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Determinants of research collaboration towards a knowledge-based economy in Ghana

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Abstract
The purpose of this study was to analyse the determinants of the intention of academic researchers to collaborate on research projects with the carriers of innovation. An explanatory sequential mixed-methods approach was employed to analyse survey data from 266 stratified sampled researchers and 11 key informants from different disciplines in two of Ghana's public universities. Analysis of variance results showed a quite high intention to collaborate, with no statistically significant differences across disciplines. Regression results indicate that attitude was the leading predictor of intention to collaborate, and it was explained by the conviction and relevance attached to the capacity of research collaboration to speed up career advancement, to be a source of income and to be a means of advancing research work. Perceived behavioural control, explained by research capability and boundary-spanning skills, and environmental possibility, made up of funding, reward and administrative support, also influenced the intention of respondents to engage in research collaboration. The authors therefore propose that the universities should acknowledge and count research collaboration as a criterion in the promotion of academics and, together with national actors, should spearhead the establishment of a national research and innovation fund, research and innovation award schemes, and the requisite administrative support.

Keywords
Collaboration determinants, entrepreneurship, innovation, intention, research collaboration

From the advent of Schumpeter's theory of economic development to endogenous growth models and the knowledge spillover theory of entrepreneurship, it has been well established that knowledge or research output and innovation are fundamental co-drivers of economic growth and development (Acs et al., 2013; Schumpeter, 1983 [1934]). For instance, a test of the knowledge spillover theory of entrepreneurship by Acs et al. (2009) proved that the more efficiently knowledge flows over from entities such as universities and research institutions to other entities for exploitation, the greater the effect of new knowledge on entrepreneurship for innovation, competitiveness, growth and development. Reciprocal effects have also been found, for example, by Karlsson and Andersson (2009) who note that the location of industrial research and development (R&D) in Sweden is quite sensitive to the location of university R&D and vice versa, with a stronger sensitivity for the latter.

In this context, there is a growing recognition of planned interventions in support of research and innovation-driven interactions among the key actors in the knowledge-based economy (Becker, 2015; Ranga and Etzkowitz, 2013). Major national interventions include the enactment of policies and legislation, such as the Bayh–Dole Act in the United States, the formalization of collaboration in Sweden aimed at enhancing the incentives and rewards for research and innovation-driven interaction and the establishment of research foundations and councils that set and direct national and regional research and innovation agendas (Grimaldi et al., 2011; Henrekson and Rosenberg, 2001).

In Ghana, the Council for Scientific and Industrial Research (CSIR) and public universities are the principal actors in charge of knowledge production in the country's

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knowledge-based economy. The CSIR was established in 1968 to implement government policies on scientific R&D and to promote the commercialization of research results through 13 research institutes, in the areas, among others, of agriculture, health, medicine, environment and technology (Asare and Essegbey, 2016). The CSIR also coordinates and administers the operations of the Science and Technology Research Endowment Fund (STREFund) which is governed by a board of trustees with representation from the CSIR, the Association of Ghana Industries, the Ministry of Finance and Economic Planning, universities, the National Council for Tertiary Education, the Ghana Academy of Arts and Sciences and the Ghana Atomic Energy Commission (Ministry of Environment, Science and Technology, 2010; Mouton et al., 2015). Mouton et al. (2015) argue that the board is a mechanism by which the STREFund, as a second-layer agent, satisfies the interests of the CSIR as its immediate principal.

In addition, Ghana's public universities are mandated, by the laws that established them, to conduct research that will advance the knowledge base of the Ghanaian economy. For example, Section 2 of the Kwame Nkrumah University of Science and Technology (KNUST) Act, Kumasi Act – 1961 (Act 80) enjoins the university to provide higher education, undertake research, disseminate knowledge and foster relationships with outside people and organizations. Similar mandates can be found in the University of Cape Coast (UCC) Law 1992 (PNDC Law 278) and the University of Ghana Act, 2010 (Act 806). For instance, Section 2 of the UCC Law stipulates that the university should execute its knowledge production function with particular reference to the needs and aspirations of the people of Ghana and other countries in Africa (Crabbe, 2005; University of Ghana, 2012).

Research in universities and in public research institutes should be key to Ghana's national research agenda because Ghanaian businesses are relatively under-resourced to conduct adequate research for technological innovation and catch-up (Robson and Obeng, 2008; Sawyerr, 2004). Moreover, the Ghanaian economy, which is mainly driven by the private sector, thrives on the operations of micro, small and medium-sized enterprises which constitute about 92% of businesses in the country (Ameyaw et al., 2016; Mensah and Nyadu-Addo, 2012). These enterprises perform very little of the scientific research necessary for competitive innovation (Robson and Obeng, 2008) and as a result rely on the spillover of knowledge, in the form of research findings, from universities and public research institutes for innovation (Acs et al., 2009). Moreover, the research interests of the few capable firms may not be driven by national research priorities due to conflicting interests like profit maximization versus the conduct of research as a public good (Fuller, 2005).

As a result, some public universities, such as the KNUST and the UCC, have implemented measures in support of research and extension which embrace research collaboration between academic researchers and the carriers of innovation. KNUST was established in 1951, as the Kumasi College of Technology, to promote science and technology in Ghana. It is made up of several academic disciplines in science, technology and the arts, as well as research centres such as the Institute of Human Settlement Research and the Kumasi Centre for Collaborative Research into Tropical Medicine. UCC, on the other hand, was established in 1962 as a University College with the core mandate to promote science education in Ghana. Over the years, UCC has expanded its core mandate to include other academic disciplines, including Development Studies, Business Studies and Health Sciences. The university is home to a number of research units, such as the Centre for Education Research, Evaluation and Development, the Institute for Development Studies and the Laser and Fibre Optics Centre, which, among other things, promote research collaboration.

KNUST and UCC renewed their commitment to research and extension in 2013, with UCC establishing the Directorate of Research, Innovation and Consultancy (DRIC) and KNUST setting up the Office of Grants and Research (OGR). The DRIC and OGR offer a wide range of services, including administrative, financial and technical support to academics for the conduct of research, especially multidisciplinary and policy-driven research. An additional responsibility of the OGR is to complement the efforts of the Technology Consultancy Centre (TCC) at KNUST. The TCC, established in 1972, collaborates with academic departments to research, develop and transfer sustainable technologies to small and medium-scale industries in Ghana. In relation to institutional priorities regarding the contribution of teaching, research and extension activities towards the promotion (career advancement) of academic researchers, the statutes of KNUST and UCC place a (relatively) higher premium on the publication of research findings.

In spite of the various national and institutional interventions, a study by Bartels and Koria (2014) on Ghana's national system of innovation established that the system faces the challenges of extensive coordination failures, an ineffective framework of incentives and a lack of connectivity between actors. Moreover, although in 2000 the government of Ghana launched the first national science and technology policy, the absences of a national research policy and a national research fund have been identified as major sources of coordination failure and ineffectiveness in Ghana's innovation system (Amankwah-Amoah, 2016).

Furthermore, Ghana's gross expenditure on research and development (GERD) as a percentage of gross domestic product (GDP) has been woefully inadequate and below the 1% target of member countries of the African Union, as indicated in the 2014 (second) edition of the *African*

Innovation Outlook (NPCA, 2014). Available statistics show that Ghana's GERD was 0.23%, 0.47% and 0.38% in 2007, 2008 and 2010, respectively (Bartels et al., 2016; Mouton et al., 2015) and the government of Ghana funded 68.3% of the GERD (NPCA, 2014). Consequently, university researchers often seek external sources of funding for their research work. For instance, Van Schalkwyk (2015), in a review of a report on eight flagship African universities, including one in Ghana, notes that universities engaged more in activities such as consulting and service-oriented work, which were fuelled by the need to secure external research funding.

In view of the structural and funding challenges, the government of Ghana has, since 2012, been spearheading consultations on the establishment of a national research fund that will call for competitive grant applications from academic researchers, with the aim of ensuring that society benefits from state-funded research (Vice Chancellors Ghana, 2013). Moreover, the government of Ghana has pledged to devote 1% of GDP to R&D in the short to medium term and to increase the GERD to 2.5% of GDP in the long term (Starrfmonline, 2017).

Cognizant of the myriad challenges and the ardent quest of the nation to drive its development agenda through science and technology, we deemed it expedient to explore and analyse the factors that influence the intention of academic researchers at UCC and KNUST to execute their knowledge production function through recursive interactions aimed at the conduct of research and the commercialization of research output.

The study relied on an extended version of the theory of planned behaviour (Ajzen, 1991; Kautonen et al., 2015), which stipulates that intention is a strong predictor of actual behaviour, and that other factors, including environmental possibility, can also play important role. Specifically, we explored the influence of academic researchers' attitude towards collaboration, their perceived behavioural control (PBC) over collaboration, their subjective norm (SN) on collaboration and their perceived environmental possibility (PEP) for collaboration, on their intention to collaborate with the carriers of innovation in the conduct of research for the advancement of Ghana's knowledge-based economy.

In the sections that follow we review the relevant literature, set out our methodology, discuss the results of the study and summarize our conclusions and recommendations.

Literature review

Research collaboration in the knowledge-based economy

Research is a purposive and curiosity-driven inquiry aimed at producing knowledge (Adria and Boechler, 2004; Sarantakos, 2005). From the perspective of the universal application of knowledge, research is expected to be scientific in nature, and therefore may be viewed as the systematic process of collecting, analysing and interpreting data for a given purpose (Leedy and Ormrod, 2010). Ketokivi and Choi (2014) identify transparency as a key characteristic of scientific research, which calls for access to the logic that generates the research conclusions and the premise that informs such conclusions. This assertion was emphasized in Stokes's (1997) widely adopted quadrant model of scientific research, which categorized it into three main types according to the primary purpose or objective of the research: basic research, applied research and use-inspired basic research.

Whereas basic research, as defined in Stokes's quadrant, is driven by the goal of creating understanding or generating knowledge for its own sake or advancing science, applied research is conducted for the purpose of using the findings to solve problems or generate innovation, and use-inspired basic research embraces both the desire to develop understanding and consideration of practical application (Ooms et al., 2015). Studies, for example those by Calvert (2002) and Shichijo et al. (2015), have shown that university researchers are often interested in basic research due to the advantage of advancing their field of inquiry and their career, while industry is very often interested in applied research for the purpose of innovation. Use-inspired basic research, therefore, presents university researchers and industry with the opportunity to meet their individual and collective aspirations, as posited by Stokes in his quadrant model of scientific research. Nevertheless, studies have shown that all the three research types can eventually contribute to innovation – and in particular that basic research has been the source of various technological breakthroughs (Ahmadpoor and Jones, 2017).

The type of research notwithstanding, the nature, volume of work, skills requirements and resource implications of scientific research ('research' hereafter) often make collaboration an indispensable part of the research process (D'Este and Perkmann, 2011; Gaughan and Bozeman, 2016). Research may therefore be carried out by two or more people from the same institution, or from different institutions (Bozeman et al., 2013); the same may be said of economic sectors (Teirlinck and Spithoven, 2013), nations and global organizations (Blais et al., 2014; Fox et al., 2016). This study, however, focuses on research and innovation-driven interactions between university researchers and the carriers of innovation in all sectors of an economy.

Therefore, drawing on definitions and explanations by Bukvova (2010) and McKelvey et al. (2015), we define research collaboration as interactions, driven by social capital and other resources, for the pursuit of research aimed at advancing knowledge in the field of inquiry and developing innovation or generating opportunities for innovation. Research collaboration constitutes a fundamental feature

of the knowledge-based economy, an economy that thrives on knowledge backed by massive investment in research, innovation and human and social capital (Leydesdorff, 2012) – as opposed to a traditional or factor-driven economy which relies heavily on natural resources and unskilled labour for development (Vares et al., 2011). The significance of research collaboration lies mainly in its capacity to act as a vital medium for the creation and transformation of knowledge, particularly tacit knowledge, into competitive innovations that can spur economic growth and development (Johnson et al., 2002; Robin and Schubert, 2013). The knowledge exchange literature indicates that the tacit dimension of knowledge, a key source of competitive advantage, is embedded in the holder and cannot be easily transferred without the holder's participation in the knowledge exchange process (Karlsson and Andersson, 2009).

As a result, research collaboration becomes critical to the effective transfer and or exchange of tacit knowledge. This role of research collaboration is justified by the fact that innovation drives economic development (Schumpeter, 1983 [1934]), while research findings, an invaluable source of knowledge, must flow over to the carriers of innovation (Acs et al., 2013). In so doing, the stock of economic knowledge, which expands the available set of entrepreneurial opportunities, grows to feed the knowledge base of the economy (Audretsch et al., 2012), thereby augmenting the capacity for innovative and knowledge-driven entrepreneurship which has become 'an important means by which technical change – the unexplained residual in standard growth equations – gets translated into economic growth' (Baumol et al., 2011: 4).

The facilitating role of research collaboration in the knowledge-based economy makes it necessary for actors in the economy to carry out their functions in a recursive manner. Notably, the university (particularly with a research mission), industry (representing the carriers of innovation in all sectors of an economy) and government must recursively interact in their respective roles of knowledge production, innovation and support and regulation (Ranga and Etzkowitz, 2013). Etzkowitz et al. (2000) and Byman and Kroenig (2016) argue that, over the years, the university has been criticized for operating from an 'ivory tower' due to its limited connection with industry and the workplace and with policymakers.

The ivory tower clearly has no place in the knowledge-based economy since collaboration is indispensable to economic development and the university has a critical role to play in that collaboration. An elaboration of the research-related roles of the university by Tuunainen (2013) shows that the university must provide relevant knowledge for industrial innovation (Etzkowitz and Leydesdorff, 1995); undertake research into the functioning of institutions for policy action (Hughes et al., 2011) and offer insights into alternative livelihoods for sociocultural advancement (Tuunainen, 2013). Academic researchers are, therefore, expected to collaborate with knowledge users so that, through the use of embedded resources or the social capital of the interaction, the right knowledge will be produced and eventually utilized for the development of competitive innovations.

Nevertheless, the involvement of university researchers in research collaboration and the capacity of collaboration to drive research and innovation depend on the existence of an enabling environment. Particularly important is an environment that includes structures, systems and incentives that support research collaboration and that will therefore encourage the building of collaborative intentions that will eventually be translated into action (Bartels and Koria, 2014; D'Este and Perkmann, 2011). As stipulated by the theory of planned behaviour (Ajzen, 1991), intention is a strong predictor of actual behaviour; hence, analysis of intention and its predictors is essential to the design of appropriate interventions for the promotion of the desired behaviour.

Theory of planned behaviour and hypotheses development

The theory of planned behaviour posits that 'intentions to perform behaviors of different kinds can be predicted with high accuracy from attitudes towards the behavior, subjective norms, and perceived behavioral control' (Ajzen, 1991: 179). A general rule of the theory is that the stronger the intention to engage in a behaviour, the more likely is its performance (Kautonen et al., 2015). The theory is based on the assumption of individual processing of available information, mediating the effects of biological and environmental factors on behaviour and foregrounding cognitive self-regulation as an important factor (Ajzen, 2011). This assumption is in line with a fundamental feature of extrinsic motivation, which is said to reflect external control or true self-regulation of behaviour (Ryan and Deci, 2000). It is also assumed that behavioural beliefs comprise attitudes towards the behaviour, normative beliefs constitute the underlying determinants of SNs and control beliefs provide the basis for perceptions of behavioural control. In addition, the relative importance of the main antecedents of behaviour is expected to vary across behaviours and situations (Ajzen, 2011; Pearson and Hamilton, 2014).

We therefore propose in Figure 1 that the intention to engage in research collaboration is a function of attitude towards research collaboration, PBC over research collaboration, the SN regarding research collaboration and PEP for research collaboration. Intention, according to Ajzen (1991), connotes a willingness to act or how hard people are willing to try, and how much effort they are planning to exert, to perform a given behaviour. By this definition, intention is compatible with the concept of motivation explained by Ryan and Deci (2000) as being moved to act by factors that are intrinsic or extrinsic to the performance

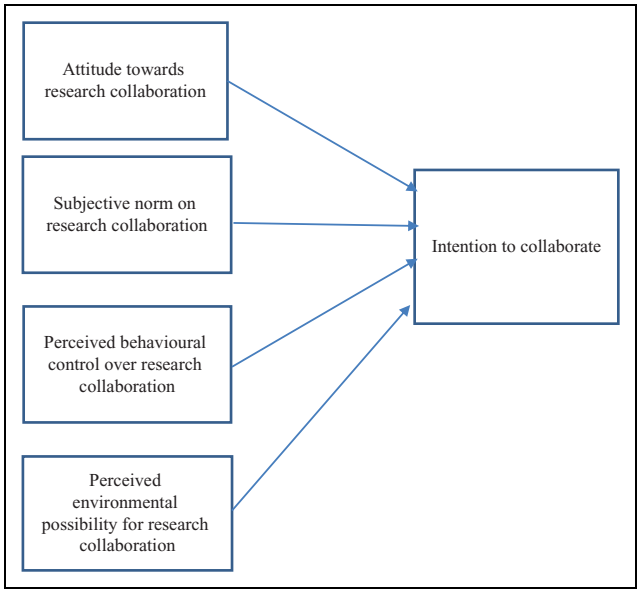

Figure 1. Conceptual framework of the determinants of research collaboration. Source: Authors' construct.

behaviour. One such key factor, according to the theory of planned behaviour, is attitude towards a behaviour; that is, the degree to which a person favourably or unfavourably evaluates a given behaviour in relation to desired opportunities such as advancement and pleasure (Kautonen et al., 2015).

Comparatively, attitude towards behaviour is consistent with the concept of motivators or intrinsic factors that Herzberg (1987 [1968]) explained as comprising advancement and achievement tied to a particular performance behaviour. Like intrinsic motivators, which are deemed to be the primary source of performance satisfaction that influence people to give of their best in performance behaviour (Herzberg, 1987 [1968]), attitude towards behaviour is often regarded as the main predictor of intention in the theory of planned behaviour. For example, a study by Ajjan and Hartshorne (2008) on the determinants of faculty decisions to adopt Web 2.0 technologies at a university in the Southeastern United States found attitude to be the only determinant that had a very significant effect on behavioural intention. Another study, by Cheung and Vogel (2013) in Canada, showed that attitude had a significant positive influence on students' intention to use Google applications in their projects. Consequently:

Hypothesis 1: Attitude to research collaboration has a significant influence on intention to collaborate.

Figure 1 also shows the SN regarding research collaboration as a possible antecedent of intention to collaborate. SN is defined, in the theory of planned behaviour, as the perceived social pressure to perform or not to perform a given behaviour (Ajzen and Klobas, 2013). The element of social pressure makes the SN comparable to the social norm as defined by Granovetter (2005). Granovetter (2005) explains that the social norm consists of shared ideas about the proper way to behave and that, together with the threat of sanctions, the social norm increases the likelihood of trust and the meeting of obligations among close peers.

There have been mixed results on the influence of the SN on intention (Ajjan and Hartshorne, 2008; Cheung and Vogel, 2013). For example, using an extended and decomposed version of the theory of planned behaviour, Cheung and Vogel (2013) aimed to explain the factors that influence the acceptance of Google applications for students' collaborative learning. The main finding of the study was that attitude, self-efficacy, sharing and the SN of peers had a significant positive influence on the intention to use the Google applications in student projects. However, in Ajjan and Hartshorne's (2008) study of the determinants of faculty decisions to adopt Web 2.0 technologies, the SN had no significant effect on behavioural intention. Given the mixed results on the impact of the SN on intention, we propose a non-directional hypothesis as follows:

Hypothesis 2a: The SN regarding research collaboration does not significantly influence the intention to collaborate.

Hypothesis 2b: The SN regarding research collaboration significantly influences the intention to collaborate.

We also advance PBC over research collaboration as a possible antecedent of the intention to collaborate (Figure 1). PBC is defined, in the theory of planned behaviour, as the perceived ease or difficulty of performing a given behaviour. According to Ajzen (1991), PBC is closest in meaning to the concept of perceived self-efficacy as expounded by Bandura (1982). Bandura (1982: 188) explains that 'Perceived self-efficacy is concerned with judgements of how well one can execute courses of action required to deal with prospective situations.'

It is increasingly clear that academics who actively engage with the carriers of innovation are effective in the conduct of research. For instance, Baba et al. (2009) highlight heterogeneity in scientists' capabilities as an important factor in determining their ability to interact with and offer valuable consultancy to firms in the advanced materials sector. A study by Hughes and Kitson (2012) also reveals widespread interest among academics in use-inspired basic research. On the basis of the relevance of research capability and boundary-spanning skills to collaboration, we define PBC as attributable to these two critical factors.

Hypothesis 3: PBC over research collaboration significantly influences the intention to collaborate.

Another important feature of PBC is that it is made up of background factors. For example, Ajzen (2011) provides

further illustration of PBC as including background factors, such as the availability of time and resources, which dictate the likelihood of behavioural achievement. Background factors embedded in the concept of PBC can be likened to hygiene or extrinsic factors. According to Cerasoli et al. (2014), hygiene factors offer the prospect of instrumental loss or gain and include such items as working conditions, rewards and policies. This feature of PBC makes room for the separation of the background factors from the primary factors. For instance, Ajjan and Hartshorne (2008) and Cheung and Vogel (2013) extend and decompose the theory of planned behaviour by assessing perceived resource availability as an additional predictor of intention.

Following Ajjan and Hartshorne (2008) and Cheung and Vogel (2013), we separate the primary PBC factors from background factors and label the latter as environmental possibility for research collaboration (Figure 1), consisting of all resources and incentives that are external to the individual academic researcher. These include the availability of time (Ajjan and Hartshorne, 2008; Moore et al., 2010), funding (Bozeman and Gaughan, 2007; Perkmann and Walsh, 2009), rewards (Cerasoli et al., 2014), the availability of innovation carriers with the appropriate absorptive capacity (Qian and Acs, 2013) and physical infrastructure and administrative support (Hughes and Kitson, 2012).

Studies by Henrekson and Rosenberg (2001) and Robin and Schubert (2013), for example, identify physical infrastructure and administrative support, including technology transfer offices, as critical to the coordination of efforts and funds in support of collaboration between the university and the carriers of innovation. A related study by Bozeman and Gaughan (2007) on the impact of grants and contracts on academic researchers' interaction with industry establishes, among other findings, that funding in the form of grants and contracts is critical to such interactions. Therefore:

> **Hypothesis 4**: Environmental possibility for research collaboration significantly influences the intention to collaborate.

Methodology

Using an explanatory sequential mixed-methods design (Fetters et al., 2013; Jogulu and Pansiri, 2011), we collected data through a survey of academic researchers (all university staff with teaching, research and extension responsibilities) from KNUST and UCC (KNUST, 2005; UCC, 2012). The total population of the study was 1531. Fifty-nine per cent of the study subjects were from KNUST and 41% from UCC. The population represented various academic disciplines, which were similar in both institutions, thus permitting its subsequent stratification into the three broad disciplines of science, technology, engineering and mathematics (STEM), social sciences and arts.

The groupings were informed by categorizations in previous studies, such as those by Hughes and Kitson (2012) and Moore et al. (2010). Therefore, all academics in STEM departments formed the STEM group. Academics in departments that teach and research various forms of expressions of human experience rooted in culture constituted the arts group. The social sciences group comprised academics in departments researching society in terms of its structure, systems, functions and relationships (Bakhshi et al., 2008; Hughes and Kitson, 2012). In all, the STEM group was made up of 896 academic researchers, social sciences of 408 and the arts of 227. For KNUST, 645, 130 and 125 of the population were from the STEM, social sciences and arts, respectively, while for UCC the equivalent numbers were 251, 278 and 102.

With reference to the sample size determination table by Sarantakos (2005), the total population of 1531 yielded a theoretical sample of 310, which we increased to 511 to account for non-response and allow for estimation, the validity and reliability of measures for parametric analysis and the reduction of type 1 and type 2 errors (Leedy and Ormrod, 2010). Random samples were computer-generated and the 511 academics were selected through proportionate stratified sampling to cater for institutional and discipline-related variations.

Specifically, we began the sampling procedure by dividing the elements of the population for each institution into the three strata of STEM, social sciences and arts, giving us six strata in all (three for each institution). The proportion of each stratum in relation to the entire study population was determined, and this was multiplied by the sample size of 511 to arrive at the subsample size for each stratum.

The sample sizes for STEM, social sciences and arts at UCC were 82, 92 and 35, respectively, and those for KNUST were 215, 46 and 41. Ultimately, respondents from each stratum in each university were selected by instructing the computer to generate a set of random numbers equal to the number of sample units in each stratum. Thereafter, with a simple command, the computer was further instructed to choose names from the list of each stratum totalling the sample size calculated for it (Leedy and Ormrod, 2010; Sarantakos, 2005).

We designed a questionnaire (see Table 1 for independent variable measures) in accordance with the theory of planned behaviour and our review of the related literature. The dependent variable, intention to collaborate, was defined as the extent to which one intends to, will try to and will plan to conduct research with or for an individual or entity, within the next 4 years, with inputs from others interested in using the research findings for purposes other than academic.

The questionnaire items (see Online Supplementary Appendix) were measured on semantic differential rating scales ranging from 1 to 7, with 1 the lowest score and 7 the highest score. The questionnaire was ethically cleared by

Table 1. Variables and measures.

Constructs/variables	Indicators
1. Attitude:	(*Sources:* D'Este and Perkmann, 2011; Hughes and Kitson, 2012, etc.)
Research	RC will advance research, and desire to advance research
Teaching	RC will improve teaching, and desire to improve teaching
Promotion/career advancement	RC will speed-up promotion, and desire to speed up promotion
Income generation	RC will bring extra income, and desire to earn extra income
Reputation	RC will improve personal reputation, and desire to improve personal reputation
2. Perceived behavioural control:	(*Sources:* Baba et al., 2009; Chang et al., 2011, etc.)
Boundary spanning	Ability to relate, and influence of ability to relate on RC
Research capability	Ability to conduct various types of research, and influence of ability to research on RC
3. Subjective norm:	(*Sources:* Ajjan and Hartshorne, 2008; Cheung and Vogel, 2013, etc.)
Institutional norm	Institutional expectation to collaborate, and motivation to comply with institutional expectation
Peers	Peers approval of RC, and motivation to comply with expectations of peers
Superior	Head's support for RC, and motivation to comply with head's expectations on RC
Community leader	Community leader's expectation of RC, and motivation to comply with expectation of CL
4. Environmental possibility:	(*Sources:* Baba et al., 2009; Bozeman and Gaughan, 2007; Moore et al., 2010; Robin and Schubert, 2013, etc.)
Time	Time availability, and importance of time availability to RC
Funding	Availability of funding for RC, and importance of funding to RC
Rewards	Availability of reward for RC, and importance of reward to RC
Intellectual property	Availability of enforceable intellectual property rights for RC, and importance of enforceable intellectual property rights to RC
Infrastructure	Availability of infrastructure for RC, importance of infrastructure to RC
Administrative support	Availability of administrative support for RC, and importance of administrative support for RC
Collaborating partner	Availability of potential collaborating partner(s), and importance of partner availability to RC
Absorptive capacity	Availability of capable user of collaborative research output, and importance of user availability to RC

Source: Authors' compilation.
Note: RC: Research collaboration; CL: Community leader.

the UCC Institutional Review Board in August 2014 and pilot-tested at KNUST in September and October 2014. Eventually, 266 completed survey questionnaires were retrieved during data collection from November 2014 to March 2015. Eleven key informants were interviewed in May and June 2015 in line with the connecting approach to the chosen research design (Fetters et al., 2013). Those 11 people included 8 experienced academics (four from each university) and 3 key duty bearers – the Director of DRIC in UCC, the Heads of the OGR and the TCC in KNUST.

We processed and analysed the quantitative data with tools from IBM Statistical Product and Service Solutions Version 19. Mindful of the fact that data from the social sciences hardly have perfect distributions, denoted by zero skewness and kurtosis (Osborne, 2013), the normality of the data distribution was checked against upper limits of ± 2 skewness and ± 7 kurtosis, as recommended by Curran et al. (1996). The decision was also informed by robustness tests of the violations of the assumption of normality by Schmider et al. (2010) and Lantz (2013) who pegged highly skewed data at 2.00.

Afterwards, the 19 scaled items of the independent variables were subjected to factor analysis (principal component analysis (PCA)) for the identification of the items that strongly held together. The selection of items was based on Ajjan and Hartshorne's (2008) and Cheung and Vogel's (2013) decision rule of 0.5 and above factor loadings and a Cronbach's α of 0.7. We then created composite variables in line with the theory of planned behaviour (Ajzen, 2011). The variables included intention to collaborate, as the dependent variable, and the four independent construct variables of attitude, PBC, SN and PEP. After assessing the normality of the resultant data and suitability for parametric analysis, standard multiple regression analysis was performed to ascertain the determinants of the intention to collaborate.

We analysed the qualitative data through coding of similar and contrasting themes. In line with the weaving approach to the interpretation and reporting of research findings (Fetters et al., 2013), the qualitative results were integrated into the relevant aspects of the quantitative results.

Results and discussion

Demographic characteristics of respondents

We assessed four background characteristics of respondents: sex, rank, academic discipline and years of service. Total filled responses were 266 for sex, 266 for rank, 256 for academic discipline and 261 for years of service (Table 2). The majority (76%) of respondents were male. In terms of rank, senior lecturers were the majority (48%) while professors formed the minority (2%). Assistant lecturers, lecturers and associate professors made up 11%,

Table 2. Sex, rank and academic discipline of respondents.

	Frequencies (*N*) and valid percentage		
	UCC	KNUST	Total
Gender			
Male	93 (46%)	108 (54%)	201 (76%)
Female	19 (29%)	46 (71%)	65 (24%)
Subtotal	112 (44%)	154 (58%)	266 (100%)
Rank			
Assistant lecturer	17 (15%)	11 (7%)	28 (11%)
Lecturer	45 (40%)	43 (28%)	88 (33%)
Senior lecturer	33 (29%)	95 (63%)	128 (48%)
Associate professor	14 (12%)	2 (1%)	16 (6%)
Professor	4 (4%)	1 (1%)	5 (2%)
Subtotals	113 (100%)	152 (100%)	265 (100%)
Discipline			
STEM	47 (44%)	112 (75%)	159 (62%)
Social sciences	43 (40%)	21 (14%)	64 (25%)
Arts	17 (16%)	16 (11%)	33 (13%)
Subtotals	107 (100%)	149 (100%)	256 (100%)

Source: Field survey (2015).
Note: UCC: University of Cape Coast; KNUST: Kwame Nkrumah University of Science and Technology; STEM: science, technology, engineering and mathematics.

33% and 6%, respectively. In addition, 62% of the respondents belonged to the STEM group, while the smallest group was from the arts (13%). The social sciences accounted for 25%.

The minimum and maximum number of years for which respondents had worked as academics were 1 year and 39 years, respectively, while the mean stood at 10 years with a standard deviation of 6.699, a kurtosis of 0.675 and a skewness of 0.761. That is, the skewness suggests that most respondents had served in their respective institutions as academic researchers for not more than 10 years.

Intention to collaborate

The conceptual framework of the study (Figure 1) shows intention to collaborate as a means of understanding the willingness of academics to engage in research collaboration in the future. The results of a descriptive analysis of the three measures of intention to collaborate, on a scale of 1–7 (*very low* to *very high*), showed mean scores of 5.77, 5.51 and 5.94 of academics' agreement with 'intend to collaborate', 'will try to collaborate' and 'plan to collaborate', respectively. Although the skewness and kurtosis did not demonstrate perfectly normal (0) data distribution, the respective statistics were below skewness of ± 2 and kurtosis of ± 7, signifying that the departure from non-normality was not substantial (Curran et al., 1996; Kim, 2013); hence, the mean was reported as the measure of central tendency. The Cronbach's α for the intention to collaborate scale was 0.88.

Eventually, descriptive analysis of overall intention to collaborate showed a quite high intention to collaborate with a mean score of 5.73, a standard deviation of 1.01 and skewness and kurtosis values of –1.374 and 3.037, respectively. The skewness indicated that the intention to collaborate scores to some extent clustered at the high end of the distribution, whereas the kurtosis values signified that the distribution was, somehow, peaked, though not alarming. The literature shows that skewness and kurtosis become problematic when the skewness is above ± 2 and kurtosis is beyond ± 7 (Kim, 2013; Schmider et al., 2010). A one-way between-groups analysis of variance (ANOVA) showed an insignificant Levene's statistic of $p = 0.257$, at $\alpha = 0.05$, an indication that the assumption of homogeneity of variance was not violated (Pallant, 2011; Zikmund et al., 2013).

Descriptive statistics of the ANOVA, based on 251 responses, showed that the three academic disciplines had similar mean scores, interpreted as a quite high intention to collaborate. Comparatively, the STEM group had the highest intention to collaborate (5.78), closely followed by social sciences (5.77). The arts group had the lowest intention to collaborate (5.36). However, according to the ANOVA results, there was no statistically significant difference in the intention to collaborate scores for the three academic disciplines, $F(2, 248) = 2.258$, $p = 0.107$. We then subjected a number of potential explanatory variables to factor analysis, regression analysis and, eventually, a one-way between-groups ANOVA.

Factor analysis of the possible determinants of intention to collaborate

In accordance with the theory of planned behaviour (Ajzen, 2011), we propose, in the conceptual framework of the study, intention to collaborate as a function of a number of factors or items (see Table 3). The suitability of the data for factor analysis was assessed. Examination of the correlation matrix of the data showed the presence of several coefficients of 0.3 and above. The Kaiser–Meyer–Oklin value of sampling adequacy (Pallant, 2011) was 0.894, exceeding the recommended value of 0.6 and the Bartlett's test of sphericity (Pallant, 2011) reached statistical significance, supporting the factorability of the correlation matrix.

Eventually, a three-factor PCA yielded eigenvalues exceeding 1, explaining a total of 53.398% of the variance. Inspection of the scree plot revealed a clear break after the third component in support of the three-factor solution, with component 1 contributing 37.893%; component 2, 9.825%; and component 3, 5.680% to the total variance of 53.398%. To aid in the interpretation of the three components, oblimin rotation was conducted. The rotated solution showed the presence of a simple structure, with the three components demonstrating a number of strong

Table 3. Aggregate measures of the possible determinants of intention to collaborate.

	N	*M*–*M*	Mean	SD	Skewness	Kurtosis
1. Attitude (ATT) towards research collaboration (RC; $\alpha = 0.877$) – conviction and relevance that RC will:						
Advance research (ATT1)	261	2–7	5.95	0.958	−1.323	2.909
Improve teaching (ATT2)	262	2–7	5.89	0.936	−0.876	1.071
Expedite promotion (ATT3)	259	1–7	5.68	1.229	−1.471	3.231
Be a source of extra income (ATT4)	265	1–7	5.12	1.391	−0.947	0.865
Improve reputation (ATT5)	262	1–7	5.59	1.177	−1.530	3.438
2. PBC over RC ($\alpha = 0.724$) – importance and ability to:						
Relate well with collaborating partners (PBC1)	261	3–7	5.89	0.827	−0.566	0.285
Conduct various types of research (PBC2)	260	3–7	5.64	0.829	−0.643	0.949
3. SN on RC ($\alpha = 0.893$) – expectation and readiness to comply with:						
Institutional mandate on RC (SN1)	260	1–7	5.75	1.060	−1.643	4.117
Peers approval of RC (SN2)	249	1–7	5.56	1.019	−0.891	1.192
Head's support for RC (SN3)	259	1–7	5.47	1.090	−1.149	2.176
Community leader's expectation on RC (SN4)	257	1–7	4.83	1.420	−0.870	0.282
4. EP for RC ($\alpha = 0.954$) – availability and importance of:						
Funding for collaboration (PEP1)	264	1–7	5.02	1.094	−0.630	0.754
Rewards for collaboration (PEP2)	263	1–7	4.70	1.330	−0.779	0.263
Enforceable intellectual property rights (PEP3)	261	1–7	5.22	1.158	−0.853	0.958
Infrastructure for collaboration (PEP4)	260	1–7	5.29	1.017	−0.759	1.521
Administrative support for collaboration (PEP5)	259	1–7	5.33	1.072	−1.286	2.861
Collaborating partner(s) (PEP6)	260	2–7	5.47	0.955	−0.722	1.590
Capable user of research output (PEP7)	260	1–7	5.43	1.067	−1.207	3.042
Time for collaboration (PEP8)	264	1–7	2.61	1.009	1.101	1.656

Note: RC: Research collaboration; PBC: perceived behavioral control; SN: subjective norm; EP: environmental possibility; PEP: perceived environmental possibility.

loadings of 0.5 and above (Kautonen et al., 2013; Pallant, 2011), and most variables loading substantially on only one component (Cheung and Vogel, 2013). In instances when a variable loaded strongly on two components – for example, collaboration will 'be a source of extra income' (ATT4) – the highest loading was considered. Although community leaders' expectation of research collaboration (SN4) and availability of collaborating partners (PEP6) had factor loadings of 0.5+, they were not selected for interpretation because they did not load together with their counterpart items. This was done to facilitate reasonable interpretation of the results (Pallant, 2011).

Examination of the factor loadings (see Table 4) showed that PBC had all its two variables loading strongly on component 1, while in relation to SN three of the five variables loaded strongly on component 1. The variables were, first, the expectations of the university (SN1); second, expectations of colleagues (SN2); and, third, expectations of immediate superior(s) (SN3) with regard to research collaboration and the readiness of respondents to comply with the expectations of these significant others. Variables on environmental possibility for research collaboration loaded negatively and mainly on component 2. Three of the variables – availability and importance of

Table 4. Factor loadings of the aggregate measures of the possible determinants of intention to collaborate.

	Components			Selected scales			
	1	2	3	1	2	3	α
ATT1	0.454		0.560			0.560	
ATT2	0.474		0.434				0.694
ATT3			0.899			0.899	
ATT4		−0.573	0.620			0.620	
ATT5	0.438						
PBC1	0.716			0.716			
PBC2	0.720			0.720			0.724
SN1	0.738			0.738			
SN2	0.728			0.728			0.815
SN3	0.751			0.751			
SN4		−0.535					
PEP1		−0.597			−0.597		
PEP2		−0.817			−0.817		
PEP3	0.410	−0.417					0.728
PEP4	0.381	−0.409					
PEP5	0.413	−0.508			−0.508		
PEP6	0.577						
PEP7	0.332	−0.488					
PEP8		0.309					

Note: ATT: attitude; PBC: perceived behavioral control; SN: subjective norm; PEP: perceived environmental possibility.

Table 5. Descriptive statistics of the variables of the study.

Variables	*N*	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
INT	262	1	7	5.73	1.013	–1.374	3.037
ATT	255	1	7	5.82	0.954	–1.414	3.795
SN	247	1	7	5.62	0.885	–1.448	4.109
PBC	257	3	7	5.77	0.725	–0.498	0.676
PEP	258	2	7	5.02	0.936	–0.838	1.097

Note: INT: intention to collaborate; SN: subjective norm; PBC: perceived behavioral control; PEP: perceived environmental possibility.

Table 6. Determinants of intention to collaborate.

Determinants	*B*	SE	Beta	*t*	Sig.	Partial correlation	Tolerance	VIF
(constant)	1.544	0.506		3.053	0.003			
ATT	0.404	0.067	0.380*	5.990	0.000	0.364	0.779	1.284
SN	–0.057	0.086	–0.050	–0.668	0.505	–0.044	0.555	1.800
PBC	0.231	0.099	0.165*	2.335	0.020	0.151	0.628	1.594
PEP	0.165	0.071	0.153*	2.332	0.021	0.150	0.732	1.366

Note: $R^2 = 0.264$; adjusted $R^2 = 0.251$, $*\alpha = 0.01$. Dependent variable: intention to collaborate (INT); SN: subjective norm; PBC: perceived behavioral control; PEP: perceived environmental possibility; VIF: variance inflation factor.

funding (PEP1), rewards (PEP2) and administrative support (PEP5) – had strong loadings of –0.5 and above.

Further inspection of Table 4 reveals that component 3 had a clear pattern emerging, with loadings from variables only on attitude towards research collaboration. The variables were the conviction and relevance expressed by respondents that collaboration would advance their research work (ATT1), fast track their promotion (ATT3) and bring extra income (ATT4), with factor loadings of 0.560, 0.899 and 0.620, respectively. Subsequent to the factor analysis, reliability analysis was conducted for items that loaded highly under each construct variable.

The results showed Cronbach's αs of 0.694 and above for the various scales (see Table 4) – an indication of the possibility of using the measures as separate scales (Ajjan and Hartshorne, 2008; Pallant, 2011). Therefore, based on Ajjan and Hartshorne's (2008) and Cheung and Vogel's (2013) recommendations, items in the respective scales were transformed, through aggregation and averaging, into composite variables for regression analysis.

Analysis of the determinants of intention to collaborate

In order to ascertain the actual predictors of intention to collaborate, we conducted standard multiple regression analysis. Descriptive statistics of the regression analysis (Table 5) showed that the dependent and independent variables, measured on scales with minimum scores of 1 and maximum scores of 7, had mean scores from 5.02 to 5.82. The mean scores signify that intention to collaborate (INT), attitude towards research collaboration (ATT), PBC over research collaboration, SN on research collaboration and PEP for research collaboration were quite high among the academic researchers surveyed. Comparatively, attitude towards research collaboration had the highest mean score of 5.82 (SD = 0.954), while PEP had the lowest mean score of 5.02 (SD = 0.936).

Assessment of the skewness and kurtosis values indicated tolerable departures from the assumption of normality which only becomes problematic when the skewness is above ± 2 and kurtosis is beyond ± 7 (Kim, 2013; Schmider et al., 2010). In addition, inspection of the normal probability plot of the regression standardized residual showed the data points appearing in a reasonably straight diagonal line from bottom left to top right, suggesting no major deviation from normality (Lind et al., 2005; Pallant, 2011). Preliminary analysis showed no violation of the assumptions of multicollinearity, linearity and homoscedasticity. Thus, assessment of the correlation matrix indicated some relationship between the independent variables and the dependent variable, whereas the correlations between each pair of the independent variables were all below 0.7 (Pallant, 2011).

Consequently, we regressed the four construct variables on intention to collaborate. The coefficients table (Table 6) indicates high (above 0.10) tolerance levels and variance inflation factors of less than 10 in support of the absence of multicolinearity (Pallant, 2011; Zikmund et al., 2013). The regression model summary showed an R^2 of 0.264 and an adjusted R^2 of 0.251, reaching statistical significance at $\alpha = 0.01$. Thus, the model explained 26.4% of the variance in intention to collaborate. Inspection of the beta values in the coefficients table showed that attitude towards research

collaboration (beta = 0.380, $p = 0.000$), PBC over research collaboration (beta = 0.165, $p = 0.020$) and PEP for research collaboration (beta = 0.153, $p = 0.210$) made significant contributions to the model, except SN (beta = –0.050, $p = 0.505$).

We then conducted ANOVAs to assess whether academics from the STEM, social sciences and arts groups differed on the three predictors of intention to collaborate. The purpose of the analysis was to direct policy attention to the academic discipline(s) in most need of intervention. Results of the ANOVAs showed insignificant Levene's statistics for the three determinants (ATT: $p = 0.121$, at $\alpha = 0.05$; PBC: $p = 0.121$, at $\alpha = 0.05$; and PEP: $p = 0.537$, at $\alpha = 0.05$), which means that the assumption of homogeneity of variance was not violated (Lind et al., 2005; Zikmund et al., 2013). The ANOVA revealed absence of a statistically significant difference, at $\alpha = 0.05$, in the scores for the determinants of research collaboration across the three academic disciplines (ATT: $F(2, 241) = 1.879$, $p = 0.155$; PBC: $F(2, 244) = 0.530$, $p = 0.589$; and PEP: $F(2, 245) = 0.492$, $p = 0.612$). Thus, academic researchers from STEM, social sciences and the arts did not differ, significantly in attitude, PBC and PEP for research collaboration.

The preceding regression results showed that attitude towards research collaboration was the most important predictor of intention to collaborate. In order of importance (as determined by factor weights), attitude was explained by the conviction and relevance attached to the capacity of research collaboration to speed up one's career advancement, to be a source of income and to be a means of advancing research work. The finding is supported by interview results, with all eight interviewees from the various academic disciplines confirming research collaboration as a vital medium for advancing research, teaching and promotion. For instance, one interviewee's explanation of the relevance of research collaboration to research was that 'it helps to sharpen one's research skills'. The finding is consistent with Moore et al.'s (2010) view, established in a related study, that almost half of academics cited new insights for their work and new contacts in their field as the leading impact on their research, while teaching was positively affected mainly in terms of increasing willingness to use real-world examples and to deliver courses that were more directly relevant to the needs of employers.

PBC over research collaboration was the next major predictor of intention. Thus PBC, assessed as the ability of academic researchers to conduct various research types and to relate well with their collaborating partners, was fundamental to their intention to collaborate with the carriers of innovation. In other words, self-efficacy, based on expertise and boundary-spanning or relational skills (Bandura, 1982; Hughes et al., 2011; Hughes and Kitson, 2012), was important to academics' willingness to engage in research collaboration.

PEP for research collaboration was the third important predictor of intention. PEP comprised the availability and importance of funding, rewards and administrative support for research collaboration. Assessment of the double items measuring rewards, funding and administrative support on the basis of their availability and importance (see Table 3) revealed higher mean scores of 5.08, 5.60 and 5.70, respectively, for importance as against availability (mean scores of 4.31, 4.42 and 4.94, respectively).

All 11 academic researchers who participated in the interviews upheld the relevance of PEP but bemoaned its limited nature. Some emphatically noted that investing one's time in 'extra teaching' (e.g. teaching on distance education programmes) was becoming relatively lucrative, while for others non-monetary forms of appreciation, such as receiving a letter of gratitude from the university authorities, were not forthcoming. Interviewees expressed anxiety about limited funding opportunities for research in general and the fact that there was no clear national research agenda or funding. The implication is that the current funding, administrative support and reward systems do not adequately cater for the expectations of academics in relation to their intentions to collaborate.

The overall findings are consistent with those of Ajjan and Hartshorne (2008) and Cheung and Vogel (2013), which show attitude towards behaviour, PBC and environmental possibility significantly influencing behavioural intention. In much agreement with Ajjan and Hartshorne (2008), it can be said that SN did not play a significant role in predicting the intention of academics to collaborate with the carriers of innovation due to the high degree of independence that academics have in decision-making for certain aspects of their professional duties.

Conclusions and policy implications

The primary aim of this article has been to examine the intention of university researchers in two Ghanaian universities to engage in research collaboration in the form of carrying out research with or for the carriers of innovation for the eventual use of the research findings in innovation. The study also analyses the determinants of the intention of the academics to collaborate, using Ajzen's theory of planned behaviour. The results show that the intention of the academics to engage in research collaboration was quite high, irrespective of the academic discipline to which they belonged. That is, the academics agreed to a large extent that they would or planned to engage in research collaboration in the immediate future.

The intention of the academics to engage in research collaboration was influenced by their attitude towards research collaboration, their PBC over collaboration and the PEP for collaboration, regardless of discipline. SN was not a major predictor of intention to collaborate. An overall implication of the findings is that interventions should not

discriminate among academic disciplines, particularly in terms of changing attitudes, behavioural control and environmental possibility for research collaboration.

The leading determinant was attitude towards research collaboration, explained by the researchers' desire and the importance they attached to the capacity of research collaboration to advance their research work, teaching and promotion. Thus, the top priority for the respondents was the opportunity that collaboration would offer for the advancement of their academic career, as opposed to the creation of innovation or opportunities for innovation that would advance the knowledge base of the Ghanaian economy.

It is therefore advisable for external research partners, university administrators and policymakers who wish to promote research collaboration to give credence to use-inspired basic research, due to its inherent capacity to meet the dual goals of advancing science and innovation. It is also essential for the stakeholders to ensure that promotion policies duly recognize collaborating academics by making their engagement in research collaboration count prominently towards their career advancement, regardless of the type of research – whether basic, applied or use-inspired basic research – that is carried out. Such a policy will prevent selectivity on the part of academics and will encourage greater engagement in research collaboration for the sake of advancing Ghana's knowledge-based economy. This will serve as a means of making up for the extra time and effort expended on research collaboration.

Although the PBC of the academics, in terms of their research capabilities and boundary-spanning skills, was quite high and predicted intention to collaborate, the PEP for research collaboration, in its capacity as a predictor of intention to collaborate, was lower and could be a source of discouragement for academics to realize their intention to collaborate in the future. An implication of this finding is that current institutional and national structures, systems and incentives for research and innovation in Ghana are not sufficient to encourage university researchers to engage in collaboration that will drive research and innovation for the Ghanaian economy. Therefore, we recommend for policy attention the need to enhance access to funding, possibly through the establishment of a national research and innovation fund, the expansion of institutional research and innovation award programmes, and the provision of the requisite infrastructure, with an emphasis on enhanced administrative support for R&D.

From a theoretical perspective, the conceptual framework of the determinants of research collaboration, developed on the basis of the theory of planned behaviour, could serve as a guide to future studies on research collaboration for attainment of a knowledge-based economy. The study has also demonstrated the feasibility of an additional construct variable, of environmental possibility, as a predictor of intention within the framework of the theory of planned behaviour.

Nevertheless, the study is limited in a number of ways and offers the opportunity for further research. Specifically, the article focuses on only one group (i.e. the university) of key actors in Ghana's knowledge-based economy, and the study involved only two universities out of the eight public universities in the country. Thus, it does not offer comprehensive insights into the determinants of research collaboration in Ghana and the findings should, therefore, be interpreted within its scope while a broader scope is encouraged in future research.

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References

Acs ZJ, Audretsch DB and Lehmann EE (2013) The knowledge spillover theory of entrepreneurship. *Small Business Economics* 41: 757–773.

Acs ZJ, Braunerhjelm P, Audretsch BD, et al. (2009) The knowledge spillover theory of entrepreneurship. *Small Business Economics* 32: 15–30.

Adria M and Boechler P (2004) The organizational meaning of research. *Canadian Journal of University Continuing Education* 30(1): 37–54.

Ahmadpoor M and Jones BF (2017) The dual frontier: patented inventions and prior scientific advance. *Science* 357(6351): 583–587.

Ajjan H and Hartshorne R (2008) Investigating faculty decisions to adopt Web 2.0 technologies: theory and empirical tests. *The Internet and Higher Education* 11(2): 71–80.

Ajzen I (1991) The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50(2): 179–211.

Ajzen I (2011) The theory of planned behaviour: reactions and reflections. *Psychology & Health* 26(9): 1113–1127.

Ajzen I and Klobas J (2013) Fertility intentions: an approach based on the theory of planned behavior. *Demographic Research* 29(8): 203–232.

Amankwah-Amoah J (2016) The evolution of science, technology and innovation policies: a review of the Ghanaian experience. *Technological Forecasting and Social Change* 110: 134–142.

Ameyaw B, Korang JA, Twum ET, et al. (2016) Tax policy, SMEs compliance, perception and growth relationship in Ghana: an empirical analysis. *British Journal of Economics, Management & Trade* 11(2): 1–11.

Asare R and Essegbey GO (2016) Funding of agricultural research and development in Ghana: the case of Council for Scientific and Industrial Research (CSIR). *Technology and Investment* 7(2): 40–50.

Audretsch DB, Hülsbeck M and Lehmann EE (2012) Regional competitiveness, university spillovers, and entrepreneurial activity. *Small Business Economics* 39(3): 587–601.

Baba YN, Shichijo N and Sedita SR (2009) How do collaborations with universities affect firm's innovative performance? The role of 'Pasteur scientists' in the advanced materials fields. *Research Policy* 38: 756–764.

Bakhshi H, Schneider P and Walker C (2008) *Arts and Humanities Research and Innovation*. Bristol & London: Arts and Humanities Research Council (AHRC) & NESTA.

Bandura A (1982) Self-efficacy mechanism in human agency. *American Psychologist* 37(2): 122–147.

Bartels FL and Koria R (2014) Mapping, measuring and managing African national systems of innovation for policy and development: the case of the Ghana national system of innovation. *African Journal of Science, Technology, Innovation and Development* 6(5): 383–400.

Bartels FL, Koria R and Vitali E (2016) Barriers to innovation: the case of Ghana and implications for developing countries. *Triple Helix* 3(12): 1–30.

Baumol WJ, Litan RE, Schramm CJ, et al. (2011) Innovative entrepreneurship and policy: toward initiation and preservation of growth. In: Calcagnini G and Favaretto I (eds), *The Economics of Small Businesses, Contributions to Economics*. Berlin: Springer-Verlag, pp. 3–23.

Becker B (2015) Public R&D policies and private R&D investment: a survey of the empirical evidence. *Journal of Economic Surveys* 29(5): 917–942.

Blais P, Hirnschall G, Mason E, et al. (2014) Introducing INSPIRE: an implementation research collaboration between the department of foreign affairs, trade and development Canada and the World Health Organization. *Journal of Acquired Immune Deficiency Syndromes* 67: S105–S107.

Bozeman B and Gaughan M (2007) Impacts of grants and contracts on academic researchers' interactions with industry. *Research Policy* 36(5): 694–707.

Bozeman B, Fay D and Slade CP (2013) Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. *The Journal of Technology Transfer* 38(1): 1–67.

Bukvova H (2010) Studying research collaboration: a literature review. *Sprouts: Working Papers on Information Systems* 10(3). Available at: https://aisel.aisnet.org/sprouts_all/326 (accessed 18 March 2013).

Byman D and Kroenig M (2016) Reaching beyond the ivory tower: a how to manual. *Security Studies* 25(2): 289–319.

Calvert J (2002) Making academic research useful. Scientists' responses to changing policy demands. In: *NPRNet conference on rethinking science policy: analytical frameworks for evidence-based policy*, Brighton, England, 21–23 March. Available at: https://www.researchgate.net/publication/228985597_Making_academic_research_useful_Scientists'_responses_to_changing_policy_demands (accessed 20 September 2012).

Cerasoli CP, Nicklin JM and Ford MT (2014) Intrinsic motivation and extrinsic incentives jointly predict performance: a 40-year meta-analysis. *Psychological Bulletin*. 140(4): 980–1008.

Cheung R and Vogel D (2013) Predicting user acceptance of collaborative technologies: an extension of the technology acceptance model for e-learning. *Computers & Education* 63(2013): 160–175.

Crabbe CRACV (2005) *Laws of Ghana*, Vol. 7. London: LexisNexis Butterworths Ltd.

Curran PJ, West SG and Finch JF (1996) The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods* 1(1): 16–29.

D'Este P and Perkmann M (2011) Why do academics engage with industry? The entrepreneurial university and individual motivations. *The Journal of Technology Transfer* 36(3): 316–339.

Etzkowitz H and Leydesdorff L (1995) The triple helix-university-industry- government relations: a laboratory for knowledge based economic development. *EASST Review* 14(1): 14–19.

Etzkowitz H, Webster A, Gebhardt C, et al. (2000) The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy* 29(2): 313–330.

Fetters MD, Curry L and Creswell JW (2013) Achieving integration in mixed methods designs – principles and practices. *Health Services Research* 48(6): 2134–2156.

Fox MF, Realff ML, Rueda DR, et al. (2016) International research collaboration among women engineers: frequency and perceived barriers, by regions. *Journal of Technology Transfer*. 42(6): 1292–1306.

Fuller S (2005) What makes universities unique? Updating the ideal for an entrepreneurial age. *Higher Education Management and Policy* 17(3): 27–49.

Gaughan M and Bozeman B (2016) Using the prisms of gender and rank to interpret research collaboration power dynamics. *Social Studies of Science* 46(4): 536–558.

Granovetter M (2005) The impact of social structure on economic outcomes. *The Journal of Economic Perspectives* 19(1): 33–50.

Grimaldi R, Kenney M, Siegel DS, et al. (2011) 30 years after Bayh–Dole: reassessing academic entrepreneurship. *Research Policy* 40(8): 1045–1057.

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.

Herzberg F (1987 [1968]) One more time: how do you motivate employees? Reprint. *Harvard Business Review* 65(5): 87–96.

Hughes A and Kitson M (2012) Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the

factors constraining its development. *Cambridge Journal of Economics* 36(3): 723–750.

Hughes A, Kitson M, Probert J, et al. (2011) *Hidden Connections: Knowledge Exchange Between the Arts and Humanities and the Private, Public and Third Sectors*. Cambridge: AHRC and Centre for Business Research, University of Cambridge.

Jogulu UD and Pansiri J (2011) Mixed methods: a research design for management doctoral dissertations. *Management Research Review* 34(6): 687–701.

Johnson B, Lorenz E and Lundvall BÅ (2002) Why all this fuss about codified and tacit knowledge? *Industrial and Corporate Change* 11(2): 245–262.

Karlsson C and Andersson M (2009) The location of industry R&D and the location of university R&D: how are they related? In: Karlsson C, Andersson AE, Cheshire PC and Stough RR (eds), *New Directions in Regional Economic Development*. Heidelberg: Springer, pp. 267–290.

Kautonen T, Van Gelderen M and Fink M (2015) Robustness of the theory of planned behavior in predicting entrepreneurial intentions and actions. *Entrepreneurship Theory and Practice* 39(3): 655–674.

Kautonen T, Van Gelderen M and Tornikoski ET (2013) Predicting entrepreneurial behaviour: a test of the theory of planned behaviour. *Applied Economics* 45(6): 697–707.

Ketokivi M and Choi T (2014) Renaissance of case research as a scientific method. *Journal of Operations Management* 32(5): 232–240.

Kim HY (2013) Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics* 38(1): 52–54.

Kwame Nkrumah University of Science and Technology (KNUST) (2005) *Corporate Strategic Plan (2005 – 2014)*. Kumasi: KNUST.

Lantz B (2013) The impact of sample non-normality on ANOVA and alternative methods. *British Journal of Mathematical and Statistical Psychology* 66(2): 224–244.

Leedy PD and Ormrod JE (2010) *Practical Research Planning and Design*. 9th ed. Boston: Pearson Education, Inc.

Leydesdorff L (2012) The triple helix, quadruple helix, . . . , and an *N*-tuple of helices: explanatory models for analyzing the knowledge-based economy? *Journal of the Knowledge Economy* 3(1): 25–35.

Lind DW, Marchal G and Wathen SA (2005) *Statistical Techniques in Business & Economics*. 12th ed. Boston: McGraw-Hill/Irwin.

McKelvey M, Zaring O and Ljungberg D (2015) Creating innovative opportunities through research collaboration: an evolutionary framework and empirical illustration in engineering. *Technovation* 39: 26–36.

Mensah MSB and Nyadu-Addo R (2012) Juxtaposition of the role of small businesses and the state in Ghana's economic development. *International Business and Management* 5(1): 75–82.

Ministry of Environment, Science and Technology (2010) *National Science, Technology and Innovation Policy*. Accra: Ministry of Environment, Science and Technology.

Moore B, Hughes A and Ulrichsen T (2010) *Synergies and Trade-offs Between Research, Teaching and Knowledge Exchange*. Research Report to HEFCE. Cambridge: Public and Economic Corporate Consultants (PACEC) and the Centre for Business Research (CBR).

Mouton J, Gaillard J and Van Lill M (2015) Functions of science granting councils in Sub-Saharan Africa. In: Cloete N, Maassen P and Bailey T (eds), *Knowledge Production and Contradictory Functions in African Higher Education*. Cape Town: African Minds, pp. 148–170.

NPCA (2014) *African Innovation Outlook 2014*. Pretoria: NEPAD Planning and Coordinating Agency (NPCA).

Ooms W, Werker C, Caniëls MC, et al. (2015) Research orientation and agglomeration: can every region become a silicon valley? *Technovation* 45: 78–92.

Osborne JW (2013) Is data cleaning and the testing of assumptions relevant in the 21st century? *Frontiers in Psychology* 4: 370–376.

Pallant P (2011) SPSS *Survival Manual a Step by Step Guide to Data Analysis Using SPSS*. 4th ed. Crowns Nest: Allen & Unwin.

Pearson M and Hamilton K (2014) Investigating driver willingness to drive through flooded waterways. *Accident Analysis & Prevention* 72: 382–390.

Perkmann M and Walsh K (2009) The two faces of collaboration: impacts of university-industry relations on public research. *Industrial and Corporate Change* 18(6): 1033–1065.

Qian H and Acs ZJ (2013) An absorptive capacity theory of knowledge spillover entrepreneurship. *Small Business Economics* 40(2): 185–197.

Ranga M and Etzkowitz H (2013) Triple helix systems: an analytical framework for innovation policy and practice in the knowledge society. *Industry and Higher Education* 27(4): 237–262.

Robin S and Schubert T (2013) Cooperation with public research institutions and success in innovation: evidence from France and Germany. *Research Policy* 42(1): 149–166.

Robson PJA and Obeng BA (2008) The barriers to growth in Ghana. *Small Business Economics* 30(4): 385–403.

Ryan RM and Deci EL (2000) Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary Educational Psychology* 25(1): 54–67.

Sarantakos S (2005) *Social Research*. New York: Palgrave Macmillan.

Sawyerr A (2004) Challenges facing African universities: selected issues. *African Studies Review* 47(1): 1–59.

Schmider E, Ziegler M, Danay E, et al. (2010) Is it really robust? Reinvestigating the robustness of ANOVA against violations of the normal distribution assumption. *Methodology* 6(4): 147–151.

Schumpeter JA (1983 [1934]) *The Theory of Economic Development*. R. Opie (Trans.) with new introduction by J. E. Elliott. Reprint, Brunswick, NJ: Transaction Publishers.

Shichijo N, Sedita SR and Baba Y (2015) How does the entrepreneurial orientation of scientists affect their scientific

performance? Evidence from the quadrant model. *Technology Analysis & Strategic Management* 27(9): 999–1013.

Starrfmonline (2017) Government to increase research, development fund to 2.5% of GDP- Akufo Addo. Available at: https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Government-to-increase-research-development-fund-to-2-5-of-GDP-Akufo-Addo-601858 (accessed 8 January 2018).

Stokes DE (1997) *Pasteur's Quadrant: Basic Science and Technological Innovation*. Washington, DC: Brookings Institution Press.

Teirlinck P and Spithoven A (2013) Research collaboration and R&D outsourcing: different R&D personnel requirements in SMEs. *Technovation* 33(4): 142–153.

Tuunainen J (2013) Science transformed? Reflections on professed changes in knowledge production. *Organizations, People and Strategies in Astronomy* 2(OPSA 2): 43–71.

University of Cape Coast (UCC) (2012) *University of Cape Coast Statutes*. Cape Coast: UCC.

University of Ghana (2012) *Basic Laws of the University of Ghana*. Accra: University of Ghana.

Van Schalkwyk F (2015) University engagement as internationalisation: indicators and insights. In: Cloete N, Maassen P and Bailey T (eds) *Knowledge Production and Contradictory Functions in African Higher Education*. Cape Town: African Minds, pp. 203–229.

Vares H, Parvandi Y, Ghasemi R, et al. (2011) Transition from an efficiency-driven economy to innovation-driven: a secondary analysis of countries global competitiveness. *European Journal of Economics, Finance and Administrative Sciences* 31: 124–132.

Vice Chancellors Ghana (2013, July 17) [Letter to UTAG]. Cape Coast: University of Cape Coast Branch of UTAG Archive.

Zikmund WG, Babin BJ, Carr JC, et al. (2013) *Business Research Methods*. 9th ed. Australia: South-Western, Cengage Learning.