

## **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. However, comprehensive analysis of the drivers of IRC in many developing countries remains lacking. This study applies a binary logistic model to examine the determinants of IRC in Uganda while a beta regression was used for the propensity to collaborate. Using retrospective data from the Uganda National Council for Science and Technology, results indicate that IRC in Uganda is determined by gender, region where researcher attained their highest qualification, research sponsor, research Field, Research type 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 and 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. 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 joint 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 has the capacity to deal with them alone. These have prompted collaborations by researchers from countries very far apart resulting into the notion of the “death-of-distance”. Wuchty (2007) notes that IRC teams are expanding across interdisciplinary fields as more research is increasingly being undertaken across institutional and geographical boundaries. Recent evidence has further shown that one out of five research articles have authors from more than one country (NSF, 2019). Researchers collaborate with each other for a number of reasons which include improving their visibility and recognition while others collaborate in order to utilise equipment (often specialised) 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, the proliferation of external networks was identified by Hu et al. (2016) as being primary determinants of IRC. Several indicators have been used 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.

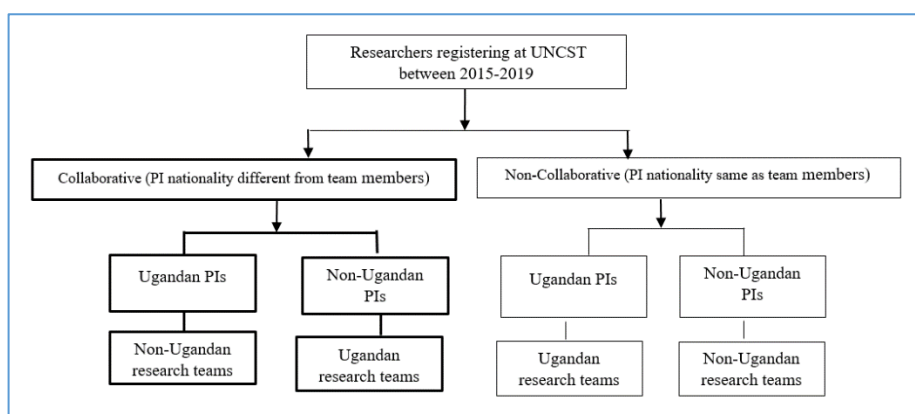
This study assesses the propensity to collaborate by examining the underlying factors that are likely to pre-dispose a researcher to engage in IRC. Rostan et al (2014) found that researchers working in the physical sciences and mathematics are more likely to collaborate with international colleagues. 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 with in other sciences and in particular Social Sciences & Humanities. This shows that the discipline or field of study is an important derivative of IRC. IRC has also impacted on 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, 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. 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 about 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 researchers' propensity to engage in IRC.

## Methods

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 for increasing 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 8: Process of selecting participants**



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

**Table 3: Number of Registered Researchers (2015-2019)**

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

The number of researches conducted in different fields of Study to be included in the Study was got using Yamane (1967)'s Formula of calculating sample Size. This shows the number of registered researches 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 are 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**.

### 3.4.2. 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. 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 item 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 of 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.

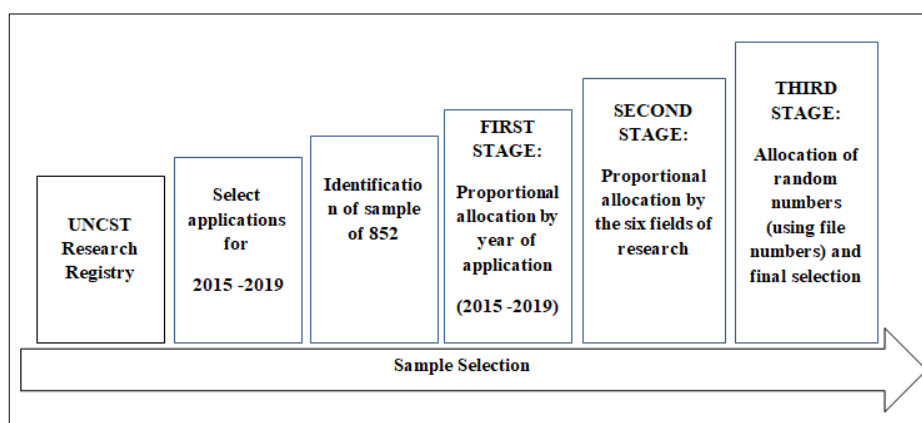
**Table 4: Total Number to be sampled in Different Fields of Study (2015-2019)**

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

**Source: Primary Data**

In this study, a “**collaborative**” research was defined as *any research that included more than one nationality in the research team*. This could either be the Principle Investigator and/or members of the research team with different nationalities. A 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 the Figure 3 below.

**Figure 9: Sample Selection Procedure**



Secondary data was collected from the RS1 forms (See Annex) that applicants fill to undertake research in Uganda. An online version of the form can be found at <https://research.uncst.go.ug/data/signup/>. 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 is 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 observed dependent variable *Y* (Collaboration Status or CS) can be 1 if the researcher is collaborating and 0 if the researcher is not collaborating

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

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,  $\beta$  is a vector estimate for regression coefficients.  $\varepsilon$  Is the error term is 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;

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

Where  $\beta_i$  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  $\beta_i$  using the maximum likelihood method.

### Model Specification for determining the propensity to collaborate

The propensity to collaborate of 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 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 make an assumption 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, Johnson 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  $\mathbf{X}$ ;  $x_i: i = 1, 2, \dots, n$  and  $pc$  take values on the interval (0,1) denoted by  $\mathbf{pc}$ ;  $pc_i: i = 1, 2, \dots, n$ , 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  $i$ th value of  $x_i \in R^n$ .

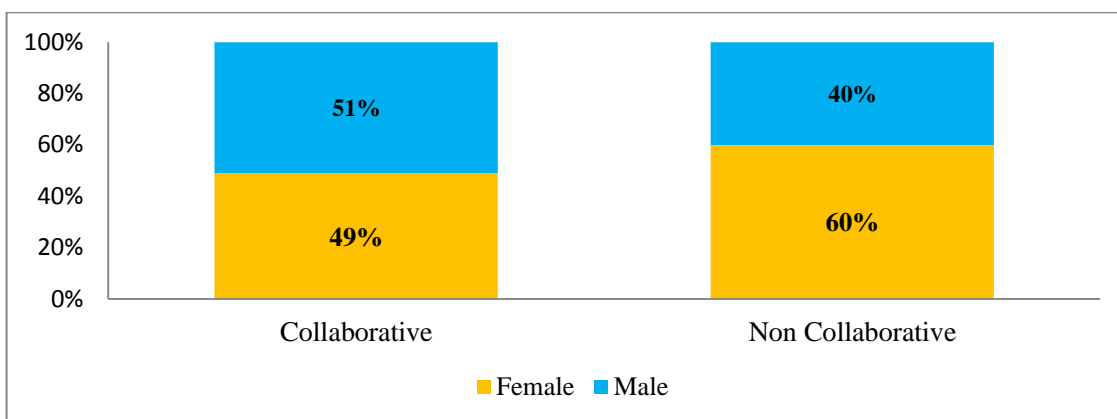
Our objective is thus to fit the model by determine the regression coefficients through making inference about the parameters of interest based on the available data.

### Results

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 female representing 60%). Even though male PIs are generally collaborating more than female PIs, female are collaborating more than male especially in academic-related research. The summary of these findings is shown in

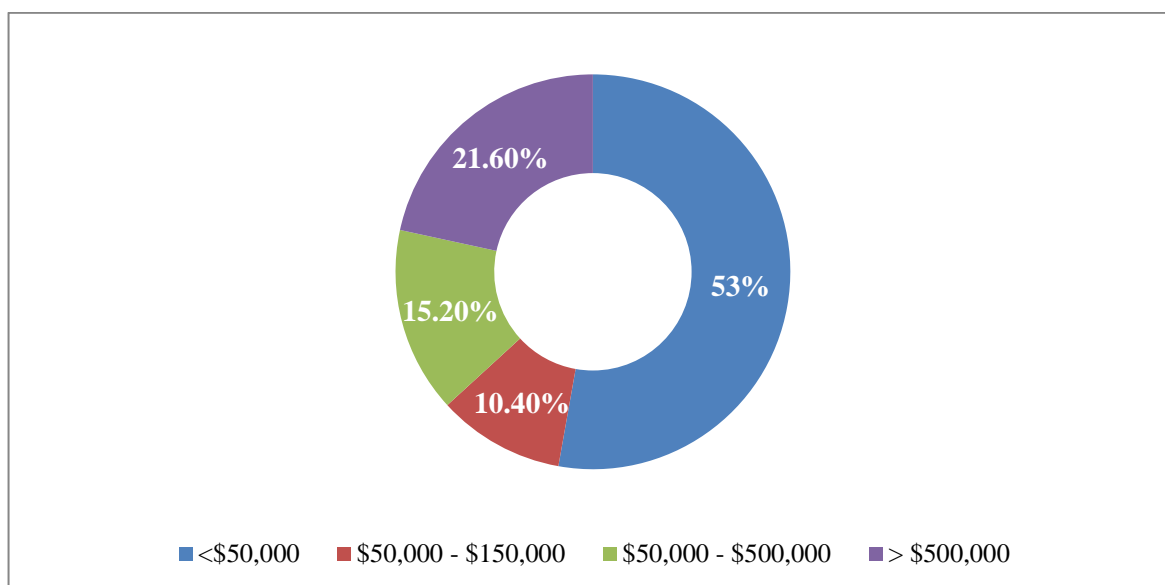


**Fig. 10: Gender of the PI and Collaborative Status**



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 gender is almost minimal (less than 2%). Most of the researches conducted have 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 in nature. Collaborative research has a higher budget on average (\$258,520) compared non collaborative research (\$52,144); ( $p < 0.05$ ,  $f\text{-value} = 6.92$ ).

**Fig. 11: Research Budget Categories**



Findings revealed that more than 85% of the PIs in Uganda have at least a postgraduate degree. The Figure 11 below shows that about half (344 researchers representing 51%) of the collaborative research is led by PhD-holding Principle Investigators. In non-collaborative research, researchers with the master’s degree as their highest qualification are 109 representing 49%. This confirms 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 the Table 5 below.

**Table 6: Results of a multiple logistic Regression (Prob>Chi<sup>2</sup>=0.00; LR Chi<sup>2</sup> (10) = 101.29**

| Factors  | Category           | Odds Ratio (coefficients) | Standard Error | P-value | Confidence Interval |
|--|--------------------|---------------------------|----------------|---------|---------------------|
| <b>Research Type(Academic)</b>                       | Non Academic       | 1.955125                  | .3311722       | 0.000   | 1.40278-2.724938    |
| <b>Gender(Female)</b>                                | Male               | 1.599043                  | .2677453       | 0.005   | 1.151687-2.22017    |
| <b>Field of Research (Humanities)</b>                | Combined           | 1.117987                  | .0622731       | 0.045   | 1.003-1.246952      |
|  | 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  |                           |                |         |                     |
| <b>Sponsor of Research (Foreign University)</b>      | 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        |
| <b>Research Budget</b>                               | <b>Combined</b>    | 1.000003                  | 7.07e-07       | 0.000   | 1.00002-1.00004     |
| <b>Region studied Highest Qualification (Uganda)</b> | 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 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 more likely to be collaborative compared to academic research. The gender of the researcher is also a significant predictor of the 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 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 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, its only researchers from health sciences that have a higher likelihood of collaborating. Researchers in the health sciences are actually twice more likely to engage in collaborative research compared to researchers from 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 researches are also significantly collaborative in nature. There is significant relationship between the budget of the research and its collaborative status with researchers engaged in highly funded researchers 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 that had their highest qualification in Europe and 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 that 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 that have their highest qualification in Uganda. The other researchers who had their qualification in other regions are not significantly different from those that have their qualification in Uganda. Findings show that IRC is significantly explained by 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, there are certain factors that increase a researcher's likelihood in 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: 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 budget of research, research field and research field were significant in explaining whether the collaborative status of the research, they are 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 7: 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 the foreign PIs are significantly likely to be engaged in internationally collaborative research.

The funder of the research influences a research team's propensity of collaboration ( $p < 0.05$ ). Research funded by foreign Universities tend to have the highest propensity of collaboration when compared to other funders of the research. Foreign private funded researches 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 from Uganda. Those whose highest qualification from Europe and USA have the highest propensity to collaborate. 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.

## Conclusion

IRC is both a policy goal and an instrument to support development and competitiveness. The underlying patterns of IRC is 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 a field of the natural sciences at a university". These contextual realities about the personal characteristics of those who collaborate provides critical insights into both the performance and practice of IRC. Certain institutional factors pre-dispose entities to engage in IRC. Institutional research policies, systems and structures that 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 into a number of 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, 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 which continue to limit the potential of women from attaining 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 bearing in 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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