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# Determinants of universities' spin-off creations

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**ABSTRACT**

The idea of entrepreneurial university seeks to boost the transfer of academic knowledge to firms and foster socio-economic development. The main objective of this paper is to examine the various determinants that influence universities knowledge transfer activities. To fulfil this objective, we draw our dataset from the higher education and business survey (HESA-BCI) conducted across the United Kingdom in the 2017/18 academic year and the partial least square structural equation was used. The Results demonstrated that funding, patents, and rewards all have significant influence on universities spin off creation. The results also showed that patents played a significant mediating role towards universities spin off creation. Findings of this study contribute to validating the important factors that promotes entrepreneurial activities at universities as well as contributing to knowledge transfer activities. The findings have positive implications for researchers, academic entrepreneurs, and university management aiming to exploit and commercialise university knowledge.

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## 1. Introduction

The entrepreneurial university model has gained prominent scholarly attention as knowledge and innovation concept vital for improved competitiveness, stimulating economic and firms' growth and wealth creation (Pugh et al., 2018). Universities undertaking entrepreneurial activities are classified as more efficient in research commercialisation through mediums such as licences and patents or mainly through spin-off creations (O'Shea et al., 2007). The entrepreneurial university has been instrumental in addressing the ongoing second academic revolution in the academic spheres. Knowledge transfer and academic research commercialisation activities have helped in the classification of universities as innovators. Universities and other higher educational institutions have become knowledge hubs and birthplaces of academic spin-offs (or spinouts) that boost the commercialisation of research and the creation of new firms (Fuerlinger et al., 2015).

As a matter of concern, universities' entrepreneurial activities can be a gateway to business innovation (Odei & Anderson, 2021). Entrepreneurial responsibilities are

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initiated when an opportunity is discovered and is determined to have an economic value that can lead to establishing a new business. Scientific discoveries are commercialised through spin-offs established close to university campuses and academic researchers (Odei & Stejskal, 2018). Innovation can boost the existing technological trend of local businesses and thus promote both social and technological development (Guerrero et al., 2015). The establishment of business incubators and technology parks near university campuses ensures cooperative bonding with emerging industries. Universities collaborating with companies help intensifies business transactions between customers, vendors, and academic researchers (Iansiti & Levien, 2004). In addition, these measures can help develop innovation systems where the theoretical knowledge from employees would be beneficial to the technology transfer offices within universities and provide legal support for their invention. Entrepreneurial activities enhance regional and national economic growth and boost the finances of universities and university faculties.

The increase in entrepreneurial universities worldwide can be seen as 'waves' of growth that affect organisational structures and move different regions and countries forward. According to Rooksby (2020), the US introduced the first wave of entrepreneurial universities in 1920 (Portuguez Castro & Gómez Zermeño, 2012). MIT, Stanford, and the University of Wisconsin were pioneers in having good patent policies and in developing technology transfer that established new businesses and created new industries (O'Shea et al., 2007). The second wave took place in Western Europe from the early 1990s, when universities in the UK, France, Belgium, the Netherlands, and other countries transformed themselves into entrepreneurial institutions with commercial responsibility for enhancing socio-economic development (Dalmarco et al., 2018). Entrepreneurial universities in the UK identify business opportunities and become competitive by formulating productive policies for academic institutions and central government, contributing significantly to regional development. These universities have also adopted theoretical and methodological approaches in the academic research process. They have also initiated a more practical approach than the previous university teaching that used descriptive input-output analysis to measure economic impacts (Roessner et al., 2013).

This paper aims at examining the factors that drive academic entrepreneurship (or spin-off creation) in the United Kingdom and proposes measures that universities can adopt in new EU countries aiming to be entrepreneurial. Specifically, we aim to identify some leading factors contributing to spin-off creation in the UK and propose some strategies that higher education institutions in new EU member countries can emulate to be entrepreneurial. This article aims to answer the following research question: *What determinants contribute to the success of spin off creation among universities in the United Kingdom?* Our findings from a sample of 164 UK universities show that reward provided to academics for their labour plays a major role in spinoff creation and sustenance among the sampled universities. The second most significant result also show that the protection of intellectual property using patents also positively contribute to university spin off creation. We also find that funding plays a vital role in promoting academic spin off creation and positively impacts on patent acquisitions. The study is novel and differs from the previous existing studies on

academic spin offs (see for instance Audretsch & Belitski, 2019). Spin-off formation and patenting have been studied worldwide using micro, meso and macro analysis.

However, studies have focussed more on patenting and commercialising academic research output using variables such as a patent acquisition. Fewer studies have examined rewards given to academic researchers as a variable in determining spin-off creation, number of new patents application filed in a year and number of patents granted in a year for the result of spin-off and public funding leading to spin-off creation. These studies have focused on tangible factors, but we show that intangible factors such as rewards for faculty members can influence them to make full commitments to spin off creations. We also find evidence that rewards for faculty influence their ability to acquire patents which is demonstrated to impact spin offs creation. These results contribute the literature on entrepreneurial universities as we have shown that rewards are an important determinant capable of driving academic spin off creation. Second, this paper contributes to the theory of knowledge transfer by emphasising entrepreneurial education beyond normal classroom teaching and learning and promotes quality research and practical knowledge transfer, thus shaping a new theoretical concept of business education. Our results have policy and practical implications for policy makers universities aiming to be entrepreneurial. This research is essential because the results can be adopted to improve entrepreneurial activities in universities in especially in new EU member countries is very low (Nowiński et al., 2019). We find that spin-offs are understudied in new EU member countries, so university managements and policy makers need to ensure that there is adequate funding for universities to undertake and commercialise their research.

This paper is structured as follows. The next section reviews the key literature on academic entrepreneurship and the various factors driving and sustaining it. Section 3 presents the methodology and data sources for the empirical analysis of entrepreneurial universities. Section 4 presents the empirical results and the robustness test using the Structural Equation Model (SEM), and Section 5 considers the results in the light of previous studies and concludes with recommendations and suggestions for further research.

## 2. Theoretical background

It is widely acknowledged that universities are strategic agents in the knowledge-based economy (Czarnitzki et al., 2016). Not only do they supply a competent human capital base, but they also conduct quality and economically viable research and subsequently aim to commercialise this valuable knowledge. Based on this concept, universities' entrepreneurialism and academic spin-offs have become a reliable method of technology transfer (Fischer et al., 2019). Recent literature on university spin-off activity has shown that industries are not built by chance: their establishment requires a systematic approach. University spin-off firms are one of how academic institutions transform new ideas into innovations and commercialise them. University spin-off companies are also considered an entrepreneurial avenue for university graduates involved in conducting academic research.

A spin-off is a project which sprung up from an existing project and came from a parent company or university (Link & Scott, 2017). University spin-offs are characterised by transferring research activities into products and services using innovative technology for commercial purposes (Nanda & Sørensen, 2010). They are considered crucial in knowledge transfer, as their primary objective implies high innovative potential, which triggers competition and contributes to the creation of enterprises and regional development (M'chirgui et al., 2018). Consequently, spin-off comprises of the accomplishment of universities new mission: addressing societal, economic, cultural, and political issues, and drives local development and national competitiveness. This has transformed university from traditional teaching into entrepreneurial universities (Noventa, 2021). The emergence of university spin-offs can be determined by several individual attributes, organisational and institutional factors (Marzocchi et al., 2019).

### 2.1. Individual attributes as determinants of spinoff activity

Several studies have highlighted the significance of entrepreneurial attributes in shaping the behaviour of individuals championing spinoffs activities within universities. Other authors emphasis the role played by competent and highly skilled personnel in influencing academic entrepreneurship. Kolb and Wagner (2015) discovered that educational entrepreneurs with outgoing personalities were more likely to be involved in spinoff activity. Furthermore, a similar study by Meoli et al. (2020) found that researchers' entrepreneurial intentions and career choices positively affect the creation of spinoff within Italian universities. Similarly, Odei and Anderson (2021) analyse the role of higher education institutions in fulfilling their third mission, which is engaging in intensive research which results in the establishment of new businesses in the UK. The authors emphasised that for universities to recognise their role in regional development, resource personnel should not be overlooked.

### 2.2. Organisational determinants of university spinoff activity

Social scientist operating at the firm level have adopted new strategies in studying spin-off activity. Rather than focussing on economic factors driving academic research, a social scientist has focussed on human resource as an essential determinant for driving spin-off. Specifically, these scientists sought to establish the relationship between spin-off activity and the nature of funding, the quality of academic research and the presence of technology transfer offices and incubators. One factor that has received massive attention is the level and the nature of funding for R& D activities within universities. Link and Scott (2017) discovered that the number of spin-off firms created from UK universities was positively linked with R&D expenditure. Gulbrandsen and Smeby (2005) used data from a questionnaire study among all tenure university professors in Norway using 1967 respondents utilising the relationship between industrial funding and spin-off creation. Similar analyses were conducted by O'Shea et al. (2008) and found a positive and statistically significant correlation between the extent of funding and its impact on academic research. The

nature of research universities engage in seems to be very relevant for spin-off creation. An empirical study conducted by Odei and Stejskal (2018) examined the spin-off rate at UK universities from 2015 to 2016 and found evidence that the nature of university grant contributed positively to spin-off formation rates. Faculty quality has been cited as another crucial factor that influences spin-off. A study by Nanda and Sørensen (2010) linked the success of competent human capital to rewards and motivation from management. Another study by Zwick (2021) also demonstrated that faculty members could develop innovative ideas to establish a new firm. The authors suggested that it may be easier for academic researchers from top tier institutions to assemble resources to create start-ups incubators for credibility reasons.

### 2.3. Institutional determinants of university spinoff activity

The central point of university spin-off relies on institutional behaviour. This idea suggests that universities with good cultural norms support commercialisation of academic research and lead to higher spin-off activity rates. For instance, Etzkowitz et al. (2019) assert that the founding mission and institutional support towards entrepreneurship by universities such as Standford and MIT played an essential role in developing academic entrepreneurship. Other authors, Klofsten et al. (2019), asserted that the involvement of university professors in entrepreneurial creation is affected by the social relations and institutions in which the professors find themselves. However, O'Shea et al. (2007) disputed this claim. They concluded that the changing role of universities towards the commercialisation of academic research needs to combine governmental and institutional support mechanism for the spin-off to take place. Peifer et al. (2021) also discovered that vibrant group members with good work etiquette would help predict active involvement in commercialisation. Universities that lack a supportive culture of commercialisation can take series of action. Authors Siegel et al. (2003) posits that for institutions to foster a climate of entrepreneurship, institution administrators should focus on five organisational and managerial factors: (1) a lucrative reward system for the University Technology Transfer Offices (UTTO); (2) effective management of Staff in the Technology Transfer Office (TTO); (3) University policies to promote technology transfer; (4)Increasing the level of skilled and competent resource personnel at the UTTO; (5) Working to eliminate cultural and information barriers that slow the growth of UTTO processes. This process needs some duration to realise its impact on spin-off creation fully. Universities need to go beyond putting short-term measures to build an entrepreneurial culture to commercialise and encourage entrepreneurial behaviour throughout the institution (Uslu et al., 2019).

### 2.4. Economic importance of spin-offs creation

University spinoffs are relevant to creating new firms because of the powerful technologies used in the establishment of these companies. For instance, the Russell Group in the UK has been economically beneficial through job creation and help in creating delivering quantitative and qualitative research with outstanding teaching

and learning, which has transformed local businesses and the public sector. The UK government inject about 87 billion pounds into the recruitment of competent and qualified resource personnel to aid in their activities (Russell Group, 2021). The Russel group report found out that every pound granted to research-intensive universities from the Higher Education Innovation Fund resulted in about 13 pounds impact on society and the broader economy. Among other findings, the study reports indicate that the company has produced 68 per cent of the UK's world-leading research and has produced 50 per cent of both undergraduates and postgraduate research (Russell Group, 2021). This stream of literature reviewed the economic impact of university spinoff and the consequences of university research activity.

### 2.5. Other determinants of university spin off activity

Several economic factors drive spin-off creation. Among such activities are the patent, rewards, and funding. The burgeoning literature on university spin-off activities have shown that spin-off companies are not created accidentally, but they require efforts and policies.

The funding of academic research plays a vital role in the creation of university spin-offs. The amount invested in research positively contributes to university spin-off activities (Rasmussen et al., 2014). Without access to funds, quality research that leads to commercial value will be limited (Bodolica & Spraggon, 2021). Financial resources are also necessary to write the business plans and conduct the market research needed to construct new spin-off firms (Mosey et al., 2017). Governments worldwide fund academic research in universities and other organisations because of its spillover effect and its contribution to economic development (Odei & Anderson, 2021). Research by Odei and Stejskal (2018), shows that the number of spin-off firms newly created by universities in the UK results from research and development funding. The US government's funding of research through the Bayh-Dole Act has contributed significantly to creating spin-off in universities (Guerrero et al., 2015). Investment funding is also used to pay researchers to develop products and ideas (Muscio et al., 2016). When universities have successfully carried out quality research and analysed its commercial importance and potential, they look to investment funding to establish new businesses. Incubator funding is also necessary to provide the infrastructure needed to sustain new spin-off industries. Establishing science parks to promote spin-off requires enormous financial investment and requires financial support from governments and other stakeholders that benefit from them. Many European countries such as the UK, Germany, Italy, and Spain collaborate with universities by providing financial support for the establishment of new spin-off firms (Muscio et al., 2016). *Therefore, we propose that*

**Proposition 1.** *Funding is highly probable to contribute to spin-off creation.*

Rewards are an institutional support mechanism that plays a crucial role in universities creating spin-offs (Hayter et al., 2018). Providing faculty members with financial incentives increases their commitment and motivate them to create academic spin-offs. The UK government provides financial and political incentives to boost entrepreneurship (Etzkowitz et al., 2019). Hayter et al. (2018) show that when universities

provide royalty disbursements to their employees it has a positive impact on the effectiveness of technology transfer. Rewards strengthen employee's commitment, persistence and creativity that would bring new innovative ideas needed for spinoff creation. Thus, higher employee motivation leads to better engagement and productivity. Therefore, it is not a surprise that incentives and rewards have become top priorities for most businesses. Conversely, less engagement in rewards and incentives does not make employees feel proud to work for their company as they do not act ass brand ambassadors and do not share the firm's values. *Therefore, we propose that*

**Proposition 2.** *Rewards given to employees are more likely to contribute to spin-off creation.*

Patents are intellectual property that gives innovators the legal right to their products and credits inventors when the general public accesses their work. Thus, they protect innovation, encourage new knowledge, and lead to regional and social development. Some conditions need to be fulfilled for patents to be approved. First, a constitutional requirement must be fulfilled because the invention and its technology must be socially helpful to attain a patent award for the newly created spin-off firm. This helps protect the product and its commercialisation (Odei et al., 2021). The facilities make the data readily available before the spin-off is created and coordinate with the technology transfer office. Second, for a patent to be granted for commercialisation, the invention must be new and cannot be an idea that already exists in the marketplace. In the UK, the intellectual property regime is linked to protecting patents, which has contributed massively to universities' entrepreneurial and economic development. Patent protection provides industries or an inventor the legal right to exclude others from claiming the ideas newly created (M'chirgui et al., 2018). From an economic point of view, patents aim to solve inappropriate problems allowing spin-off firms to maximise profit and create product value. According to Lai (2021) if an industry fails to recover the cost of its invention because its information is made available to the public, then the industry should expect lower outputs. The reality is that tight intellectual property protection will motivate new spin-off firms to develop new ideas and technology in an enabling environment and commercialise their activities. *Therefore, we propose that*

**Proposition 3.** *Patents are more likely to contribute to spin-off creation.*

## 3. Methodology

### *3.1. Research model and question*

The UK academic environment is seeing a major transformation which is changing the roles of universities and other higher educational institutions in regional development. universities in the UK have embraced their third mission (Odei & Anderson, 2021) and have seen a major impact on the establishment of startups and spin offs. Despite this transformation of academic entrepreneurship and spin out activities in the United Kingdom, less studies have focussed on the factors driving these entrepreneurial prospects within universities. This research will be examining some leading

factors contributing to spin off creation in the UK and propose some strategies that tertiary institutions in new EU member countries can emulate to be entrepreneurial to contribute to regional development. To fulfil the objective of the paper, this research will answer the following research question: what are the factors driving entrepreneurial activities in UK universities?

### 3.2. Sample and data collection

In order to comprehensively understand knowledge transfer and entrepreneurial activity in UK universities, we analysed the internal factors that contribute to the creation of university spin-offs. The data for the analysis comes from the Higher Education Business and Community Interaction Survey (HE-BCI) for the 2017/18 academic year. The HE-BCI is a compulsory survey of all higher educational institution in the United Kingdom and has been collating financial and knowledge- transfer data in the United Kingdom since 1999. The HE-BCI is a secondary survey conducted annually and its mandatory for all higher education institutions in England, Scotland, and Wales. It collects data on universities engagements with general community, industries (Rae et al., 2012). It provides information on research activities in both the private and public sector, ranging from consultancy to commercialisation of intellectual property. It collects data on activities that directly benefit the community, such as patent acquisition, research and development funding, and incentives. We sampled a total of 164 universities involved in entrepreneurial activity in the 2017/18 academic year. The sample of universities focuses on all UK publicly funded higher education institutions in the 2017/18 academic year. However, the participant schools exclude further education colleges in England, Northern Ireland and Scotland which is not part of HESA. The data contains variables such as patents, rewards, funding, and spin-off. The HE-BCI dataset is designed purposely to disseminate higher education information with the aim of establishing new businesses through collaboration with academic institutions. This data source has been used by other researchers in similar empirical studies (Odei & Stejskal, 2018).

### 3.3. Methodological approach

The Partial Least Square-Structural Equation Modelling (PLS-SEM) was adopted for the empirical estimation. The PLS-SEM does not require data to be normally distributed, as in the case of Co-Variance-Based Structural Equation Modelling (CB-SEM). The PLS-SEM is known to be useful when the research is aimed at predicting or to identify key constructs (Shmueli et al., 2019). The PLS-SEM is shown to provide accurate assessments for estimations with small sample size like ours. According to Hair et al. (2006) the use of the PLS-SEM approach by the authors was a result of the explanation of the variance of the detailed variables which is also appropriate for exploratory studies. Two linear equations define the structural equation model: the structural model and the measurement model. The structural model shows the relationship between the constructs, whereas the measurement model shows the relations between the construct and the observed indicators. Structural Equation Modelling

**Table 1.** Selected studies on the factors promoting the creation of university spin-offs.

| Contributory factors | Studies |
|---|---|
| Rewards | Etzkowitz et al. (2019); Hayter et al. (2018) |
| Patent policies and technology transfer | Lai (2021); M'chirgui et al. (2018) |
| Spin offs | Ramaciotti and Rizzo (2015); Odei et al. (2021) |
| Investment funding | Bodolica and Spraggon (2021); Mosey et al. (2017) |

*Source*: Authors' compilation.

(SEM) provides theoretical and graphical interpretation, making it easier to understand. We chose the traditional Partial Least Squares (PLS) path model due to its distribution-free assumption, predictive nature, and self-explanatory development approach to understanding the key factors that influence entrepreneurial activity (spin-offs) in UK universities (Kock & Hadaya, 2018). The SEM is also preferred for empirical analysis because it enables the establishment of relationships between theoretical constructs using regression or path coefficients. The SEM makes use of path diagram for easy understanding through graphical visualisation. Path analysis in SEM enables all coefficients linked in the multiple regression models to be estimated simultaneously (Kock, 2011). SEM uses standardised path coefficients, making it possible to estimate reliable relationships between latent variables. The constructs considered in this paper are reflective and were created by considering the aggregates of the observed variables. These aggregates reflect the latent variables we consider in the model. The SEM adopts two approaches to calculate the causal relationship between the latent variables and the indicators used. The covariance-based calculates the path coefficients by minimising the differences among covariance matrices (Schumacker & Lomax, 2004). This approach also employs the parametric assumptions in the calculation of the coefficients and the significance levels ($p$-values). The second SEM approach factors the variance-based and estimates the coefficient by using latent variable based on the weighted aggregates of all indicators used. It does not use the parametric assumptions in calculating $p$-values (Table 1).

## 4. Results

We begin the results and discussion with the descriptive statistics Table 2 below which indicate that the average public funding support for universities was 5875.94 pounds, collaboration contribution in cash was 754.96 pounds, and collaborative contribution in kind was 1731.97 pounds. The number of average disclosures for patents was about 26.72%, while the number of new patents application filed in a year was 12.91%. The number of patents granted in a year had a mean of 10.41, and the average cumulative patent portfolio was 125.29. Again, spin-offs with ownership of higher education providers were around 5.57, formal spin-offs not higher education providers owned were about 1.54, and staff start-ups were about 2.79. Lastly, rewards given to employees accounted for the spin-off was 79%.

Before presenting the empirical results, we present the indicators used to determine the validity of the reflective measurement model to fit the data. The results in Table 3 focus on the measurement model results. It is evident that the loading which measures the simple regression gradient if an indicator is regressed with its construct. Cheah et al. (2018) proposed that the recommended threshold for item loadings must

**Table 2.** Descriptive statistics.

| | N | Min | Max | Mean | Std. deviation |
|---|---|---|---|---|---|
| Public funding | 164 | 0 | 72476 | 5875.94 | 11788.360 |
| Collaborative contribution—Cash | 164 | 0 | 21261 | 754.96 | 2261.615 |
| Collaborative contribution—In kind | 164 | 0 | 30962 | 1731.97 | 5065.928 |
| Number of disclosures | 164 | 0 | 394 | 26.72 | 60.512 |
| Number of new patents applications filed in year | 164 | 0 | 258 | 12.91 | 33.564 |
| Number of patents granted in year | 164 | 0 | 321 | 10.41 | 32.952 |
| Cumulative patent portfolio | 164 | 0 | 3609 | 125.29 | 375.868 |
| Spin-offs with some HEP ownership | 164 | 0 | 70 | 5.57 | 11.030 |
| Formal spin-offs, not HEP owned | 164 | 0 | 36 | 1.54 | 4.158 |
| Staff start-ups | 164 | 0 | 59 | 2.79 | 8.103 |
| Rewards | 164 | 0 | 1 | .79 | .407 |

*Source*: Authors' computation.

**Table 3.** Reliability and validity measurements.

| Constructs | Indicators | Loadings | AVE | VIF | Dijkstra– Henseler's rho ($\rho A$) |
|---|---|---|---|---|---|
| Spin offs | Spin off 1 | 0.911 | 0.617 | 1.524 | 0.825 |
| | Spin off 2 | 0.797 | | 1.533 | |
| | Spin off 3 | 0.620 | | 1.232 | |
| Patents | Patent 1 | 0.869 | 0.821 | 2.634 | 0.948 |
| | Patent 2 | 0.919 | | 4.038 | |
| | Patent 3 | 0.926 | | 6.745 | |
| | Patent 4 | 0.910 | | 5.284 | |
| Funding | Funding 1 | 0.886 | 0.630 | 1.499 | 0.835 |
| | Funding 2 | 0.718 | | 1.378 | |
| | Funding 3 | 0.768 | | 1.360 | |
| Rewards | Reward 1 | 1.000 | 1.000 | 1.000 | 1.000 |

*Source*: Authors' computation.
*Note*: AVE = average variance extracted, VIF = variance inflation factor.

be above 0.70. As shown from our loadings results, all the individual item loadings met the recommended 0.70 threshold. We begin with the validity of the construct to test the internal consistency of the model. Of the many methods used to measure reliability, we chose Dijkstra–Henseler's rho ($\rho A$) because it is considered the most consistent and significant measure of internal consistency and reliability (Cheah et al., 2018). According to Nunnally and Berstein (1994), a minimum reliability value of 0.7 is acceptable. Our results show that all our constructs surpassed the minimum acceptable threshold (as shown in Table 2 below), indicating that they are internally consistent. Secondly, we employed the average variance extracted (AVE) approach for the convergent validity assessment, which measures unidimensionality. According to Fornell and Larcker (1981), AVE values of 0.5 and above are acceptable. The results in Table 2 show that all our constructs surpassed the minimum AVE threshold. In addition, we ensured that our structural models had no potential collinearity issues that might lead to misleading findings due to the variables measuring the same relationships. To measure collinearity, we used Variance Inflation Factor (VIF) criteria. According to Hair et al. (2006), the VIF should not be greater than 10; higher values indicate a possible collinearity issue. Our results show that our constructs' VIF criteria are all below the threshold of 10 implying that our variables are not contaminated with potential multicollinearity problems.

The results of the structural model are also presented in Figure 2 and Table 4 below. We first evaluated the structural model's predictive power to determine its

**Table 4.** Results of structural model.

| Effect overviews | Original coefficients | Mean values | Standard errors | *t*-values | *p*-values | Cohen's *f*2 | Decision |
|---|---|---|---|---|---|---|---|
| Patent -> Spin Off | 0.593 | 0.593 | 0.118 | 5.029 | 0.001*** | 0.724 | Accepted |
| Funding -> Spin Off | 0.299 | 0.307 | 0.131 | 2.291 | 0.022* | 0.186 | Accepted |
| Funding -> Patent | 0.593 | 0.632 | 0.086 | 6.892 | 0.001*** | 0.553 | Accepted |
| Rewards -> Spin Off | 0.095 | 0.083 | 0.031 | 3.041 | 0.002*** | 0.029 | Accepted |
| Rewards -> Patent | 0.101 | 0.092 | 0.042 | 2.390 | 0.017* | 0.016 | Accepted |

*Source*: Authors' computation.
*Note*: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

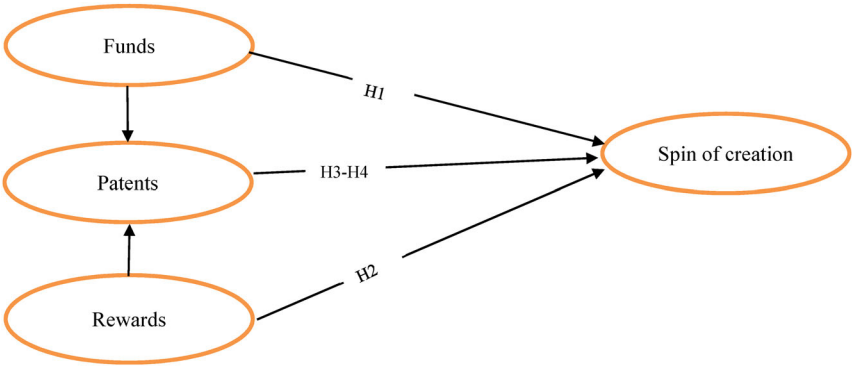


**Figure 1.** A conceptual framework.
*Source*: Authors' creation.

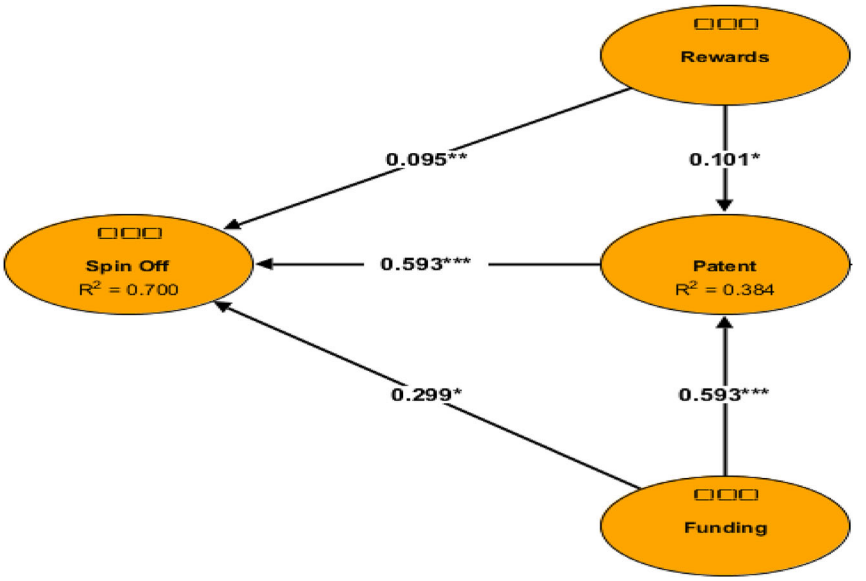


**Figure 2.** Graphical representation of the structural model.
*Source*: Authors' computation.
Note: *** Parameter significant at 99% level, ** significant at 95% level, * significant at 90% level.

accuracy, viewed as the combined effect of the independent variables on the dependent variables using the coefficient of determination ($R^2$). Our results in Figure 1 show that the $R^2$ value is 0.38 for the mediating variable and 0.70 for the spin-off variable. These coefficients of determination score ($R^2$) results show that both the mediating and outcome variables variable have strong predictive powers or effect sizes (see Cohen, 1988).

Table 3 and Figure 1 present the regression coefficients and the equivalent $p$-values of the SEM model specification for the probability of patents, funding and rewards contributing to universities' knowledge transfer activity using spin-offs. The path coefficients are the most significant results for the structural model. The path coefficients measure the change in the dependent variable caused by a unit change in an independent variable based on the condition that all the remaining independent variables are held constant. The results show a positive and statistically significant relationship between funding and patent acquisition ($\beta = 0.593$; $p < 0.001$). Funding had a moderate effect on universities' spin-off creation and related activities ($f^2 = 0.553$). We again find a positive and statistically significant association between funding and the establishment of spin-offs ($\beta = 0.299$; $p < 0.022$). Funding had a substantial impact on spin-off creation ($f^2 = 0.186$). The results also demonstrate a positive and statistically significant relationship between rewarding faculty members and their propensity to acquire patents ($\beta = 0.101$; $p < 0.017$). Another aspect of interest is the indirect relationship established between rewards and spin-off creation. We found a positive and statistically significant relationship between rewards and patent acquisition ($\beta = 0.101$; $p < 0.017$). Patent acquisition demonstrated a strong effect on universities spin-off creation with the highest $f^2$ value of 0.724. The results also show a direct and a positive and statistically significant relationship between patent acquisition and spin-off creation ($\beta = 0.593$; $p < 0.001$). Rewards also demonstrated to be a statistically significant factor that can influence spin-off creations with $f^2$ value of 0.029. Although significant, reward had an unsubstantial effect on spin-off creations and patent acquisition with $f^2$ value of 0.016.

## 5. Discussion

Higher educational institutional governance is still the top-down approach fully dependent on government funding. Government intervention does not allow universities to operate freely. New EU member countries can emulate the approach of UK universities by combining an entrepreneurial orientation and economically viable scientific research. This will better these higher education institutions as a source of vital knowledge needed to commercialise innovative ideas and technologies. Furthermore, higher educational institutions can integrate entrepreneurship into their curricula to equip students to be more practically oriented, which in the long run will enable students to solve real economic problems that do not require complex solutions. Higher education institutions in the new EU member countries need to adapt to rapid societal changes and develop an awareness of the need to strengthen entrepreneurship development (Boldureanu et al., 2020).

Our result on funding signifies that when universities with entrepreneurial capabilities have access to funding for research and commercialisation, it is very likely to impact their patent acquisition positively. Funding has one of the highest impacts on universities' propensity to obtain patents that can subsequently influence the establishment of spin-offs. Without this, universities are highly unlikely to conduct economically viable research that can be commercialised. The commercialisation of academic research in spin-off creation is a high-cost activity that requires funds that can be sourced from individuals or the government. Understanding the funding makeup is vital because it is the decisive factor that can establish spin-offs. The positive coefficient elasticity in the result means that a reliable source of funding increases the probability of universities spinning out firms to commercialise their knowledge. Whether from internal or external sources, funding positively affects the creation of university spin-offs because funding is needed for infrastructure development and building ultramodern businesses where the university would transfer their technology for regional development. This result is critical because it allows faculty members, university researchers, and other higher educational institutions to access the needed capital to acquire knowledge and share innovative ideas for commercialisation (Audretsch & Belitski, 2019; Fischer et al., 2019). Our result is akin to the conclusions of Rasmussen et al. (2014) and Odei and Stejskal (2018), who also find that funding stimulates spin-off activities in UK universities.

The rewards available to faculty members are to stimulate their entrepreneurial activities and point to an exciting direction, as we expected. Our results again demonstrate that rewards and incentives can induce universities spin-off activities. The positive elasticity of the coefficient in the results means that when faculty members are given incentives and rewards, the likelihood of patent acquisition increases. Rewarding faculty members for their initiatives serves as an incentive to increase their contribution to universities' entrepreneurial initiatives. When faculty members are rewarded for conducting research, it helps them commit more of their time and resources to develop new ideas, which helps establish a spin-off. The opposite of the argument can also be valid; the absence of a clear-cut rewards scheme will make faculty and researchers reluctant to come with innovation. Low rewards dampen the entrepreneur drive, which can lead to low innovation. The reward scheme adopted by the UK can be implemented in emerging economies in order not to "kill entrepreneurial spirits" in academic researchers. Our result has affirmed that when faculty members involved in commercialising research and creating spin-off are well rewarded both in cash and kind, their propensity to contribute more to spin-off formation and knowledge transfer activity is increased. New ideas can emerge in different ways through promoting employees who partake in new research in kind or cash; this will compel them to devote their time and resources for spin-off creation across other departments within the university. This result is similar to the findings of Muscio et al. (2016) and Meoli et al. (2019), who concluded that rewarding technology transfer activity is essential to boost the participation of researchers and faculty members in forming spin-offs and commercialising academic research.

The results on patents have the highest elasticities and have shown that patent has a positive effect on universities spin-off creations and related activities. This means

that the patent variable plays a mediating role in stimulating spin-off creation at universities. When patents are granted to university, there is a corresponding increase in spin-off creation because patent helps in safeguarding invention that can protect new products, design, or research processes from meeting certain demands on the market. This result means that copying or importing an invention without the consent of the originator will lead to sanctions. According to our findings, a patent from academic institutions has given researchers a guarantee and revenue source for their invention. The result has proven why the UK and European Union have a strong policy to protect research activities and thus has given researchers and scientists confidence in protecting their invention, leading to spin-off creation. These measures adopted by the UK and the European Union to protect their inventions can also be emulated in other emerging economies where spin-off activities have been low. This result is similar to the findings of Jung and Kim (2018), Ferri et al. (2019), Samo and Huda (2019), who all concluded that when researchers and faculty members acquire patents, the likelihood that universities and other research organisations create spin-offs is positively and significantly affected. In a similar study using the same datasets, Odei and Stejskal (2018) also find that patent acquisition by faculty members highly influences universities in the United Kingdom to spin out new firms to commercialise their knowledge.

## 6. Conclusion

The objective of this paper is to analyse the determinants of the creation of spin-offs in UK universities. Knowing these determinants will enhance the creation of spin-offs in universities in new EU member countries, where entrepreneurial activity is underdeveloped. The Structural Equation Model was used to analyse 164 UK universities engaged in spin-off activities. The results of the empirical study show that funding, patents, and rewards have a significant influence on and are the major drivers of the creation of spin-offs, confirming the results of previous studies. We established a positive and statistically significant relationship between funding, patent, and rewards, which are the important contributors to spin-off creation. Our research affirmed that funding and patent have the highest effects on universities spin off creation in the sampled universities. Therefore, our results show that universities and other higher educational institutions can utilise financial support from governments and non-governmental bodies for spin-off activities. The results of our analysis have again demonstrated that rewards influence spin-off creation and patent acquisition; thus, there is a need for management to reward employees for motivating them for a more excellent work output. We also find compelling evidence in our sampled universities that the availability of funding influence faculty acquisitions of patents.

The results on the effect sizes showed that patents have the highest impact on the probabilities for universities to spin out firms. The results further show that funding was the second factor that had the second largest effect size on faculty' ability to apply and obtain patents to protect technical inventions. Rewards showed to have the least impact on faculties abilities to secure patents for intellectual property right

protection. Our results have practical and policy implications for policy makers and university managers aiming to promote knowledge transfers and commercialisation.

### 6.1. Practical implications

This paper contributes to the theory of knowledge transfers by emphasising the importance of university research and knowledge matter for spinning out of industries to utilise the academic research and knowledge. Hence, promoting high quality and economically viable research should be the focus of higher educational institutions. knowledge transfer, thus shaping a new theoretical concept of business education. Based on this university managers need to encourage scientist to insist on quality research, there need to exist some rewards and motivation packages to make undertaking quality research a priority. Again, the results point to the positive role of funding in the spin off creation and sustaining process. The need for funding for research commercialisation will be dependent again on the quality research undertaken by these higher educational institutions. So higher academic researcher must make quality research a topmost priority to attract funding for both future research and spin offs creation.

Furthermore, the results have indicated that faculty and scientist motivations, incentives, and rewards may be fundamental factors to enable researchers to be more committed to creating spin-offs. Spin-off entrepreneurs should take note of the form of compensations or bonus schemes involved in transitioning from an academic to a business entity and reward employees for their contribution to the academic firms' establishments. A possible implication for policy makers is to provide funding support for universities and other higher educational institutions to support their research and commercialisation efforts. Another policy implication is for policy makers to provide the regulation framework for knowledge protection using intellectual property rights tools such as patents and European utility models. This will help to protect knowledge production and dissemination leading to an increase in the knowledge stock.

## 7. Recommendation

Therefore, we recommend that universities invest more in patents and funding to contribute to economic and social development. Financial support from government and non-governmental bodies can be utilised for spin-off activities in academic institutions, and industry can profit from and reinvest in spin-off activities. Universities can also borrow from financial institutions to enhance spin-off and other entrepreneurial activities. Our analysis has again shown that rewards and patents influence the creation of spin-offs through knowledge transfer and licence acquisition.

Entrepreneurship education needs to include technicalities that will help researchers learn new skills and adopt a creative mindset that will benefit academic institutions and go a long way to provide start-up ideas for sole proprietorship after graduation. Besides just teaching a course in entrepreneurship, universities should establish entrepreneurship centres that can be hubs for conducting academic and

industrial research. This will be more effective and provide internal and external measures to promote entrepreneurial culture and help industrialisation. However, further research is recommended to investigate the inverse significance of university-industry collaboration and its impact on spin-off creation. Lastly, in transitioning Eastern European countries, the concept of academic entrepreneurship is yet to be fully embraced due to the continuing over-reliance on EU funding and the strings attached. Universities can emulate the success stories of UK universities as they have been documented to be pioneers in academic spin offs. Countries in transitioning EU member countries aiming to be entrepreneurial need to formulate policies that favour knowledge production and dissemination beyond the academic environment.

### 7.1. Limitations

This study contributes to the existing literature on the creation of spin-offs. However, it has the following limitations. The sample of 164 universities is small, considering the total number of universities involved in spin-off activities. Secondly, this study focuses on internal factors and determinants that are highly probable to influence universities' spin-off creation and knowledge transfer. We believe that spin-off creation is not limited to factors internal to universities. Other external factors are highly likely to contribute to spin-off and galvanise universities to spin-off firms. We, therefore, encourage further research that incorporates neglected aspects such as the impact of legislation, the ease of doing business as an influence on establishing spin-offs, government support for knowledge transfer activities, strategic planning, and spin-off governance. This will shed more light on the factors that stimulate technology transfer in universities. Academic research needs to be conducted so that it will lead to entrepreneurship. In countries that do not invest in spin-off activities, academic research should be made practical by collaborating with businesses to promote spin-off. This study could be replicated in new EU member countries still transitioning to democracy, where universities are yet to commercialise their research activity for economic gain. The other limitation of this study is adopting 'spin-off formation' as its dependent variable; it did not factor in what happens before and after specific stages that are part of the life cycles about creating spin-offs. Thus, the results of this study do not explain other significant aspects of spin-offs, such as academic program contributing to spin-off, survival, and their growth rate of spin-out firms. Lastly, the dataset used for the empirical models did not provide enough information about the characteristics of the sampled universities. Hence it was difficult to get more details on whether the sampled universities and higher education institutions are public and private universities, their dimensions and range of fields of focus, sizes, and roles of specific organisations (TTOs). We conclude with suggestion for future research. This study did not consider on key issues such as legislation, ease of doing business that can influence establishing spin-offs, government support for knowledge transfer activities, strategic planning, and spin-offs governance. We encourage further research to incorporate these omitted factors to get a detailed understanding of the factors driving spin off creations among these universities and higher educational institutions.

We also recommend future research to be undertaken in other countries to validate our findings.

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