Determinants of International Research Collaboration in Uganda: Case Study research registered at Uganda National Council for Science and Technology (2015-2019)

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Abstract

International Research Collaboration (IRC) has been on the rise globally. This study set out to establish the determinants of IRC in Uganda and the researcher's propensity to engage in IRC. The study considered several predictors like Gender, the Region where PI attained their highest research qualification and the field of research. A binary logistic model was used to identify the determinants of IRC while a beta regression was used for the propensity to collaborate. Results show that IRC in Uganda is determined by Gender, the region where the researcher attained their Highest Qualification, Research Sponsor, field of research, type of research, and Research Budget. The study shows that developing countries need to develop robust research systems to be "effective partners" in IRC. More gender-inclusive research policies are critical. IRC should be framed around national priorities and intentionally pursued within university research systems.

Keywords: International, Research, Collaboration, Developing countries

Introduction

International Research Collaboration (IRC) occurs when research actors or entities from different countries engage in a research undertaking. The history of IRC can be traced back to the eighteenth and nineteenth century as countries began to attempt to "professionalise" science and to collaborate on published work (Beaver and Rosen, 1979). Since 1991, IRC has grown by more than ten-fold in most advanced countries and 20-fold for the BRICs (Adams, 2013). More than ever, researchers from different countries are participating in collaborations, largely driven by technology and the emergence of a global research agenda. Issues like climate change, desertification, and sustainable water resource management are pervasive and no single country can deal with them alone. These have prompted collaborations by researchers from countries very far apart resulting in the notion of the "death-of-distance". In Uganda, the level of IRC has been on the rise with over three papers out of five published by international collaborative teams (UNCST, 2022). These research partnerships between Uganda-based academics and partners from other systems is partly fuelled by institutional and structural realities that dictate knowledge production, communication, access, uptake, adaptation and use. The instrumental benefits from these unique collaborations have been reflected by the convergence of a global research agenda and a shared commitment to responsive research that balances rigour and relevance and a redistribution of global research resources and outputs (De Sousa Santos, 2014). However, inspite of this trend, expenditure on research and development (GERD) in many sub-Saharan countries remains low. In Uganda, the GERD averaged about 0.17% while 65% of higher-education research funding is derived from foreign sources.

Exploring these research partnerships is critical in developing new evidence for increased research funding and exploring the underlying imperatives that are quietly shaping these vital research relationships.

Literature Review

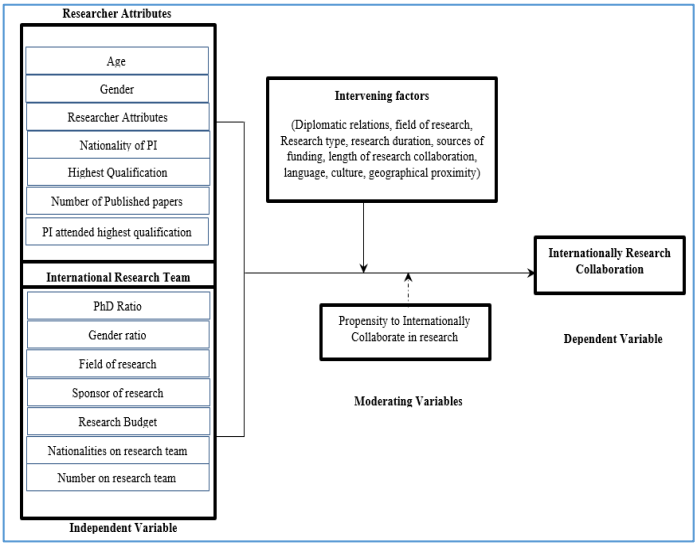
Wuchty (2007) notes that IRC teams are expanding across interdisciplinary fields as more research is increasingly being undertaken across institutional and geographical boundaries. Researchers collaborate for several reasons which include improving their visibility and recognition while others collaborate to utilize equipment (often specialized) in another country (Narin *et al,* 1991). Other reasons for collaboration range from the acquisition of expertise and new ideas needed for their research (Beaver and Rosen, 1979) while historical ties; linguistic preferences; geographical proximity; and specific problem issues (e.g. disease control or natural disaster mitigation) remain critical drivers of IRC. The increase in IRC has also been attributed to the reduction in travel costs and the diffusion of information communication technologies (Hoekman et al., 2010). In trying to calibrate the state of IRC, some studies have focused on its structures and dynamics (Narin et al., 1991) while others have dwelt on its effects. Other studies have tried to present several factors that influence the extent to which researchers engage in IRC. Leahey (2016) identified policy, specialization, resource constraints, and the influential role of ICT as being primary drivers of IRC. Similarly, the presence of a clear reward system and the proliferation of external networks were identified by Hu et al. (2016) as being primary determinants of IRC. Several indicators have been used to track to track trends in IRC. These range from the number of co-authored scientific papers, the number of joint patents by researchers from the global north and south, and the level of funding for collaborative research engagements, among others. According to Kweik (2020), academic discipline, type of institution, and national reward structure all influence IRC. Other studies have shown that the option to be engaged in IRC may be determined by purely personal reasons (Wagner & Leydesdorff, 2005). Other factors that predispose researchers to engage in IRC undertakings may relate to where they studied, the composition of the research team, and the type of institution where they acquired their research qualification. How "active" a researcher is in the global virtual college also predisposes them to engage in international research. In deriving the determinants, the role of gender cannot be overemphasised. According to Halevi (2019), the role of female scientists in IRC has been amplified over the last fifty years. Whereas female researchers are just as involved in research collaborative platforms, there could be fewer opportunities for them to engage in IRC. Kwiek (2018) concluded that being female is a negative predictor of participation in IRC networks. Kwiek and Roszka (2019) conclude that while male scientists exhibit a higher propensity to collaborate internationally, female scientists are more collaborative in all other collaboration types (general, national, and institutional).

Funding is also a critical determinant of IRC. This is because, as Cummings and Kiesler (2007) have shown, IRC is an often resource-heavy undertaking that may dictate when, how, and with whom researchers collaborate. Collaboration presupposes a shared research goal, defined by activities rather than by the actors involved, and refers only to research that includes personal interactions. A researcher's propensity to engage in IRC is likely to be shaped

by several factors. Essers *et al* (2020) note that researchers with much collaboration in the recent past may be intrinsically more eager to collaborate in the future. They further note that a proxy for that propensity is the number of co-authors that each author had over the last ten years. This study assesses the propensity to collaborate by examining the underlying factors that are likely to pre-dispose a researcher to engage in IRC. Rostan et al (2014) found that researchers working in the physical sciences and mathematics are more likely to collaborate with international colleagues. Between 2007 and 2011, Pouris and Ho (2014) found that Tropical Medicine, Parasitology, and Infectious Diseases represented the highest concentration of research collaboration. This corroborates findings by a study that showed that women are more likely to participate in disciplines in which they are less likely to collaborate internationally (NSF, 2009). Gaillard (2015) noted that researchers with degrees in engineering have a higher propensity to collaborate internationally than those within other sciences in particular Social Sciences and humanities. This shows that the discipline or field of study is an important derivative of IRC. IRC has also impacted the nature of research activity among developing countries. A *Scientometric* analysis by Pouris and Ho (2014) showed that African researchers collaborating with international partners increased by 66% between 2007 and 2011. Several factors have shaped the participation of African researchers in IRC frameworks. Confraria *et al* (2019) found that African researchers who did their doctoral studies outside of Africa, and who had the opportunity to move abroad were more likely to collaborate with colleagues from outside of Africa. Like many developing countries, the evidence on IRC and its determinants is sparse. Figure 1 shows the summary of drivers of research collaboration and the intervening drivers.

Figure 1:

Conceptual Framework for International Research Collaboration



Like many similar Research Councils across Africa, tracking the trends of IRC has been a challenge. Whereas these Councils are mandated to guide research undertaking and overall national research policy, they have limited influence in shaping and guiding the types of research collaborations being undertaken within their eco-systems. Anecdotal evidence has shown that whereas researchers in Uganda are increasingly participating in IRC, there is a limited understanding of the scope and nature of this form of collaboration. Whereas the Uganda National Council for Science and Technology (UNCST) is mandated to register all research types in Uganda, evidence on the nature of IRC is not available. The main objective of the study is to identify factors that are shaping IRC in Uganda and to specifically establish a researcher's propensity to engage in IRC.

Source: Author's design

Theoretical Frameworks

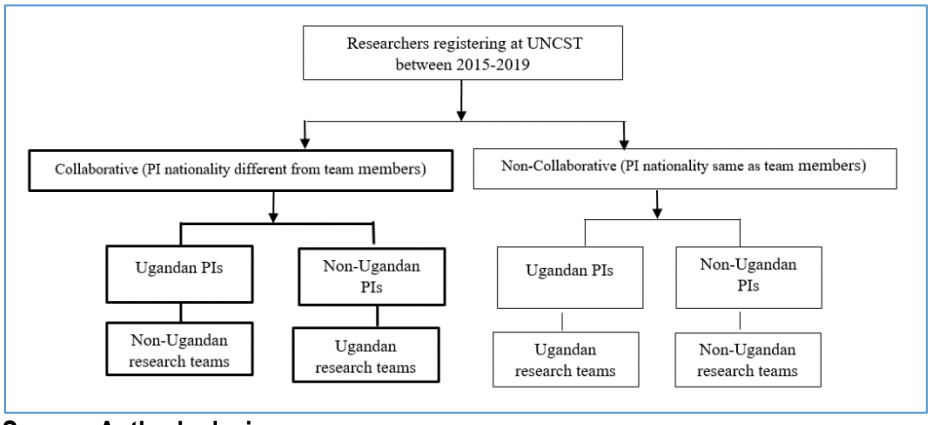
Available evidence shows that human beings often find the best solutions to complex challenges through collaboration than by working on their own (Kelley & Littman, 2001). Collaboration is defined as a mutually beneficial and well-defined relationship entered into by two or more organizations to achieve common goals (Mattessich et al., 2001). According to Vygotsky (1978), collaboration is borne out of constructivism which emphasizes emphasise social interaction as an important component of knowledge acquisition and learning. When applied to IRC, a constructivist theory would focus on how shared meanings, norms, and social structures influence the formation and success of collaborations. Checkel (1998), observes that collaborative behaviour is commonly shaped by a "constructivist Institutionalism" outlook in which institutional structures define the rules, norms, and expectations of the scientific community. Collaborations are shaped by shared norms and meanings among researchers. The construction of common understanding regarding the importance of collaboration and the value of diverse perspectives enhances the likelihood of international collaboration (Wendt, 1999). Common identity markers, such as belonging to a particular academic discipline, can facilitate collaboration (Tajfel & Turner, 1986). This is common in many SSA countries where the field of science often shapes the locus for IRC. These imperatives shape the drivers shaping IRC in nascent research systems like Uganda. The drivers of IRC highlight the importance of shared meanings, identity, social interactions, and institutional structures that shape knowledge co-creation by research actors operating in different historical, cultural and economic environments.

Research Methodology

The study followed an exploratory research design using quantitative aspects of IRC. Exploratory research is defined by Burns and Groove (2001) as research conducted to gain new insights, discover new ideas, and increase knowledge of the phenomenon. The study focused on the research that is registered at UNCST. The data for the research registered between 2015 and 2019 was extracted from the UNCST and categorized as either being "Collaborative" or "non-collaborative" depending on the composition of the research team. The process is highlighted in Figure 2 below.

Figure 2:

Process of selecting participants



Source: Author's design

As shown in Table 1 below, a total of 3,658 researchers were identified for this period (2015-2019) across the different fields of science registered at UNCST.

Table 1:

Number of Registered Researchers (2015-2019)

Fields of Science	**2015**	**2016**	**2017**	**2018**	**2019**	**TOTAL**
Health Sciences	235	253	289	290	292	**1359**
Social Sciences	323	307	366	438	373	**1807**
Information Sciences	5	19	6	6	4	**40**
Physical Sciences	4	2	4	3	0	**13**
Agricultural Sciences	20	47	46	25	25	**163**
Engineering Sciences	7	7	7	4	2	**27**
Natural Sciences	41	50	53	62	43	**249**
TOTAL	**635**	**685**	**771**	**828**	**739**	**3658**

The number of research conducted in different fields of Study to be included in the Study was obtained using Yamane's (1967) Formula for calculating sample Size. This shows the number of registered research for this period where n is the sample size *e* is the level of precision.

$$n = \frac{N}{1 + Ne^2}$$

Accordingly,, $N = 3658$, we have adopted a precision of 3% in this study.

$$n = \frac{3658}{1 + 3658(0.03)^2}$$

As a result, the sample size n was **852.**

Sample Stratification

Stratified Sampling was used to determine the composition of the sample in different fields of study registered by UNCST from 2015 to 2019. The proportional allocation formula under stratified sampling was used to calculate the stratum sample size; proportional allocation was adopted since all fields of study were equally important to be included in the study. The number of research items from each field of study in the table below was selected using simple random sampling.

Proportional Allocation Formula for Determination of Stratum Sample Size

$$n_h = n\frac{N_h}{N}$$

Where;

- n_h is the Stratum Sample Size (The Number Selected from a particular field of Study)
- n is the total sample size selected for the study
- N_h is the Stratum Population Size(Number of Research Conducted in a particular field of Study)
- N is the total population size (Total Number of Research Conducted from 2015 to 2019)
- The number of research item from each field of study in the table above were selected using simple random sampling

The resultant sample allocation is shown in Table 2.

Table 2:

Total Number to be sampled in Different Fields of Study (2015-2019)

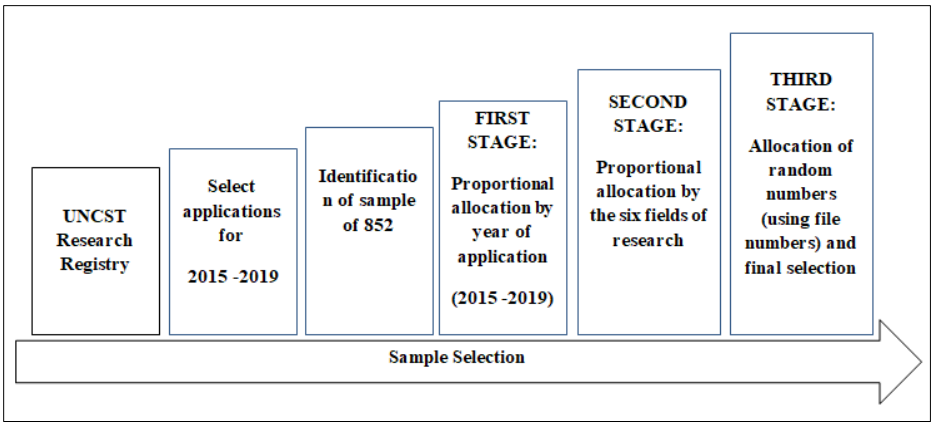
Field	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Health Sciences	50	59	67	68	68	**312**
Social Sciences	75	72	85	102	87	**421**
Information & Communication	1	4	1	1	1	**8**
Physical Sciences	1	1	1	1	0	**4**
Agricultural Sciences	5	11	11	6	6	**39**
Industrial & Engineering Sciences	2	2	2	1	1	**8**
Natural Sciences	10	12	13	15	10	**60**
Total	**144**	**161**	**180**	**194**	**173**	**852**

Source: Primary Data

In this study, **"collaborative"** research was defined as *any research that included more than one nationality in the research team*. This could either be the principal investigator and/or members of the research team with different nationalities. Research was defined as **"non-collaborative"** if *all researchers were from the same country.* A summary of the process of sample selection is provided in Figure 3 below.

Figure 3:

Sample Selection Procedure



Secondary data was collected from the RS1 forms (found at: https://research.uncst.go.ug/data/signup/) that applicants fill out to undertake research in Uganda. An online version of the form can be found at Pre-determined details for this study were subsequently captured. The researcher decoded the necessary information from each file which was entered in an Excel spreadsheet. The data was later exported to the *R* program for analysis.

The dependent variable defined the Collaborative Status of the research. As previously defined, a research study was categorized as either being **collaborative** or **non-collaborative**. This variable was coded as a dummy variable with 1 for collaborative and 0 for non-collaborative. Researchers' decisions with whom they would want to engage in IRC are generally non-random. As such, the exploratory variables for IRC in this research were: The highest education level of the PI, Gender, Nationality of PI, Research type (academic or non-academic), Field of study, Research duration, Estimated budget of the research study, Region where PI attained their highest research qualification, Number of publications, PhD ratio (number of members with a PhD as a proportion of all team members) and Sponsor of research.

Model Specification for Assessing the Determinants of International Research Collaboration

IRC in this particular study is a binary outcome with a researcher either collaborating or not. A binary logistic model was used to determine the probability of collaboration. The binary logistic model assumes that the observed dependent variable Y (Collaboration Status or CS) can be 1 if the researcher is collaborating and 0 if the researcher is not collaborating

$$CS = f(x) = \begin{cases} 1, if \ \ CS^* > 0 \\ 0 \ \ otherwise \end{cases}$$

Where $CS^* = X\beta + \varepsilon, with\ \varepsilon \sim N(0,1)$

Where CS denotes the researcher's collaboration status observed in the data, CS^* is latent and can thus not be observed, so we model CS by making a normality assumption about the error terms of CS^* X denotes a vector of explanatory variables, β is a vector estimate for regression coefficients. ε Is the error term assumed to be normally distributed with zero mean and variance one (Peduzzi, Concato, *et al*. (1996).

We then apply a binary logistic regression given by;

$$logit(p) = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + .. + \beta_n X_n$$

Where β_i the regression coefficients are determined, X_i are the explanatory variables associated with the reference group and p is the probability that a researcher is collaborating (Ozturk, 2019).

To fit the model we need to determine the regression coefficients β_i using the maximum likelihood method.

Model Specification for determining the propensity to collaborate

The propensity to collaborate in research is defined as the proportion of international collaborators in the team;

$$pc = \frac{n}{N}$$

Where pc is the propensity to collaborate, n is the number of international collaborators on the team and N is the total number of researchers on the team.

In this study, we investigate what influences the propensity to collaborate among our researchers in the country. The propensity values are restricted in the interval of $(0,1)$. Several methods have been proposed to model data with a dependent variable restricted in that interval and they include beta regression, fractional logistic regression, fractional regression, Bayesian beta, and fractional regression among others (Cribari-Neto and Zeileis (2009).

We assume that our propensity to collaborate follows a beta function given by; $P(y|a,b) = \frac{\Gamma(a+b)pc^{a-b}(1-y)^{b-1}I_{(0,1)}(pc)}{\Gamma a \Gamma b}$

Where $a, b > 0, I_B(x)$ denotes the indicator function for the event$x \in B$, pc denotes the propensity to collaborate and $\Gamma(.)$ denotes the indicator function (Branscum *et al,* 2007). Given our data set of explanatory variables; nationality, highest education level, estimated budget, duration of the research, gender, and our dependent variable propensity to collaborate

Let our independent variables be denoted by $\boldsymbol{X}$; $x_i: i = 1,2, \ldots n$ and pc take values on the interval $(0,1)$ denoted by $\boldsymbol{pc}; pc_i i = 1,2, \ldots n$, so our given data point is given by (x_i, pc_i) and also let $\boldsymbol{\beta}$ denotes a vector of regression coefficients.

The beta regression model given (x_i, pc_i) follows a beta distribution with density function $f(pc, \mu_i; \phi)$;

$$f(pc; \mu, \phi) = \frac{1}{B(\mu\phi, (1-\mu)\phi} pc^{\mu\phi-1}(1-pc)^{(1-\mu)\phi-1}, 0 < pc < 1$$

Where $B(.)$ Is the beta function, $E(pc_i) = \mu_i \in (0,1)$ which is related to the ith value of $x_i \in R^n$.

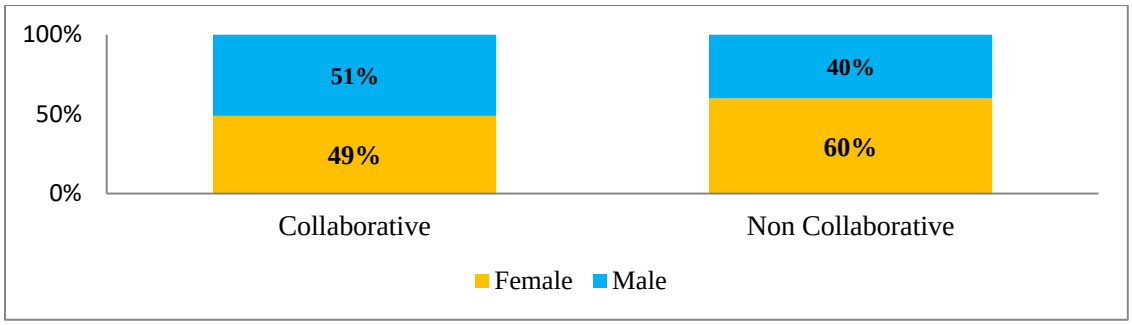
Our objective is thus to fit the model by determining the regression coefficients by making inferences about the parameters of interest based on the available data.

Results Presentation

Findings show that almost an equal number of males and females are engaged in collaborative research. There is a significant difference in non-collaborative research with more female than male researchers (about 133 females representing 60%). Even though male PIs are generally collaborating more than female PIs, females are collaborating more than males, especially in academic-related research. The summary of these findings is shown in

Figure 4:

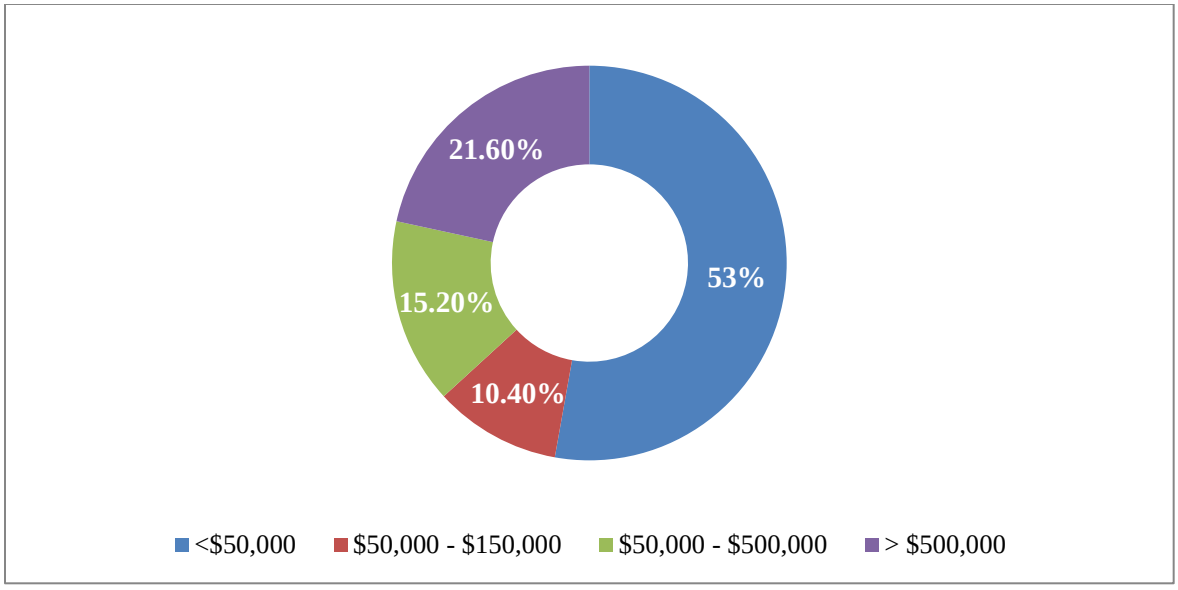
Gender of the PI and Collaborative Status



The chi-squared test of independence shows that the gender of the researcher significantly impacts his or her ability to collaborate with a higher percentage of male researchers (51.47%) collaborating more than their female counterparts ($p<0.05$, $\chi^2 = 5.0246$), however, the difference in collaboration between the two genders is almost minimal (less than 2%). Most of the research conducted has a budget of less than 50,000 with an estimated median budget of 27,500 USD. However, 21.6% of the research budgets are over $500,000 with almost all of them being collaborative. Collaborative research has a higher budget on average ($258, 520) compared non collaborative research ($52,144); ($p<0.05$, f-value=6.92).

Figure 5:

Research Budget Categories



Findings revealed that more than 85% of the PIs in Uganda have at least a postgraduate degree. About half (344 researchers representing 51%) of the collaborative research is led by PhD-holding principal investigators. In non-collaborative research, researchers with a master's degree as their highest qualification are 109 representing 49%. This confirms the findings by Otieno *et al.* (2008) who found that universities use international collaborations for institutional capacity development and strengthening research capacity.

Determinants of international research collaboration in Uganda

There is anecdotal evidence that shows that many researchers in Uganda are undertaking IRC. The key imperative under this objective was to establish the key determinants or drivers of IRC. Using multivariate analysis, the study tested several explanatory factors that were derived from literature review and other field perspectives. The dependent variables of the model are dichotomous: researchers who collaborate with international colleagues and those who do not. A summary of the results is provided in Table 3 below.

Table 3:

Results of a multiple logistic Regression (Prob>Chi²=0.00; LR Chi² (10) = 101.29

Factors	Category	Odds Ratio(coefficients)	Standard Error	P-value	Confidence Interval
Research Type(Academic)	Non-Academic	1.955125	.3311722	0.000	1.40278-2.724938
Gender(Female)	Male	1.599043	.2677453	0.005	1.151687-2.22017
Field of Research	Combined	1.117987	.0622731	0.045	1.003-1.246952

(Humanities)	Health Sciences	1.933515	.3728611	0.001	1.325-2.8216
	Agriculture	.9041914	.3300666	0.783	.4422-1.8492
	Natural Sciences	1.015309	.3219417	0.962	.5454- 1.8901
	Engineering	.4910408	.2572879	0.175	.17584-1.3712
	ICT	.4118785	.2365143	0.122	.1336-1.269
	Physical Sciences				
Sponsor of Research (Foreign University)	Combined	.808844	.0631009	0.000	.6941598-.942475
	Foreign Government	1.060066	0.23	0.816	.64773-1.7348
	Foreign Private	.6828398	.1504943	0.0083	.44332-1.0518
	Private Local	.622178	.1969514	0.134	.3345534-1.157
	GOU Funded	.4438104	.1905291	0.0058	.1913-1.0295
Research Budget	**Combined**	1.000003	7.07e-07	0.000	1.00002-1.00004
The region studied Highest Qualification (Uganda)	Combined	1.149407	.0428746	0.000	1.0684-1.236
	USA	3.564198	.8000535	0.00	2.2956-5.534
	Other America	2.247805	1.579859	0.249	.5669-8.913
	China	1.046112	1.038882	0.964	.14937-7.3265
	Other Asia	2.658959	2.19388	0.236	.52771-13.398
	Europe	3.043403	.6293667	0.000	2.0292-4.564
	Other Africa	1.858811	.7871978	0.143	.81051-4.263
	Australia	2.32914	2.115017	0.352	.39286-13.809

IRC is significantly explained by the gender of the principal investigator, region where they completed their highest qualification, sponsor of the research, field of research, research type, and research budget. The collaborative status of the researcher is however not significantly influenced by the following factors; nationality of the researcher, duration of the research, years of experience after the highest qualification, and educational level of the principal investigator. Non-academic research is almost twice as likely to be collaborative compared to academic research. The gender of the researcher is also a significant predictor of International collaborative status of the research with male-headed research teams having a higher likelihood of undertaking collaborative research by about 1.6 times compared to female-headed research. This is consistent with several other studies that have found gender differences in the level of collaboration (Ynalvez & Shrum, 2011). Other research has shown that women had "smaller" collaboration networks as compared to men. Interestingly, the data shows that the age of the researcher is not a significant predictor of engagement in IRC. This is at variance with Gaillard *et al* (2015) who found that researchers in mid-career stages (40 years and above) are more likely to collaborate internationally than those who are in the early or late career stages.

The field of research where the researcher belongs significantly impacts the collaborative status of the researcher. In comparison with humanities and social sciences which had the highest number of collaborating researchers, it's only researchers from health sciences that have a higher likelihood of collaborating. Researchers in the health sciences are twice as likely to engage in collaborative research compared to researchers from the humanities and social sciences. Bukvova (2010) notes that experimentalists tend to collaborate more than theoreticians since

experimental research requires is often more while requiring more instrumentations. By working together in collaboration, research costs can be shared and research facilities can be better optimized. The type of organization that funds the research significantly influences the collaborative status of the research (P<0.005). In addition, funding from foreign private companies also significantly determines research collaboration. Government-funded research is also significantly collaborative. There is a significant relationship between the budget of the research and its collaborative status with researchers engaged in highly funded research having a higher likelihood of engaging in internationally collaborative research. IRC in Uganda is also significantly explained by the region where the principal investigator completed his or her highest qualification. When compared to researchers who had their highest qualification in Uganda, it's only those researchers who had their highest qualifications in Europe and the USA that have a high likelihood of engaging in IRC when compared to those who had their highest qualification in Uganda. Researchers who had their highest qualification outside Uganda have a higher likelihood of collaboration (almost 4 times more likely) when compared to those who had their highest qualification in Uganda. Those who attained their highest qualification in Europe are 3 times more likely to be collaborative compared to those who have their highest qualification in Uganda. The other researchers who had their qualifications in other regions are not significantly different from those who have their qualifications in Uganda. Findings show that IRC is significantly explained by the gender of the principal investigator ($p < 0.005$), region where the PI completed their highest qualification ($p < 0.005$), sponsor of the research ($p < 0.005$), field of research ($p < 0.005$), research type ($p < 0.005$) and budget ($p < 0.005$). The collaborative status of the researcher is however not significantly influenced by the following factors; nationality of the researcher, duration of the research, years of experience after the highest qualification, and educational level of the principal investigator.

The Propensity to Collaborate

The propensity to collaborate was defined as the *"likelihood of engagement in collaborative research".* Whereas researchers are engaged in collaborative research, certain factors increase a researcher's likelihood of engaging in such research. As such*, "propensity to collaborate"* was taken to mean the proportion of international researchers on an international research team. This propensity was a ratio between 0 and 1. As shown in Table 5, certain key factors are significantly associated with the propensity to undertake IRC in Uganda. These include the sponsor of Research, age of PI, nationality of PI, region where the PI attained his highest qualification, and the PhD ratio in the research team ($p<0.005$). Other factors, such as the type of research, experience of the researcher, gender of PI, duration of the research, budget of the research, qualification of the PI, and Research field do not significantly explain the propensity of collaboration of the research teams. Even though the budget of research, research field, and research field were significant in explaining the collaborative status of the research, they were not significant in explaining the overall team propensity to collaborate. This is an interesting finding since some of these factors were strong determinants of IRC (Objective 1) but were not significant in explaining the research team's propensity to collaborate.

That is, even though, for instance, the Research budget and Field of research were significant in explaining the collaborative status of the research, they are not significant in explaining the overall team's propensity to collaborate.

Table 4:

Factors explaining the propensity to undertake international collaborative research

Variable	Category	Coefficients	p-value	Confidence interval	Standard Error
Nationality	Combined	.0764197	0.000	.04976 -.10307	.0136016
	USA	.4225905	0.000	.27809 -.56709	.0737275
	Other America	.4582004	0.008	.1173-.8991	.14587
	China	.56789	0.002	.1956- .72011	.1337957
	Other Asia	.5766715	0.001	.23149-.9218	.1761137
	Europe	.4345961	0.000	.27683-.5923	.0804961
	Other Africa	.4578768	0.001	.1956-.72011	.1337957
	Australia	.2228981	0.575	-.5565-1.0023	.3976778
Sponsor of Research	Combined	-.0573151	0.044	-.1130-.0016	.0284282
	Foreign Government	-.1064791	0.176	-.2607-.04778	.0787009
	Foreign Private	-.1353569	0.0069	-.2813-.01059	.0744683
	Private Local	-.1399525	0.276	-.3918 -.11188	.1284866
	GOU Funded	-.3098253	0.0085	-.662602 -.0429513	.1799914
Region of Highest Qualification	Combined	.0715868	0.000	.04439 -.09879	.013879
	USA	.4276186	0.000	.2734 -.58125	.0783848
	Other America	.4754645	0.007	.1315-.8194	.175502
	China	.4122459	0.017	.13456- .6567	.1234
	Other Asia	.5702499	0.001	.2254 -.9150	.1759175
	Europe	.4326058	0.000	.26843 -.5967	.0837655
	Other Africa	.4288789	0.001	.165542-.692	.134358
	Australia	.315782	0.427	-.463-1.0945	.3973426
PhD Ratio		.2897482	0.002	.11085- .46864	.0912742
Age of PI	Combined	-.0650689	0.0074	-.136 -.0061	.0363581
	25-35 years	-.3157333	0.042	-.6200-.01146	.1552471
	35-50 years	-.2977845	0.024	-.5568-.03876	.1321561
	>50 years	-.3298534	0.015	-.5959 -.0638	.1357425

Although the nationality of the PI was not a significant factor in explaining the collaborative status of the researcher, this factor significantly explains the propensity of collaboration of research teams($p < 0.05$). The propensity of collaboration is generally higher for PI from outside Uganda. This means that foreign PIs are significantly likely to be engaged in internationally collaborative research.

The funder of the research influences a research team's propensity for collaboration ($p < 0.05$). Research funded by foreign Universities tends to have the highest propensity of collaboration when compared to other funders of the research. Foreign private funded research and government of Uganda funded research are the most significant

among the funders with the propensity of collaboration being low if the research projects are funded by these two. Researchers who have had their highest qualification outside Uganda are likely to be in research teams with a higher propensity to collaborate when compared to researchers whose highest qualification is from Uganda. Those whose highest qualification is from Europe and the USA have the highest propensity to collaborate. The propensity of collaboration is higher for teams having a higher number of PhD holders on the team (high PhD Ratio) compared to other research teams with lower PhD holders. These findings are consistent with Duque *et al* (2005) and Ynalvez & Shrum (2011), who found that more than half of those who collaborate have earned their PhD from a developed country. They conclude that having trained in developed countries, such researchers have a higher propensity to collaborate. The propensity to collaborate decreases with increasing age of the PI. Principal Investigators above 50 years have the least propensity to collaborate.

Conclusions

IRC is both a policy goal and an instrument to support development and competitiveness. The underlying patterns of IRC are critical in shaping and identifying policies and strategies for the future (Guellec & de la Potterie, 2000). The study shows that the typical researcher undertaking IRC in Uganda is undertaking academic research in health sciences, is male, is about 49 years old, has studied from a foreign university for their highest qualification, and receives funding for their research from a foreign source. Whereas this is dissimilar to Rostan *et al.* (2014) who found that the prototypical academic figure in IRC is a man, in his mid-50s or younger, working as a professor in the field of the natural sciences at a university". These contextual realities about the personal characteristics of those who collaborate provide critical insights into both the performance and practice of IRC. Certain institutional factors predispose entities to engage in IRC. Institutional research policies, systems, and structures create the necessary enabling environment for such collaborations to thrive. For instance, institutional policies on gender-inclusive research can enhance the participation of female researchers in international research teams. IRC in Uganda occurs within a policy and regulatory vacuum. This has resulted in several missed opportunities over the years. The study shows that IRC is not shaped by geographical proximity. Other enablers, like technology, have enhanced IRC beyond certain locales. Other factors seem to shape IRC beyond geographical proximity. IRC should be driven by certain intrinsic national interests or priorities. These collaborations can be leveraged, more intentionally by building national systems for science diplomacy. However, the absence of frameworks within which such IRC occurs has the propensity to collaborate. **As** shown, gender remains a significant predictor of IRC in Uganda. This finding points to systemic inequities that continue to limit the potential of women to attain higher qualifications, especially at the PhD level. This gap in human capacity limits the potential contribution of women. This disparity in gender participation also has a bearing on the type of research being collaborated upon. The heavy dependence on foreign funding means that research undertaken is not shaped by national priorities. Foreign funding also limits the leverage that local research actors have in determining where, how, when, and who undertakes research. The determinants of IRC vary from country to country. They are also

shaped by different contextual and relative characteristics of the actors or countries involved. Specific human capacities are required to gainfully engage in IRC. The government can strengthen funding for research, especially at the doctoral level, or provide PhD training options the higher education institutions. Regularising research cooperation with other "collaborative" countries should enhance cooperation and create new avenues for science diplomacy. Universities should be encouraged to develop research policies that are explicit on IRC and that provide the necessary regulatory regime by which they can intensively engage with partners in other countries.

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