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INCOME GENERATION ACTIVITIES FROM ACADEMICS AT UNIVERSITIES AND ENGAGEMENT WITH STAKEHOLDERS

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Abstract

The paper explores the effect of different stakeholders (the definition of the term "stakeholder" within this research paper is presented in the Introduction) on the income generation of the university. There is a growing focus from the research perspective and university management on the ability of universities to sustain their financial sustainability due to the shortage of financial support from the government. Adopting different instruments, university faculty is one of the vital stakeholders for generating revenues for the university via engaging with different actors. This research adopted quantitative techniques by applying secondary data on university-industry collaboration in the UK to evaluate the effect of different stakeholders on university financial positions. The results show that government and Industry are among the initial stakeholders to contribute to university financial results while the support of other actors is vital but different across university types. This research can be helpful for university managers as a guide to explain different paths of collaboration with stakeholders that can lead to different strategies to increase university income.

Keywords:

Universities; income generation; academic staff; sustainability.

Universities are institutions that follow the “principle of borderless generation, dissemination and look for/of novel and comprehensive knowledge” [Wachter et al. 2012: 26]. They can acquire different funding sources to the extent how those sources can impact their financial structure. Besides the government, universities can acquire funding from different resources based on how such resources could impact the financial performance of academia [Alshubiri 2020].

Changing government policies and reducing funding for universities put university sustainability under pressure. By definition, sustainability is the ability of an institution "to uphold an activity without quality loss and by using appropriate resources into the future" [Nalwoga 2021]. The sustainability of universities in terms of finances plays a critical role in maintaining ordinary university operations.

The number of evidence suggests that universities with reliable income flows and sound financial systems can perform multiple missions (teaching, research, and entrepreneurship) more effectively [Modugno and Di Carlo 2019; Sazonov et al. 2015]. For that, they need

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to secure financial sustainability, which is the ability of the university to fulfill its mandate [Nalwoga 2021]. It is predicted that many universities could face financial sustainability challenges as they have to rely on multiple sources of revenue streams [Sazonov et al. 2015].

Following Jongbloed [Jongbloed 2004], policymakers and leadership at the university use funding as a component of adopted government instruments. Thus, funding is more than simple resources distribution to the university. It at large defines the university's strategy and mission. However, not much attention and exploration have been paid to the contribution of diverse stakeholders into the university income generation via different activities performed by academia in terms of three missions of the university [Miller et al. 2014].

For this research, we define a stakeholder as any actor, institution, or organization involved in university activities on new knowledge generation and dissemination contributing to income generation. These stakeholders are government, Industry, university faculty, technology transfer, intellectual property offices, business incubators and science parks, venture capitalists. The university plays a leading role in these interactions, facilitating the flow of knowledge and promoting regional economic development [Etzkowitz et al. 2008; Miller and Acs 2017]. This is supported by empirical research primarily based on observations in both developed [Liu et al. 2018] and developing countries [Belitski et al. 2019].

This research questions what the university is as an institution concerning stakeholders who facilitate and encourage its revenues generation at different levels of engagement.

Universities can be considered a complex phenomenon due to their divergent strategic goals and the internal and external stakeholders they deal with [Bartell 2003; O'Kane et al. 2015]. However, research on universities lacks the complexity of models needed to explain the interdependent processes amongst the different stakeholders involved [Foss and Gibson 2015] and their impact on university income. This research implies a holistic approach to university concerning collaboration with stakeholders.

Contemporary research on university engagement with other actors has several drawbacks. First, there is no clear explanation of the university's stakeholders who contribute to income generation. In addition, little research exists that conceptualizes the structure, mechanisms, and links such universities build while engaging with external stakeholders [Hayter 2016] to generate additional income for academia. This research will cover the identified gap.

Using longitudinal data on 139 UK universities (2009-2016) collected by the Higher Education Statistics Agency (HESA), this study theoretically develops and empirically tests the concept of the entrepreneurial university. It demonstrates how collaboration between various stakeholders on knowledge generation and spillovers can change university income.

The article has the following structure. The next section describes the conceptual framework, stakeholders' involvement, and classification. After that we present the UK evidence and the hypothesis. We follow by discussing the data and methodology. At the end we present results, as well as provide discussion and conclusions.

The stakeholder theory approach to entrepreneurial university

The stakeholder theory could be vital in higher education while explaining the relationships between academia and various stakeholders. The business science literature was the foundation for the stakeholder concept [Freeman 1984], while the latter is traced back to "The Theory of Moral Sentiments" of Adam Smith. The modern use of the stakeholder concept in management literature originated in 1963 when Stanford Research Institute introduced the expression to augment and summarise the notion of stakeholder as the group to whom management should be responsive [Jongbloed et al. 2008].

According to Freeman [Freeman 1984], initially, the stakeholder concept was determined as "those groups without whose support the organization would cease to exist," and the definition came from Stanford Research Institute (SRI) in 1963.

Table 1

Categorization of entrepreneurial stakeholders at different levels of engagement

№	Categorization	Stakeholders	Authors
1	Individual-level – General stakeholders	Research-focused staff and intermediaries, such as cooperative research centers, university-corporate research centers, on-site executive education programs, industry-consulting intermediaries, research labs, students	O'Gorman et al. 2008; Gray and Boardman 2010; Siswanto et al., 2013; Nielsen, 2009; Jongbloed, 2004; Acosta et al. 2011
2	Organizational level Specialized stakeholders	Technology transfer office, centers for entrepreneurship, venture capitalist, angel investor, crowd investors, banks and financial groups, Research and Science parks, accelerators, Business incubators	Wächter et al., 2012; Jongbloed et al. 2008; Belitski & Heron 2017; Guerrero, 2016; Huyghe et al. 2016; Malairaja and Zawdie, 2008; Grimaldi and Grandi, 2005; Barbero et al., 2012; Robles, 2017; Roura, 2015
3	System-level Systemic stakeholders	Government and Industry	Jongbloed & Vossensteyn, 2001; Frølich et al., 2010; van Looy et al., 2011; Powers and McDougall, 2005

A widely used statement of who or what stakeholders are was introduced by Freeman [Freeman 1984] and is defined as "any group or individual who can affect or is affected by the achievement of the firm's objectives" [Freeman 1984: 16]. According to Freeman, any business organization should consider its stakeholders' interests while making strategic decisions or choices.

The recognition of the main groups of stakeholders is not straightforward [Jongbloed et al. 2008]. In business, both customers and employees are qualified as stakeholders, while according to Winston [Winston 1999], academia is sharing an identical behavior. However, different employees and customers can have a diversified influence on organizations. Applying stakeholder framework to management may be a helpful instrument assisting organizational actors while dealing with environments [Freeman 1984]. It allows selectively perceiving, evaluating, and interpreting stakeholders' attributes. Mitchell et al. [Mitchell et al. 1997] applied Freeman's stakeholder concept and developed an approach that assists in recognizing "who or what really counts" and evaluating the extent to which managers paid attention to their stakeholders.

There are three main approaches within stakeholder theory including normative (why the interest of a particular stakeholder should be considered), instrumental (define the effect stakeholders have on the organizational performance) as well as a descriptive approach (defining whether stakeholder interest is taken into consideration by a company) [Donaldson and Preston 1995; Alsos et al. 2011].

Based on Burrows [Burrows 1999], we present different stakeholders of universities on the different levels of engagement, including individual, organizational, and system. Stakeholders are divided by specific groups at different levels of engagement that are accepted as influencing the universities' behavior, policy, and actions. Table 1 includes a list of actors to which universities are supposed to pay attention at an individual, organizational and system levels of engagement. There is the fact that the degree of attention is not similar in each case.

Following Bartell [Bartell 2003], universities are highly complex organizations with various internal and external stakeholders. They might include several research centers which are generally (but not always) multi- or transdisciplinary. They operate at the individual level, represented by the university faculty and students.

Such new centers and units can be linked to the steering core and the heartland departments, including technology transfer offices, business incubators, science parks, or venture capitalists operating at the organizational (university) level. Like science parks that become autonomous, some peripheral units may have the name and sponsorship of the university but then operate much like mediating institutions

situated between the university and outside organizations. Organizational level stakeholders link academia with stakeholders operating at the system level who are not necessarily connected to or belonging to the individual university and include government and Industry. System-level stakeholders operate independently of the university and can exist within the ecosystem and impact the university operation and absorption of university results (government and Industry).

We want to point out that there is no one way, no one model to emulate. Nevertheless, the developmental peripheries have a valuable outcome: they move a university toward a dual structure of basic units in which traditional departments are supplemented by centers linked to the outside world.

Stakeholders' involvement at different levels of engagement

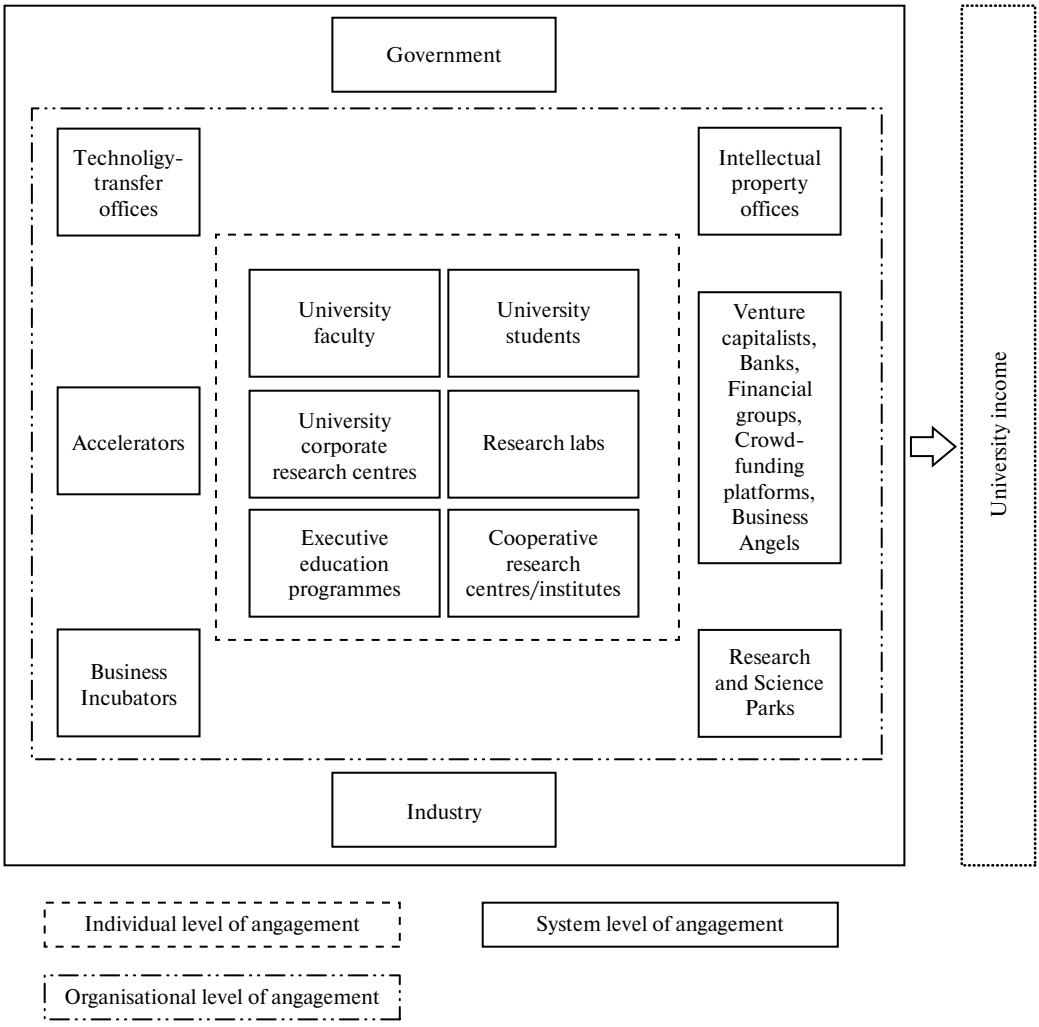
Relaying on stakeholder theory approach, our broad understanding and inclusion of individuals and organizations as stakeholders of entrepreneurial university build on academic entrepreneurship literature [Bradley et al. 2013] and knowledge spillover of entrepreneurship literature [Link et al. 2006; Braunerhjelm et al. 2010; Audretsch 2014; Audretsch and Belitski 2017]. Although in their essential study, Guerrero et al. [Guerrero et al. 2015] argued that entrepreneurial universities should embrace stakeholders' responsibilities and the complex relationships between them, entrepreneurial university literature still provides limited insights on the structure of the entrepreneurial university and the role of stakeholders in challenging and facilitating the entrepreneurial university income at different levels of engagement [Audretsch 2014].

Based on this theoretical gap in the extant literature [Autio et al. 2014; Guerrero and Urbano 2012, 2014], this paper will aim to categorize and distinguish three extinct types of entrepreneurial university stakeholders at the three levels of engagement (Table 1) and identify the role they play in fostering university income.

Within three dimensions and building on Yusef [Yusef 2008] categorization aligned with the entrepreneurial university model [Audretsch 2014], it is possible to distinguish three categories of entrepreneurial university stakeholders: (1) general (individual level): organizations and individuals that produce and spillover knowledge within the entrepreneurial university (e.g., research-focused staff and intermediaries, such as cooperative research centers, university-corporate research centers, on-site executive education programs [Gray and Boardman 2010], industry-consulting intermediaries, research labs [O'Gorman et al. 2008]; (2) specialized (organizational level): organizations and individuals that seek out new channels and forms of knowledge transfer and facilitate knowledge spillover of entrepreneurship outside the university level (e.g., technology transfer office, centers for entrepreneurship; research and science parks, incubators and accelerators). These stakeholders generate technology advances and facilitate technology diffusion through intermediaries such as technology transfer offices (TTOs). In addition, they provide support for existing companies or help jump-start new firms via incubators or science parks. These stakeholders may also raise finance (e.g., venture capitalist, angel investor, crowd investors, banks, and financial groups). The third category of stakeholders is (3) systemic stakeholders (system level): organizations that facilitate entrepreneurial incentives [Fayolle and Linan 2014] and encourage knowledge spillover of entrepreneurship within the university and into the ecosystem (government and Industry) [Link et al. 2006; Autio et al. 2014]. Former may (or not) necessarily have financial assets needed for a specialized stakeholder. Conceptually the categorization of university engagement with stakeholders at different levels is presented in Figure 1.

Research on entrepreneurial universities can benefit from applying a more holistic approach across different levels of analysis. Thus, at the individual level, university research labs and departments represented by faculty and students engage in different activities to generate third-stream income. One of the widely used pathways to collaborate with stakeholders is engagement with government and

Figure 1
Stakeholders' engagement at university by levels



Industry representing the system level of analysis. University faculty could engage with system-level stakeholders directly or via support of organizational-level stakeholders, including technology transfer offices or business incubators and science parks.

UK universities context

When it comes to the UK Higher Education System, it is historically diverse and heterogeneous [Goddard et al., 2014]. Such differences have the origin from medieval times when Oxford and Cambridge universities were established; creation of civic universities in industrial regions during Victorian times; as well as the following reforms, including the establishment of red brick universities over the inter-war time and the new universities in 1960 and the following incorporation into the university sector of the Colleges of Advanced Technology. In addition, within the UK higher education system, a divide is often

done between old universities which have been established before 1992 (typically more research focused) and new universities granted university status after 1992 as a consequence of the Further and Higher Education Act [HMSO 1992], as well as former university colleges, gained the status of the university in recent years.

New universities are more teaching-oriented as well as their third mission activities are more locally focused given their traditional orientation on vocational education and training as well as their low involvement in basic research [Charles et al. 2014; De la Torre et al. 2018].

In addition, there is also a further divide between 24 research-intensive older universities (Russel Group universities) and other older universities as well as between newer universities known as former polytechnics (these institutions offered higher diplomas and degrees in more technical subjects and were governed more at the national level) and those institutions previously known as further education colleges [McCormack et al. 2014]. Due to the heterogeneity existing within the Russel Group [Boliver 2015] and the dominance of top universities, a more fine-grained differentiation is made between the latter and the rest of the universities in the Russel Group.

Hypotheses development

Individual-level

Income generation is mostly acquired at teaching-led universities via education and teaching services [Siswanto et al. 2013]. When it comes to research-led universities, academics in such institutions are transformed to be more researchers rather than lecturers [Kasim 2011] while they become academic entrepreneurs at entrepreneurial universities [Audretsch 2014]. It is anticipated that they publish more articles and books to keep acquiring research grants as the external source of income. Furthermore, entrepreneurial universities expected their staff to act more entrepreneurially, gaining third-stream income via commercializing research results, providing consultancy services, or creating new ventures [Etzkowitz 2003]. Thus, university staff is advised to their maximum slack of capacity to generate additional income for the university. The slack capacity can be referred to as the staff hours not utilized by faculty but paid by the university in salary [Nielsen 2009].

Students are another group of internal stakeholders of the university within the knowledge generation and transfer process, leading to the third-stream income. Students are considered other sources of funding both via paying tuition fees and contributing to the new knowledge creation through research and entrepreneurship [Jongbloed 2004]. According to Acosta et al. [Acosta et al. 2011], the total number of university students is considered as one of the vital mechanisms to explain the creation of new ventures contributing to university income generation.

Thus, university staff and students are at the initial points of knowledge and technologies development and represent the university at the individual level as stakeholders' interaction. This led us to hypothesize that:

H1: *University staff and students positively affect university income for both research- and teaching-oriented entrepreneurial universities.*

Organizational level

Commercialization (selling IP rights) is handled and allocated without delimitating internally compared to other types of income generation activities [Wächter et al. 2012]. However, the environment and conditions for the staff are essential factors in the process of knowledge cultivation and provide support for the commercialization activities without compromising core academic values. To facilitate knowledge and technologies commercialization, universities establish or develop collaboration with specific academic-based business units at the organizational level.

One of them is organizations or departments such as technology transfer and patenting offices helping universities codify new knowledge and/or technologies and transfer them to business or Industry. Starting from the end of the 80th more contract-based relationships between academia and business were adopted, and universities established intellectual or technology transfer offices. Such enti-

ties help professionally manage intellectual property rights [Jongbloed et al. 2008] mostly raised from research outcomes. TTOs act as intermediaries facilitating the expansion of outcomes of university activities arising from its labs to start-up firms and businesses [Belitski & Heron 2017]. However, there is evidence that university faculty might bypass TTO and directly explore the inventions on the market [Guerrero 2016; Huyghe et al., 2016]. They can do it, e.g., to avoid the bureaucracy from such departments to fill in all the documents and wait for the university's decision or unwilling to share the royalty with such department and university [Huyghe et al. 2016]. When the innovation or business idea has not arisen directly from the research but occurred as novation having a potential to fill the gap on the market and satisfy customers' needs, such idea can directly be explored on the market [Belitski & Heron 2016]. This led us to hypothesize that:

H2: *Technology transfer offices have no effect on university income in teaching-oriented universities, while they do positively affect university income in research-oriented universities.*

Another set of stakeholders presented at the organizational level of the university is science parks, business incubators, and venture capitalists (and business angels) who help to facilitate the spillover of new technologies or knowledge in the form of new ventures directly into the business or Industry.

When it comes to Science parks, they are defined as a business support and technology transfer initiative which ensure logistical, technological, financial, and administrative facilities additionally to providing access to customers and suppliers, human capital, and public subsidies which otherwise may not be available on the start-up level of new venture creation [Phan et al. 2005]. Science parks usually encourage and support start-ups with close interaction with knowledge creation centers and are placed in the close interface between Industry and academia [Malairaja and Zawdie 2008]. They work with both knowledge-intensive firms and start-ups arising from the business idea (e.g., start-up as an outcome of the university module).

As for the Business incubators, they were initially defined as facilities assisting earlier-stage growth of new ventures by providing different services and linking together capital, technologies, and knowledge to accelerate technologies growth and new ventures creation [Hassan 2020]. University business incubators are defined as institutions ensuring support for young business start-ups [Grimaldi and Grandi 2005; Barbero et al. 2012] via providing physical space to promote the development of university-based new ventures [Xu 2009]. Around thirty percent of business incubators are university-based [Robles 2017]. They are efficient platforms to search for cooperation and create networks to generate added values [Roura 2015].

At the initial stages of development, all the new ventures require access to funding that can be acquired from venture capitalists or business angels [Wright et al. 2006]. Together with financial capital, these stakeholders provide managerial and technical advice on running a business to academic entrepreneurs and provide access to the business networks in the area [Bock et al. 2018]. In addition, VC ads connections to Industry and markets [Vohora et al. 2004]. This led us to hypothesize that:

H3: *Science parks, business incubators, and VCs positively affect university income for both research- and teaching-oriented universities.*

System-level

Government funding is considered as one of the vital sources of finance, together with the income gained from tuition fees and other private institutions. Government funding comprises operational and research grants, and private funding might include donations, consultancy, etc., and research grants from companies [Jongbloed 2004].

In allocating financing for universities, policymakers can employ different approaches, including negotiation base, performance base, and formula-based approach [Jongbloed 2001]. This helps to ensure competition and quality among universities in the country [Jongbloed and Vossensteyn 2001]. The performance-based funding indicates that universi-

ties receive funding based on the "taximeter" system. For example, this is linked with the number of students who passed the examination, the number of degrees awarded, the number of patents or the amount of IP revenues, and the number of publications [Frølich et al. 2010]. Collaborative research officially forms the relationships between two stakeholders when it comes to research, while from the educational point of view government provides generous funding to support students and fund education degrees.

Another stakeholder presented at the system level is Industry. The close collaboration of universities with academia increases chances of IP revenues generation via applying innovations ensuing from research [van Looy et al. 2011]. Furthermore, Industry positively affects the chances of direct commercialization of university research outputs via contract research [Powers and McDougall 2005], creating an entrepreneurial culture in academia. Collaboration with Industry is benefiting for research and teaching focused universities via contracts and facilitating a culture of acquiring third stream incomes. This led us to hypothesize that:

H4: *Industry and government positively affect university income for both research- and teaching-oriented universities.*

Data and method

Sample

The sample for this research comprises 139 UK universities that have utilized knowledge through commercialization, commodification, or both channels while collaborating with stakeholders. The data have been accessed from the Higher Education Statistics Agency (HESA), which conducts the university-business collaboration survey (Higher Education Business and Community Interaction Survey (HE-BCIS)). Data is in open-access and is available at the university level. The HE-BCIS statistics have been supplemented using additional data from HESA (e.g., university establishment year, number of faculty, and students by subjects of study). HE-BCIS data also include information on the university's strategic priorities, entrepreneurial activities, and income levels. From the total sample of universities that participated in the HE-BCI survey, we excluded those with no outcomes related to third-stream income generation.

On the data level, "entrepreneurial university" has been defined as an institution with entrepreneurial outcomes from teaching, and/or research missions, or both. Institutions that have established support structures to facilitate knowledge commercialization and spillovers have been considered. From the teaching perspective, we considered entrepreneurial outcomes of a university, such as a start-up creation (both staff and graduate). We considered such entrepreneurial outcomes as income generated from contract research, IP revenues, and spin-offs creation from the research perspective. We also considered consultancy and training activities as the main factor in disseminating new knowledge (entrepreneurial mission) from both teaching and research activities.

Furthermore, such results should be supported by the established internal system, either for gaining additional income from the research dimension (mostly TTOs or licensing offices) or the teaching dimension (mostly business incubators or science parks), or both. Following Henrekson and Rosenberg [Henrekson and Rosenberg 2001], the existence of the mentioned structures is considered to be one of the key aspects for the emergence of university-based entrepreneurship and, consequently, a third-stream income.

For example, if University A has a third-stream income from performing its teaching mission (e.g., start-ups) but has not achieved them from utilizing research outcomes (e.g., spin-offs or revenues from selling IP), University A is still in the sample. A university has been excluded from the evaluation of this research if there is no evidence of getting third-stream income from any of the missions. Following this procedure, from the total sample of UK higher education establishments, 29 universities have been excluded as not following the requirements for the covered period. Details of all the universities included in the sample are presented in Table A1 in Appendix.

Variables

Dependent variable

According to Etzkowitz et al. [Etzkowitz 2000], entrepreneurial universities engage with the third mission to facilitate national or regional economic performance and to boost academia's financial position. For this study, we thus consider university income as a dependent variable to measure how all three university missions (or teaching, research, and entrepreneurship) contribute to it.

In return for fulfilling their research mission and having a responsibility to society [Neave 2000], universities receive funding from the government. Government funding constitutes a significant proportion of university income, particularly in research-oriented institutions. Contributing to social-economic development and the search for the commercialization of knowledge, universities engage with Industry (e.g., contract research, training, consultancy) to fulfill their entrepreneurial mission [D'Este and Perkmann 2011]. In pursuit of an entrepreneurial mission, universities engage with Industry via Intellectual Patent Offices (IPOs) and TTOs. It allows universities to obtain additional income by selling intellectual property rights (IPRs). The commercialization of knowledge may also include establishing new ventures from teaching (start-ups) and research (spin-offs) missions. Universities often hold shares in new ventures, contributing to their additional income [Audretsch et al. 2016]. Altogether, the activities mentioned above contribute to university income generation.

Independent variables

Independent variables have been grouped based on the outcomes and types of collaboration with different stakeholders at three levels of engagement.

System-level of engagement (systemic stakeholders – Government and Industry).

Within the model, the government has been represented by the total value of collaborative research contracts per university staff or the total funding that the government (both the UK and EU) provides to universities for conducting research [Bramwell and Wolfe 2008; Guerrero et al. 2015]. The Industry as a stakeholder has been represented by the total value of consultancy per staff and the value of contract research per staff. Both indicators are considered as outcomes of the third-stream activities [Sengupta and Ray 2017] additionally to the training courses universities provide to businesses [Hewitt-Dundas 2012] (e.g., bespoke courses at business premises and CPD – courses for professional development). These two stakeholders function independently of the university within the region or country and constitute a system level of engagement.

Individual-level of engagement (general stakeholders – university students and staff).

Stakeholders at the individual level of engagement are represented by the total number of research staff, teaching staff, and research and teaching staff, following the UK standards of university academic staff employees [Belitski and Heron 2016; Acosta et al. 2011]. Doctoral students and those studying other higher degrees have been included as well [Hayter et al. 2018]. Furthermore, the share of undergraduates and postgraduates in STEM, biology, medicine and physics, business, and administrative courses have been considered together with the university employment indicators per 1,000 students [Jongbloed et al. 2008; Pavone 2019]. This group of stakeholders is represented at the individual level of university engagement with other actors.

Organisational level of engagement (specialized stakeholders – TTO, Business incubators, Science parks, Venture capitalists, Business angels).

Technology transfer services from TTO can be organized both internal and/or external to the university [Siegel et al. 2003] together with the patenting offices, who as a stakeholder represented by the number of patents granted (per staff member) [Hewitt-Dundas 2012; Guerrero et al. 2015]. These two stakeholders have been considered operating at the organizational level of the university as an institution.

Additionally to TTO and IPO, venture capitalists and/or business angels as stakeholders are operating at the organizational level. These stakeholders are represented by the total value of investment university new ventures receive

(spin-offs and staff and graduate start-ups). Whether internally or through outsourcing, the collaboration between universities and science parks, and business incubators have been measured by whether universities provide or receive services from these stakeholders [Kalahari et al. 2019]. VCs, science parks, and business incubators also operate at the organizational level of the university.

A number of new companies created to explore university inventions also contribute to the university income, including via shareholding [Markman et al. 2009]. However, this measure does not capture the number of new ventures created by students, while at the majority of universities, more start-ups than spin-offs have been created being supplemented by programs and classes [Siegel and Wright 2015]. In addition, Astebro et al. [Astebro et al. 2012] pointed out that there is a lack of studies evaluating student-led start-ups' impact on university outcomes. It is essential to use these metrics within the elite and other university types, e.g., teaching, which has more education-related third-stream activities than research-related [Wright et al. 2017].

Table A2 (Appendix A) provides descriptive statistics for all variables used in our estimation for the overall sample of 139 UK universities and descriptive statistics for each subgroup of entrepreneurial universities: the Russel Group, polytechnics, and teaching-led universities. Means and standard deviations across the four samples allow us to compare the university-level characteristics for each group in the population.

To measure the reliability of stakeholders' groupings Cronbach alpha approach has been applied, popular in social science research [Wooldridge 2012]. We created three distinct types of stakeholders based on our three core subgroups or sublevels of engagement (individual, organizational and system stakeholders). Cronbach's alpha is a measure of scale reliability and might be written as a function of the number of tested items and the average inter-correlation among them [Wooldridge 2012]. All new constructs have Cronbach alpha greater than 0.70, the reliability threshold for this analysis [Cronbach 1951].

Control variables

As factors impacting university income, control variables have been included concerning the entrepreneurial university and its social responsibilities within the UK context [Guerrero et al. 2015; Marzocchi et al. 2019]. These variables considered university-specific features regardless of the type of engaged stakeholder and were included in the model with a one-year lag to reinforce a causality.

The following variables have been considered as controls: a strategic plan to engage with business, incentives for faculty for engaging with business, income from renting university facilities, top five universities. University age has been included controlling for university maturity.

Following Etzkowitz [Etzkowitz 2003], universities can utilize and rent their facilities and equipment to businesses, generating third-stream income, and thus contributing to university revenues. University-level characteristics for each sub-group in the population can be compared through means and standard deviations [Wooldridge 2010].

All the data have been checked for outliers. Figures 1-4 (Appendix B) present plots with the residuals of the regressions. The results of the images are constant as we move from the left to right in the figures meaning that the variances of the residuals are constant, and the dataset appears to have no evidence of heteroscedasticity. In addition, we present the results of the Breusch-Pagan test to validate our results (presented under each Figure, Appendix B). We have clear evidence to accept that there is no heteroscedasticity in our data.

Method

Pooled Ordinary Least Squares (OLS) estimation has been applied to test the hypotheses considering university and time fixed effects.

The following equation was estimated:

$$y_{it} = f(\beta x_{it}, \Theta z_{it}, \alpha, \lambda, \mu_{it}) \quad i=1,...,N;\ t=1,...,T \qquad (1)$$

Where y_{it} is the university income of a university i at time t. β and Θ are parameters to be estimated, x_{it} is a vector of independent explanatory variables lagged one year (stakeholders at three levels of engagement), z_{it} is a vector of exogenous control variables lagged one year;

α indicates time fixed effects to capture potential changes over time for all the universities in the sample; and λ captures university fixed effects to evaluate the potential changes within each university over time (e.g., university-specific characteristics such as culture, traditions, informal institutions, etc.).

In addition to the Pooled OLS basic estimation, we estimate (2) adding interactions between stakeholders (φ_{it}):

$$y_{it} = f(\beta x_{it}, \psi\varphi_{it}, \Theta z_{it}, \alpha, \lambda, \mu_{it}) \quad i=1 ,..., N; t=1,...,T \quad (2)$$

Where y_{it} is the university income of a university i at time t. β, and Θ are parameters to be estimated, x_{it} is a vector of independent explanatory variables lagged one year (four groups of stakeholders), z_{it} is a vector of exogenous control variables lagged one year; φ_{it} is a vector of interactions between stakeholders lagged one year. Interaction effects were applied to check if the effect of one variable depends on the value of another variable (Bell and Jones, 2015).

This research has performed an estimation of the overall sample of 139 universities for seven years within 2010–2016, including all independent and control variables with the lag of one year. Model (1) has been estimated for three samples of entrepreneurial universities subgroups following UK higher education system. For incorporating the non-linear relationships between dependent and independent variables, logarithmic transformations of some variables have been used. For addressing any concerns with multicollinearity, a variance inflation factor (VIF) has been used, which is always less than 5 for each variable (Wooldridge, 2010).

Results

We start by reporting the results of Table 2, which illustrates the role of stakeholders in university income. The results are grouped by university type and include four different models of university collaboration with stakeholders.

Table 2

Results of OLS regression: Dependent variable University income

University type	**Entrepreneurial university**	**Teaching Universities**	**Russel group Universities**	**Polytech Universities**
Specification	**(1)**	**(2)**	**(3)**	**(4)**
System level				
UK government funding	0.014*** (0.01)	0.020*** (0.01)	0.022*** (0.01)	0.003 (0.01)
Consultancy and CPD	0.107*** (0.01)	0.125*** (0.01)	0.103*** (0.02)	0.090*** (0.02)
Contract research	-0.010 (0.01)	-0.042*** (0.01)	0.049** (0.02)	0.013 (0.01)
Organisational level				
External Science Park	0.060** (0.03)	-0.001 (0.03)	0.052* (0.03)	0.001 (0.03)
University Science Park	0.078*** (0.03)	0.036 (0.04)	-0.011 (0.03)	-0.005 (0.04)
University Business incubator	-0.014 (0.02)	0.045 (0.03)	0.117*** (0.03)	-0.066** (0.03)
External Business incubator	0.072 (0.05)	0.179** (0.07)	0.216*** (0.05)	0.136 (0.09)
University spin-offs	-0.010 (0.02)	-0.022 (0.02)	0.007 (0.01)	0.063*** (0.02)
Graduate start-ups	0.016** (0.01)	0.010 (0.01)	-0.003 (0.01)	0.019** (0.01)
Staff start-ups	0.013 (0.02)	0.064** (0.03)	0.006 (0.02)	0.010 (0.02)
Patents granted	-51.87*** (8.82)	-35.14*** (9.13)	-35.38 (28.2)	10.66 (14.73)
IP revenues	0.054*** (0.01)	0.063*** (0.01)	-0.003 (0.01)	0.009* (0.01)
TTO exist at university	0.066* (0.03)	0.134*** (0.04)	-0.026 (0.02)	0.113** (0.05)
TTO and other organisations	0.072** (0.03)	0.044 (0.04)	0.043 (0.04)	0.117** (0.05)
Investment in spin-offs	-0.005 (0.00)	-0.009 (0.01)	0.003 (0.00)	0.002 (0.00)
Investment in staff start-ups	0.004 (0.01)	0.003 (0.01)	0.001 (0.00)	-0.005 (0.01)
Investment in graduate start-ups	-0.002 (0.00)	-0.014** (0.01)	0.002 (0.00)	-0.001 (0.00)

Individual level				
Doctoral students	0.161*** (0.02)	0.146*** (0.02)	0.391*** (0.05)	0.070*** (0.02)
Teaching capital	0.011* (0.01)	0.020*** (0.01)	-0.023* (0.01)	0.011* (0.01)
Research capital	0.107*** (0.01)	0.142*** (0.01)	0.0595* (0.03)	0.044** (0.02)
Teaching and research capital	0.026*** (0.01)	0.020* (0.01)	0.025** (0.01)	0.007 (0.01)
STEM UG	0.349 (0.24)	0.599** (0.27)	0.858 (0.56)	0.157 (0.48)
STEM PG	-0.873*** (0.28)	-0.976*** (0.28)	0.41 (0.79)	0.609 (0.92)
Biology PG	0.770*** (0.19)	1.684*** (0.32)	-0.169 (0.46)	-0.39 (0.93)
Biology UG	-0.338* (0.19)	-1.140*** (0.22)	-0.349 (0.33)	1.452*** (0.48)
Business PG	-0.015 (0.18)	0.160 (0.21)	0.283 (0.54)	0.402 (0.58)
Business UG	-0.773*** (0.23)	-1.194*** (0.28)	-0.621 (0.62)	0.449 (0.36)
Other degree	0.141*** (0.02)	0.060*** (0.02)	0.154*** (0.05)	0.250*** (0.03)
Employment rate	-0.006 (0.02)	-0.047* (0.03)	-0.001 (0.06)	-0.066 (0.06)
Control variables				
Income from infrastructure	0.014*** (0.00)	0.020*** (0.01)	-0.014** (0.01)	0.004 (0.01)
Business engagement	-0.010 (0.01)	-0.072*** (0.02)	0.005 (0.01)	-0.029** (0.01)
Incentives for business engagement	-0.032** (0.01)	0.065*** (0.02)	-0.042*** (0.01)	0.030** (0.02)
Regional strategy	-0.047** (0.02)	-0.014 (0.03)	-0.007 (0.02)	-0.000 (0.02)
University established year	-0.001*** (0.00)	0.001*** (0.00)	-0.001*** (0.00)	-0.001*** (0.00)
University fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Constant	9.103*** (0.22)	8.182*** (0.32)	8.290*** (0.47)	11.12*** (0.52)
Number of obs.	953	567	168	210
R2	0.916	0.904	0.972	0.846
RMSE	0.275	0.247	0.088	0.119
F stat	230.830	107.4105	108.1121	22.598
loglikelihood	-99.337	9.777	193.100	171.178
resid DOF	888	464	126	168

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency.
Standard errors are in parenthesis.

Concerning the conceptual model of an entrepreneurial university, all the groups of stakeholders have contributed to the university's income. We report the main findings in this section and discuss them in the next section.

Government and Industry are significant and positively contribute to the university's income generation (column 1, Table 2).

The government's contribution to the university's income is positive and statistically significant in funding. In particular, a 1% increase of Other UK Government department funding would increase university income by 0.014% (β=0.014, $p<0.001$). When it comes to academia's collaboration with Industry, an increase in revenues from consultancy and training would lead to an increase in university income by 0.107% (β=0.107, $p<0.001$).

Human capital has positive effects on a university's income generation. In terms of faculty, growth of human capital represented by teaching staff by 1% would increase the university income by 0.011% (β=0.011; $p<0.05$), represented by research staff – by 0.107% (β=0.107, $p<0.001$), while the rise by 1% of staff represented by teaching and research focus together would increase university income by 0.027% (β=0.027, $p<0.001$).

An increase in the number of doctoral students by 1% would lead to the growth in university revenues by 0.161% (β=0.161, $p<0.001$), in other highly qualified students – by 0.141%

(β=0.141, p<0.001). An increase in the number of postgraduate students in biology, physics, and medicine by 1% would enlarge university income by 0.770% (β=0.770, p<0.001). Interestingly, an increase in the number of biology, physics and medicine undergraduates by 1% decreases university income by 0.338% (β=-0.338, p<0.05), in STEM postgraduates – by 0.873% (β=-0.873, p<0.01), in business undergraduates – by 0.773% (β=-0.773, p<0.001).

TTO existence at the university impact the rise in university revenues by 0.066% (β=0.066, p<0.05), while the collaborative work with TTO and external agencies would lead to the rise in revenues by 0.072% (e.g., IPO) (β=0.072, p<0.05). An increase in IP revenues by 1% enlarges university income by 0.055% (β=0.055, p<0.001).

In case the university has science parks belonging to academia, it increases university income by 0.079% (β=0.079, p<0.001), and collaboration of university with external science parks increase university income by 0.061% (β=0.061, p<0.01). Growth in the number of graduate start-ups by 1% further increases university income by 0.017% (β=0.017, p<0.001).

Regarding other control variables, a rise in the facility and equipment-related services by 1% increase university income by 0.015% (β=0.015, p<0.001). Interestingly, if the university is oriented towards the region, that might diminish university revenues by 0.047% (β=-0.047, p<0.01).

As one could predict, younger universities have lower university incomes (β=-0.001, p<0.001).

Interaction effects

Interaction analysis was used to demonstrate how interactions between seven groups of stakeholders (science parks and business incubators; government; Industry; TTO; VC; and two types of human capital: university faculty and university students) affect university income. These seven groups of stakeholders were created from the aggregated four subgroups using the Cronbach alpha approach to build the constructs. For the overall sample (or 139 Entrepreneurial Universities) (column 1, Table 3), the combination of government and Industry (β=0.146, p<0.001) has a strong positive effect on university income and have the potential to increase university revenues by 0.146%. We also found that the combination of industry and human capital (students) would lead to an increase in university income by 0.236% (β=0.236, p<0.001). The combination of venture capitalists and human capital (students) also increases university income by 0.101% (β=0.101, p<0.05). A combination of government and human capital (students) might lead to a decrease in university income by 0.372% (β=-0.372, p<0.001). A combination of TTO and university human capital reduces university income by 0.099% (β=-0.099, p<0.001).

Russel Group University

Concerning the Russel Group universities (research-oriented universities) (column 3, Table 2), their model of collaboration with stakeholders has similarities with the general model of entrepreneurial universities (column 1, Table 2). However, the coefficients for the *technology transfer and intellectual property offices as* stakeholders were insignificant. For example, having TTOs on campus did not show any effects explained by the nature of the data. For the 24 Russel Group universities, there is no variation in the data on having TTOs on campus, as all of them have established TTOs supported initially by the government. The interactions between IPOs and TTOs were positive.

Government and Industry both have significant and positive effects on university income. Thus, an increase in research funding from Other UK Government departments by 1% led to a rise in university revenues by 0.022% (β=0.022, p<0.001). An increase of consultancy and training provided to the Industry by 1% would lead to the growth of university revenues by 0.103% (β=0.103, p<0.001), while the growth of contract research academia performing with Industry by 1% positively affects university income by 0.049% (β=0.049, p<0.01).

When it comes to Russel Group universities, human capital engaged in the research activities positively contributes to university income

generation. Thus, an increase in university research only capital by 1% would enlarge university income by 0.060% (β=0.060, p<0.05); university research and teaching capital – by 0.026% (β=0.026, p<0.01). However, the growth in the number of teaching capital only by 1% could lead to the fall in university revenues by 0.024% (β=-0.024, p<0.05).

When it comes to students, growth in the number of doctoral students by 1% will increase university income by 0.391% (β=0.391, p<0.001). In addition, a rise in the number of students studying on other high degrees by 1% lead to the growth in university income by 0.154% (β=0.154, p<0.001).

Having business incubators on campus (β=0.117, p<0.001) and collaborating with external business incubators (β=0.216, p<0.001) increase university income by 0.117% and 0.216%, respectively. Furthermore, collaboration with external science parks increases university income by 0.052% (β=0.052, p<0.05).

Concerning the control variables, an increase in facilities and equipment-related services could reduce university income by 0.015% (β=-0.015, p<0.001). We also controlled for the Top 5 universities (Oxford University, Cambridge University, Manchester University, Imperial College London, and University College London), which are part of the Russel Group, and our results demonstrated that these five universities have higher incomes than the rest of the group approximately by 0.170% (β=0.170, p<0.001).

As for the research-oriented universities (the Russel group), our hypotheses H1, H2, and H4 were thus fully supported as all the stakeholders represented contribute to university income. However, as mentioned earlier, we could not distinguish differences in income due to the presence of TTOs and patenting offices (H3), as all Russel group universities have established TTOs and use patenting offices. This is a limitation related to the measurement of TTOs due to the nature of the data.

Interaction effects

Table 3, column 3 illustrates the results of interactions between stakeholders for the Russel group universities and their effect on university income. We find a positive and significant effect of a combination of science parks, business incubators, and TTOs on university income (β=0.293, p<0.01). This demonstrates that the TTOs at Russel Group universities facilitate science park activities as a conduit for university income. A combination of TTOs and venture capitalists (β=0.135, p<0.01) as well as human capital teaching (students), research capital (faculty), and VC (β=0.182, p<0.01) increase university income by 0.135% and 0.182%, respectively. The significant negative associations were related to combinations of government and TTO (β=-0.266, p<0.01) as well as TTO and human capital (students) (β=-0.232, p<0.01), decreasing university income by 0.266% and 0.232% accordingly.

Polytechnic Universities

Considering the Polytechnic universities in general, all the stakeholder types contribute to the university income generation except patenting offices (column 4, Table 2).

Concerning collaboration with Industry, consultancy and professional development courses enlarge university income by 0.090% (β=0.090, p<0.001).

Growth in the number of teaching – (β=0.011, p<0.05) and research-oriented (β=0.044, p<0.01) faculty by 1% increases university income generation by 0.011% and 0.044% respectively. When it comes to students, a rise in the number of doctoral students (β=0.071, p<0.001) and those with other postgraduate degrees (β=0.250, p<0.001) by 1% positively contribute to university income by 0.071% and 0.250% accordingly. In addition, a rise in the number of undergraduates in biology, physics, and medicine by 1% increases university revenues by 1.452% (β=1.452, p<0.001).

Having TTOs at university (β=0.113, p<0.01) and engaging with external TTOs (β=0.117, p<0.01) positively affect university income generation by 0.113% and 0.117%, respectively.

Interestingly that having business incubators at the university could negatively affect university income generation at Polytechnics

Table 3

Regression results including interaction effects model

University type	**Entrepreneurial university – full sample**	**Teaching Universities**	**Russel group Universities**	**Polytech Universities**
Specification	**(1)**	**(2)**	**(3)**	**(4)**
Science Parks and Business Incubators	0.121*** (0.04)	0.067 (0.05)	-0.034 (0.24)	-0.005 (0.07)
Government	0.150*** (0.03)	0.166*** (0.04)	0.384* (0.22)	0.169*** (0.05)
Science Parks and Business Incubators x Government	0.059 (0.05)	0.029 (0.08)	-0.058 (0.10)	-0.143* (0.07)
Industry	0.732*** (0.04)	0.563*** (0.07)	0.907** (0.41)	0.266** (0.11)
Science Parks and Business Incubators x Industry	-0.077 (0.07)	-0.158 (0.10)	0.243 (0.28)	0.007 (0.20)
TTO	0.001 (0.02)	0.060* (0.03)	0.190 (0.15)	-0.112** (0.05)
Science Parks and Business Incubators x TTO	0.025 (0.04)	0.179** (0.07)	0.293*** (0.10)	-0.060 (0.05)
Human capital: university faculty	0.449*** (0.04)	0.458*** (0.06)	0.777** (0.36)	0.056 (0.09)
Science Parks and Business Incubators x Human capital: university faculty	-0.114 (0.08)	-0.297*** (0.11)	-0.141 (0.16)	0.058 (0.10)
VC	-0.022 (0.04)	0.001 (0.05)	-0.030 (0.13)	0.153* (0.08)
Science Parks and Business Incubators x VC	-0.031 (0.04)	-0.075 (0.07)	-0.053 (0.04)	-0.035 (0.05)
Human capital: university students	0.154*** (0.03)	0.102** (0.05)	0.062 (0.31)	0.467*** (0.12)
Science Parks and Business Incubators x Human capital: university students	-0.027 (0.07)	0.196* (0.10)	-0.048 (0.13)	-0.096 (0.12)
Patenting office	-51.07*** (12.35)	-35.28** (17.19)	-136.8 (201.17)	-108.800** (43.91)
Science Parks and Business Incubators x Patenting office	-9.234 (21.73)	-10.51 (27.76)	-194.3* (98.73)	131.7** (51.53)
Government x Industry	0.146*** (0.05)	0.140** (0.06)	0.291 (0.25)	0.011 (0.11)
Government x TTO	0.018 (0.03)	-0.022 (0.05)	-0.266*** (0.08)	0.029 (0.05)
Government x Human capital: university faculty	0.035 (0.05)	0.061 (0.06)	-0.122 (0.18)	-0.186* (0.10)
Government x VC	-0.015 (0.04)	0.046 (0.07)	0.078 (0.05)	0.017 (0.08)
Government x Human capital: university students	-0.372*** (0.06)	-0.346*** (0.08)	-0.147 (0.14)	-0.0150 (0.10)
Government x Patenting office	-24.07 (20.32)	-3.208 (27.12)	-177.500* (98.57)	-102.900** (43.55)
Industry x TTO	0.071 (0.05)	0.063 (0.07)	0.052 (0.17)	0.275** (0.13)
Industry x Human capital: university faculty	-0.009 (0.05)	-0.098 (0.07)	-0.881** (0.38)	0.178 (0.25)
Industry x VC	0.065 (0.07)	0.118 (0.10)	-0.416*** (0.15)	-0.383* (0.20)
Industry x Human capital: university students	0.236*** (0.07)	0.168* (0.09)	0.049 (0.28)	-0.046 (0.26)
Industry x Patenting office	-87.68*** (33.61)	-34.25 (44.23)	41.48 (230.90)	226.900* (117.60)
TTO x Human capital: university faculty	-0.099** (0.04)	0.002 (0.06)	0.032 (0.13)	-0.147** (0.07)
TTO x VC	0.007 (0.03)	-0.055 (0.06)	0.135*** (0.05)	0.062 (0.04)
TTO x Human capital: university students	-0.074 (0.05)	-0.153** (0.07)	-0.232*** (0.07)	0.040 (0.08)
TTO x Patenting office	7.571 (15.90)	-9.494 (22.11)	22.80 58.27	62.87* (35.13)
Human capital: university faculty x VC	0.030 (0.06)	0.059 (0.10)	0.182** (0.08)	-0.008 (0.12)

Human capital: university faculty x Human capital: university students	-0.030 (0.07)	-0.060 (0.09)	0.166 (0.23)	0.205 (0.15)
Human capital: university faculty x Patenting office	11.290 (33.20)	21.460 (42.73)	252.700 (160.37)	-0.134 (73.86)
VC x Human capital: university students	0.101* (0.05)	0.0217 (0.09)	0.024 (0.08)	0.230** (0.11)
VC x Patenting office	-39.700* (20.98)	-23.660 (27.38)	160.700** (73.77)	-2.602 (53.45)
University established year	-0.001* (0.00)	0.001** (0.00)	-0.001** (0.00)	-0.001*** (0.00)
Top 5 universities members of Russel group	0.411*** (0.08)		0.569*** (0.08)	
University fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Constant	11.97*** (0.21)	10.67*** (0.38)	11.94*** (0.35)	14.37*** (0.46)
N	992	593	168	210
R2	.88	.82	.91	.67
RMSE	.33714	.37	.15	.17
F stat	167.27	59.67	33.11	8.42
Loglikelihood	-306.55	-232.19	103.71	93.81

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency
*Note: Significance *0.05%, **0.01%, ***0.001% do not include zero; Standard errors are in parenthesis*

by 0.067% (β=-0.067, $p<0.01$), while the creation of university spin-offs (β=0.063, $p<0.001$) and graduate start-ups (β=0.019, $p<0.01$) positively contribute to income generation by 0.063% and 0.019%.

Concerning the control variables included in the model (1), incentives for staff to engage with business can affect university income generation positively by 0.031% (β=0.031, $p<0.01$), while having strategic plans to engage with business is negatively associated with income generation (β=-0.030, $p<0.01$).

We conclude that our hypotheses H1, H2, and H4 were supported for Polytechnic universities. TTOs positively affected income generation (column 4, Table 3). Our H3, which argued that TTOs and patenting agencies do not affect university income in teaching-oriented universities, is thus not supported. TTOs at Polytechnic universities increase university income.

Interaction effects

Interaction analysis for Polytechnic universities is illustrated in column 4 (Table 3). A combination of stakeholders – Industry and TTOs – increases university income by 0.275% (β=0.275, $p<0.01$), as does a combination of VC and human capital by 0.230% (students) (β=0.230, $p<0.01$). This demonstrates that in Polytechnic universities, students may raise VC funds. There is also a significant negative association between science parks, business incubators, and government (β=-0.143, $p<0.05$); government and human capital (faculty) (β=-0.186, $p<0.05$); and TTOs and human capital (faculty) (β=-0.147, $p<0.05$).

Teaching-led Universities

The concept of knowledge transfers at teaching-led universities, or universities not included in any of the previously mentioned groups, is illustrated in column 2, Table 3.

First, an increase in government funding by 1% positively affects university income generation by 0.020% (β=0.020, $p<0.001$). As for the collaboration with Industry, an increase in consultancy by 1% rise university revenues by 0.125% (β=0.125, $p<0.001$), however, an increase in contract research by 1% could affect the income generation negatively at the university by 0.042% (β=-0.042, $p<0.001$).

From the faculty perspective, rise in the number of research (β=0.142, $p<0.001$) and a mix of research and teaching capital (β =0.020, $p<0.05$) by 1% increases university income by 0.142% and 0.020% respectively (column 2, Table 3).

An increase in the number of doctoral students (β=0.146, p<0.001) and other degree-holding students (β=0.060, p<0.001) as well as biology, physics and medicine postgraduates (β=1.684 p<0.001) each by 1% would lead to the growth of university income by 0.146%, 0.060% and 1.684% accordingly. Meanwhile, rise in the number of STEM postgraduates (β=-0.975, p<0.001) as well as biology, physics and medicine undergraduate (β=-1.140, p<0.001) and business and administrative studies undergraduate students (β=-1.194, p<0.001) negatively affect university income by 0.975%, 1.140%, and 1.194% respectively.

At the organizational level, having TTOs at universities would lead to an increase in university income by 0.134% (β=0.134, p<0.001), growth in IP revenues by 1% would increase university income by 0.063 (β=0.063, p<0.001). At the same time, collaboration with patenting offices could be damaging for generating university income for teaching universities (β=-35.14, p<0.001).

Collaboration with external business incubators increases university income by 0.179% (β=0.179, p<0.05) while on- and off-campus science parks, as well as off-campus business incubators, seem do not affect university income (Table 3, column 2). Staff start-ups created at the university (β=0.064, p<0.01) are drivers of university income and an increase in 1% of staff start-ups created can increase university income by 0.064%.

Among the control variables, utilization of equipment-related services increases university income by 0.020% (β=0.020, p<0.001), while incentives for staff to engage with business increase university income by 0.065% (β=0.065, p<0.01). Across all specifications, university age (establishment year) is negatively associated with income, meaning that earlier established universities have a higher income than those established earlier.

For the other teaching-oriented universities, all stakeholders contribute to income generation, supporting our hypotheses H1, H2, and H4. Our H3 is not supported as the presence of a TTO at a university increases university income in both teaching-led and research-led universities.

Interaction analysis for the rest of the teaching universities is illustrated in Table 3, column 2. The following combinations of stakeholders are positive and significant for university income: science parks/business incubators and TTO (β=0.179, p<0.01); science parks/business incubators and university faculty (β=0.196, p<0.05); government and industry (β=0.140, p<0.01) and industry and university faculty (β=0.168, p<0.05). There was a negative association between science parks/business incubators and human capital (faculty) (β=-0.297, p<0.01); government support and human capital (students) (β=-0.346, p<0.001); and TTOs and human capital (students) (β=-0.153, p<0.01).

Discussion

Via analyzing the impact of stakeholders, this paper analyzed the effect of stakeholders at different levels of engagement on university income.

For the general concept of the entrepreneurial university, all the stakeholders initially considered thus represent or shape the university revenues.

Both government and Industry contribute to university income. The government's provision of financial resources is one of the critical elements of entrepreneurship [Fini et al. 2011]. The positive influence of Industry is explained by their financial support [Klepper 2007] and their facilitation and exchange of ideas and information [Deeds et al. 1997]. In addition, the Industry boosts patenting activity and IP generation by providing access to relevant resources and competencies [Kortum and Lerner 2001].

Faculty, holding different roles (engaging purely in teaching or research, or a combination of both) contribute positively to entrepreneurial university income. In addition, postgraduate students also increase university income [Meoli and Vismara 2016].

At the organizational level, both IPO and TTOs increase university income. This has been found in the previous literature [Siegel and Waldman 2019; Siegel 2018].

Other stakeholders at the organizational level, such as science parks, business incuba-

tors, and venture capitalists, positively contribute to university income. For example, according to Marzocchi et al. [Marzocchi et al. 2019], their influence is shown through achieving the entrepreneurial mission, including using knowledge through creating new companies. In addition, the venture capitalist funding available at science parks and business incubators is one of the most vital instruments needed to promote the creation of new ventures [M'Chirgui et al. 2018; Florida et al. 2020].

One common conceptual problem is to ignore the realities of the entrepreneurial process. For instance, many public venture capital initiatives are abandoned after a few years: the programs' designers should consider that these initiatives take many years to bear fruit.

Others have added requirements–such as the stipulation that portfolio companies focus only on explicitly "precommercial" research–that, while seemingly reasonable from a public policy perspective, run counter to the entrepreneurial process. In other cases, reasonable programs have been created that are too tiny to have any impact or so large that they swamp existing funds.

A second common conceptual problem is to ignore the market's dictates. Far too often, government officials have sought to encourage funding in industries or geographic regions with a lack of private interest. Whether driven by political considerations or hubris, these efforts have wasted resources. Effective programs address this problem by demanding credible private sector players provide matching funds.

Concerning the Russel Group universities, the concept of university collaboration is mainly similar to that of the general entrepreneurial university model. However, there are several differences.

The first contradiction is thus related to the adverse effects of a teaching-oriented faculty on the outcomes for Russel Group universities. According to Somers et al. [Somers et al. 2018], one of the challenges facing entrepreneurial universities is related to a lack of resources that focus on teaching orientation. However, much more is expected from the faculty being more diverse and multidirectional, as they will be able to perform different activities simultaneously (teaching, research, entrepreneurship, engaging with society, etc.) [Mccowan 2017].

In the Russel Group universities, we see significant positive complementarities between TTOs and science parks, business incubators, venture capitalists. This might show a strong connection between the research and entrepreneurship missions of universities in this subgroup. In this context, spin-off companies are a crucial part of the university's entrepreneurial mission. They include the development of business activity based on the technology which emerged from the academic engagement [Markman et al. 2008]. In this way, they represent an entrepreneurial output directly connected to the university's capacity to transfer research benefits to society [Rasmussen et al. 2011].

Turning to the polytechnic universities, collaborations with businesses work better only through consultancies and training with Industry, while the complementarities between knowledge Government and business incubators are antagonistic. We believe that the negative sign of this combination is impacted by the negative effect of the business incubators separately. These findings support the results of Kolympiris and Klein [Kolympiris and Klein 2016]. They identified that business incubators seem to diminish the quality of scientific and technical innovation, while average licensing revenues reduce the income generated by the university's innovative activities (related to the university's research mission). However, business incubators also positively affect university income by creating new companies (university entrepreneurship mission) [Marzocchi et al. 2019].

Looking at teaching-led universities, knowledge providers – or human capital – are significant, following the traditional human capital view [Sideri and Panagopoulos 2018; Pavone 2019]. For this university type, collaboration with Industry based on the contract research has a negative effect. This shows that the research at this university type might not have a commercial focus.

Regarding the government and Industry, they are a significant factor for these universities when stakeholders complement the collaboration from the organizational level. At the same time, TTOs, science parks, and business incubators positively contribute to the outcome, both separately and by complementing each other. There are negative associations between government and university students and university students and TTOs. Above, we have described the potential reasons the direction of the connection would have negative associations. These include the bureaucracy and/or an aggressive policy on intellectual rights from the TTO side [Siegel et al. 2003; Huyghe et al. 2016], and issues of IP sharing with the university from the students' perspective [Bradley et al. 2013].

As for other factors supporting previous findings, our research shows that being a member of a Russell Group university has a reputational impact on the university's outputs, significantly boosting research-related entrepreneurial outcomes [Sengupa and Ray 2017].

For entrepreneurial and teaching-oriented universities, facility- and equipment-leasing income has a positive association with knowledge transfer income. Such interactions between university and industry help strengthen existing collaborations and enhance the likelihood of future links between the two. These results are consistent with the previous literature, indicating that collaboration with Industry forged via using university equipment and facilities can increase knowledge transfer activities [Hewitt-Dundas 2012].

Our results are also supportive of the literature about university strategy, showing that university strategic orientation and its entrepreneurial component shape the entrepreneurial outcomes of the university [Wright et al. 2017].

Conclusions

To conclude, income generated by university academic staff is among the most vital resources to ensure sustainability and the development of an entrepreneurial university. Two objectives were achieved in this research: types of third-stream activities undertaken by university staff and students while collaborating with stakeholders at different levels of engagement and the extent of their influence at different university types. The most popular income generation activities at both teaching and research-oriented entrepreneurial universities are research contracts from the government and Industry. However, our results clearly show that actors at the organizational level, such as technology transfer offices primarily for research-focused universities and science parks and business incubators for all the types of the entrepreneurial university, play a significant role in generating additional income and thus achieving sustainability. Thus, academic involvement with stakeholders is not restricted to one level but is influenced by the interplay of factors from three levels: individual, organizational, and system [Perkmann et al. 2021]. Organizational support provided by the university is considered to be among the most important factors for academic engagement [Perkmann et al. 2013]. Thus, how academics perceive university support at various levels might determine their decision to engage with others for third-stream income generation [Borch 2010], contributing to its sustainability.

An essential role for academics to participate in third-stream income for universities of all types would play incentives for staff to engage with business and university mission towards achieving particular entrepreneurial outcomes. This research can be helpful for university managers as a guide to explain different paths of collaboration with stakeholders that can lead to different strategies to increase university income. The results of this study could help certain parties to get to know some issues in university collaboration with stakeholders for income generation. It should guide the university managers to decide on better directions for collaboration with different actors in attaining optimal results in university income generation.

Appendix A

Table A1
Universities included into the sample by subgroups

Polytechnic University	Russel Group University	Rest Teaching-oriented university
Anglia Ruskin University; Bournemouth University; The University of Brighton; Birmingham City University; The University of Central Lancashire; Coventry University; The University of East London; The University of Greenwich; The University of Lincoln; Kingston University; Leeds Beckett University; Liverpool John Moores University; The Manchester Metropolitan University; Middlesex University; De Montfort University; University of Northumbria at Newcastle; The Nottingham Trent University; Oxford Brookes University; University of Plymouth; The University of Portsmouth; Sheffield Hallam University; London South Bank University; Staffordshire University; The University of Sunderland; Teesside University; The University of West London; University of the West of England, Bristol; The University of Westminster; The University of Wolverhampton; London Metropolitan University	The University of Birmingham; The University of Bristol; The University of Cambridge; University of Durham; The University of Exeter; The University of Leeds; The University of Liverpool; Imperial College of Science, Technology and Medicine; King's College London; London School of Economics and Political Science; Queen Mary University of London; University College London; Newcastle University; University of Nottingham; The University of Oxford; The University of Sheffield; The University of Southampton; The University of Warwick; The University of York; The University of Edinburgh; The University of Glasgow; Cardiff University; The Queen's University of Belfast; The University of Manchester	The Open University; Cranfield University; Royal College of Art; Buckinghamshire New University; University of Chester; York St John University; University of St Mark and St John; Falmouth University; The University of Winchester; Liverpool Hope University; University of the Arts, London; University of Bedfordshire; The University of Northampton; Ravensbourne; Rose Bruford College; Royal Academy of Music; Royal College of Music; Southampton Solent University; University of Cumbria; Trinity Laban Conservatoire of Music and Dance; University of Worcester; Bath Spa University; The University of Bolton; University of Gloucestershire; University of Derby; University of Hertfordshire; The University of Huddersfield; The University of Chichester; The University of Wales, Newport; Glyndŵr University; Cardiff Metropolitan University; University of South Wales; Swansea Metropolitan University; Trinity University College; University of Abertay Dundee; Glasgow School of Art; Queen Margaret University, Edinburgh; The Robert Gordon University; The University of the West of Scotland; Glasgow Caledonian University; Edinburgh Napier University; Aston University; The University of Bath; The University of Bradford; Brunel University London; The City University; The University of East Anglia; The University of Essex; The University of Hull; The University of Keele; The University of Kent; The University of Lancaster; The University of Leicester; Birkbeck College; Goldsmiths College; Institute of Education; London Business School; London School of Hygiene and Tropical Medicine; Royal Holloway and Bedford New College; The Royal Veterinary College; St George's Hospital Medical School; The School of Pharmacy; University of London; Loughborough University; The University of Reading; The University of Salford; The University of Surrey; The University of Sussex; The University of Strathclyde; The University of Aberdeen; Heriot-Watt University; The University of Dundee; The University of St Andrews; The University of Stirling; University of Wales Trinity Saint David; Aberystwyth University; Bangor University; Swansea University; University of Ulster; The Institute of Cancer Research; Norwich University of the Arts; Royal Agricultural University; University of the Highlands and Islands; The University of Buckingham; University for the Creative Arts

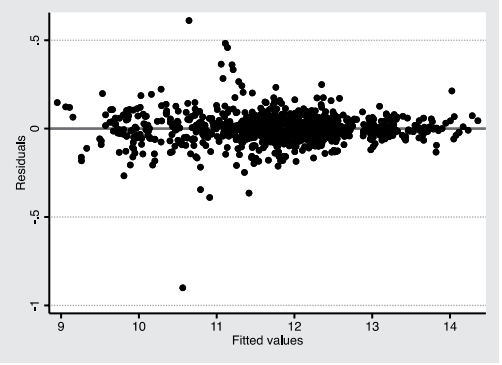
Table A2
Descriptive statistics of the sample

Variable	Entrepreneurial University			Russel Group Universities			Polytechnic Universities			Rest Teaching Universities		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
University total income	952	11.87	0.95	168	13.15	0.46	210	12.05	0.27	566	11.44	0.83
Total income from facilities and equipment services	953	4.85	2.84	168	6.94	2.42	210	5.18	2.06	567	4.09	2.88
Business plan for business engagement	953	4.22	0.80	168	4.29	0.76	210	4.28	0.78	567	4.17	0.82
Incentives for staff to engage with business	953	3.74	0.83	168	4.04	0.77	210	3.54	0.89	567	3.71	0.79
Regional strategy	953	0.33	0.47	168	0.20	0.40	210	0.37	0.48	567	0.34	0.47
Contribution to ec. develop.: widening participation access	953	0.68	0.47	168	0.62	0.49	210	0.80	0.40	567	0.67	0.47
Contribution to ec. develop.: graduates' retention into the region	953	0.42	0.49	168	0.33	0.47	210	0.54	0.50	567	0.40	0.49
Contribution to ec. develop.: support for community	953	0.34	0.47	168	0.32	0.47	210	0.31	0.46	567	0.35	0.48
Contribution to ec. develop.: developing local partnership	953	0.48	0.50	168	0.44	0.50	210	0.51	0.50	567	0.47	0.50
Contribution to ec. develop.: meeting regional skills needs	953	0.48	0.50	168	0.33	0.47	210	0.64	0.48	567	0.47	0.50
Contribution to ec. develop.: knowledge exchange	953	0.57	0.50	168	0.81	0.39	210	0.54	0.50	567	0.51	0.50
Contribution to ec. develop.: supporting SME	953	0.59	0.49	168	0.45	0.50	210	0.67	0.47	567	0.61	0.49
Contribution to ec. develop.: research collaboration	953	0.63	0.48	168	0.93	0.25	210	0.51	0.50	567	0.60	0.49
External Science park	953	0.23	0.42	168	0.30	0.46	210	0.24	0.43	567	0.20	0.40
Science park at the university	953	0.21	0.41	168	0.39	0.49	210	0.18	0.39	567	0.17	0.38
Business incubator support at the university	953	0.66	0.47	168	0.81	0.39	210	0.64	0.48	567	0.63	0.48
Business incubator support out of the university	953	0.04	0.19	168	0.08	0.28	210	0.01	0.12	567	0.03	0.17
Number of university spin-offs	951	0.49	0.68	168	0.97	0.74	210	0.36	0.57	565	0.40	0.64
Number of graduate start-ups	953	2.03	1.66	168	1.95	1.48	210	2.79	1.62	567	1.76	1.65
Number of staff start-ups	953	0.23	0.50	168	0.27	0.53	210	0.25	0.56	567	0.21	0.46
Number of patents granted	953	0.00	0.00	168	0.00	0.00	210	0.00	0.00	567	0.00	0.00

Other UK Government departments funding	952	5.38	2.95	168	7.71	2.19	210	5.66	1.98	566	4.67	3.04
Collaborative contribution other funding	952	2.91	2.93	168	4.41	3.51	210	2.93	2.63	566	2.50	2.70
Consultancy and CPD courses per staff	950	8.14	1.65	168	9.46	0.69	210	8.75	0.68	565	7.55	1.79
Contract research total value	953	7.10	2.66	168	10.17	0.78	210	7.08	0.88	567	6.29	2.69
IPI revenues generation	953	3.56	2.85	168	6.99	1.47	210	2.78	2.09	567	2.88	2.66
TTO exist at the university	953	0.54	0.50	168	0.79	0.41	210	0.50	0.50	567	0.48	0.50
TTO and external agency for commercialisation	953	0.31	0.46	168	0.21	0.41	210	0.44	0.50	567	0.29	0.45
Employment rate per 1000 students	953	4.35	0.66	168	4.81	0.36	210	3.97	0.25	567	4.34	0.72
Number of students on doctorate degree	953	4.03	1.66	168	6.19	0.46	210	3.92	0.66	567	3.48	1.60
University teaching capital (number of faculty)	953	4.79	2.11	168	5.90	0.91	210	4.95	2.07	567	4.42	2.24
University research capital (number of faculty)	953	5.62	1.62	168	6.73	0.67	210	6.08	1.43	567	5.15	1.65
University teaching & research capital (number of faculty)	953	2.89	1.86	168	4.65	1.66	210	2.91	1.58	567	2.40	1.69
External investment: Spin-offs with univ. ownership	953	3.13	3.97	168	7.84	3.63	210	1.29	2.52	567	2.47	3.45
External investment: Staff start-ups with univ. ownership	953	0.59	1.80	168	1.17	2.75	210	0.33	1.26	567	0.51	1.58
External investment: Graduate start-ups	953	1.64	2.61	168	2.67	3.58	210	1.71	2.42	567	1.28	2.23
Share of stem undergraduates	953	0.07	0.06	168	0.10	0.04	210	0.08	0.03	567	0.06	0.06
Share of stem postgraduates	953	0.03	0.04	168	0.05	0.04	210	0.02	0.03	567	0.02	0.05
Share of biology physics and medicine postgraduates	953	0.03	0.07	168	0.07	0.05	210	0.02	0.03	567	0.03	0.08
Share of biology physics and medicine undergraduates	953	0.10	0.07	168	0.17	0.05	210	0.08	0.03	567	0.08	0.07
Share of business & administrative studies postgraduates	953	0.04	0.06	168	0.04	0.02	210	0.04	0.04	567	0.04	0.07
Share of business & administrative studies undergraduates	953	0.07	0.05	168	0.04	0.02	210	0.11	0.04	567	0.07	0.06
Number of students studying on other higher degree	953	6.56	1.25	168	7.81	0.40	210	6.94	0.49	567	6.07	1.29

Appendix B

Figure 1
Heteroscedasticity plot – Entrepreneurial universities (general sample)

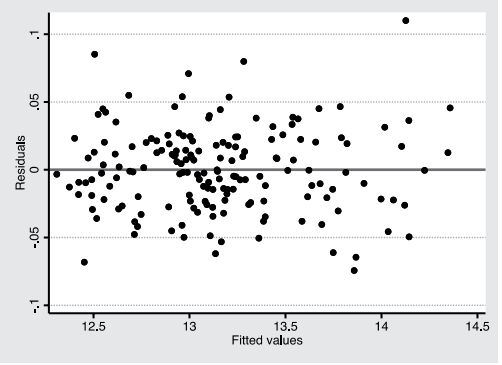


Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms
Variable: Fitted values of University income
H0: Constant variance

chi2(1) = 182.39
Prob > chi2 = 0.0000

Figure 2
Heteroscedasticity plot – Russel universities

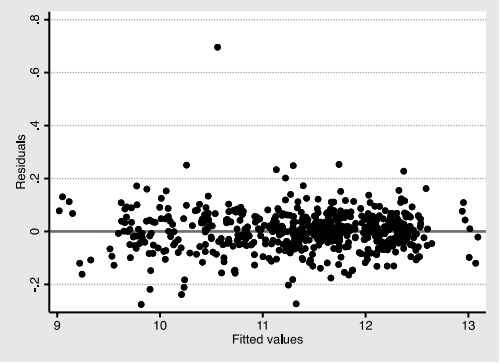


Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms
Variable: Fitted values of University income
H0: Constant variance

chi2(1) = 4.89
Prob > chi2 = 0.0271

Figure 3
Heteroscedasticity plot – Rest teaching universities

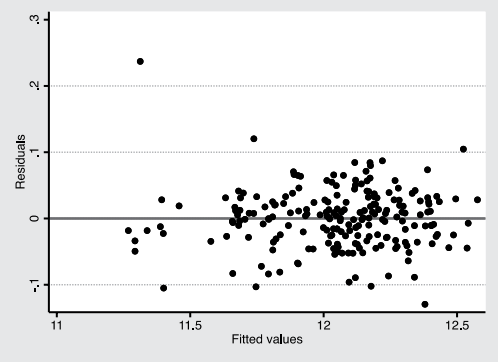


Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms
Variable: Fitted values of University income
H0: Constant variance

chi2(1) = 45.48
Prob > chi2 = 0.0000

Figure 4
Heteroscedasticity plot – Polytechnic universities



Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms
Variable: Fitted values of University income
H0: Constant variance

chi2(1) = 12.16
Prob > chi2 = 0.0005

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КОММЕРЧЕСКАЯ ДЕЯТЕЛЬНОСТЬ УНИВЕРСИТЕТОВ

ВЗАИМОДЕЙСТВИЕ СО СТЕЙКХОЛДЕРАМИ

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Резюме

В работе рассматривается влияние различных стейкхолдеров на формирование приносящей доход деятельности университета. На сегодняшний день способность университета самостоятельно поддерживать своё финансовое благополучие в условиях ограниченной финансовой помощи со стороны государства находится в фокусе внимания как учёных, так и администраций университетов. Профессорско-преподавательский состав является одним из ключевых стейкхолдеров, применяющих различные инструменты для привлечения дохода в вуз, в том числе через взаимо-

действие с различными субъектами экономической деятельности. В рамках данного исследования были применены количественные методы анализа. На основе вторичных данных о взаимодействии высших школ и предприятий в Великобритании автор провёл оценку воздействия различных стейкхолдеров на доходность вуза. Согласно полученным результатам государство и предприятия являются основными стейкхолдерами, которые оказывают значимое влияние на финансирование университетов, тогда как другие субъекты хотя и важны, но эффективность их воздействия зависит от каждого конкретного вуза. Это исследование может быть полезным для административного аппарата высшей школы, поскольку показывает различные стратегии взаимодействия со стейкхолдерами, что, в свою очередь, может привести к разработке своей стратегии поведения для увеличения доходности вуза.

Ключевые слова:

университеты; приносящая доход деятельность; профессорско-преподавательский состав; экономическая стабильность.