented; proliferation of teaching-oriented positions); an increased number of roles within the HEI hierarchy devoted to teaching quality assurance. All the above are expected to have exacerbated the potential attentional bias towards teaching. Even where teaching loads have remained the same, faculty in HEIs are likely to devote more time to teaching-related activities due to the motivating factors above and are likely to have skewed their attention towards teaching-related activities, thus sacrificing activities related to other HEI missions (research and KE activities).

There is also an effect that is more bottom-up, as it comes from individual attitudes and incentives. Past work argues that prevailing incentives in HEIs and the scientific community constitute significant barriers to the advancement of third mission activities: career progression in academia and recognition within the scientific community rest mainly upon research performance (Freel, Persaud, and Chamberlin 2019). In a general trend towards a reduction in the time each scientist can devote to a single task, time scarcity forces the decision of which activity to focus on to become more valuable (Becker 1992). As scientists can now choose to allocate a unit of time to a wider set of activities, the opportunity cost of any forgone activity gets higher. In our specific case, there is an effect of time

constraints: individuals will have less time overall due to teaching reorientation within the organisation. In a context of less time available for non-teaching-related activities, faculty members will tend to prioritise research over knowledge exchange activities given the higher weight that research output bears for recognition within the academic community and for career advancement within the HEI system (Koryakina, Sarrico, and Teixeira 2015).

In light of the above, this study investigates the research question of the impact of increased attention to teaching-related activities on the variety (breadth) and intensity (depth) of HEI knowledge exchange activities.

## Identification strategy

This work exploits the change in tuition fees charged by HEIs located in England and Wales to identify the causal effect of the increased focus on the teaching mission on the 'third mission', and in particular on the variety and intensity of HEI knowledge-exchange activities. The focus is on a 2012 reform that raised the cap on tuition fees in England and Wales to £9,000 per year for students starting university in the 2012/13 academic year. Although the decision to increase fees was at the discretion of HEIs, there is widespread evidence that all HEIs in England and Wales increased their fees to the maximum tuition limit. Tuition fees for HEIs in Scotland and Northern Ireland did not increase, instead staying at a level comparable to the pre-2012 period (Sa, 2014).

To identify the average treatment effect of this tuition fee policy implementation on KE outcomes from publicly funded collaborative research by HEIs based in England and Wales, we implement a difference-in-difference (DiD) methodology by estimating the following two-way fixed effects model:

$$Y_{it} = \alpha_i + \gamma_t + \delta D_{it} + \beta X'_{it} + \varepsilon_{it}, \quad (1)$$

where  $\alpha$  are HEI-level fixed effects that account for time-invariant differences between HEIs,  $\gamma$  are time dummies that account for time-varying factors equally affecting both treated and non-treated HEIs,  $X'$  is a set of control variables,  $\varepsilon$  is the error term and  $D$  represents the treatment exposure.  $\delta$  is the parameter to be estimated, which corresponds to the average treatment effect on the treated (ATET).

## Data and measures

Our main source of information is the Gateway to Research (GtR) website. GtR reports information on over 100,000 research projects across multiple categories (e.g. fellowships, proofs of concept, studentships, vouchers). We focus on research grants, which is the most numerous category and accounts for almost half of the research projects funded under UKRI, taking into consideration only finished projects that started between 2006 and 2013.<sup>1</sup> The final dataset is a balanced panel comprising information on 89 HEIs observed between 2006 and 2013, which were involved in 26,124 research projects for a total value of about 10.5 billion pounds. Among the 89 HEIs, 14 are in Scotland and represent the non-treated group, while 71 are in England and 4 in Wales. Tables A1-A2 and Figure A1 in the supplemental online material provides descriptive information on the dataset.

## Dependent variables

As described above, the GtR database comprises information at the project level. Importantly for our work, detailed information on project outcomes is available, including information on the KE activities carried out within each project remit. The relevant project outcomes fall into 11 different categories: engagement activities, collaboration, further funding, policy influence, research tools and methods, research databases and models, artistic and creative products, software and technical products, intellectual property, products interventions & clinical trials, spin outs.

The variable proxying the variety of KE activities (*breadth*) measures the average number of distinct project outcomes for a HEI in a given year. Conversely, the variable measuring the intensity of KE activities (*depth*) takes into consideration the importance of each project outcome. To compute this, for each project and each outcome type ('engagement activities', 'collaborations', 'further fundings', and so on) we count the number of distinct outcomes (number of distinct engagement activities developed, number of further grants obtained, and so on), if any. Then, for every project we classify as intense (depth equal to 1) the outcome types that scored in the top 10 percent of the distribution of outcome numbers<sup>2</sup> and average this by HEI-year. Table C1 in the online supplemental material reports descriptive statistics for these variables.

### **Explanatory and control variables**

Our main explanatory variable is the dummy variable  $D$  in [equation \(1\)](#), which takes the value of 1 for English and Welsh HEIs from 2011 onwards and 0 otherwise.<sup>3</sup> Although the reform took effect starting from academic year 2012/2013 for HEIs based in England and Wales, the critical vote passed in the House of Commons on the 9th of December 2010, thus paving the way to the increase in the tuition fee cap. Even before the final approval in the House of Commons, the reform had been strongly debated and discussed by government officials, political parties and HEI representatives. This heated debate is likely to have produced anticipation effects on the part of HEIs, which started to prepare in advance for the new law coming into force. HEIs put in place new regulations and routines characterised by an increased attention to teaching-related activities. This is also apparent in our data, which show an increasing divergence between treated and untreated HEIs starting from the years before the reform came into force. Thus, the treatment year was set to 2011 in order to control for these anticipatory effects.

Furthermore, the empirical model includes a set of control variables (e.g. Cassiman, Di Guardo, and Valentini 2010), all log-transformed. These are derived from project-level and organisation-level information. More specifically, for HEI  $i$  at time  $t$  we include the number of projects started in year  $t$  ( $num\_proj$ ), the average project value in pounds ( $pounds$ ), the average number of organisations involved ( $num\_org$ ) and the average length in months ( $length$ ). In line with other empirical studies at the university level (e.g. Ramaciotti and Rizzo 2015), estimates also include the size of the HEI (number of academic employees –  $acad\_staff$ ) and the amount of research funding obtained in pounds ( $recurrent\_res$ ). Table C1 in the online supplemental material reports summary statistics for the above variables.

### **Results**

[Table 1](#) reports the results of our analysis. When it comes to the controls, the results are in line with expectations. In line with past evidence, the size of the research projects (both in terms of  $pounds$  and  $num\_org$ ) is found to be positively correlated with both *breadth* and *depth* (Iorio, Labory, and Rentocchini 2017). Conversely, the higher the number of projects ( $num\_proj$ ) in which a HEI is involved, the lower the *breadth* and *depth* of KE outcomes. The average project length and the HEI's size are not found to be associated with our outcome variables.

The main contribution of our work lies in the finding that our treatment  $D$  is negative and significant for both of our dependent variables: the breadth and depth of KE outcomes from research grant projects. Our results show that raising the tuition fee for English and Welsh HEIs negatively affected the variety and intensity of KE outcomes from research projects by these HEIs compared to Scottish and Northern Irish HEIs. More specifically, the change of focus in favour of teaching-related activities meant, on average, 0.34 fewer distinct KE outcomes and decreased the intensity of KE outcomes by 0.26. The reliability of the results in the present work rests upon the absence of systematic differences between HEI in the treated and untreated groups. For robustness checks on the issue above, please refer to Appendix B in the online supplemental material.



**Table 1.** Regression results on breadth and depth.

|                      | (1)<br><i>breadth</i> | (2)<br><i>depth</i>   |
|----------------------|-----------------------|-----------------------|
| <i>D (ATET)</i>      | -0.346***<br>(0.102)  | -0.258***<br>(0.0901) |
| <i>num_proj</i>      | -0.212**<br>(0.0937)  | -0.222**<br>(0.102)   |
| <i>pounds</i>        | 0.275***<br>(0.0911)  | 0.283***<br>(0.0709)  |
| <i>num_org</i>       | 0.567***<br>(0.0624)  | 0.492***<br>(0.0511)  |
| <i>length</i>        | 0.363<br>(0.198)      | 0.00273<br>(0.124)    |
| <i>acad_staff</i>    | 0.265<br>(0.329)      | 0.231<br>(0.257)      |
| <i>recurrent_res</i> | 0.243<br>(0.139)      | -0.0213<br>(0.0668)   |
| constant             | -7.561**<br>(3.172)   | -4.151**<br>(2.052)   |
| HEI FE               | Yes                   | Yes                   |
| Time FE              | Yes                   | Yes                   |
| Observations         | 712                   | 712                   |
| R-squared            | 0.801                 | 0.563                 |
| Number of HEIs       | 89                    | 89                    |
| F                    | 189.5                 | 26.59                 |

Robust standard errors in parentheses.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

These results add to the stream of literature investigating the relationship between missions at HEIs and the complementarity versus substitutability between them. While most of the extant literature on the topic has focused on the relationship between the third mission and research (Landry et al. 2010; Degl'Innocenti, Matousek, and Tzeremes 2019; Freel, Persaud, and Chamberlin 2019), this study provides evidence on the effect of an increased focus on the teaching mission on third mission output. Moreover, the results resonate with studies concerned with teaching activities at HEIs, notably studies focusing on the effect of the increase in tuition fees. These studies look at the effect of tuition fees on student behaviour, however (Wakeling and Jefferies 2013), and lack any evidence regarding the effect of teaching on the behaviour of academic staff.

## Concluding remarks

This paper analyses the link between a change of focus towards the HEI teaching mission and the variety (breadth) and intensity (depth) of KE activities. In doing so, the study bridges two partially disconnected streams of the literature in science and innovation studies focusing on the tensions generated among the different HEI missions and the heterogeneity of HEI KE activities. The work also contributes to the nascent empirical literature exploiting increasing data availability at the project level of analysis (Vanino, Roper, and Becker 2019) and by relying on an identification strategy seeking to provide causal interpretations to the results in this area of research (Perkmann et al. 2021).

Results show a strong negative effect of the increase of tuition fees on both the variety and intensity of KE activities by English and Welsh HEIs. This is driven by the higher likelihood of these HEIs reducing their effort on outcomes relating to KE activities after the reform. Conversely, the research grants they apply for tend to be the same in terms of number, partners and duration compared to projects obtained by the control group.<sup>4</sup>

Our study confirms the importance of taking into consideration the rich heterogeneity characterising HEIs (also in the design of policies relevant for HEIs). If 'one size does not fit all' (Benneworth, Pinheiro, and Sánchez-Barrioluengo 2016; Sánchez-Barrioluengo, Uyarra, and Kitagawa 2019), then



changes to relevant functions of HEIs can have unintended consequences in terms of the relative importance of their missions. This work shows that this was indeed the case for the 2012 reform, which consistently increased tuition fees for English and Welsh HEIs and led to a greater focus on the teaching mission compared to the others. Consequently, our results shed light on the unintended consequences of HEI reforms, which are not only reflected in the different behaviour of students (Wakeling and Jefferies 2013) but also in tangible effects on the third mission of HEIs (Krücken 2014).

In addition, this study provides further insight into results from previous work regarding potential substitutability between HEI missions (Sánchez-Barrioluengo 2014; Bianchini et al. 2016). Our results highlight how the change in the 'mission mix' of a HEI bears important consequences in terms of the variety (breadth) and intensity (depth) of KE activities, reducing them consistently. This adds to the extant literature on the complementarity versus substitutability of missions (Degl'Innocenti, Matousek, and Tzeremes 2019; Freel, Persaud, and Chamberlin 2019) and has important implications for the definition of KE adopted by performance assessment systems and for the increasingly important role of HEIs as policy advisors (Rossi 2018).

Our results suggest a number of implications for policy makers and HEI managers. First, the study bears important implications for the strategic role that HEIs are expected to play as knowledge centres at the regional level, where interaction with local partners is possibly more important than international research excellence (Benneworth, Pinheiro, and Sánchez-Barrioluengo 2016; Seeber et al. 2019). As HEIs are increasingly expected to contribute to regional development via the output of their third mission activities, this work shows that a change in the relative importance of the teaching mission compared to other missions can alter the internal institutional configuration of HEIs and, consequently, impact their regional contribution via third mission output. Second, the study also has important implications for the relationship HEIs have with external constituents and internal members. Previous literature has shown that HEIs choose mission statements that are both plausible to external stakeholders and consistent with the values of internal actors (Seeber et al. 2019): policymakers should bear in mind that shifting incentives can inadvertently dealign the goals of HEIs from their originally intended purposes. Finally, as the three missions of HEIs (research, teaching and social engagement) are characterised by complex associations, HEI managers and policymakers should adopt relevant policy changes and steer their implementation to avoid unintended consequences on activity profiles and stakeholder prioritisation (de la Torre, Rossi, and Sagarra 2019).

This paper has certain limitations that open up avenues for future research. First, it focuses on KE activities arising from public research grants – a subset of the KE activities undertaken by HEIs. Second, the size of our sample is limited and does not allow us to provide further insight across relevant dimensions (e.g. established vs new HEIs, geographical location) because this would have reduced the statistical power of our empirical tests. Finally, our estimation sample refers to HEIs based in the UK only, so the external validity of our exercise may be limited in terms of its application to other (more diverse) institutional settings (e.g. HEIs in other European countries).

Despite these limitations, this work is a preliminary step in an arguably promising trajectory. A greater understanding of the complementarities between HEI missions and how changing this mix affects HEI KE activities in a casual way may provide further insight into policy and managerial issues concerning HEI strategies and the fine-tuning of appropriate systems of incentives.

## Notes

1. Please refer to Appendix A in the supplemental online material for further information on the role of collaborative research projects in KE activities and additional details on the construction of the database.
2. Similar results are obtained when we use the 25th percentile instead of the 10th percentile. Results are available from the authors upon request.
3. Similar results are obtained when excluding Wales from the treated group.
4. See Appendix B and Table B1 in the online supplemental material for further details.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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