ASSESSING THE IMPACT OF THE U.K.'s RESEARCH EXCELLENCE FRAMEWORK ON THE RELATIONSHIP BETWEEN UNIVERSITY SCHOLARLY OUTPUT AND EDUCATION AND REGIONAL ECONOMIC GROWTH

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ABSTRACT

This paper assesses the relationship between stakeholder influence, university scholarly and educational output, and regional economic growth. Specifically, we theorize that stakeholder intervention with respect to university teaching and learning, scholarly research, and entrepreneurship enhances the contribution of universities to regional economic growth. We test this theory using data from the UK's Research Excellence Framework (REF), an evaluation of the research impact of British higher education institutions. We find that business school graduates, as well as graduates in STEM and health fields, have a positive impact on regional human capital development. On the other hand, stakeholder influence, through the REF, appears to have a negative effect on the retention of human capital, but a positive effect on commercialization in the region. Our findings provide new evidence of positive economic spillovers arising from university research and education and the role of fields, such as business administration, in enhancing human capital development and economic growth. They also lend credence to the notion that graduates are an important channel of knowledge and technology transfer.

KEYWORDS

Learning and Education; Economic Growth; Entrepreneurship; Technology Transfer; Scholarly Impact; Stakeholders; UK-REF

Research on the scholarly impact of universities and especially, business schools, is crucial in the context of the "entrepreneurial" university and efforts on the part of these institutions to enhance economic growth and address grand societal challenges (Guerrero et al., 2016; Klofsten et al., 2019). These trends underscore the importance of assessing whether university scholars "make a

difference," by broadening our understanding of what constitutes impact to include practical, societal, public policy, and educational impacts (Hoffman, 2016; Haley et al., 2017; Haley, 2018; Lybeck, 2021; Wickert et al., 2021). Inspired by these articles and the recent rise of the Responsible Research in Business and Management (RRBM) network (Tsui, 2022; Siegel, 2022), we seek to apply two theories that relate to in an effort to the relationship between stakeholder influence, scholarly impacts, and economic growth.

The first is endogenous growth theory, which seeks to explain why some regions and nations outperform others (Romer, 1986; 1994, Mankiw et al., 1992). This literature has shown that innovation and entrepreneurship are important sources of economic growth and that key institutions, such as research universities, play a critical role in enhancing the quantity and quality of human capital (Audretsch, 2014; Crow et al., 2020). For example, universities have transformed education and learning paradigms (Lawrence et al., 2012; Voss & Page, 2020), adapted knowledge creation modes (Audretsch, 2014; Baruch et al., 2020), and engaged in socio-economic initiatives (Gibb & Hannon, 2006; Pollack et al., 2017; Eesley & Miller, 2018; Klofsten et al., 2019; Cooke & Kumar, 2020) to meet the needs of socio-economic models. Since the 1980s, scholars have investigated the economic impact of universities' scholarly activity beyond academic papers, based on input-output relationships and sophisticated econometric models (Guerrero et al., 2015). In these studies, the main outputs/outcomes have been the labor force (Bessette, 2003) and revenue obtained from patents and R&D collaborations (Siegel et al., 2004; Audretsch & Feldman, 1996), while the inputs have been with direct expenditures incurred to develop the outputs (Bessette, 2003), scholars' productivity or changes in the gross domestic product (Roessner et al., 2003; Guerrero et al., 2015; Valero & Van Reenen, 2019). In the last decade, some studies have highlighted measures about the causal impacts of universities on (local) economies by comparing locations of university grants (Andrews, 2019), as well as made emphasis on the role of universities in local

entrepreneurial ecosystems (Tartari and Stern, 2018). University administrators have questioned the role of business schools in adapting the business education tradition to capitalism demands (Much, 2021; Jones & Andrews, 2019) or social philanthropy views of co-creation of value (Thomas & Ambrosini, 2021; Spicer et al., 2021). Although editors have acknowledged that macro-level factors are relevant to business education priorities, discussions about these issues are rare (Nkomo, 2015, p. 242). The bottom line is that we still know very little about university scholarly activity contributes to economic growth (Audretsch, 2014; Vos & Page, 2020).

A second theory we wish to employ is *stakeholder theory*, which analyzes how the interests of individuals/groups related to organizations use their relation to influence governance or performance (Freeman et al., 2010). This supports the argument that public intervention could influence organizational aims and outcomes (Urbano & Guerrero 2013; Pollack et al., 2017) through multiple pressures regarding transparency, accountability, the democratization of research outcomes, and scholarly impacts (AACSB, 2012; REF, 2014; Kneale et al., 2016; Amdam & Benito, 2021). In the university context, we consider that public administration is a key stakeholder of universities because it provides public funds and has the "power" to influence university governance and performance. For example, the higher education regulators have implemented mechanisms to allocate public funds to ensure advanced societal and economic contributions (Davies & Mangan, 2007; Audretsch, 2014). Although previous studies have highlighted new metrics beyond the traditional ones (Van de Ven, 2007; Van de Ven & Johnson, 2006; Aguinis et al., 2014; Andrews, 2019), only a few members of the university community have proactively encouraged or implemented these metrics of scholarly impacts. Therefore, little is still known about the scholarly impacts understood as an "auditable or recordable occasion of influence" (Haley et al., 2017), as well as the stakeholders' influence on the re-definition of scholars impacts on

economic, practical, societal, policy, and educational scenarios (Audretsch, 2014; Haley et al., 2017; Haley, 2018; Wickert et al., 2021).

Based on the two above arguments, the universities would proactively promote these actions and reactively respond to higher education stakeholders' demands. This study focused on how stakeholders have been re-directing university outcomes/impacts through the intervention to contribute to economic growth that still requires robust conceptual and empirical discussion (Drucker et al., 2007; Guerrero et al., 2015; Haley et al., 2017; Andrews, 2019; Valero & Van Reenen, 2019; Wickert et al., 2021).

We contribute to the literature on scholarly impact in three ways: First, we extend the consideration of the contribution of universities to regional economic growth (Guerrero & Urbano, 2012; Guerrero et al., 2015). Specifically, we provide empirical evidence on the economic role of university graduates from different schools/faculties such as business, social science, medicine, arts, mathematics, engineering, and natural science. Our paper also relates to the discussion of academic capitalism, especially in business schools (Jones & Andrews, 2019). Our results underscore the need to better understand the lack of interdisciplinarity in business schools, in terms of formal, curricular and research partnerships with other university schools (science, innovation centers, engineering), which may limit entrepreneurial activity and entrepreneurship education.

A second contribution of the paper is to the stakeholder theory literature, by extending the academic discussion about the influence of university stakeholders (e.g., higher education agencies) on how universities co-create value to meet societal needs (Haley et al., 2017; Wickert et al., 2021). In particular, the study provides empirical evidence about the effect of an evaluation system that is used to allocate research funding (MacDonald, 2017). Based on these results, effective governance/management in teaching-research entrepreneurship and innovation (Crow et

al., 2020) take relevance to the role of business schools educating (social) entrepreneurs and (social innovators (Lawrence et al., 2012).

A third contribution of the paper is to the scholarly impact, by examining the discussion of metrics of scholarly impacts beyond the traditional ones (citations, journal rankings, books) associated with the outcome of each university's activities (teaching, research, and entrepreneurship) and connecting them with economic growth factors (Van de Ven, 2007; Van de Ven & Johnson, 2006; Aguinis et al., 2014). Empirical evidence about these relationships will stimulate the discussion about bi-directional returns from universities (scholarly impacts) to society (public funding), as well as the discussion about the transformation of non-effective evaluation criteria (Davies & Mangan, 2007; Audretsch, 2014).

This article examines how stakeholders influence the university's scholarly impacts. First, this study theorizes the influence of the stakeholders' intervention on universities' teaching-learning, research, and entrepreneurship outcomes by examining the universities' scholarly impacts through the economic growth factors (e.g., human capital, knowledge capital, and entrepreneurship capital). Second, to validate the proposed conceptual model, we assess the influence of the UK's Research Excellence Framework (REF) on the UK universities' scholarly impacts, beyond metrics related to academic papers, by comparing the effects of university outcomes on economic growth before and after the REF 2014 implementation. Finally, we discuss the findings, implications, and conclusions, emphasizing the role of business schools.

THEORETICAL FOUNDATIONS

Endogenous Growth Theory and Stakeholder Theory

Endogenous growth theory emerged in the 1980s as an extension of the neoclassical growth theory to explain differences in wealth between developed and developing countries. The neoclassical

growth model propounded by Ramsey (1928) and further developed by Solow (1956) posits that economic growth results from capital accumulation through household savings. However, in the long term, population growth and technology will exogenously determine growth because it relies on the decision to invest in research and development (Solow, 1956). By assuming that technological progress is not exogenous to the economy, economic growth was explained by the level of human capital and investment in human capital over time (Mankiw et al., 1992). After many decades and numerous empirical studies of economic growth factors, such as physical and human capital (Nelson, 1981), Romer (1986) and Lucas (1988) proposed the inclusion of a new economic growth factor called knowledge capital. In this view, new ideas from people working in knowledge sectors explained productivity and improvements in economic performance. Audretsch et al. (2006) proposed the inclusion of entrepreneurial capital as a new driving economic factor that facilitates the exploration and exploitation of opportunities. Entrepreneurial capital is a conduit for increasing competition and injecting diversity (Audretsch & Keilbach, 2004a, 2004b; Audretsch & Link, 2019). In this study, the economic growth factors considered are human capital (Solow, 1956), knowledge capital (Romer, 1986; Lucas, 1998), and entrepreneurship capital (Audretsch & Keibach, 2004a, 2004b).

While endogenous growth theory helps to explain key drivers of economic performance at the macro-level, stakeholder theory outlines how stakeholders influence the ability of organizations to create value (see Table 1). Stakeholder theory explains how organizations create as much value to groups/individuals based on their power relationship, legitimacy, and resource (inter)dependence (Freeman et al., 2010; Hoffman, 2016). Stakeholder theorists have identified three relationships between organizations and stakeholders: (1) normative relationships, which occur when their interests are compulsatory considered a responsibility; (2) instrumental relationships, which occur when their influence is focused on particular priorities/needs; and (3)

descriptive relationships, which occur when their interests are taken into consideration (Alsos et al., 2011). This research adopts a normative view of stakeholders by examining the governments' mechanisms for allocating public resources to the agents that make their most productive use (Hicks, 2012). Indeed, research on performance-based funding systems has shown that the efficient competition of resources has stimulated quality, prioritized interaction with specific agents and industries, and generated socio-economic impacts (Hicks, 2012; Jonkers & Zacharewicz, 2016).

Universities are increasingly connected to the economy and society. A plausible explanation is because universities receive substantial public funds for research and education, and it is incumbent upon the sector to maximize the value of that investment over the longer term (Shewan & Coats, 2006, p. 463). However, in recent decades, perspectives on this engagement have changed after the 2008 financial crisis. Universities have significantly faced many demands from stakeholders derived from the higher unemployment rates related to their graduates, reduced public budgets in a period of fiscal austerity, and reduced demand for higher education studies (Guerrero et al., 2016). Many governments expect universities to demonstrate wider scholarly economic impacts and return on investments with more rigor than in the past to maintain economic competitiveness and sustain high living standards. It explains why the allocation of public funding based on the assessment of scholarly impact has gained attention. While impacts are assumed to be necessary by stakeholders, the empirical evidence regarding the bi-directional relationship between university and stakeholders is still required to understand the interplay between university outcomes (teaching, entrepreneurial, and research) and their impact on economic growth factors (human capital, knowledge capital and entrepreneurship capital).

Insert Table 1 about here

The UK's Research Excellence Framework

The U.K. pioneered performance-based research university funding systems (Sivertsen, 2017). From 1919 until 1986, U.K. funding of higher education was a single block grant, covering teaching and research activities, which was not specifically based on performance. In 1986, the Thatcher government implemented the Research Assessment Exercise (RAE), which was based on a peer review system to assess research quality and funding allocation. For over twenty years, this method was implemented by the UK higher education funding bodies in England, Scotland, Wales, and Northern Ireland to distribute funds of about £2 billion per year selectively based on the assessed research quality (Sivertsen, 2017).

In this view, university leaders re-conducted strategic decisions to react to emerging stakeholders' priorities/needs. The UK Department for Education & Skills (2008) consulted multiple higher education associations to improve the metric-based approach for assessment and funding, discussed alternative models to consider science, technology, engineering, and mathematics (STEM) subjects and non-STEM subjects appropriately, simplified data collection processes, and reduced the peer-evaluation costs.

After a series of consultations, the RAE was replaced by the 2014 UK's Research Excellence Framework (REF) that combined performance-based institutional funding and research evaluation. The REF's purpose was to assess the university outcomes' quality to support a dynamic and internationally competitive UK university research that makes a major contribution to economic prosperity, national well-being, and the dissemination of knowledge (REF, 2014). In particular, the REF 2014 supported equality and diversity, by applying a code of practice on the transparent equality impact assessment (REF, 2015). The evaluation criteria comprised outputs, impacts, and environment. The outputs included the originality, significance, and rigor of academic publications

such as journal articles, monographs, book chapters, and dissemination ways such as design, performance, and exhibitions. The impact is considered in terms of reach and significance of any effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment, or quality of life, beyond academia. The environment refers to sustainability in the strategy, resources, and supports.

On average, the REF 2014 results demonstrated improved quality of outcomes (22 percent) and enhanced the international excellence of research conducted in UK universities (37 percent) concerning the previous 2008 RAE evaluation (REF, 2015). Likewise, the REF2014 case studies have shown how universities across schools and departments have impacted the economy, society, culture, public policy, quality of life within the UK and abroad (REF, 2015). These results produce "quality profiles" used to allocate the university research funding from 2015 until the next round of assessment in 2024. Based on the UK's experiences, European countries have also introduced performance-based funding systems with similar metrics but less expensive evaluation methodologies than the UK experts' panels and peer-reviews (Sivertsen, 2018). Indeed, the Australian Research Quality Framework (RQF), the New Zealand Performance Based Review Fund (PBRF), and the Italian Peer Review Assessment adopted the UK assessing excellence framework (Shewan & Coats, 2006; Jonkers & Zacharewicz, 2016).

THEORY DEVELOPMENT AND HYPOTHESES

The Scholarly Impact of the University and Business School: An Endogenous Growth View

Scholarly university economic impacts through teaching-learning activities. Considering the foundations of a labor-force-based economy (Solow, 1956), the university scholarly impact should be a young labor force with fundamental values and linkages with the labor market and regulators (Audretsch, 2014). It means that universities, through teaching and learning activities,

educate and train students who become graduates with a stock of human capital such as competencies, knowledge, abilities, and skills to address the labor market needs (Becker, 1993). In this assumption, teaching and learning outcomes have provided multiple generations of graduates from diverse disciplines that disseminate their human capital into the local, regional, national, or international labor markets (Guerrero & Urbano, 2015). Sidiropoulos (2014) noted that business education provides graduates with knowledge and skills to conduct business ethically that contribute to long-term economic sustainability. Mutch (2021) exposed the role of business education in polytechnics. Likewise, in their international comparison, Marginson et al. (2013) explained the widespread government interest in improving curriculum for building skills at university schools related to STEM disciplines. These arguments support the significance of business and STEM education because both equip graduates with a broad range of managerial skills, research and development skills that enhance productivity and contribute to economic growth (Romer, 1994).

Scholarly university economic impacts through research activities. Considering the knowledge-based economy foundations (Foray & Lundvall, 1998; Godin, 2006), a new university's scholarly impact emerged related to the production of knowledge that their stakeholders (academics, firms, government agencies) transform into specific outcomes (Audretsch, 2014; Guerrero & Urbano, 2015). Partnerships between government and universities also emerged to enable knowledge transfer and public investments (Perkmann et al., 2013, 2021). For instance, the Bayh-Dole Act has facilitated knowledge creation and technology transfer from the university to society (Grimaldi et al., 2011). The scholarly economic impact of universities emerged as an important source of knowledge through research commercialization (Audretsch & Keilbach, 2008). It means that universities, through basic/applied research activities, generate knowledge outcomes such as contracts, patents, and intellectual property that will be disseminated

via collaborations, commercialization, or exchange agreements (Guerrero & Urbano, 2015). Based on their nature, university schools related to STEM fields are more likely to patent or license their discoveries and contribute to innovation-driven economic growth factors (Blume-Kohout, 2014). It has encouraged a more equalizing environment for STEM women's participation in discoveries and innovations.

Scholarly university economic impacts through entrepreneurial activities. Following the entrepreneurship-based economy foundations (Audrestsch, 2007, 2009), a university's scholarly impact emerged to provide entrepreneurial values, thinking, and actions that enhance the creation of spin-offs or start-ups (Guerrero & Urbano, 2012; Audretsch, 2014). It means that universities, through entrepreneurship or engagement activities, stimulate the creation of spin-offs or start-ups at all levels of the university community (managers, academics, researchers, students, alumni) to meet entrepreneurial stakeholders' needs (Guerrero & Urbano, 2015). Business schools have contributed to educating entrepreneurs and innovators (Lawrence et al., 2012), as well as promoting internal knowledge flows strategies between business schools, university infrastructures, and science departments (Wright et al., 2009).

Based on the links between the university scholarly impacts and the economic growth factors, we thus hypothesize:

Hypothesis 1: *A university's outcomes from teaching, research and entrepreneurship activities will positively contribute to its scholarly economic impacts.*

University's Scholarly Impacts: A Stakeholder View

Stakeholder intervention on teaching-learning impact. Higher education stakeholders have debated the employability of university graduates (Holmes, 2017; Tomlinson, 2017). These scholars have argued that universities should prepare generations of skilled graduates to be active

in the productive sectors' labor force (Audretsch, 2014), as well as to provide graduates with entrepreneurial skills that enable them to establish new firms and engage in innovation and invention, or become intrapreneurs in established organizations (Guerrero et al., 2015). There are also knowledge gaps in STEM fields across the university, which can be addressed in schools to foster entrepreneurship via education (Blume-Kohout, 2014). Although the REF 2014 does not explicitly focus on teaching-learning impacts (Cabral & Huet 2015; Tierney, 2020), directly or indirectly, the research impacts have been disseminated or implemented into the classroom (Jordan, 2020; REF, 2015), especially those related to pedagogic and education research (Kneale et al., 2016). In this view, universities should connect research outcomes and update teaching curriculum across fields (Guerrero et al., 2016)

Stakeholders' intervention on research impacts. Stakeholders have focused on designing and implementing policies in different spheres such as regional competitiveness, university-industry partnership, R&D, industrial re-structuration, and employment (Åstebro et al., 2012). Other stakeholders have promoted specific policies that stimulate research, innovation, and technology transfer into the higher education systems, such as the Bayh–Dole Act (Grimaldi et al., 2011), white papers to succeed in the knowledge economy (GOV.UK., 2016), or research excellence impacts (REF, 2014). These policymakers' interventions have reinforced knowledge capital production (Audretsch, 2014). Based on this view, universities should ensure that knowledge production generates value in society and be disseminated among stakeholders, on a commercial and non-commercial basis, including research and hands-on collaboration with academic and professional organizations (Agarwal et al., 2007). Both students and researchers from entrepreneurial and innovative universities will generate new knowledge or technological solutions that will be disseminated through postdoc practices, technology transfer processes, and extending new collaboration or partnership with multiple regional actors to strengthen socio-economic

development (Klofsten & Jones-Evans, 2000; Siegel et al., 2003; Roessner et al., 2013). The REF 2014 looked to allocate funding for university research based on the impact evaluation exercises conducted at around six-year intervals (Kneale et al., 2016). Directly or indirectly, the REF 2014 generated long-term scholarly impacts across fields associated with all economic growth factors (REF, 2015) because stakeholders acted as a filter for those universities that were not generating societal and economic value (see Audretsch & Feldman, 1996; Audretsch & Keilbach, 2008). This is relevant since the future allocation of public research funding depends on the impacts generated by research outcomes across university schools.

Stakeholders' intervention on entrepreneurship impacts. Previous studies have shown that favorable conditions towards entrepreneurship and innovation facilitate universities' contribution to society (Link & Sarala, 2019). The universities' challenges are becoming more entrepreneurial and using stakeholders' intervention to uplift their teaching and research, establishing links with regional actors to compete with other local universities and become more productive (Kirby et al., 2011; Kolympiris & Klein, 2017; Pollack et al., 2017). These policy interventions reinforced entrepreneurship capital generation (Audrestch et al., 2016). Although the ability of stakeholders to estimate the universities' entrepreneurship impacts is scarce, the university has generated its own ecosystem that serves as a conduit for entrepreneurial activity into job creation through spin-offs/start-ups, supporting local SMEs that then will become partnerships or invest retention of skilled graduates in the region. Although the REF 2014 has not been particularly related to university entrepreneurship activities, evidence from business schools has shown their ongoing strengthening of research performance based on its business orientation and regional focus (Laing, 2015). REF results (REF, 2014).

Based on the insights about the potential influence of stakeholders' intervention on the relationship between university outcomes and the scholarly economic impacts, we thus hypothesize:

Hypothesis 2: *Stakeholder intervention influences the contribution of university's outcomes into scholarly economic growth impacts*

Our proposed conceptual model is shown in Figure 1.

Insert Figure 1 about here

Adopting an endogenous growth economic view, we assume that universities' outcomes from teaching, research, and entrepreneurship activities generate scholarly impacts that stimulate regional economic growth. We propose that graduates across schools/faculties represent a labor force with a broad range of managerial, research, and development skills that benefit competitiveness and regional economic growth (Marginson et al., 2013; Sidiropoulos, 2014; Mutch, 2021). Likewise, the outcomes produced by researchers across university fields (research contracts, patents, and intellectual property) stimulate value co-creation with regional knowledge actors through commercialization and collaboration (Audretsch, 2014; Blume-Kohout, 2014). Similarly, the outcomes generated by university entrepreneurs (spin-offs and start-ups) cross knowledge fields support community needs and SMEs in the region (Wright et al., 2009; Lawrence et al., 2012; Guerrero & Urbano, 2015).

Based on the above discussion, adopting the stakeholder approach, our main argument is that stakeholders' intervention would influence the university outcomes' from teaching, knowledge

transfers, and entrepreneurship activities. In particular, how higher education agencies allocate resources according to the scholarly impacts produced by university's outcomes.

METHODOLOGY

Data

We constructed a dataset using three secondary sources of information from 2009 to 2016, considering that in 2014 was implemented the Research Excellence Framework (REF).

First, we collected secondary university data from the Higher Education Statistics Agency (HESA) and the Higher Education Funding Council for England (HEFCE). The HESA is the official agency for collecting, analyzing, and disseminating quantitative information about higher education in the UK. The HEFCE was a non-departmental public body in the UK responsible for distributing public money for higher education activities (teaching and research) to universities. One hundred sixty-nine public universities integrate the UK higher education system. However, due to the missing values, our sample was integrated by 131 universities that reported data on all variables included in our proposed model (see Table 1 and Appendix A).

Next, we collected regional secondary data from the Office for National Statistics (ONS), the executive office of the UK Statistics Authority that reports information directly to the UK Parliament. The ONS provides statistical information about the UK labor market from the Official Labor Market Statistics (NOMIS) and the Business Register and Employment Survey (BRES). We capture employment rates at geographical locations in the UK from these two sources by matching regional data to the university location data. Likewise, we also obtained regional information about business density and gross value added per capita from the ONS.

Third, we collected information from other open access secondary sources. Regarding the REF 2014 information, we used the ranking of the grade point average (GPA) prepared by the

Times Higher Education Ranking based on the overall university quality profiles provided by the HEFCE and weighted according to the number of people submitted by each university (REF, 2014, 2015). Based on the official website information, we identified the 24 research-intensive universities members of the Russell Group in our sample.

Measures

Table 2 shows the descriptions of variables.

Insert Table 2 about here

Dependent variables (university scholarly impacts): In the proposed theoretical model (see Figure 1), university scholarly impacts are associated with endogenous economic growth factors: human, knowledge, and entrepreneurship. The HEFCE has captured information from university managers confirming (yes or no) whether their university has contributed to certain economic development aspects. HEFCE has reduced heterogeneous responses using binary measures and generates comparable data across universities.

Regarding human capital impacts, the first argument is that university graduates from diverse disciplines contribute updated knowledge/skills required by regional industries to enhance competitiveness (Audretsch, 2014; Guerrero et al., 2015). We measured *human capital capabilities in the region* as equal to one when the university managers have confirmed that their graduates have addressed the knowledge and skills required by the labor market, otherwise zero. The second argument is that the accumulation or retention of university graduates promotes the generation of regional capabilities that enhance technology, innovation, and entrepreneurship (Marginson et al., 2013; Urbano & Guerrero, 2013). We measured *retention of human capital capabilities in the*

region as equal to one when university managers have confirmed that their graduates have developed/progressed into their professional careers in the region, otherwise zero.

Regarding knowledge capital impacts, the first argument is that university graduates and academics from diverse disciplines contribute to the commercialization required by the different industries to build new capabilities to be more competitive (Wright et al., 2009). We measured *knowledge commercialization in the region* as equal to one when the university managers have confirmed that their universities address the transference and commercialization of knowledge required by the regional industries, otherwise zero. The second argument is that the university increased their participation with multiple agents it is possible to act as a catalyst and represent interests in the region (Siegel et al., 2003; Roessner et al., 2013). We measured *collaboration with knowledge actors in the region* as equal to one when university managers have confirmed that their universities are addressing collaborations with multiple knowledge agents in the region, otherwise zero.

Regarding entrepreneurship capital impacts, the first argument is that university graduates and academics from diverse disciplines contribute to technological and innovation components that help reinforce the SMEs' capabilities in the region (Wright et al., 2009, 2013; Audretsch, 2014). We measured *support SMEs in the region* as equal to one when the university managers have confirmed that their universities are supporting the SMEs for improving their capabilities and competitiveness in the region, otherwise zero. The second argument is that the university increased its social engagement by supporting regional communities (Guerrero et al., 2016). Lawrence et al. (2012) has exposed the business schools' contributions to educating/training social entrepreneurs and innovators. We measured *support community needs in the region* as equal to one when university managers have confirmed that their universities are supporting community needs in the region, otherwise zero.

Independent variables (university outcomes): In the proposed theoretical model (see Figure 1), university outcomes are associated with teaching, research, and entrepreneurship activities. The HEFCE and HESA have captured quantitative information using measures to generate comparable data across universities.

Regarding teaching outcomes, the dependent variable was the composition of university graduates across disciplines to understand their participation/contribution in achieving human capital scholarly impacts. By following similar criteria that REF evaluation committees (see REF, 2014, 2015), we create six proxies that measured the percentage of graduate students per different fields by the university: (a) business and management including international studies and law; (b) social sciences including sociology, social work, and history; (c) creative including art, design, music; (d) health including clinical, public health, psychology, and other related professions; (e) STEM including science, technology, engineering, and mathematics; and (f) natural science including biology, geography, physics, and earth systems. Stakeholders interested in enhancing specific industries or disciplines will directly influence the role of graduates (see Jonkers & Zacharewicz, 2016).

Regarding research outcomes, we used three continuous dependent variables related to research contracts (Bessette, 2003), patents (Klofsten & Jones-Evans, 2000), and intellectual property (Siegel et al., 2003; Roessner et al., 2013). *Research contracts* measure the total value captured by universities from research contracts expressed in £ thousand. It represents the access to resources and capabilities for generating specific research impacts. *Patents* measure the number of patents granted per university in the analyzed period. It represents the ability of universities to preserve an exclusive right granted for technical details of an invention that provides new ways of doing something or technical solutions to problems. *Intellectual property (IP)* measures the income generated by intellectual property created through research and expressed in £ thousand. IP

includes the protection of an invention, which enables people to earn recognition or financial benefit from what they invented or created. Stakeholders interested in evaluating or assessing research outcomes will influence these metrics by reducing/increasing research funding (see REF, 2014; 2015).

Regarding entrepreneurship outcomes, we used two continuous dependent variables related to university spin-offs (Krabel & Mueller, 2009) and university start-ups (Bramwell & Wolfe, 2008). *Spin-offs* captured the turnover obtained by technological businesses created by academics or students expressed in £ thousand. This variable represents identifying market opportunities in their research outcomes and enhancing innovative values generated by university members across multiple disciplines. *Start-up* captured the turnover obtained by technological businesses created by academics or students expressed in £ thousand. This variable represents identifying market opportunities and enhancing innovative values generated by university members across multiple disciplines. Stakeholders interested in generating societal and economic implications in the region will influence the university engagement via entrepreneurial initiatives (see Marginson et al., 2013).

Stakeholder intervention (REF): The stakeholder intervention was related to allocating public research funds based on the research outcomes and impacts. We used information from the Times Higher Education Ranking that provided the overall university quality profiles and weighted according to the number of people submitted by each university (REF, 2014, 2015). *REF* measures the overall grade point average (GPA) per university in our statistical model, representing the evaluation received per university. Then, in the robustness test, REF was measured by a binary variable that captured the effect of REF intervention in the UK universities taking value one for its implementation (2014-2016) and value zero for the period before its implementation (2009-2013).

Control variables: We included university controls and regional controls.

Regarding university controls, using the HEFCE and HESA information, we included controls related to the resources and capabilities of the universities. First, we controlled the human resources investment per university by introducing the *students per staff per university ratio* in the analysis, and it represents the total available faculty employed related to the total students at the university per year (Bessette, 2003). Second, we controlled the *investment in infrastructure and equipment* per university (O'Shea et al., 2005). Both binary variables were equal one when the university managers confirmed that their universities invested in infrastructure and equipment, otherwise zero. Third, we controlled the *government funding per university* measured by the funding received by the government (£ thousand) per university. Finally, based on the Russell Group website information[2], we identified the 24 research-intensive universities members of the Russell Group in our sample. The importance of this control variable is that the 2014 REF results showed that 68% of world-leading research with an outstanding evaluation impact was carried out in Research Group universities (REF, 2015). Therefore, *Russell Group* is a binary variable that takes value one if the analyzed university is listed as one of the 24 most-research-intensive universities in the UK, and zero otherwise (Guerrero et al. 2015; Aghion et al., 2010).

Regarding regional controls, we include three variables obtained from the ONS. First, *the GVA per capita* measures the economic development and control for the relationship between regional economic development and university activity related to regional economic growth (Audretsch and Keilbach, 2008). By including this variable, the wealth conditions are observed in the university's region. Second, the *graduates' employment rate* captures the level of employment of university graduates in the region (Martin, 1998; Urbano & Guerrero (2013). It controls the opportunities across graduates. Third, *the business density* represents the difference between

[2] For further information, visit http://www.russellgroup.ac.uk/home/

business start-ups and business closures as % of the total number of businesses in a region (Audretsch and Keilbach, 2008). This control variable is useful for understanding the number of businesses in the region related to the university.

Model

To test our hypotheses, given the nature of our dependent variables, we used logistic panel data estimation as follows:

$$y_{it} = \beta_i x_{it-1} + \beta_i z_{it-1} + \Theta m_{jt-2} + \lambda_t + u_{it-1} \quad (1)$$

$$E[\varepsilon] = 0 \text{ and } Var[\varepsilon] = \sigma^2 V \qquad i=1,..., N; \quad t=1,...,T$$

where y_{it} is a binary university scholarly impact *i* at time *t* (dependent variables). β and Θ are parameters to be estimated, x_{it} is a vector of university outcomes, z_{it} is a vector of control variables at university while and m_{jt} is a vector of control variables at region *j* at time *t.* u_{it} independent and identically distributed. V is a known n × n matrix. If V is diagonal but with unequal diagonal elements, the observations y are uncorrelated but have unequal variance, while if V has non-zero off-diagonal elements, the observations are correlated. Note that λ_t is a university-invariant vector that accounts for any time-specific effect that is not included in the regression (e.g., changes in regulation, global crisis effects). According to Hosmer et al. (2013), the interpretation of coefficients depends on three elements: first, the sign of coefficients on the independent variables represents an increment (positive sign) or a decrement (negative sign) in the probability of the dependent variable; second, the coefficient of the independent variable (while the rest remain fixed) represents how much increase/decrease the probability of the dependent variable by increasing that

independent variable in 1 unit; and the specific percentage of increment could be calculated by the odds ratios using exp(β_i). This study interprets results according to the logit coefficients' statistical significance and signals. Table 3 provides the descriptive statistics and correlation matrix for all variables.

Insert Table 3 about here

According to Aguinis et al. (2017), moderation occurs when the relationship between two variables depends on a third one. Our study assumes that REF represents an intervention of stakeholders on the university outcomes and their consequent economic impacts on the society (REF, 2014). Therefore, REF is a moderator in the relationship between university outcomes and university' scholarly impacts. This moderation effect was tested by the interaction between each university outcome and REF.

RESULTS AND DISCUSSION

Tables 4, 5, and 6 show the descriptions of variables.

Insert Table 4, 5, and 6 about here

The UK Universities' Scholarly Economic Impacts

Our first hypothesis examined the relationship between the university's outcomes and the university's scholarly impacts.

Concerning teaching-learning outcomes (graduates), our results support the relationship between graduate students from diverse university schools/fields and scholarly economic growth impacts (H1). Model 1a shows that business school graduates are most likely to contribute to scholarly economic impacts through human capital capabilities [β=5.36; $p< 0.01$]. The meaning of the β coefficient is that a one percent increase in business school graduates in a region increases the human capital capabilities of that university's region by 5.36%. These results reveal that the UK regional labor markets tend to be satisfied with the knowledge and skills of business graduates. Similar tendency is observed in graduates from STEM [β=4.45; $p< 0.05$], social science [β=3.66; $p< 0.05$], and health [β=3.25; $p< 0.01$]. These findings show that a one percent increase in STEM graduates at the university by one percent, increases human capital capabilities in that university's region by 4.45%. Similar results are found for social science and health care graduates, 3.66% and 3.25%, respectively. It appears that UK universities are educating students who contribute to the economic development of their communities.

In this view, Model 2a shows the highest propensity to accumulate human capital from business graduates in the region [β=6.11; $p< 0.05$]. We find that a one percent increase in STEM graduates leads to a 6.11% in accumulation of human capital in that university's region. Similar results are found for social science and health care graduates, [β=4.09; $p< 0.05$] and [β=3.12; $p< 0.05$], respectively. The retention of business and STEM university graduates in the region strongly contributes to building business capabilities and consolidating these professional careers in the UK. By considering these positive outcomes (Model 1a and Model 2a), university schools should continue improving the quality standards in the teaching-learning process, as well as, continue updating the teaching programs across disciplines by considering the new skills/knowledge needed by the labor market to reinforce their scholarly economic impacts.

Model 3a and Model 4a show the UK graduates' contribution in commercial and commercialization with knowledge actors in the region. While business graduates show a lower propensity to be involved in knowledge commercialization scholarly impacts [β=-7.44; $p< 0.01$], STEM graduates have the highest propensity to be enrolled in both knowledge commercialization activities [β=7.08; $p< 0.01$] and collaboration with regional knowledge actors [β=7.92; $p< 0.01$]. While by increasing the STEM graduates per university by one percent, they will contribute to an increment of 7.08 in knowledge commercialization activities and 7.92 in collaboration with regional knowledge actors, the increment by one percent in the business school graduates per university will decrease 7.44 their impact on knowledge commercialization. A plausible explanation is that STEM graduates represent specialization in applied research for extending the university's economic growth impacts by disseminating their skills and knowledge in the region (Audretsch, 2014; Audretsch et al., 2013). Indeed, STEM graduates are more likely to continue their relationship with university projects connecting with the most updated technologies and innovations than business schools graduates. In this regard, business schools should reinforce the development of interdisciplinary initiatives across STEM schools and other university schools to reduce their knowledge transfer and commercialization limitations. Indeed, better engagement with local/international business can also improve the flow of business schools technology and innovation to the wider world (Thorpe & Rawlinson, 2014).

Model 5a and Model 6a show the propensity of graduate students to support SMEs and community needs in the region. In this regard, business graduates are more likely to be engaged in support of SMEs in the region [β=3.81; $p< 0.01$], as well as community needs in the region [β=8.48; $p< 0.05$]. Therefore, a one percent increase in a university's business graduates increases that university's contribution to support SMEs and community needs in the region by 3.81% and 8.48%, respectively. These results show the transformation of business schools towards increasing their

engagement and scholarly impacts in regional economic and social initiatives. These insights are relevant considering that the most common question for UK business schools has been producing better engagement without reducing the solid research records and financial sustainability by attracting a large number of students (Thorpe & Rawlinson, 2014). Our results show a similar pattern in the contribution of health graduates [β=3.13; $p< 0.05$] and STEM [β=8.48; $p< 0.05$]. Therefore, an explanation behind these insights in business, health, and STEM schools is the response to the necessary UK universities' engagement with multiple agents to demonstrate/legitimize the required socio-economic impact (Watermeyer, 2011) and ensure the sustainability of the university business model (Thorpe & Rawlinson, 2014).

Concerning research outcomes (research contracts, patents, and IP), our results support the relationship between research outcomes and scholarly economic growth impacts (H1). Model 3a and Model 4a show that universities with contract research have a positive effect on facilitating knowledge commercialization between a university, its multiple external regional stakeholders [β=0.63; $p< 0.01$], and research collaboration [β=1.76; $p< 0.01$]. In this view, by increasing the total value of contracts per university by £ thousand, their contribution to knowledge commercialization and research collaboration in the region will increase 0.63 and 1.76, respectively. These results confirm that university-industry collaborations are crucial in disseminating capabilities, resources, and knowledge in the region (Perkmann et al., 2013, 2021). Indeed, Model 5a shows the contribution of research contracts to supporting regional SMEs' capabilities [β=1.24; $p< 0.10$]. Interestingly, by increasing the total value of contracts per university by £ thousand, their contribution to supporting SMEs' capabilities in the region will increase 1.24. Therefore, the UK universities through research contracts contribute to economic growth beyond academic papers by fostering regional capabilities through knowledge commercialization in their localities and mobilizing collaboration networks with local agents enrolled in the innovation and

entrepreneurial ecosystems. Likewise, results show that the patents slightly increase university research commercialization with multiple regional actors [β=0.48; p< 0.05], while intellectual property slightly increases further knowledge collaborations [β=0.40; p< 0.01]. While the increment in the number of patents granted per university by one grant will increase only 0.48 research commercialization impacts in the region, the increment in the intellectual property income by £ thousand will increase only 0.40 the knowledge collaboration in the region. The Russell Group universities with the highest propensity to participate in knowledge commercialization scholarly impacts in the region [β=2.28; p< 0.05] demonstrate a plausible explanation behind the slight impacts observed in the entire university sample.

Concerning entrepreneurial outcomes (spin-offs and start-ups), our results support the relationship between entrepreneurial outcomes and scholarly economic growth impacts (H1). University spin-offs positively facilitate knowledge commercialization [β=0.30; p< 0.10] with multiple regional actors, while there is no strong evidence regarding supporting collaboration, SMEs, or supporting regional communities. University start-up activity positively affects the propensity to support local SMEs [β=1.07; p< 0.05]. In this view, by increasing the turnover of staff start-ups per university by £ thousand, their contribution to community needs in the region will increase 1.07. Our results revealed the non-significant-statistical contribution of the turnover spin-off owned by the UK universities on entrepreneurial capital impacts. Although the rationale for spin-off policy has been part of the university and public budgets schemes (Mustar & Wright, 2010), plausible explanations are related to the entrepreneurial orientation among UK universities and the limitations in terms of productivity of spin-offs owned by the UK universities in comparison with the spin-offs non-owned by universities (Guerrero et al., 2015).

REF's Influence on UK Universities' Scholarly Impacts

Our second hypothesis relates to the influence of the REF on the relationship between the university outcomes and the impact of the university on economic growth.

Concerning the influence of REF, Model 1b and Model 2b show the negative effect of the influence of REF on the university's contributions to the retention of human capital [β=-5.69; $p< 0.05$] followed by human capital covering the regional skills needs [β=-4.13; $p< 0.05$]. By increasing the grade point average (GPA) of the university quality profile obtained in the REF2014 evaluation, the REF contribution to human capabilities and talent retention in the region will decrease by 4.13 and 5.69, respectively. Regarding knowledge capital, Model 3b and Model 4b show the positive influence of REF on both the commercialization [β=1.49; $p< 0.05$] and collaboration [β=3.95; $p< 0.01$]. By increasing the grade point average (GPA) of the university quality profile obtained in the REF2014 evaluation, the REF contribution to commercialization and collaboration in the region will increase by 1.49 and 3.95, respectively. Regarding the entrepreneurship capital, results show positive entrepreneurship effects for the direct impact of educational policy (REF) were found for supporting SMEs [β=4.05; $p< 0.05$], and meets the community needs of the regional [β=1.01; $p< 0.01$]. By increasing the grade point average (GPA) of the university quality profile obtained in the REF2014 evaluation, the REF contribution to support SMEs and to meet community needs in the region will increase by 4.05 and 1.01, respectively. Although the REF 2014 does not explicitly focus on teaching-learning impacts (Cabral & Huet, 2015; Kneale et al., 2016; Tierney, 2020) or entrepreneurship impacts (Laing, 2015; Guerrero et al., 2015), our results show different patterns in how REF contributes to knowledge capital and entrepreneurship capital. These results provide insights that need to be considered by government authorities by reinforcing the human capital, knowledge capital, and entrepreneurship capital.

Concerning the moderation effect of REF, results show the negative moderation effect of REF generated on the contribution of graduates from business [β=-2.08; p< 0.05], health [β=-3.83; p< 0.10], STEM [β=-8.34; p< 0.10], and natural science [β=-4.77; p< 0.10] on human capital in the region. By increasing the grade point average (GPA) of the university quality profile obtained in the REF2014 evaluation, the moderation effect REF on university graduates will decrease their contribution on human capital capabilities in the region. A similar pattern is observed on STEM graduates' contribution to accumulated human capital in the region [β=-12.51; p< 0.05]. However, the net effect of the interaction is positive by considering the effect of the coefficient of the moderated variable (graduates) with the respective interaction. Model 4b and Model 5b show how REF moderates the effect of patent's outcomes on knowledge capital forces through commercialization of research with multiple agents in the region [β=1.72; p< 0.05], as well as research contracts outcomes on extending regional collaborations with multiple regional partners [β=1.17; p< 0.01]. By increasing the grade point average (GPA) of the university quality profile obtained in the REF2014 evaluation, the moderation effect REF on patents and on research contracts will increase by 1.72 and 1.17, respectively their impact on knowledge capital metrics. These results offer insights into how a higher education policy (REF, 2014) that looked for enhancing the research of excellence with impact value for society (Kneale et al., 2016) is (in)directly enhancing the contribution of all UK universities to economic forces (Audretsch, 2014). However, results do not provide strong evidence about the moderation effect of REF on entrepreneurship capital.

Robustness test

We find strong empirical evidence for H2, given that the average level of university economic growth impacts increased in the period 2014-2016, as compared to 2000-2013, for all variables.

We continue by interpreting these findings by calculating and explaining the predictive margins. We are presenting the exercise only using one university outcome (intellectual property research activities) influenced by REF based on logistic estimations (coefficients in base effects and interaction effects). We used the 'marginal' effects to compute the standard errors of the means. Figure 2 illustrates the strength and direction of the relationship and changes in the marginal effect between university intellectual property outcomes and scholarly impacts. It also allows us to compare two periods –before and after REF 2014 - to test our hypotheses directly. Figure 2 illustrates the intellectual property outcomes and various university scholarly impacts before (dotted line) and after REF (solid line).

Insert Figure 2 about here

Regarding human capital, Figure 2A illustrates that an increase in intellectual property outcomes before REF had a negative and significant effect on regional skills needs. The higher the intellectual property outcomes of the university, the less they were likely to invest in local skills. REF has significantly changed this pattern, increasing the likelihood of universities with low and high intellectual property outcomes contributing to regional skills development.

Regarding knowledge capital, Figure 2B illustrates an increase in the propensity of universities to have higher commercialization rates with every unit increase in intellectual property outcomes with the reverse pattern before the REF. In this view, REF had the most pronounced effect on universities, increasing their licensing outcomes, increasing their propensity to commercialize research (Roessner et al., 2013). More specifically, we found that the university's propensity to disseminate knowledge in the region increases significantly after REF, increasing intellectual property outcomes (Figure 2C). This result demonstrates that intellectual property

outcomes have a weak association with knowledge dissemination in the region as intellectual property outcomes and knowledge flows to firms who pay for it. Figure 2D shows how extending regional collaborations vary where the propensity to engage in research collaboration varies 0.7 after REF 2014 for firms at different levels of intellectual property outcomes. Interestingly, increased intellectual property outcomes during 2009-2013 were negatively related to extending regional collaborations: more intellectual property revenues mean less collaboration on research.

With respect to entrepreneurial capital, Figure 2E demonstrates changes in a university's propensity to support SMEs when the intellectual property outcomes increase. Universities with higher intellectual property outcomes are less likely to support local SMEs. REF 2014 significantly distorts this relationship, shifting the predicted margins line upwards to 0.8 propensity to support SMEs (after 2014). Interestingly, after REF, the university aims to support SMEs independently of the level of intellectual property outcomes. Supporting SMEs and extending regional collaborations emerge as the two critical functions of the university, independent of the size of intellectual property outcomes. Figure 2F illustrates the effects of university research outcomes on supporting local communities, with the overall pattern during 2009-2016 remaining unchanged. The REF 2014 shifts the predicted margin upwards to 0.8 probability to support local communities. The effect is equal for universities with high and low intellectual property outcomes.

IMPLICATIONS FOR STAKEHOLDERS

Our results have several implications for stakeholders, as follows:

Implications for business schools and management. One key policy implication is that business schools and business education, more generally, yield highly positive knowledge and economic impacts. It is clear that business graduates in the UK contribute to the regional labor force and talent retention. Efforts on the part of business schools to promote entrepreneurship in

research and education, and efforts to promote more engagement with the business community, appear to generate high social returns. Business graduates appear to be highly involved in knowledge commercialization and collaboration, via their participation in research projects and engagement initiatives with SMEs or the community. If the UK funding agencies request consultations, the business schools should consider these insights to reinforce their scholarly impacts via research projects that allow connecting teaching and research. This relationship is important because business schools are the main providers of learning for potential entrepreneurs and social innovators that will generate returns to society by solving community needs (Lawrence et al., 2012). Indeed, the scholarly impacts on teaching should also be considered part of the impacts criteria to society in terms of the talent produced in the region, as well as the retaining of talent produced by the universities in the region. In particular, similar indicators are part of the higher education statistics that provide each university to the HESA, but are ignored by the public administrators in funding allocation systems. Regarding university governance, deans of business schools should assess the impact of enhancing their business schools distinctiveness, without forgetting the roles of incentives and capabilities required for positive impact to occur (Thorpe & Rawlinson, 2014).

Implications for university administrators. A key implication for university administrators and those who govern universities is that these institutions generate value into society through multiple scholarly impacts from teaching-learning, research, entrepreneurship, or engagement activities. Strategically, university managers would identify their dynamic individual and organizational capabilities to re-design strategies that connect them with societal needs and regional actors (Klofsten et al., 2019; Barauch et al., 2020). Internal university environments are crucial in terms of incentives for the university community and enhancing values and proactive entrepreneurial behaviors (Vos & Page, 2020). In this view, the accountability and the

democratization of research outcomes via scholarly impact pressures would be considered an opportunity to legitimize the role of their universities in developing their localities and regions. For instance, the REF experience would be considered a benchmarking or best practice for national higher education systems facing the reduction of funds and need an efficient allocation of results that generate impacts beyond the traditional ones (academic papers). Indeed, university managers would activate their potential actionable recommendations for practice by rethinking the effectiveness of current scholarly impacts.

Implications for teachers, academics, and students. Although REF does not have a direct orientation towards teaching-learning and entrepreneurship, the results of this study provide insights into the relevance of translating updated research into the classroom (not only from pedagogical fields but also from multi-disciplinary areas). Our results indirectly highlight the relevance of business schools in the configuration of an entrepreneurial or social engagement identity in the university community (students, managers, academics, teachers) that should be transversally shared across university faculties and research fields. The preservation of values and heritage is also crucial for building future generational cohorts (Maclean et al., 2020; Mesny et al., 2020). Universities are co-responsible for the intellectual preparation of these generations as well as the retention of skilled and talented (Vos & Page, 2020). This study indirectly shows the importance of values, role models, and culture. Indeed, it is needed to change policymakers' perceptions about their expected societal, research, and economic outcomes/impacts from the university community.

Implications for policymakers. The main implication is providing some preliminary insights regarding the effects of higher education policies that reinforce university contributions' quality, diversity, and coverage. Although this manuscript is not evaluating the effectiveness of REF, our insights could also provide information about the expected impacts at the societal and economic

dimensions that would be generating the UK's higher education policy. This study demonstrates the nuanced relationship between each type of university outcome (teaching, research, and entrepreneurship) and the universities' contribution to economic growth factors (human, knowledge, and entrepreneurship) before and after the stakeholder intervention takes place (REF). In doing so, policymakers should evaluate and re-define the university activities depending on the type of socio-economic impact they are interested in (Audretsch, 2014). Indeed, these are relevant for considering in future editions of REF. In this regard, a special implication for the UK policymakers is that as we live in the big digital era, it is crucial to advance open-access information about REF case studies (2014 and 2020) and updated higher education data to follow-up university impacts. Dual benefits came from this exercise: first, the production of research about the scholarly impact of UK universities that allows sharing experiences, challenges, and opportunities useful for other national higher education systems interested in learning about a similar type of policies (e.g., Australia, New Zealand, Hong Kong, and Ireland); and second, legitimize the contribution of universities in UK regions, becoming a role model and positioning the university impacts overseas.

Implications for SMEs and regional ecosystem actors. The main implication is providing preliminary insights regarding the potential outcomes behind each university activity (teaching, research, and engagement) and how, through diverse mechanisms (university-industry collaborations, students' practices, research contracts), SMEs or entrepreneurs could share resources, capabilities, and developing specific projects with universities. Particularly, nowadays, the collaboration among universities, enterprises, governments, non-profit organizations, and civil society is crucial for facing multiple challenges related to unexpected events (e.g., COVID-19 pandemic see Siegel & Guerrero, 2021). For regional ecosystem actors, universities are considered the bridge between innovation and ecosystem ecosystems. Reinforcing their collaboration would contribute to developing dynamic regional capabilities that allow achieving well-being,

sustainability, and socio-economic development in the region. Especially the critical role developed by business schools that have captured the attention of educational journal editors (Caza et al., 2022).

LIMITATIONS AND FUTURE RESEARCH

The first limitation is the coverage of our period of analysis. REF requires time to be developed/implemented and to be achieved the outcomes. Thus, analysis of the effects of REF requires an extended period along with robust panel data for 10-15 years (Guerrero et al., 2015; Wright et al., 2017). While we observe the university's propensity to generate university economic growth impacts four years before and three years after REF, longer lags could demonstrate whether the effect is short-term or if it can be accelerated over time. It is an important question, as it may change the policy implementation period. In the case of short-term effects, there should be shorter periods between REFs. Meanwhile, if the effects persist, public resources could be saved by having longer periods between each REF. Future research should consider building longitudinal analysis (waiting for the next round of evaluations), combining quantitative and qualitative methods, and exploring comparison analysis with similar evaluation systems adopted in other countries (e.g., Australia, New Zealand, Hong Kong, and Ireland). In this regard, Shewan and Coats (2006) recognized the need to explore whether the research evaluation systems are the most appropriate and cost-effective mechanism to achieve university scholarly impacts.

The second limitation is the proxies used to measure university economic growth impacts. We applied secondary data sources that conditioned the measurements used to test our proposed conceptual model. Although these measures provide empirical evidence, a natural extension of this is collecting data from surveys or case studies that allow the objective/subjective particularities behind each university research and entrepreneurial outcome to be captured (Eesley & Miller, 2018; Breznitz & Zhang, 2019; Marzocchi et al., 2019). Indeed, our measure of the entrepreneurial

orientation of the university (Russell group) could be improved based on re-considering/building a new metric (Guerrero et al., 2015). For instance, the analysis of other types of capitals such as social or financial. Future studies implementing this metric could also consider other tests like fixed effects when samples differ quite slightly. It would also be useful, as noted in Perkmann et al. (2021), to conduct additional research on the economic impact of academic engagement with industry at business schools and other units on campus. As suggested by these authors, we should explore unique characteristics across business schools (e.g., how interdisciplinary each school is) that either advance or detract from university efforts to advance "academic entrepreneurship" (e.g., entrepreneurship in the curriculum, technology and knowledge transfer, and research partnerships with entrepreneurs).

A third limitation of our study relates to the size, meaning, and significance of our estimated effects of the impacts of research and education on economic growth for theory and practice. Our empirical analysis is based on a file combining several public datasets, which have several restrictions. Although we analyzed this dataset rigorously, future studies could be based on an improved methodological design with even more rigor and practical impact, as suggested by Aguinis et al. (2010), Combs (2010), and Bettis (2012).

The fourth limitation is the need for additional theory development. Our study links the theoretical foundations of economic growth theory (economic) and stakeholder approach (management) to understand a policy intervention to redefine higher education scholarly impacts. Future research should explore other perspectives for improving the understanding of higher education scholarly impacts, such as the reconfiguration of scholars' identities based on the different types of scholarly impacts and the link between career development, gender inclusion-equality, and scholarly impacts. Indeed, the simultaneous analysis of bi-directional returns between university (via scholarly impacts) and society (via research funds) (Davies & Mangan, 2007;

Audretsch, 2014). All these limitations allow academics to continue a research agenda about scholarly impact.

CONCLUSIONS

This study fills a gap in the stakeholder literature by assessing how stakeholder intervention (REF, 2014) influences university outcomes and the impact of scholarship and education on economic growth. Our findings indicate that stakeholder intervention through the REF resulted in an increase in the university's propensity to contribute to economic and entrepreneurial growth (Siegel and Wessner, 2012; Heaton et al., 2019). Therefore, stakeholder interventions should include a combination of resources, measures, and organizational capabilities that promote quality, effectiveness, diversity, and superior returns for all actors: universities, stakeholders, and society (MacDonald, 2017). Given that universities are under increasing pressure to demonstrate their economic and social contribution, at the same time as financial support from the government for business schools and universities is dwindling, this is certainly welcome news (Wickert et al., 2020). We hope that our results stimulate a discussion regarding other types of stakeholder interventions that can enhance the economic and social value of business school and university teaching and research.

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TABLE 1
Theoretical Approaches

Endogenous growth theory			Stakeholder theory			Interplay
Predominant economic growth factor	Expected university outcomes	Expected university scholarly impact	Predominant public intervention	Expected university outcomes	Expected university scholarly impact	
Labor-force-based economy	Skilled labor force	Building human capital capabilities in the region	Labor market agents	Skilled labor force	Employed graduates	(a) The intervention of stakeholders on university inputs (resources and capabilities), outputs (teaching, research, engagement), and impacts (social and economic) (b) The intervention of universities managers on the stakeholders' requests via associations of field or public consultations
Knowledge-based economy	Research production	Knowledge dissemination in the region	Innovation ecosystems agents	Research production	Research return investments via value creation	
Entrepreneurial economy	Engagement, spin-offs, and start-ups	Entrepreneurial capabilities in the region	Economic and entrepreneurial ecosystem agents	Engagement and entrepreneurial initiatives		

Source: Authors

TABLE 2
Description of Variables

	Variable	Description	Source
University scholarly impacts	Human capital capabilities in the region	Equals one if the university manager confirmed that its university is addressing the human capital capabilities required in the region, zero otherwise	HEFCE & HESA
	Retention of human capital capabilities in the region	Equals one if the university manager confirmed that its university is addressing the retention of human capital capabilities in the region, zero otherwise	
	Knowledge commercialization in the region	Equals one if the university manager confirmed that its university is addressing the transference and commercialization of knowledge in the region, zero otherwise	
	Collaboration with knowledge actors in the region	Equals one if the university manager confirmed that its university is addressing the collaboration with multiple knowledge agents in the region, zero otherwise	
	Support SMEs in the region	Equals one if the university manager confirmed that its university is addressing the support of SMEs needs in the region, zero otherwise	
	Support community needs in the region	Equals one if the university manager confirmed that its university is addressing the support of social communities in the region, zero otherwise	
University outcomes	Business graduates	The percentage of business graduates per university	HEFCE & HESA
	Social science graduates	The percentage of social science graduates per university	
	Creative graduates	The percentage of creative graduates per university	
	Health graduates	The percentage of health graduates per university	
	STEM graduates	The percentage of STEM graduates per university	
	Natural science graduates	The percentage of natural science graduates per university	
	Research Contracts	The total value of contracts (£ thousand) per university	HEFCE & HESA
	Patents	Number of patents granted per university	
	IP	Intellectual property (IP) income (£ thousands) per university	
	Spin-offs	Spin-offs turnover (£ thousands) with HEI ownership per university	
	Start-up	Staff start-ups turnover (£ thousands) per university	
Stakeholder intervention	REF	The grade point average (GPA) of the university quality profile obtained in the REF2014 evaluation	Times Higher Education Ranking
Control variables	Ratio students per staff per university	The ratio of staff per student at university	HEFCE & HESA
	Infrastructure investment per university	Equals one if the university manager confirmed that its university has invested in infrastructure, zero otherwise	
	Equipment investment per university	Equals one if the university manager confirmed that its university has invested in equipment, zero otherwise	
	Government funding per university	Total funding received by the government (£ thousand) per university	
	Russell Group	Equals one if the university is a member of the Russell Group, zero otherwise	Russell Group
	GVA per capita per region	Gross value added per capita, in thousand £	ONS
	Business density per region	The difference between start-ups and closures as % of the total number of businesses in a city	
	Graduates employment per region	The employment rate (%) of graduates in the region where is located the university	

Note: ONS = Office National Statistics; HESA = the Higher Education Statistics Agency; HEFCE = the Higher Education Funding Council for England
Source: Authors

TABLE 3
Descriptive Statistics and Correlation Matrix

		N	Mean	Std. Dev.	Min	Max	1	2	3	4	5	6	7
1	Human capital capabilities in the region	1134	0.48	0.50	0.00	1.00	1						
2	Retention of human capital capabilities in the region	1134	0.41	0.49	0.00	1.00	0.4235*	1					
3	Knowledge commercialization in the region	1134	0.27	0.45	0.00	1.00	0.3878*	0.4456*	1				
4	Collaboration with knowledge actors in the region	1134	0.57	0.50	0.00	1.00	0.0525	0.2206*	0.4597*	1			
5	Support SMEs in the region	1134	0.57	0.50	0.00	1.00	0.4055*	0.3876*	0.4166*	0.1779*	1		
6	Support community needs in the region	1134	0.36	0.48	0.00	1.00	0.3676*	0.3840*	0.4295*	0.2032*	0.2592*	1	
7	Business graduates	1134	0.08	0.39	0.00	12.83	-0.0094	0.0514	0.1943*	0.2801*	0.0025	-0.0417	1
8	Social science graduates	1134	0.06	0.28	0.00	9.15	0.1290*	0.1240*	0.1216*	0.1513*	0.0339	-0.0012	0.3927*
9	Creative graduates	1134	0.13	0.36	0.00	10.16	0.0176	0.0981*	0.0743*	0.0455	0.0487	0.0531	0.4963*
10	Health graduates	1134	0.02	0.12	0.00	3.13	0.0799*	0.0564	0.1800*	0.2305*	-0.0127	-0.0504	0.4600*
11	STEM graduates	1134	0.06	0.06	0.00	0.59	0.0506	0.0521	0.2190*	0.3056*	0.0720*	-0.0489	0.4188*
12	Natural science graduates	1134	0.07	0.29	0.00	9.32	-0.0176	-0.0095	0.1801*	0.2634*	0.0725*	-0.0605*	0.4119*
13	Research Contracts	1134	6.29	3.27	0.00	12.04	-0.0388	0.0225	0.3046*	0.4909*	0.0096	-0.1351*	0.4604*
14	Patents	1134	0.86	1.19	0.00	5.50	-0.1342*	-0.0701*	0.3001*	0.3755*	-0.0453	-0.1095*	0.3389*
15	IP	1134	3.08	2.89	0.00	11.07	-0.1220*	-0.0896*	0.3237*	0.4161*	-0.0136	-0.1247*	0.4303*
16	Spin-offs	1134	3.79	4.14	0.00	11.81	-0.1158*	-0.0495	0.3127*	0.3995*	-0.0028	-0.0953*	0.4753*
17	Start-up	1134	1.45	2.77	0.00	11.29	-0.0342	0.0484	0.1762*	0.1836*	0.0730*	-0.0148	0.2286*
18	REF	1050	2.71	0.44	1.00	3.49	-0.2085*	-0.1324*	0.1758*	0.3809*	-0.0850*	-0.0581	0.2136*
19	Ratio students per staff per university	1134	15.79	18.33	0.32	300.20	0.1352*	0.0001	-0.0614*	-0.0742*	0.018	-0.0335	-0.0523
20	Infrastructure investment per university	1134	0.28	0.45	0.00	1.00	0.1571*	0.1515*	0.3091*	0.2612*	0.1662*	0.1205*	0.2487*
21	Equipment investment per university	1134	0.22	0.42	0.00	1.00	0.2087*	0.2568*	0.4309*	0.2665*	0.2080*	0.1992*	0.2212*
22	Russell Group	1134	0.15	0.36	0.00	1.00	-0.1292*	-0.0667*	0.1889*	0.3089*	-0.1005*	-0.0354	0.2484*
23	Government funding per university	1134	1667.77	4074.29	0.00	40484.00	-0.0292	-0.0798*	0.2381*	0.3099*	-0.0052	-0.0328	0.3579*
24	GVA per capita per region	1134	29.92	9.54	14.66	49.93	-0.1185*	-0.1721*	0.045	0.0202	-0.0824*	0.1057*	-0.1425*
25	Business density per region	1134	2.32	3.12	-4.71	11.44	0.1831*	0.1810*	0.3394*	0.1598*	0.1870*	0.3631*	-0.0523
26	Graduates employment per region	1134	2.28	2.36	0.00	7.91	0.1276*	0.2008*	0.2006*	0.1415*	0.1721*	0.0783*	0.3201*

Note : * significant at 5% level.

		9	10	11	12	13	14	15	16	17	18	19	20
9	Creative graduates	1											
10	Health graduates	0.4940*	1										
11	STEM graduates	0.4187*	0.4180*	1									
12	Natural science graduates	0.3910*	0.4566*	0.4413*	1								
13	Research Contracts	0.2242*	0.4090*	0.4227*	0.4164*	1							
14	Patents	0.0777*	0.3108*	0.3812*	0.3494*	0.4190*	1						
15	IP	0.1115*	0.3307*	0.4420*	0.4298*	0.4324*	0.4118*	1					
16	Spin-offs	0.1732*	0.3848*	0.5289*	0.4670*	0.4493*	0.4644*	0.4641*	1				
17	Start-up	0.0757*	0.2019*	0.2692*	0.2332*	0.3132*	0.3288*	0.3124*	0.4407*	1			
18	REF	-0.0019	0.1820*	0.2141*	0.1973*	0.4532*	0.4777*	0.5809*	0.4936*	0.2518*	1		
19	Ratio students per staff per university	-0.0977*	0.1068*	-0.0472	0.0650*	-0.0012	-0.1794*	-0.2180*	-0.1520*	-0.0689*	-0.1737*	1	
20	Infrastructure investment per university	0.1286*	0.2185*	0.2772*	0.2426*	0.3241*	0.2420*	0.2491*	0.3364*	0.2174*	0.1169*	0.0615*	1
21	Equipment investment per university	0.1020*	0.1706*	0.2413*	0.2334*	0.2843*	0.2100*	0.2652*	0.3284*	0.1804*	0.1146*	-0.0228	0.5245*
22	Russell Group	0.1238*	0.2218*	0.2664*	0.2574*	0.4967*	0.5970*	0.5660*	0.4688*	0.1936*	0.4537*	-0.1628*	0.2182*
23	Government funding per university	0.0183	0.3141*	0.3467*	0.3560*	0.6236*	0.4984*	0.5347*	0.4905*	0.2575*	0.5218*	-0.0483	0.2636*
24	GVA per capita per region	-0.0621	-0.1722*	-0.2395*	-0.2061*	-0.1337*	0.0168	-0.0461	-0.0477	-0.1631*	0.0817*	-0.3152*	-0.1942*
25	Business density per region	-0.0345	-0.0684*	-0.1095*	-0.0933*	-0.0809*	0.0234	-0.0272	0.005	-0.0877*	0.033	-0.2252*	0.0175
26	Graduates employment per region	0.2753*	0.2425*	0.3688*	0.2776*	0.2619*	0.1133*	0.1907*	0.2626*	0.3396*	0.1153*	-0.0299	0.2488*

		21	22	23	24	25	26
21	Equipment investment per university	1					
22	Russell Group	0.1752*	1				
23	Government funding per university	0.1978*	0.4549*	1			
24	GVA per capita per region	-0.1907*	-0.0166	-0.0567	1		
25	Business density per region	0.0749*	-0.0277	-0.0446	0.5371*	1	
26	Graduates employment per region	0.2736*	0.0808*	0.0922*	-0.3139*	-0.1017*	1

Note : * significant at 5% level.

TABLE 4

University Scholarly Impacts via Human Capital (Model 1 and Model 2)

Dependent variable	Human capital capabilities in the region						Retention of human capital in the region					
Independent variables	Model 1a			Model 1b			Model 2a			Model 2b		
	Coef	SE	P>|z|	Coef	SE	P>|z|	Coef	SE	P>|z|	Coef	SE	P>|z|
Business graduates	5.3631	1.7325	***	10.3712	5.0294	**	6.1095	1.9085	**	2.3924	2.0786	
Social science graduates	3.6686	1.2775	***	8.6025	9.0990		5.0288	1.0384	**	0.3505	0.6006	
Creative graduates	0.4467	1.0362		0.5875	7.4114		0.5502	1.4204		9.9183	9.0730	
Health graduates	3.2505	1.4247	**	10.6058	4.7815	**	3.1231	1.0501	**	31.8516	12.2268	***
STEM graduates	4.4589	1.8241	**	22.7487	8.3955	**	4.9165	1.7097	**	12.2465	9.4364	
Natural science graduates	0.7236	1.2764		12.4984	6.8900	**	3.3558	1.7506	**	10.2117	8.4202	
REF	-4.1333	1.1270	**	-4.7429	1.9036	**	-5.6955	1.9308	**	-1.5098	0.3324	**
REF*Business graduates				-2.0900	0.8258	**				-0.8008	3.5255	
REF*Social science graduates				-4.8132	1.5523					-1.5015	4.4157	
REF*Creative graduates				-0.3584	0.3887					-2.9890	3.2573	
REF*Health graduates				-3.8383	0.4642	*				-12.5129	4.5669	**
REF*STEM graduates				-8.3456	3.5091	*				-5.3709	5.3613	
REF*Natural science graduates				-4.7789	2.6482	*				-3.7169	3.4904	
Research Contracts	-0.2568	0.0455	**	-0.2630	0.0503	**	0.2514	0.2431		0.2669	0.1845	
Patents	-0.3222	0.2064		-0.3058	0.2075		-0.1551	0.2347		-0.2204	0.2497	
IP	0.0969	0.1166		0.1060	0.1186		-0.1038	0.1442		0.0463	0.1456	
Spin-offs	-0.1011	0.0856		-0.0817	0.0864		-0.0898	0.1031		-0.0515	0.1093	
Start-up	0.0970	0.0950		0.1012	0.0954		0.1170	0.0093	**	0.2262	0.0115	**
Ratio students per staff per university	-0.1092	0.0473	**	-0.1229	0.0485	**	-0.1392	0.0581	*	-0.1434	0.0521	**
Infrastructure investment per university	1.5174	0.4515	***	1.4970	0.4553	***	1.3207	0.4979	**	1.6372	0.5502	**
Equipment investment per university	2.0827	0.5191	***	2.1395	0.5245	***	2.7751	0.6384	***	3.4174	0.7037	***
Russell Group	-1.7613	1.1946		-1.2759	1.2886		-1.2876	1.4437		-2.9719	1.7990	*
Government funding per university	0.4100	0.0954	**	0.4100	0.0954	**	0.4290	0.1902	**	0.4100	0.0954	**
GVA per capita per region	0.0226	0.0389		0.0279	0.0397		0.0884	0.0638		0.1517	0.0743	*
Business density per region	0.4573	0.0617	***	0.4545	0.0619	***	0.5251	0.0773	***	0.4565	0.0670	***
Graduates employment per region	0.5285	0.1191	***	0.5244	0.1213	***	0.4661	0.1304	***	0.6266	0.1485	***
Constant	7.8122	3.2673	***	10.1189	4.4595	**	7.2667	3.1414	**	-6.7556	2.9389	***
Constant (var)	11.1677	3.3907	***	10.9219	3.2967	***	14.5984	5.7949	***	22.61443	9.3002	***
N	917			917			917			917		
Fixed-effects log likelihood	-420.14			-415.748			-327.21			-418.977		
Mixed-effects log likelihood	-336.21			-332.96			-268.66			-331.706		
Prob > chi2	***			***			***			***		
Wald chi2(19)	103.2			103.04			93.47			91.64		
LR test vs. logistic model												
chibar2(01)	167.86			165.58			117.09			179.91		
Prob >= chibar2	***			***			***			***		

Note: * significant at 10% level; ** significant at 5% level and *** significant at 1% level.

TABLE 5

University Scholarly Impacts via Knowledge Capital (Model 3 and Model 4)

Dependent variable	Knowledge commercialization in the region						Collaboration with regional knowledge actors					
Independent variables	Model 3a			Model 3b			Model 4a			Model 4b		
	Coef	SE	P>|z|	Coef	SE	P>|z|	Coef	SE	P>|z|	Coef	SE	P>|z|
Research Contracts	0.6317	0.0675	***	1.3802	1.3708		1.7608	0.2617	***	1.3384	0.4269	***
Patents	0.4833	0.2226	**	5.0483	2.2041	**	-0.1037	0.2599		2.4952	2.3309	
IP	0.0212	0.1233		-0.3338	1.1731		0.4017	0.1511	***	-1.3110	1.1930	
REF	1.4918	0.2750	**	1.2135	0.4914	**	3.9547	1.0664	***	2.1809	0.7870	***
REF*Research contracts				-0.2573	0.4896					1.1773	0.0224	***
REF*Patents				1.7245	0.7610	**				-0.9597	0.8479	
REF*IP				0.1220	0.4167					0.3450	0.4439	
Business graduates	-7.4438	2.9085	***	-6.6886	3.3431	**	-3.7268	3.3527		-3.3216	3.6596	
Social science graduates	-0.2807	1.3132		-0.4433	1.4426		0.2520	1.7313		0.2646	1.8182	
Creative graduates	0.5112	1.0599		0.8994	1.1855		-2.8452	2.5684		-2.8305	1.6030	
Health graduates	0.0279	1.3679		-0.1821	1.5060		-2.3155	1.8779		-2.4429	2.0045	
STEM graduates	7.0822	2.8794	***	6.6980	3.3778	**	7.9272	2.6773	***	7.4660	2.9293	***
Natural science graduates	0.7521	1.2429		0.5791	1.3533		-0.6232	1.4988		-0.6312	1.5647	
Spin-offs	0.3002	0.0842	*	-0.0636	0.0912		-0.1207	0.1049		-0.1116	0.1087	
Start-up	0.5596	0.0800	*	0.0685	0.0864		0.5001	0.0880	*	-0.0006	0.0895	
Ratio students per staff per university	-0.1114	0.0575	**	-0.1140	0.0615	**	-0.1821	0.0583	**	-0.1891	0.0600	**
Infrastructure investment per university	1.4193	0.4634	**	1.5946	0.4971	***	1.3077	0.5849	**	1.3473	0.5955	**
Equipment investment per university	2.5118	0.5728	***	2.8553	0.6285	***	1.5858	0.6245	**	1.5438	0.6315	**
Russell Group	2.2828	0.1163	**	3.2541	1.0541	**	0.3660	1.5608		0.2067	1.7431	
Government funding per university	0.4131	0.0880	**	0.4557	0.1968	**	0.4463	0.0199	**	0.4435	0.2019	**
GVA per capita per region	0.0754	0.0499	*	0.0851	0.0541	*	0.1218	0.0066	**	0.1358	0.0697	**
Business density per region	0.6344	0.0862	***	0.6477	0.0894	***	0.2869	0.0718	***	0.2888	0.0725	***
Graduates employment per region	0.3743	0.1246	**	0.3824	0.1314	**	0.1090	0.1259		0.1041	0.1283	
Constant	-12.1330	4.6382	**	-13.9449	4.0953	*	-16.1017	4.8829	***	-11.9227	4.7012	
Constant (var)	5.7038	2.8436	***	10.9219	3.2967	***	12.2752	5.5485	***	13.2203	6.0507	***
N	917			917			917			917		
Fixed-effects log likelihood	-248.541			-246.606			-251.908			-251.006		
Mixed-effects log likelihood	-233.015			-229.894			-213.075			-212.146		
Prob > chi2	***			***			***			***		
Wald chi2(20)	72.13			70.53			54.55			54.31		
LR test vs. logistic model												
chibar2(01)	31.05			33.42			77.67			77.72		
Prob >= chibar2	***			***			***			***		

Note: * significant at 10% level; ** significant at 5% level and *** significant at 1% level.

TABLE 6

University Scholarly Impacts via Entrepreneurial Capital (Model 5 and Model 6)

Dependent variable	Support SMEs in the region						Support community needs in the region					
Independent variables	Model 5a			Model 5b			Model 6a			Model 6b		
	Coef	SE	P>|z|	Coef	SE	P>|z|	Coef	SE	P>|z|	Coef	SE	P>|z|
Spin-offs	0.1661	0.0871		0.2037	0.7316		0.0446	0.0971		0.4206	0.8029	
Start-up	1.0719	0.0860	**	0.4271	0.7567		0.0384	0.1003		0.0490	0.8784	
REF	4.5223	1.9394	**	4.7933	1.0464	**	1.0113	0.0536	*	1.6592	0.7391	*
REF*Spin-offs				0.0130	0.2578					0.1331	0.2827	
REF*Start-ups				0.1708	0.2578					-0.0312	0.2984	
Business graduates	3.8147	1.0561	***	1.7255	0.0997	*	8.4832	3.6272	**	8.2028	3.6632	**
Social science graduates	2.7842	0.7349	*	2.7029	0.7765	*	2.2997	0.7848	*	2.1603	0.8162	*
Creative graduates	0.5036	1.2444		0.5234	1.2627		0.3368	1.3304		0.2481	1.3452	
Health graduates	3.1338	0.8003	**	3.1573	0.8228	**	1.0378	1.7002		0.0139	1.6917	
STEM graduates	1.2155	0.0311	*	1.1652	0.0754	*	6.0874	3.4260	**	5.8076	1.4767	*
Natural science graduates	0.1852	1.4597		0.1804	1.4717		2.7723	1.6034	**	2.8200	0.5850	*
Research Contracts	1.2448	0.2125	*	0.2515	0.2140		0.1298	0.2043		0.1284	0.2046	
Patents	0.2252	0.2158		0.2291	0.2216		0.4734	0.2512		0.4972	0.2567	
IP	0.1561	0.1567		0.1593	0.1604		0.2663	0.1377		0.2750	0.1394	
Ratio students per staff per university	-0.1108	0.0606	**	-0.1107	0.0616	**	-0.0783	0.0555		-0.0772	0.0557	
Infrastructure investment per university	0.9454	0.4468	**	0.9296	0.4489	**	1.8457	0.5241	***	1.8668	0.5269	***
Equipment investment per university	2.6755	0.6403	***	2.6933	0.6456	***	2.3152	0.6488	***	2.3152	0.6522	***
Russell Group	2.5528	1.3430	*	2.6853	1.4129	*	0.7083	1.3415		0.8550	1.3844	
Government funding per university	0.4762	0.1731	***	0.4798	0.1740	**	0.3601	0.1872	**	0.3691	0.1883	**
GVA per capita per region	0.1081	0.0546	**	0.1093	0.0556	**	0.1093	0.0595	**	0.1085	0.0601	**
Business density per region	0.4204	0.0677	***	0.4210	0.0680	***	0.5717	0.0802	***	0.5749	0.0806	***
Graduates employment per region	0.3353	0.1237	**	0.3376	0.1252	**	0.4183	0.1398	**	0.4130	0.1406	**
Constant	5.8205	0.1703	**	6.5178	0.4502	**	-11.7982	5.1593	*	-10.8813	5.5716	*
Constant (var)	11.8865	4.8421	***	10.9219	3.2967	***	12.2752	5.5485	***	13.2203	6.0507	***
N	917			917			917			917		
Fixed-effects log likelihood	-329.426			-329.069			-285.381			-284.832		
Mixed-effects log likelihood	-278.459			-278.220			-250.541			-250.430		
Prob > chi2	***			***			***			***		
Wald chi2(20)	72.05			71.74			73.67			73.48		
LR test vs. logistic model												
chibar2(01)	101.93			101.7			69.68			68.8		
Prob >= chibar2	***			***			***			***		

Note: * significant at 10% level; ** significant at 5% level and *** significant at 1% level.

FIGURE 1

Proposed Conceptual Model

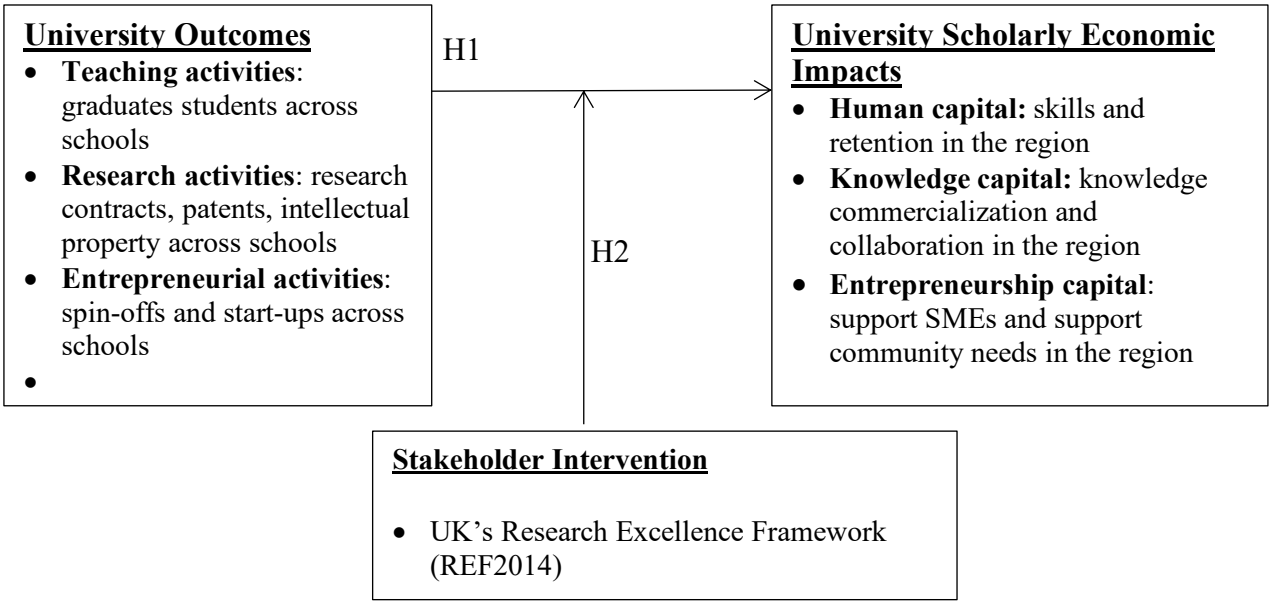
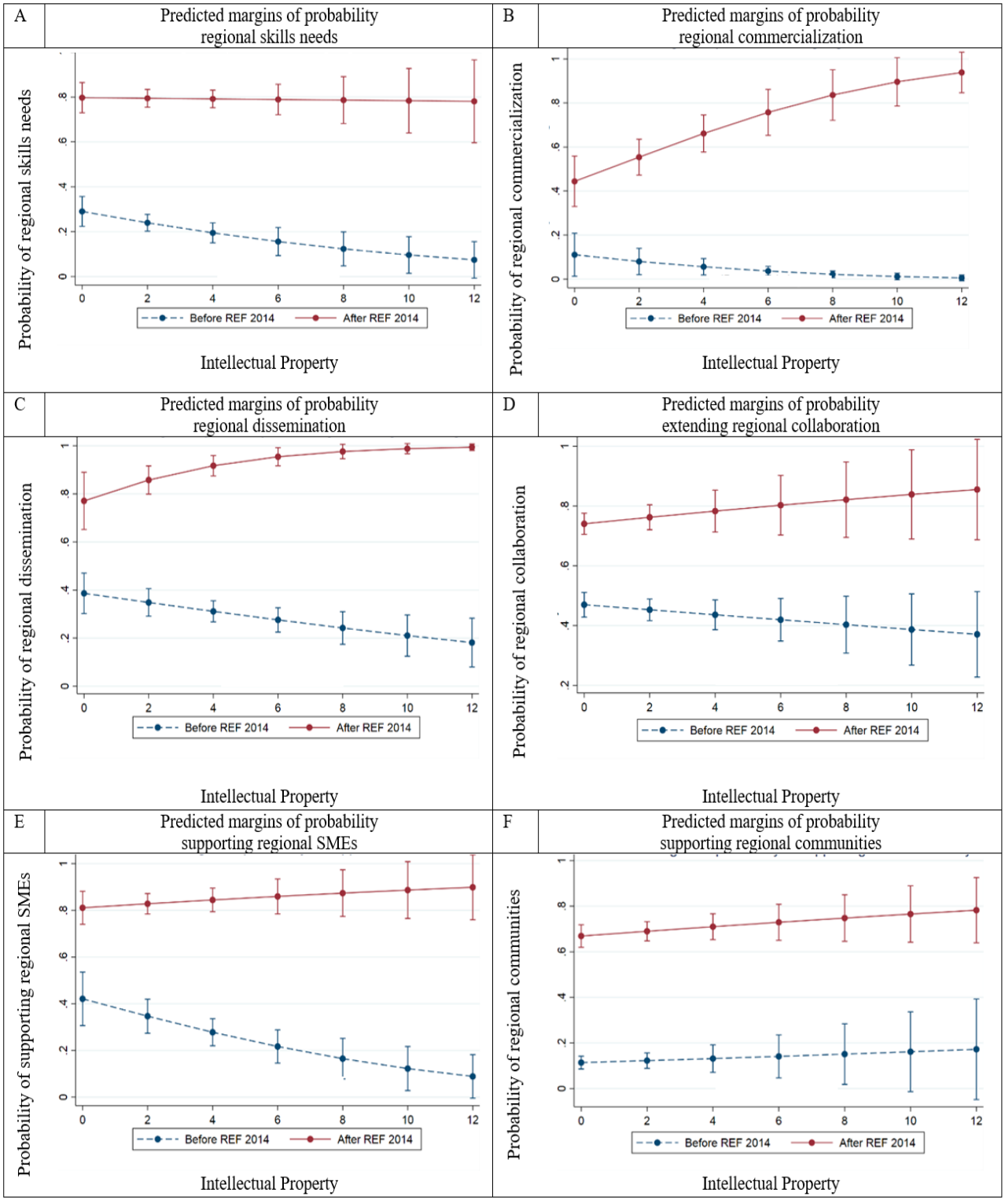


FIGURE 2
The Impact of University Intellectual Property on Endogenous Growth
before REF (dotted line) and after REF (solid line)



APPENDIX A

Universities Included in this Study

Anglia Ruskin University	Swansea University	St Mary's University College
Conservatoire for Dance and Drama	The Royal Central School of Speech an..	Swansea Metropolitan University
Aston University	The Arts University Bournemouth	University of London (Institutes)
Cardiff University (*)	The Robert Gordon University	University of Nottingham (*)
Bath Spa University	The City University	University of Plymouth
Birkbeck College	The Institute of Cancer Research	University of South Wales
Birmingham City University	The Liverpool Institute for Performing Arts	University of St Mark and St John
Bournemouth University	The Manchester Metropolitan University	University of Suffolk
Brunel University London	The National Film and Television School	University of the Arts, London
Buckinghamshire New University	The Nottingham Trent University	University of the West of England
Courtauld Institute of Art	The Royal Veterinary College	University of Warwick (*)
Cardiff Metropolitan University	The Open University	York St John University
Coventry University	The School of Oriental and African St..	Durham University (*)
De Montfort University	The School of Pharmacy	Queen University of Belfast (*)
Edinburgh Napier University	The University of Aberdeen	Southampton Solent University
Glasgow Caledonian University	The University of Birmingham (*)	St George's Hospital Medical School
Glasgow School of Art	The University of Bradford	St Mary's University, Twickenham
Goldsmiths College	The University of Brighton	University of Gloucestershire
Guildhall School of Music and Drama	The University of Bristol (*)	University of Hertfordshire
Harper Adams University	The University of Cambridge (*)	University of Northumbria
Heriot-Watt University	The University of Central Lancashire	University of Derby
Heythrop College, London	The University of Chichester	Sheffield Hallam University
Imperial College London (*)	The University of Dundee	
Institute of Education	The University of East Anglia	
King's College London (*)	The University of East London	
Kingston University	The University of Edinburgh (*)	
Leeds Beckett University	The University of Exeter (*)	
Leeds College of Art	The University of Glasgow (*)	
Leeds College of Music	The University of Greenwich	
Leeds Trinity University	The University of Huddersfield	
Liverpool Hope University	The University of Hull	
Liverpool John Moores University	The University of Keele	
London Business School	The University of Leeds (*)	
London Metropolitan University	The University of Leicester	
London School of Economics (*)	The University of Liverpool (*)	
London School of Hygiene and Tropical..	The University of Manchester (*)	
London South Bank University	The University of Northampton	
Loughborough University	The University of Oxford (*)	
Middlesex University	The University of Portsmouth	
Newcastle University (*)	The University of Reading	
Newman University	The University of Sheffield (*)	
Norwich University of the Arts	The University of Southampton (*)	
Oxford Brookes University	The University of St Andrews	
Plymouth College of Art	The University of Strathclyde	
Queen Margaret University, Edinburgh	The University of Sunderland	
Queen Mary University of London (*)	The University of Sussex	
Royal College of Music	The University of the West of Scotland	
Ravensbourne	The University of Wales, Newport	
Roehampton University	The University of West London	
Rose Bruford College	The University of Westminster	
Royal Academy of Music	The University of Wolverhampton	
Royal College of Art	The University of York (*)	
Royal Conservatoire of Scotland	Trinity Laban Conservatoire of Music	
Royal Holloway and Bedford New c.	University College Birmingham	
Royal Northern College of Music	University College London (*)	
SRUC	University of Abertay Dundee	

Note: * Listed as Russell Group Universities