International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 15, Issue 11, 2021

An Exploratory Analysis of Key Antecedents of Academic Entrepreneurship in Nigeria

Caleb M. Adelowo[1], **Jhalukpreya Surujlal**[2], [1]Postdoctoral Fellow, Faculty of Economic and Management Sciences, North-West University, Potchefstroom, South Africa, [2]Professor, Faculty of Economic and Management Sciences, North-West University, Potchefstroom, South Africa. Email: [1]calebakinrinademip@gmail.com [2]babs.susrujlal@nwu.ac.za
[1]https://orcid.org/0000-0002-4578-5708 [2]https://orcid.org/0000-0003-0604-4971

More than ever, universities are under intense pressure to make concrete contributions to innovation and economic competitiveness through active knowledge transfer engagements. Knowledge transfer activities assist universities to achieve the 'third mission' objective as well as providing opportunity for them to access industry resources, commercialise research outputs and bolster positive entrepreneurship ecosystem. Consequently, university stakeholders have to work cohesively and provide adequate incentive system for faculty members and students to express their innovativeness and creativity. In this article, the antecedents of academic entrepreneurship in Nigeria are explored through entrepreneurial university approach, shifting the lens of analysis on scientists and researchers. Data were collected from 229 faculty members from thirteen universities in Southwest Nigeria. The academic entrepreneurship engagements of faculty members were categorised into four, using principal components analysis. The results suggest that engagement in basic and applied research, entrepreneurship training, IP disclosure and existence of technology transfer facilities are pivotal to academic entrepreneurship. The article concludes with practical policy implications for relevant stakeholders.

Key words: *Academic Entrepreneurship, collaboration, intellectual property, innovation, Nigeria*

1. Introduction

Policy makers in developed and newly industrialising economies are promoting the new trend of entrepreneurial university in a number of countries through the encouragement of collaboration between universities and industries (Slaughter and Leslie, 1997; Etzkowitz, 2003, Mowery and Nelson, 2004; Oyewale, 2005; De Silva, 2015; Adelowo, 2018). The major aims are to enhance the potentials of universities to stimulate innovations and respond to societal challenges through technology commercialisation and promotion of third mission objective. As universities pursue this third mission alongside the traditional activities, their relevance to economic growth, national competitiveness and institutional productivity tend to improve (Secundo & Elia, 2014; Siegel & Wright, 2015). For instance, Adelowo and Surujlal (2020) observed significant improvement in research and teaching performance of faculties who engage in some categories of academic entrepreneurship in a developing country. It has also been argued that academic entrepreneurship presents universities with the opportunity to attract talented students and faculty members. Universities with positive ambience for entrepreneurship have high chances to create more entrepreneurs and change agents in the society. Promoting entrepreneurial universities, therefore, requires making deliberate efforts at developing entrepreneurial mind-set of faculty members and establishment of functional entrepreneurship facilities such as technology transfer offices or licensing office, incubators and science parks among others. The foregoing suggests that existing structure of university system and administration in Nigeria need to be re-organised and re-configured to accommodate the third mission activities, including technology transfer to the industry.

Scientists and researchers play significant roles in the build-up of entrepreneurial university, their involvement is key to the success of academic entrepreneurship. Academic entrepreneurship has been discussed extensively in the literature (Fini, Grimaldi, Santoni, and Sobrero, 2013; Grimaldi, Kenney, Siegel, and Wright, 2011; Wright and Siegel, 2015) but its definition and measurement are fluids and mostly dependent on researchers' discretions. For instance, Grimaldi et al. (2011) refer to academic entrepreneurship as diverse technology-based economic development initiatives, focused mainly on stimulating technological entrepreneurship in universities via patenting, licensing, start-up creation, and university-industry partnerships. In addition, great attention has been paid to the creation of new businesses based on university-developed knowledge, also known as academic start-ups or spin-outs (Fini et al., 2013). These definitions failed to account for the entrepreneurial activities which faculty members engaged in but are not officially disclosed to the universities. The undisclosed entrepreneurial activities of faculty members sometimes outweighed the disclosed ones, as most industry interaction among the faculty members are done on personal grounds. A bigger challenge within the body of literature on academic entrepreneurship is lack of coherent definition which has created leeway for authors to define the phenomenon based on their field of endeavours and perceptions. Secondly, in terms of measuring the outputs of academic entrepreneurship in universities, some academic entrepreneurial activities are extremely difficult to quantify, for example what exactly do we measure in consultancy and

industrial collaborations? Is it the number of collaborations or consultancies or the outcome of those activities? Whereas in other cases, it is extremely easier to count the numbers of firm formation and licenses signed. Meanwhile, the two scenarios represent entrepreneurial engagements of faculty. Also, the phenomenon has been less studied in developing economies, particularly in Africa and Nigeria. It is believed that understanding academic entrepreneurship within these economies could provide rich information for policy makers and practitioners on the pros and cons of such initiatives. In addition, Nigerian government had made significant efforts to promote technology commercialisation in both the universities and research institutes across the country through the creation of technology transfer offices and in some cases, incubators, science parks and entrepreneurship centres (Adelowo, Akinwale and Olaopa, 2017). However, the rate of invention and technology commercialisation has been low (Bindir, 2010; Siyanbola *et al.*, 2011). The low commercialisation may be resulting from poor research funding, weak infrastructure and poor linkage with industry among others. Despite these challenges, the few academics who engage in the commercialisation might have demonstrated entrepreneurial resilience, probably due to intrinsic or extrinsic motivations (Adelowo, 2021). In addition to individual motivations for academic entrepreneurship among the faculties, it is important to understand the key antecedents of academic entrepreneurial engagements among faculty members. This paper builds on our recent works (Adelowo, 2018; Adelowo & Surujlal, 2020) to identify key determinants of AE in the universities with a view to suggesting appropriate policy interventions to university administrators and key stakeholders in the education sector.

2. Literature on Antecedents of Academic Entrepreneurship

Academic entrepreneurship is driven by a number of factors including individual, institutional and policy environment (Perkmann et al., 2013; Abereijo, 2015; Guerrero, Cunningham and Urbano, 2015; Adelowo, 2021). For instance, Bayh-Dole Act of 1980 was an important game changer that transformed the perspectives of research organisations towards knowledge commercialisation in the USA. Similar policy was formulated and applied in Europe, Canada, Asia and in the recent decades, Africa. The main difference between the developed and developing countries' application of Bayh-Dole-like policy is in the implementation and government's ability to provide financial requirements to make innovation happen in the knowledge institutions. As parts of government efforts to stimulate entrepreneurship and provide opportunity for citizens to explore their creativity and ingenuity, important policies and infrastructure are established. The creation of technology transfer offices, business incubators, hubs, accelerators and robust venture capital further contribute to technology start-ups and commercialisation. These facilities and infrastructure have been identified as motivation for faculty members and students with entrepreneurial mindset to experiment with their entrepreneurial inclinations (EC-OECD, 2012; Gianiodis, Markman, and Panagopoulos 2016; De Jager et al. 2017).

University ecosystem matters for academic entrepreneurship, particularly the degree and intensity of research activities, research infrastructure and funding, dynamism of internal operation mechanisms and government influence. Henrekson and Rosenberg (2001) and Goldfarb and Henrekson (2003) have observed that academic environment that is characterised by intense competition tends to accommodate entrepreneurship and commercialisation compared to rigid academic environment. As a result, re-orientation of faculty members and university administrators have been suggested to accommodate innovation and entrepreneurship (Siyanbola et al., 2011; Adelowo, 2018). For instance, to promote the culture of entrepreneurship in Nigeria's universities, government formulated and implemented compulsory Entreprepreneurship education in 2006. The policy mandated all universities to set up specialised Centre for Entrepreneurship Development (CED) (Olofinyehun et al., 2018; Adelowo et al., 2018; Adelowo, 2021). It has been observed that the activities of these Centres have improved the entrepreneurial propensity among the under/postgraduates in the universities. In addition, universities in Nigeria are now establishing the directorate of research and innovation to further promote industry linkage and technology commercialisation. To make the initiative work more effectively, the relative emphasis on publication as the main yardstick for academic promotion has improved, as patent disclosure or filing now carries more weight.

What is more. Research intensive university, with specific focus on applied and experimental research tends to accumulate more commercialisable research outputs than otherwise. This is what Louis et. al. (1989) and Haeussler and Colyvas (2011) referred to as the quality of university or department which have significant effect on academic entrepreneurial engagement. As parts of the objective of this paper, we propose to investigate whether faculty's engagement in applied research tends to predispose them to entrepreneurship. For instance, a research institute in Nigeria, the National Institute for Pharmaceutical Research and Development (NIPRID) developed a sickle cell anaemia drug in 1990 through their adept engagements at applied research. Given the research intensive nature of the institute, they were able to come up inventions that have commercial potential. Similar experience occurred in the Federal Institute for Industrial Research (FIIRO) and the National Science and Engineering Infrastructure (NASENI) in Nigeria. By this, it is observed that there is high likelihood that researchers' engagement in applied research could generate invention or intellectual property. Intellectual property disclosures are now gaining momentum among the faculties in Nigeria. There have been some experiences of knowledge transfer to the industry with the assistance of development partner such as United Nations Industrial Development Organisations (UNIDO) and industry partners (Adelowo, Akinwale and Olaopa, 2017).

From the individual factor's perspective, faculty with industry relevant research tend to engage in commercialisation than otherwise. In this case, applied research matters. Faculties who engage in applied research may have more contacts with industry; thereby increase the chance of commercialising the research outputs. Miranda et al. (2017) found attitude toward entrepreneurship, creativity, perceived utility and entrepreneurial experience to be key

determinants of academic entrepreneurship intention among faculties in Spanish universities. In fact, a large scale panel study among academics in the UK universities showed that individual attributes and experience are key predators of AE (Clarysse, Tartari, and Salter, 2011). Other key individual factors that are relevant to this study are faculty's entrepreneurial orientation, age, gender and work experience, social capital or networks (Haeussler and Colyvas, 2011) and entrepreneurship training attended.

3. Research and Methods

This article utilised cross-sectional data collected from thirteen universities in Nigeria (Adelowo, 2017). The universities were selected based on NUC accreditation, presence of well-established research centres and intellectual property and technology transfer offices (Adelowo and Surujlal, 2020). These universities were mainly from the six states in Southwest. Study population includes all faculty members between the rank of Lecturer II and those on professorial cadres within the faculty of science, engineering and technology. The survey was conducted between late November 2015 and early February, 2016. In all the universities, three hundred and fifty faculty members were finally selected to participate in the survey with sixty-five percent response rate. A single set of questionnaire was designed and validated for data collection. The pre-test was conducted on twenty (20) faculty members from a research intensive university in the South-South, Nigeria.

Of the seven sections in the questionnaire, four sections are analysed in this paper, including the measure of academic entrepreneurial activities, background information of the faculty, their entrepreneurial orientation and their awareness of entrepreneurial facilities in the universities.

For the first variable, the fifteen items representing entrepreneurial engagements of faculties were measured on a three point Likert rating scale and was later reduced into four categories using principal component analysis (PCA) (Adelowo and Surujlal, 2020). Lack of preliminary data/information on faculty's entrepreneurial activities necessitated this approach, coupled with the suggestions in Gjerding*et al.* (2006). Also, it follows the catalogue of activities categorised as academic entrepreneurship in the literature (Gulbrandsen, 2016; Lewandowski, 2015; Cantaragiu, 2012; De Silva, Uyarra and Oakey, 2011; Rizzo, 2010; Jain *et al.*, 2009; Jansen *et al.*, 2009). The activities were adapted, to take care of the Nigerian context and later pre-tested on a university in the South-South Nigeria. Other interesting variables from the study include type of research prevalent among the faculties: applied, experimental and basic researches. Work experience was measured in terms of whether a faculty has previous work experience in the industry or not (dichotomous). Intellectual property disclosure is another important variable captured in this study using dichotomous variable to show whether a faculty has made intellectual property disclosure or not. Also, entrepreneurship training attended such as seminar, workshop or conferences were captured, including the presence or absence of entrepreneurship facilities in the universities. The entrepreneurial orientation of the faculty was

assessed to determine the extent to which they are entrepreneurial in their approach to teaching and research activities.

Data obtained were analysed using descriptive and inferential analysis. Specifically, the extracted factors on AE were used as dependent variables for the regression analysis. The independent variables include Work experience, IP disclosure, type of research, entrepreneurial orientation and training and entrepreneurial facilities in the universities. The paper controlled for age and gender in the regression analysis and the results are presented in tables and charts.

4. Results and Discussion

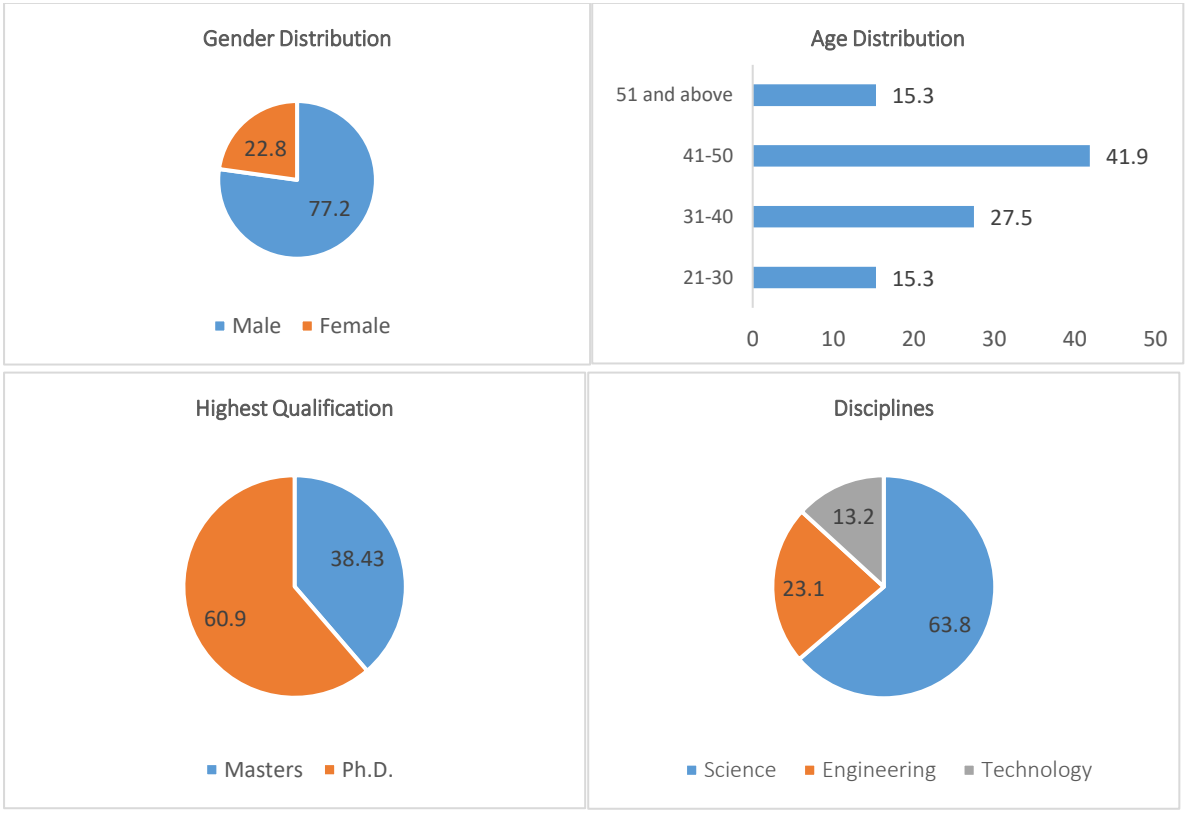
This section discusses the results obtained from the data analysis. This presents some basic demographic characteristics of the faculty while the subsequent sections discuss the results of the exploratory analysis, correlation and regression analysis where important determinants of academic entrepreneurship are elaborated.

4.1 Background Information of the Faculty Members

Figure 1 shows the demographic characteristics of the faculties who participated in the survey. Majority of the faculty members (77.2%) are male gender while only few of them are females (22.8%). This is a clear evidence of what obtains in Nigerian universities, more males across all departments. In science, engineering and technology departments considered in the study, there is the dominance of male gender, considering the capacity assessment report conducted across all Nigerian universities in 2010 by the Federal Ministry of Education (FME, 2010). There are younger faculty in the universities (21-40 years) which makes up about 42.8% of them. Those within the age range of 41-50years are also very key to manpower development in the universities and potential for possible entrepreneurship activities. As expected, majority of them are married (79.3%) and many of them (60.9%) possessed PhD degrees. The minimum qualification for lecturing in the Nigerian universities is PhD degree. However, for those with master degree, they have to show the potential to undertake doctoral programme by scoring a minimum sixty percent (60%) which is referred to as the PhD grade. In addition, it is believed that research outputs from these departments and faculties of these calibre could address specific societal problems which have potential for commercialisation. Majority of the faculty (63.8%) have their background in science, few of them (23.1%) and (13.2%) have engineering and Technology background respectively. Faculty members from these fields have been the major producers of intellectual property in the Nigerian universities, particularly patents and new product development (NOTAP, 2019). In some of the universities visited, faculty of technology, specifically the department of Agricultural Engineering and Mechanical Engineering produced more patents and innovations than others department. This may be as a results of their practical engagement with the industry and revers-engineering activities.

Further, the academic portfolio of the faculty members was also examined including current position in the university, work experience, type of research they conduct and whether they belong to any research group. The results as presented in Table 4.1 showed that fewer academics (17.1%) are on professorial cadre and majority of them (33.3%) are lecturer II. On the work experience, majority of the faculty (46.7%) have always worked in the academics while very few (18.9%) have earlier worked in the industry.

Figure 1: Demographic Distributions of Faculty Members



N=229

It has been established that industry experience has great influence on the propensity of academic to commercialise research outputs (Haeussler and Colyvas, 2011). About 19% of the faculty members do not have any work experience, as implied from those who reported not applicable. It is important to note that about 10% of the faculty members reported that they had previously worked in research institutes. There is a prevalence of applied and experimental researches among the faculties. About 27.8% of faculty members also engaged actively in basic research.

Table 4.1: Faculty's Academic Portfolio

	Percentage
Current Position	
Lecturer II	33.3
Lecturer I	28.9
Senior Lecturer	20.0
Reader/Associate professor	10.7
Professor	7.1
Work Experience (Place)*	
Industry	18.9
Academic	46.7
Research institute	10.1
NGO	4.4
International Organisation	0.9
Not applicable	19.4
Types of Research	
Basic	27.8
Applied	37.2
Experimental	35.0

N=229, *Multiple response

4.2 Exploratory Analysis of Academic Entrepreneurship in Nigeria

The fifteen items that captured academic entrepreneurship activities among the faculty members, as earlier discussed in section 3 of this paper, were subjected to data reduction strategy (Adelowo and Surujlal, 2020). These items, as presented in Table 4.2, shows the results of the principal component analysis (PCA) and how the variables of AE were prepared for robust statistical tests and analysis. PCA was conducted using Promax with Kaiser Normalisation as suggested by Costello and Osborne (2005) which produced an oblique rotation and allows factors to share variance. The results showed that the Barlett's Test of Sphericity was statistically significant (1447.004, df = 105, $p<0.000$), and the Keiser-Meyer-Olkin index of 0.884 was 'meritorious' (using the thresholds proposed by Kaiser, 1974). The analysis identified four factors with Eigenvalues greater than 1.0, and accounting for 67.42% of the variance. The 'elbow' in the scree plot and 'principle of parsimony' (Handfield and Melnyk, 1998) suggested retaining the four factors. The four factor correlations and scree plot are presented in Appendix 1. The first factor dimension was found to be dominant, accounting for 43.3% of the variance, while others account for 9.04%, 7.93% and 7.15%. In addition, these factors followed theoretical richness as they represent entrepreneurial engagements of faculty members (Gjerding et al., 2006; Jain *et al.,* 2009; Jansen *et al.,* 2009; Rizzo, 2010; De Silva, Uyarra and Oakey, 2011; Cantaragiu, 2012; Lewandowski, 2015; Gulbrandsen, 2016). The structure matrix, as reported in Appendix 1, shows the correlations between the items and the factors. The coefficients reflect all paths from a variable to a factor, since the factors are themselves correlated. In naming the variables, the paths from variables to factors were considered.

Factor one with four strong items correlations related to the contributions of faculty members to *(a) the formation of joint ventures in which university and industry are joint partners, (b) formation of one or more new spin off companies owned by the university, (c) formation of university centres designed to carry out commercialisation and (d) contract research for industry through your university*. These factors were pooled together and named as university-related entrepreneurial engagements (UREE).

Six items correlated strongly with factor two, these items were *(a) formation of company to commercialise own research output, (b) formation of company through personal industry collaboration, (c) collaborating with industry through joint research project, (d) serving as consultants to firms/companies while still being attached to university (e) developing products or services which have potential for commercialisation and (f) patenting of research outputs.* The factor was renamed start-up formation and industry collaboration activities (SUFIC) of faculty members.

Table 4.2: Factor Loadings from Exploratory Factor Analysis of AE Engagements

Structure Matrix	Components				Cronbach's α
	1	2	3	4	
UREE1 Contributing to the formation of joint ventures in which university and industry are joint partners	**.889**	.539	.414	.373	**0.878**
UREE 2 Contributing to the formation of one or more new spin off companies owned by the university	**.886**	.524	.236	.317	
UREE 3 Contributing to the formation of university centres designed to carry out commercialization e.g. incubator and science parks	**.885**	.469	.469	.462	
UREE 4 Contract research for industry through your university	**.680**	.459	.649	.443	
SUFIC1 Formation of company to commercialise own research output	.512	**.842**	.173	.305	
SUFIC2 Formation of company through personal industry collaboration	.563	**.831**	.261	.425	
SUFIC3 Collaborating with industry through joint research project	.386	**.765**	.561	.365	**0.845**
SUFIC4 Serving a consultants to firms/companies while still being attached to university	.445	**.741**	.489	.506	
SUFIC5 Developing products or services which have potential for commercialisation	.216	**.649**	.647	.385	
SUFIC6 Patenting of research output	.521	**.590**	.341	.587	
FE1 Placing students as trainee in the industry	.275	.248	**.823**	.265	0.93*
FE2 Conducting seminars and training session for industry	.465	.405	**.678**	.430	0.89*
TRE1 Initiating the development of new degree programme for schools	.417	.370	.453	**.845**	**0.71**
TRE2 External teaching for which you are paid e.g. sabbatical	.228	.324	.212	**.829**	
TRE3 Attracting fund from government and non-governmental bodies for research	.294	.530	.457	**.611**	
Variance Explained	**43.30**	**9.04**	**7.93**	**7.15**	**0.903**

*Individual item Cronbach's Alpha

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Factor three has two items strongly correlated on it, they are; *(a) placing students as trainees in the industry and (b) conducting seminars and training session for industry*. This factor is renamed faculty externship activities (FE). The fourth and the last factor related to the *development of new degree programmes for schools other than their institutions of primary assignment, external teaching for which they were paid and the tenacity to attract funding from either government or non-governmental organisations*. The three items correlated strongly with the fourth factor, and was renamed Teaching and grant related entrepreneurial (TGRE) activities.

Further, construct reliability (CR) test was performed on all the items used in the factor analysis above, the result showed good overall construct reliability with Cronbach Alpha of 0.903. Each factor's Cronbach Alpha is also presented as part of Appendix 2.

4.3 Antecedents of Academic Entrepreneurship in Nigeria

Two layers of analysis were conducted to estimate important antecedents of AE in Nigeria's universities. Correlation analysis was done to establish the relationship between AE and key independent variables, followed by regression analysis to estimate the strength and contribution of independent variables to AE among the faculties. The results of the correlation analysis, as presented in Table 4.3, showed that gender of the faculty had non-significant negative correlation ($r=-0.54$, $p<0.43$) with university-related entrepreneurial engagements indicating that the male gender were more entrepreneurial than their female counterparts in selected universities. Similar results have been established in literature, particularly among students of higher education both in Singapore (Wang and Wong, 2004) and Nigeria (Siyanbola *et al.*, 2012b; NACETEM, 2012; Adelowo, 2018). However, gender has positive relationship with other categories of AE, that is SUFIC, FE and TRE. Generally, all the correlation coefficients are small.

Furthermore, age of the faculty is an important consideration for engagement in university-related entrepreneurial engagement, as negative correlation has been established between age of the academics and all categories of AE. This may be that faculty members in this categories are young and preparing for academic career with little or no attention on AE. In addition, most academics in this age do not have sufficient resources and experience to engage in other activities, as they are striving to build their academic career. However, the results show that middle age only shows positively significant correlation with UREE. Although, the middle age (31-40years) showed positive relationship with SUFIC and FE activities, but the relationships are not significant. This age category also has negative correlations with TRE, although not significant. Finally, on age of the academics and AE, there is a mixed result between the age of older academic and the category of AE that they engage in. For instance, age of older academics has negative but significant relationship with UREE while it was positive for the TRE. Here, it could be argued that older academics have more experience to engage in TRE, probably because of the training components whereas for the UREE, it is negative.

Table 4.3: Correlation Analysis of Antecedents of Academic Entrepreneurship Among Faculty Members

	UREE	SUFIC	FE	TRE
Gender	-.054	.093	.126	.104
Age1 (21-30years)	-.036	-.098	-.225**	-.156*
Age2 (31-40years)	.183*	.119	.092	-.039
Age3 (41-50years)	-.031	.035	.017	.030
Age4(Above 50years)	-.156*	-.109	.070	.154*
Work Experience	.158*	.022	.053	.203**
IP disclosure	.196**	.034	.149*	.196**
Tangible R&D outputs	.277**	-.040	.079	.000
Basic research	.034	.041	-.043	.079
Applied research	.208**	.128	.202**	-.115
Experimental research	.174*	.056	.195**	.010
Entrepreneurial Orientation:				
Innovativeness	.027	.128	.060	.039
Risk-taking	.071	.165*	-.021	.040
Proactiveness	.109	.148*	.115	.087
Competitiveness	.190**	.203**	.084	.093
Opportunity recognition	.177*	.201**	.092	.124
Entrepreneurship Trainings:				
Seminar	.225**	.170*	.287**	.228**
Conference	.101	.089	.221**	.157*
Workshop	.051	.150*	.279**	.188**
Entrepreneurship facilities	.273*	.090	-.004	.059

**P<0.01, *P<0.05

Legend: UREE-University-related entrepreneurial engagement
SUFIC: Start-up formation and industry collaboration
FE: Faculty externship
TRE: Training-related entrepreneurial engagement

The work experience (r=0.16, p<0.05), intellectual property disclosure (r=0.20, p<0.01) and whether faculty members have tangible research output (r=0.28, p<0.05) showed positive and significant relationship with university-related entrepreneurial engagements (UREE). Also, applied (r=0.21, p<0.05) and experimental (r=0.17, p<0.05) research showed significant relationship with UREE. One of the entrepreneurship trainings attended which showed significant relationship with UREE was seminars (r=0.23, p<0.01) and entrepreneurial facilities (r=0.27, p<0.05) equally showed significant positive relationship. The entrepreneurial facilities here included the entrepreneurship centres, intellectual property offices and incubation centres. The entrepreneurial orientations of faculty members showed significant relationship with UREE, particularly, opportunity recognition (r=0.18, p<0.01) and competitiveness (r=0.19, p<0.05).

On the start-up formation and industry collaboration (SUFIC) elements of academic entrepreneurship, entrepreneurial orientations, particularly risk-taking (r=0.17, p<0.05), pro-activeness (r=0.15, p<0.05), competitiveness (r=0.2, p<0.01) and opportunity recognition

(r=0.2, p<0.01) together with entrepreneurship training (r=0.17, p<0.05) showed significant and positive relationship with SUFIC. This is an indication that entrepreneurial orientation of faculty members and trainings attended played positive role in stimulating their potential for start-up formation and industry collaboration in the universities. This is supported by Kamariah *et al.* (2015) where entrepreneurial orientation showed positive relationship with entrepreneurial behaviour among the faculties. Of course and as expected, risk taking ability is key to SUFIC as it shows statistically significant relationship. It is noteworthy to see that work experience, gender, types of research, intellectual property disclosure and age were not statistically significant but positive relationship with SUFIC were evident.

The third strand of AE, faculty externship (FE), which relate essentially with conducting seminars and training sessions for industrialists and placing students as trainees in the industry. There is positive and significant relationship between FE and intellectual property disclosure (r=0.15, p<0.05), entrepreneurship trainings attended, particularly seminars (r=0.29, p<0.05), workshop (r=0.28, p<0.01) and conferences (r=0.22, p<0.05), and two types of research conducted by the faculties: experimental (r=0.2, p<0.01) and applied (r=0.2, p<0.01).

Finally, the final category of AE, training and grant related entrepreneurial engagement (TRE), which is closely related to traditional academic activities, showed positive relationship with work experience (r=0.20, p<0.01), IP disclosure (r=0.2, p<0.01), and entrepreneurial trainings: seminar (r=0.23, p<0.01), workshop (r=0.19, p<0.01) and conference (r=0.15, p<0.05).

Regression analysis to determine the strengths and direction of the relationships between the four categories of TAE and their influencing factors (independent variables) was performed. In general, different categories of academic entrepreneurship were influenced by different factors. The results of the analysis as presented in Table 4.4 shows that age matters for all categories of AE, as younger age (21-30 years) tends to have negative but statistically significant effect on UREE (β=-0.77, p<0.01). This is consistent with academic practices in Nigeria, as most faculties that are chosen to engage in these activities are in most cases, experienced. Faculties within the age category 41-50years however show positive contribution to UREE (β=0.34, p<0.1) and those above 50years also showed negative relationship. The results are instructive because young academics and those above 50years of age do reduce the values of UREE while those within the age of 41-50years add to it. This suggests that when universities are considering selection into certain committee who would think through participation of university in the UREE activities, middle aged academics have greater chance or likelihood of making positively useful contributions.

Further, other key statistically significant and positive variables that contribute to UREE are intellectual property disclosure (β=0.56, p<0.01), creation of tangible research output (β=0.36, p<0.05), innovativeness (β=0.38, p<0.05), competitiveness (β=0.32, p<0.05) and existence of patent office (β=0.66, p<0.01). Although, there are other variables which showed positive but not statistically significant contributions to this category of AE engagements. Overall, these

variables explained 40.4% of the factors which influenced UREE among faculty members in Nigerian university system.

Table 4.4: Regression Analysis Showing Antecedents of Academic Entrepreneurship

Independent variables	UREE	SUFIC	FE	TRE
Constant	0.82	-1.218	.382	-1.363
Age: 21-30years	-.766**	-.428	-.585*	-.305
41-50years	.335***	-.293	-.041	-.084
Above 50years	-.377	-.697*	.103	.318
Gender	.044	.459*	.291	.358***
Basic Research	.446	.180	1.439***	.698
Applied Research	.756	.059	1.627*	.229
Experimental research	.294	.170	1.120	.397
Work experience	.117	.060	-.027	.117
IP disclosure	.563**	.075	.398***	.505*
Tangible research outputs	.359*	-.097	.149	-.048
EO: Innovativeness	.375*	-.124	-.069	.195
Risk-taking	.085	.098	-.012	.034
Proactiveness	.148	.021	.006	.138
Competitiveness	.323*	.205	.138	.259
Opportunity recognition	.056	.009	.039	.114
ET: Seminar	.266	.187	.236	.246
Conference	.226	.088	.186	.170
Workshop	.026	.272	.195	.142
Entrepreneurship facilities:				
Incubator	.040	0.054	.127	.226
PO	.658**	.407*	.139	.141
CED	.033	.180	.171	.019
R	63.6%	43.9%	52.8%	51.6%
R^2	40.4%	19.3%	27.8%	26.6%
ANOVA (F)	3.76**	$1.32^{n.s}$	2.14**	2.01**

The dependent variables are UREE, SUFIC, FE and TRE

Beta coefficient were reported in all cases
p<0.05*, P<0.01**, p<0.1***

This finding is consistent with literature as studies have shown that academics with tangible research outputs and intellectual property have the propensity to be explore options for its commercialisation and become academic entrepreneurs (Link and Siegel, 2007; Thune *et al.*, 2016). At the same time the entrepreneurial orientation of the faculty members, particularly the innovativeness and competitiveness as well as the presence of technology transfer office are important in the stimulation of UREE. Therefore, university stakeholders have to pay attention to these variables when charting appropriate pathway for innovation and development of entrepreneurial university.

For the start-up formation and industry collaboration (SUFIC) aspect of AE, two variables showed positive and significant relationship with it and they are gender (β=0.46, $p<0.05$) and entrepreneurial facilities, patent office (β=0.41, $p<0.05$). This result showed clearly the need for entrepreneurial facilities in these institutions to further enhance start-up formation and industry collaboration among the faculty members. The results also indicate that gender constituted an important factor to consider when providing incentives for start-up formation and industry collaboration. Furthermore, the incentive at this point could be designed to respond to gender imbalance among the academics, particularly to prompt positive response from female faculty members. Other important factors which contributed positively to the model included applied research, work experience, IP disclosure, entrepreneurial trainings and orientations, although they were not statistically significant. However, the negative coefficient on age indicated that as academics grow older, their contribution to SUFIC declines. This result is in line with existing literature on the inverse relationship that exists between age and entrepreneurial propensity/behaviour/practice. All the variables explained 19.3% of factors which influenced SUFIC among the faculty members in the selected universities.

Faculty externship (FE) was significantly influenced by three key variables including, type of research conducted such as basic research (β=1.44, $p<0.1$) and applied research (β=1.63, $p<0.05$) with high coefficients. Younger Age (β=-0.59, $p<0.05$) and intellectual property disclosure (β=0.40, $p<0.1$) also showed statistically significant contribution to faculty externship, although age was on the negative side. These variables explained 27.8% of factors influencing faculty's engagement in this type of AE. Gender and work experience were not significant to FE in this study.

Lastly, training and grant related entrepreneurial engagement was influenced by gender (β=0.36, $p<0.1$) and intellectual property disclosure (β=0.51, $p<0.05$). These variables among others explained 26.6% of factors influencing TRE among the faculty members in the selected universities.

5 Conclusion and Policy Recommendations

This paper had explored AE in the thirteen selected universities in the Southwest Nigeria. The paper identified fifteen different strands of activities that were regarded as AE, which were then categorised into four based on data reduction strategy-PCA. Important antecedents of each category was identified using correlations and regression analyses. The study concluded that individual factors such as gender, age and work experience, including entrepreneurial orientation influence each category of AE differently. For instance, work experience did not show statistically significant contribution to the four categories of AE, although it contributed positively to them, except for FE. There are mixed results for age as a factor influencing different categories of AE. For young academics, their involvement in all categories of AE may not be encouraged as this could be the grooming periods for their academic careers. In fact, their engagement in AE has negative effect on all AE categories. The study also observed

strong and positive relationship between middle-aged academics and UREE suggesting that faculty members in this age category have potentials to add value to AE. Gender has positive relationship with all the four categories of AE, however the relationship with SUFIC and TRE were significant. Entrepreneurial orientation of faculty members, particularly innovativeness and competitiveness strongly contribute to UREE, as a category of AE. Moreover, of the three categories of researches identified in the study, basic and applied research have strong relationship with FE, although others also have positive relationship with other three categories of AE. As expected, intellectual property disclosure has strong and positive relationship with UREE, FE and TRE. Surprisingly, the relationship with SUFIC was not significant and the contribution small. Entrepreneurial training attended by the faculty members whether through seminar, workshop and conferences showed no significant relationship with any of the four categories of AE, although the direction of the relationships are positive. Entrepreneurship training tends to enhance capacity for entrepreneurship among the faculty, although the contents of the training and its delivery modes matter. On entrepreneurship facilities, the existence of patent office (PO) was found to be of important relevance to UREE and SUFIC, as it showed positive and significant relationship to the two categories. This suggests that these facilities are critical to boosting academic entrepreneurship in the universities.

From the foregoing, important policy suggestions were made to relevant stakeholders, particularly government, university administrators and faculty members. First, there is urgent need by the government to establish (where none exist) and strengthen existing entrepreneurship facilities within the university system across the country. Establishment of professorial cadre like 'professor of practice' could be encouraged in the university system to promote innovation and academic entrepreneurship. There is a need for universities to revisit the reward system in order to incentivise technology commercialisation, patent disclosures and industry related activities. Good entrepreneurial orientation among the faculty members could be harnessed by the university to create spin-offs and innovations if robust incentive system is created, for example special recognition and award of excellence for executing impactful projects. All of these could be provided for in the institutional intellectual property policy and innovation fund among others. Entrepreneurship training targeting faculty members in science, engineering and technology fields could be organised and, or strengthened to further create the consciousness of innovation among faculty members in various universities. This suggestion does not preclude the existing entrepreneurship programme targeted at the students. Universities may also take advantage of the provisions in the Nigeria's STI policy and TETFUND to co-develop tailor-made strategy and facilities that can foster research commercialisation and innovation within the system.

REFERENCES

Abereijo, I. O. (2015). Transversing 'the Valley of Death': Understanding the Determinants to Commercialisation of Research Outputs in Nigeria. *African Journal of Economic and Management Studies, 6 (1): 90-106.*

Adelowo, C. M. (2018). Factors influencing Academic entrepreneurship in Nigerian universities. International Journal of Innovation and Regional Development, 8 (4): 337-357.

Adelowo, C. M., Akinwale, Y. O., and Olaopa, O. R. (2017). Innovation and knowledge transfer in Nigeria International Journal of Research, Innovation and Commercialisation 1 (1), 57-73.

Adelowo C. M. (2021). Motivation for academic entrepreneurship in a developing country. International Journal of Entrepreneurship, 25 (6): 1-10.

Bekkers, R. and Bodas Freitas, I. M. (2008). Analysing Knowledge Transfer Channels between Universities and Industry: To what Degree do Sectors also Matter? Research Policy, 37 (10): 1837–1853.

Boardman, P. C. (2009). Government Centrality to University–industry Interactions: University Research Centers and the Industry Involvement of Academic Researchers. *Research Policy, 38 (10): 1505–1516.*

Bonaccorsi, A. and Piccaluga, A. (1994). A Theoretical Framework for the Evaluation of University-industry Relationships. *Research and Development Management, 24 (3): 229-247.*

Bozeman, B. and Gaughan, M. (2007). Impacts of Grants and Contracts on Academic Researchers' Interactions with Industry. *Research Policy, 36 (5): 694–707.*

Cantaragiu R. (2012). Towards A Conceptual Delimitation of Academic Entrepreneurship. Management and Marketing Challenges for the Knowledge Society, 7 (4): 683-700.

Carayol, N. (2003). Objectives, Agreements and Matching in Science-industry Collaborations: Reassembling the Pieces of the Puzzle. Research Policy, 32 (6): 887-908

Clark, B. R. (1998). Creating Entrepreneurial Universities: Organizational Pathways of Transformation. Pergamon: New York

Clarysse, B., Tartari, V. and Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. Research Policy, 40 (8): 1084–1093.

Costello, A. B. and Osborne, J. W. (2005). Exploratory Factor Analysis: Four Recommendations for getting the most from your Analysis. Practical Assessment, Research, and Evaluation, 10 (7): 1-9.

Crane, D. (1972). Invisible Colleges: Diffusion of Knowledge in Scientific Communities. University of Chicago Press, Chicago.

De Silva, L. R., Uyarra, E. and Oakey, R. (2012). Academic Entrepreneurship in a Resource-Constrained Environment: Diversification and Synergistic Effects. *Technology Transfer in a Global Economy, 28 (International Studies in Entrepreneurship):73-97.*

D'Este, P. and Patel, P. (2007). University-industry Linkages in the UK: What are the Factors Determining the variety of Interactions with Industry? *Research Policy, 36 (9): 1295-1313*.

Etzkowitz, H. (1998). The Norms of Entrepreneurial Science: Cognitive Effects of the new University-industry Linkages. *Research Policy, 27 (8): 823-833*.

Etzkowitz, H. (2003). Innovation in Innovation: The Triple Helix of University-Industry-Government Relations. *Social Science Information, 42 (3): 293-338.*

Etzkowitz, H. and Leydesdorff, L. (2000). The Dynamics of Innovation: From National Systems and Mode 2 to a Triple Helix of University–industry–government Relations. *Research Policy, 29 (2): 109–123.*

Feller, I. (1990). Universities as Engines of R&D-based Economic Growth: They Think they Can. *Research Policy, 19 (4): 335-348.*

Fini, R., Grimaldi, R., Santoni, S., & Sobrero, M. (2011). Complements or substitutes? The role of universities and local context in supporting the creation of academic spin-offs. Research Policy, 40(8), 1113–1127.

Gjerding, A. N., Wilderom, C. P. M., Cameron, S. P. B., Taylor, A., Scheunert, K. (2006). Twenty Practices of an Entrepreneurial University. *Higher Education Management and Policy, 18 (3):1-28*. Glassman, A. M., Moore, R. W., Rossy, G. L., Neupert, K., Napier, N., Jones, D. E. and Harvey, M. (2003). Academic Entrepreneurship: Views on Balancing the Acropolis and the Agora. *Journal of Management Inquiry, 12 (4): 353-374*.

Goldfarb, B. and Henrekson, M. (2003). Bottom-up versus Top-down Policies towards the Commercialisation of University Intellectual Property. Research Policy, 32 (4): 639–658.

Grimaldi, R., Kenney, M., Siegel, D. S. and Wright, M. (2011). 30 years after Bayh–Dole: Reassessing Academic Entrepreneurship. Research Policy, 40 (8): 1045–1057.

Guerrero, M., Cunningham, J. A. and Urbano, D. (2015). Economic Impact of Entrepreneurial Universities' Activities: An Exploratory Study of the United Kingdom. Research Policy, 44 (3): 748–764.

Haeussler, C. and Colyvas, J. A., (2011). Breaking the Ivory Tower: Academic Entrepreneurship in the Life Sciences in UK and Germany. Research Policy, 40 (1): 41–54.

Hall, B. H., Link, A. N. and Scott, J. T. (2000). Universities as Research Partners. Review of Economics and Statistics, 85 (2): 485-491.

Henrekson, M. and Rosenberg, N. (2001). Designing Efficient Institutions for Science based Entrepreneurship: Lesson from the US and Sweden. The Journal of Technology Transfer, 26 (3): 207–231.

Jain, S., George, G. and Maltarich, M. (2009). Academics or Entrepreneurs? Investigating role Identity Modification of University Scientists involved in Commercialisation Activity. *Research Policy, 38 (6), 922–935.*

Kamariah, I. Melati, A. A., Wan Omar, W. Z., Aziz, A. A., Khairiah, S. and Akhtar, C. S. (2015). Entrepreneurial Intention, Entrepreneurial Orientation of Faculty and Students Towards Commercialization. *Procedia - Social and Behavioral Sciences, 181: 349-355.*

Lee, S., Bozeman, B. (2005). The Impact of Research Collaboration on Scientific Productivity. *Social Studies of Science, 35 (5): 673–702.*

Lee, Y. S. (1996). Technology Transfer and the Research University: A Search for the Boundaries of University–industry Collaboration. *Research Policy, 25 (6): 843–863.*

Link, A. N., Siegel, D. S., and Bozeman, B. (2007). An Empirical Analysis of the Propensity of Academics to Engage in Informal University Technology Transfer. Industrial and Corporate Change, 16 (4): 641–655.

Louis, K. S., Blumenthal, D., Gluck, M. E. and Stoto, M. A. (1989). Entrepreneurs in Academe: An Exploration of Behaviours among Life Scientists. Administrative Science Quarterly, 34 (1): 110-131.

Louis, K. S., Jones, L. M., Anderson, M. S., Blumenthal, D. and Campbell, E.G. (2001). Entrepreneurship, Secrecy, and Productivity: A Comparison of Clinical and Non-clinical Life Sciences Faculty. The Journal of Technology Transfer, 26 (3): 233–245.

Martinelli, A., Meyer, M. and Von Tunzelmann, N. (2008). Becoming an Entrepreneurial University? A case Study of Knowledge Exchange Relationships and Faculty Attitudes in a Medium-sized, Research-oriented University. Journal of Technology Transfer, 33 (3): 259–283.

Miranda, F. J., Chamorro-Mera, A and Rubio, S. (2017). Academic entrepreneurship in Spanish universities: An analysis of the determinants of entrepreneurial intention. European Research on Management and Business Economics 23 (2): 113–122.

Mowery, D. C. and Nelson, R. R. (Eds.) (2004). Ivory Tower and Industrial Innovation University-industry Technology before and after the Bayh-Dole Act. Stanford University Press: Stanford.

NACETEM (2012). Characterisation of Technological Entrepreneurship Education in Nigeria Tertiary Institutions: Structure, Content and Delivery System. Hi-Digiit, Nigeria.

Oyewale A. A. (2003). Evaluation of the Interactions among the Key Components of Science and Technology and Innovation System in Nigeria. Unpublished Ph.D thesis, Technology Management, to Technology Planning and Development Unit, Faculty of Technology, Obafemi Awolowo University, Ile-Ife.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M. Llerena, P., Lissoni, F., Salter, A. and Sobrero, M. (2013). Academic Engagement and Commercialisation: A Review of the Literature on University–Industry Relations. *Research Policy, 42 (2): 423-442.*

Perkmann, M., Walsh, K. (2007). University-industry Relationships and Open Innovation: Towards a Research Agenda. *International Journal of Management Reviews, 9 (4): 259-280.*

Rizzo, U. (2010). The Governance of Knowledge in Academic Spin-Offs. Manchester Business School Working Paper, Number 593.

Shane, S. A. (2004). Academic Entrepreneurship: University Spinoffs and Wealth Creation. Edward Elgar: Cheltenham.

Shane, S. A. (2005). Economic Development through Entrepreneurship: Government, University and Business Linkages. Edward Elgar: Cheltenham.

Siegel, D. S., Veugelers, R., and Wright, M. (2007). Technology Transfer Offices and Commercialisation of University Intellectual Property: Performance and policy Implications. *Oxford Review of Economic Policy, 23 (4): 640–660.*

Siyanbola W. O., 2019. Stimulating the culture of innovation in a latecomer economy for sustainable development. A keynote paper presented at the 1st International Conference on knowledge and Innovation Management, organised by Babcock University, Ilesan, Ogun state, Nigeria, 15-18 January, 2019.

Siyanbola, W. O., 2014. Enterprise-Based Economy for sustainable development A 2014 distinguished annual lecture paper presented at the national institute for policy and strategic studies, Kuru (NIPSS), Jos. National Institute, Kuru, Jos.

Siyanbola, W. O., Ishola, O. O., Adelowo, C. M. and Egbetokun, A. A. (2011). R&D and the Challenge of Wealth Creation in Nigeria. *Asian Research Policy, 2 (1): 20-35.*

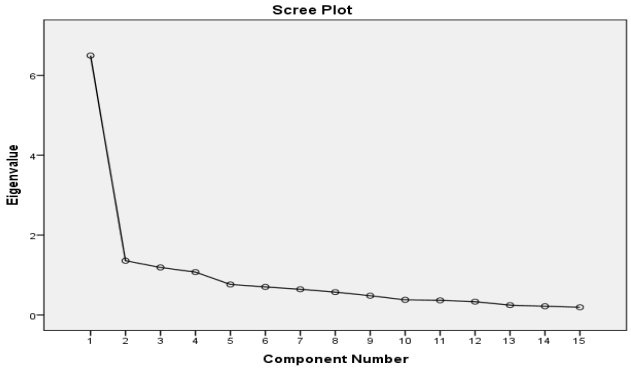
Siyanbola, W.O., Afolabi, O.O., Jesuleye, O.A., Egbetokun, A.A., Dada, A.D., Aderemi, H.O., Sanni, M. and Rasaq, M.A. (2012). Determinants of Entrepreneurial Propensity of Nigerian Undergraduates: An Empirical Assessment. *Int. Journal of Business Environment, 5 (1): 1–29.*

Slaughter, S. and Leslie, L. (1997). Academic Capitalism: Politics, Policies, and the Entrepreneurial University. Baltimore, MD: Johns Hopkins University Press.

Thune, T., Reymert, I., Gulbrandsen, M. and Aamodt P-O. (2016). Universities and External Engagement Activities: Particular Profiles for Particular Universities? *Science and Public Policy first published online June 10, 2016* Doi:10.1093/scipol/scw019.

Wang, C. K. and Wong, P. (2004). Entrepreneurial Interest of University Students in Singapore. *Technovation, 24 (2): 163-172*

Appendix



Appendix 1: Scree Plots of the CPA performed on the technological academic entrepreneurship constructs

Component Correlation Matrix

Component	1	2	3	4
UREE	1.000	.528	.380	.427
SUFIC	.528	1.000	.447	.495
FE	.380	.447	1.000	.462
TRE	.427	.495	.462	1.000