

INSTITUTIONAL FACTORS AND COMMERCIALISATION OF UNIVERSITY RESEARCH OUTPUTS AND INNOVATIONS IN UGANDA

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ABSTRACT

The rising thrust to commercialize university research outputs and innovations has emerged as a significant policy challenge regarding the higher education sector's capacity to generate socio-economic benefit. Despite emphasizing the socio-economic benefits of increased research commercialization in the policy statements and discussions, the issue of institutional factors affecting the commercialization of research outputs in universities is less mentioned. The purpose of this paper is to investigate the institutional factors, practices, and processes that influence the commercialization of research outputs in universities. A cross-sectional design was adopted and data was collected from a sample of 308 heads of academic departments in 23 chartered Universities in Uganda. The hypothesis was tested using a covariance-based Structural Equation Modelling (SEM) method in AMOS. The results indicate that institutional factors have a significant impact on the commercialization of research outputs. Therefore, there is a need for research commercialization policies such as policies on patents, and revenue-sharing frameworks in addition to training researchers in entrepreneurial skills and involving the whole change of mindset. In addition, universities need to institutionalize research commercialization targets into the performance management framework of staff such as staff appraisals, rewards, and promotions among others.

Keywords: Research Commercialization, Institutional Factors, Collaboration, Universities, SEM

1. Introduction

The increasing recognition of universities as a hotbed of new knowledge and technology to spur economic growth has led to the notion of commercialization of university research outputs globally. The commercialization of university research outputs is associated with the transformation of technology and ideas into consumable products and services that create wealth through licensing, joint ventures, spin-offs, consultancy, patenting, dissemination, and backstopping (Kenzhaliyev et al., 2020; Research Council of Zimbabwe, 2018; Bansi, 2016).

Accordingly, policies are propagated to promote the commercialization of university research. The Bayh-Dole Act (1980) is largely regarded to be a precursor for the commercialization of research outputs in America (Mowery and Sampat 2005). Other developments of the same can be seen in Western Europe and Nordic countries (the Netherlands, Ireland, the UK, Germany, Sweden, Norway, and Finland (World Intellectual Property Organisation (WIPO), 2021; Organisation for Economic Cooperation and Development (OCED), 2019; Reichert, 2019; Cornell University et al., 2020). In Asia, China has taken significant steps to commercialize research outputs in her universities by focusing on the interaction between higher institutions of learning with industries (Li and Tan 2020). As regards Africa, efforts are afoot to embrace the commercialization of research outputs in her institutions. The continent registered a 13% decrease in patent applications in 2020 to 754 compared to 868 in 2019 (African Regional Intellectual Property (ARIPO) 2020). South Africa is the leading innovative economy in sub-Saharan Africa, with the country registering 542 patent applications in 2019, of which only 14 percent were from universities (WIPO 2019).

The trend in Uganda is promising following the implementation of policy and institutional arrangements, such as the Science, Technology, and Innovation (STI) Policy, 2009; the Trade Secrets Act (2009); the Trademark Act (2010), the Industrial Property Act (2014); the Plant Variety Protection Act (2014); Buy Uganda, Build Uganda (BUBU) policies; Research Registration and Clearance Policy and Guidelines (2016); enhancement of staff salaries for universities; the establishment of research and innovation fund among others to fast-track the commercialization of research and innovation outputs (UK Department for International Development 2019; NPA 2020). In addition, the government has invested a total of UGX.111bn (\$29.15M) in research activities for Public Universities in the years (2017/18, 2018/19, and 2019/20) and UGX.621.6bn (\$163.23M) from external grants over the same period (Office of the Auditor General 2022).

In spite, of the investments in research and innovations in many African countries including Uganda, penetration of commercialization of research outputs in institutions remains low (Siringi, 2022; African Regional Intellectual Property (ARIPO, 2020)). The Global Innovation

Index (GII) ranks Uganda at 114 out of 131 states, compared to Kenya, Rwanda, and Tanzania ranked 86, 91, and 88, respectively (Cornell University, INSEAD, and WIPO 2020). Uganda's universities produced 1,837 research publications in 2018, translating into 44 publications per million people per year compared to Kenya's 3,040 research publications (57 publications per million people per year) (UK Department for International Development 2019). In addition, in 2019, the country submitted about 250 patent applications with only 2 successful registrations (Office of the Auditor General 2022).

Despite the importance associated with the commercialization of university research output, the need for investigating the antecedents, both proximal and distal remain a matter of reconciliation in the university's development agenda in Africa, if returns on investment and value for money are to be realized (OECD, 2019; WIPO, 2021; Doanh et al., 2021; WIPO, 2021; Cornell University et al., 2020; RSM PACEC LTD, 2018).

The existing research on the institutional factors and commercialization discipline is mixed. While Casani (2018), Palthe (2014), and Scott & Amarante (2016) found institutional factors to be positively associated with commercialization, the results of Alves et al. (2017); Gibson & Foss (2017) provide a contrasting picture, a situation that necessitates reconciliation. Likewise, existing studies on institutional factors and commercialization have been done in developed countries (Biranvand & Seif, 2020; Cornell University et al., 2020; Ismail et al., 2020; Bansi, 2016), yet Alves and Aureliano-Silva (2017), Ugo Finarrdi (2017) and Berggren 2017) have argued that studies on institutional factors and commercialization are country and industry-specific. Therefore, using studies from a developed setting to explain the commercialization of university research outputs in a developing country like Uganda may prove to be suspect due to the contingent characteristics of the institutional environments.

Based on the above, this paper focuses on; a) examining the relationship between institutional factors and the commercialization of research outputs and innovations in Ugandan universities, and, b) investigating institutional factors, practices, and processes that allow the commercialization of research outputs to take place in Uganda's Universities. This paper adopts the institutional theory as a theoretical lens to address these objectives in the context of Uganda. The rest of the report is ordered as follows. Section 2 is the theoretical framework; Section 3 provides the research methodology; Section 4 is the results and findings; and, Section 5 is the discussion, implications and limitations, and future research direction.

2. Theoretical Background and Hypotheses

2.1 Theoretical Background

This study is grounded on Institutional Theory. Institutional theory (DiMaggio and Powell 1983) focuses its attention on the role of social influence in modeling individual and organizational action (Scott and Amarante 2016). Institutions are man-made restrictions that structure social, political, and economic interactions (North, 1990). Therefore, institutional theory explains the role of social influence in shaping organizations' actions and conformity (DiMaggio and Powell 1983). When organizations conform to social pressures, they gain the legitimacy that secures the organization's success and survival (Scott and Amarante 2016). The primary motive for gaining legitimacy is to adhere to the said rules and routines, which enables their survival. Legitimacy can benefit an organization by securing access to valuable resources, helping to innovate, reducing risk, improving reputation, and strengthening stakeholder relations (Scott and Amarante 2016). However, the conventional argument of institutional theory is that pressure for institutional conformity forces companies to adopt the same strategies. Hence commercialization of university's research outputs does not depend solely on their will but on pressures from government, industry, and society.

The increasing recognition of universities as a hotbed of new knowledge and technology with the potential to boost economic growth, technological improvements, and competitiveness, finds strength and relevance with the integration of institutional pressures and commercialization in explaining how these dynamics can occur (Scott and Amarante 2016). Furthermore, the pressures for universities to address the commercialization agenda of their research outputs and innovations in line with society's needs, have resulted in an entrepreneurial turn (Scott and Amarante 2016). It, therefore, follows that the commercialization of university research outputs can be actualized through the interplay between the normative, regulative, and cultural-cognitive pressures from each actor of the triple helix (Scott and Amarante 2016).

Institutions comprise regulative, normative, and cultural-cognitive elements that, together with associated activities and resources, deliver stability and meaning to social life (Scott and Amarante 2016). The formal and informal institutional factors that impact the organization and organizational actors are classified into regulative, normative, and cognitive (DiMaggio and Powell 1983; Scott and Amarante 2016). The regulative pillar is about coercive procedures that set rules, monitor performance, and sanction activities to guide actions (DiMaggio and Powell 1983; Scott and Amarante 2016). The normative pillar consists of values, norms, and roles (DiMaggio and Powell 1983; Scott and Amarante 2016). Values refer to what is desirable while norms refer to how things should be done, giving legitimacy to valued ends (Scott and Amarante 2016). The cultural-cognitive pillar entails symbolic processes that work to construct a social reality that defines the nature and properties of social actions (Scott and Amarante 2016). The institutions substantially shape universities' structure, regulatory frameworks, norms, and culture (Reichert 2019; Paolucci et al. 2018).

The interaction between university, industry, and government integrates elements from various Triple Helix spheres in their design (Scott and Amarante 2016); which substantially shape universities' structure, regulatory frameworks, norms, and culture (Reichert 2019; Paolucci et al. 2018). Consequently, the pressure on universities to commercialize their research outputs originates from internal and external actors of the triple helix which drives universities to seek support from both government and industry. These pressures force universities to restructure their functionality to meet government and society needs or industry needs, hence the third mission (commercialization of their research) (Scott and Amarante 2016).

Whilst the institutional theory acknowledges the complex set of pressures from each actor of the triple helix (university, government, industry/society) in shaping the university commercialization ecosystem (Doanh et al. 2021; Scott and Amarante 2016). Ordinarily, the commercialization of university research outputs is expected to emanate from the iterative interplay among regulative, normative, and cultural-cognitive pressures emanating from each actor of the triple helix (Gibson and Foss 2017; Foss and Gibson 2015; Heitor 2015).

2.2 Institutional Pressures and Commercialization of University Research Outputs

The commercialization of research outputs and innovations in universities is shaped by the evolution of formal and informal institutional frameworks of higher education (Casani 2018; Scott and Amarante 2016; Poglajen 2012). The formal and informal institutional pressures that impact the university and university actors are classified into regulative, normative, and cognitive (Scott and Amarante 2016; DiMaggio and Powell 1983). The regulative is about coercive actions that set rules, monitor performance, and sanction activities to guide actions (Scott and Amarante 2016; DiMaggio and Powell 1983). The normative pillar consists of values, norms, and roles (Scott and Amarante 2016; DiMaggio and Powell 1983). The cultural-cognitive pillar entails symbolic processes that work to construct a social reality that defines the nature and properties of social actions (Scott and Amarante 2016).

Institutional pressures such as regulations, laws, rules, and policies affect the university commercialization ecosystem (Tweheyo et al. 2022; Reichert 2019; Kasozi 2017). Literature has shown that the commercialization of university research outputs is influenced by clear institutional and state policies and laws such as the Bayh-Dole Act in the United States and the abolition of "professor privilege" in European countries (Wang et al. 2020; Bansi 2016).

Institutional policies that govern research activity, thus, ought to motivate researchers to produce and commercialize research outputs and innovations (Farsi, Modarresi, & Zarea, 2011). Wright and Phan (2018), argue that institutions must emphasize research policies and training as this is a key driver for enhanced commercialization of research outputs and innovations. Training, as well

as sensitization, can aid institutional researchers to understand how they can exploit existing industrial linkages to promote a culture of commercialization of research outputs and innovations (Tweheyo et al. 2022).

From the normative viewpoint, duty and moral obligation form the vital elements of what pushes change (Mohamed, 2017). The entrepreneurial culture at the university level in terms of institutional, departmental, and individual attitudes and norms influences the commercialization of university research outputs and innovations (Tweheyo et al.,2022; Sonka and Saurabh 2020). The universities must inspire their people to venture into research commercialization efforts that involve a certain level of risk and at the same time, be prepared to accept failures (Asmawi et al.,2013). Risk-taking inspires innovators to attain potential returns on their research outputs such as intellectual properties and knowledge surge even though the likelihood of success is low (Asmawi et al.,2013).

Cultural-cognitive plays a substantial role in the commercialization of university research outputs. The university's norms shape the motivation and attitude values that guide the commercialization agenda of the university (Mohamed 2017; Palthe 2014). However, institutions do not only require the traditional factors of production (labor, capital, knowledge, and materials) but also hinge on the acceptance of the society in which they operate (Palthe 2014).

Existing studies have shown diverse results on the influencing factors of the commercialization of university research outputs and innovations (WIPO 2021; OECD 2019). OECD (2019), Odei (2017), and Kirchberger and Pohl (2016) have argued that the mixed or varied results could be attributed to the complex set of institutional processes unique to each country, the level of commercialization, and different methodologies and definitions considered. Thus, the study appraises how institutional factors affect the commercialization of research outputs in Uganda's Universities. Also, previous studies on the role of institutional pressures on the commercialization of research output and innovations among universities have been mixed. For instance, whilst Casani (2018) and Scott & Amarante (2016) found a significant association between institutional pressures and commercialization. Alves et al.(2017); Gibson & Foss, (2017) found contradictory results. Based on these arguments, we propose that: *H1: There is a relationship between institutional pressures and the commercialization of research outputs and innovations in Ugandan universities.*

3. Methodology

3.1 Participants and Procedures

A cross-sectional research design was adopted with a simple random sampling approach in this study. All data were collected from March to June 2022. Before data collection, a pilot test was

performed on 20 researchers in two universities to ensure the comprehensibility of the item set and allow the research assistants to familiarise themselves with the questionnaire items. Ethical approval for this survey was obtained from the affiliated institute of the corresponding author. To ensure the anonymity of the respondents and the confidentiality of their responses, the research assistants assured the respondents that all responses would remain anonymous and would be treated in the strictest confidentiality. Participations were voluntary, and no monetary reward was given to the participants as an incentive. The study had four hundred (370) questionnaires distributed to respondents, 321 questionnaires were returned and 308 were usable (completed questionnaires). This represented an effective response rate of 87% that was used in data analysis. Among the participants, 224 were male and 84 were female, 125 (40.6%) of the participants had doctoral education, and 126 (40.9%) had Master's degrees. Over 112 (36.4%) participants had worked in their present jobs for more than six years.

3.2 Measures

3.2.1 Commercialization of Research Outputs

The commercialization of research outputs was measured using three constructs of knowledge production and protection, knowledge relations, and skills development and transfer (Bansi, 2016; Coordination Committee on Science and Technology-Australia, 2005; Kenzhaliyev et al., 2020; Research Council of Zimbabwe, 2018). A sample item from the scale is, "*There are new research outputs and innovations that exist in this university.*" The participants were asked to respond using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The α coefficient of the scale was 0.89 in this sample.

3.2.2 Institutional Pressures

Institutional pressures were measured using three constructs of regulative, normative, and cultural-cognitive validated by Manolova et al. (2008), Sonka & Saurabh (2020), and Yadollahi et al. (2014). A sample item from the scale is, "*The government provides incentives for the commercialization of university research outputs.*" The participants were asked to respond using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The α coefficient of the scale was 0.78 in this sample.

3.2.3 Data Analysis

Data analysis was conducted in three major phases. First, in the initial data analysis, all variables were examined for data entry accuracy, missing values, outliers, and normality. Second, we then performed the reliability analysis, and later correlational analyses to understand the interrelationships among the key variables with SPSS v.24. Lastly, the estimated the direct effect

by testing the proposed hypothesis with Structural Equation Modeling (SEM) using Analysis of Moments Structures (AMOS v26).

4. Results

4.1 Normality Tests

The normality assumption was tested using the skewness and kurtosis as per the results (Table 1). Results from our data indicated that the values of skewness and kurtosis were close to zero points. The results implied that our data from the study were normal and good for further statistical tests as the assumption was achieved and tenable.

Table 1: Skewness and Kurtosis Statistics for Normality

Variables	N Stat	Min Stat	Max Stat	Skewness Statistic	SE	Kurtosis Statistic	SE
1. The commercialization of Research Outputs	308	1.44	4.67	-.610	.139	.206	.277
2. Institutional Pressures	308	1.30	4.78	-.407	.139	-.079	.277
3. Valid N (list-wise)	308						

Source: Primary Data

4.2 Reliability and Correlation Analysis

Correlation analyses were performed to examine the associations among the key variables. The commercialization of research outputs was positively correlated with institutional pressures ($r = .716, p < 0.01$). The α coefficient of the commercialization of research outputs scale was 0.89, while that for institutional pressures was 0.78 in this sample. Table 2 presents the details of the correlation results.

Table 2: Descriptive and Correlation Matrix

Correlations	Mean	SD	α	1	2
1) Commercialization of Research Outputs	3.5512	.45647	0.89	1	
2) Institutional Pressure	3.5208	.41549	0.78	.716**	1

** . Correlation is significant at the 0.01 level (1-tailed); N = 308

Source: Primary Data

4.3 Validity

Using Confirmatory Factor Analysis (CFA), construct validity was tested through Analysis of the Moment of Structure (AMOS v. 23) to ascertain the degree to which the operationalization of study constructs does measure what the theory asserts (Sarantakos, 2005). This analytical phase involved estimating separate measurement models for the commercialization of research outputs and institutional pressures. Construct validity was examined through convergent and discriminant validity tests. Convergent validity shows item homogeneity within the same construct, whilst discriminant validity shows item heterogeneity between different constructs.

4.4 Convergent Validity

In testing for convergent validity, the suggestions of Hair *et al.*, (2010) were followed in which three elements were examined. First, the final items should be statistically significant, with a factor loading of 0.40 or above, and highly loaded on a single factor. Second, the average variance extracted (AVE) of a latent construct ought to be a statistical value of 0.50 or above suggesting satisfactory convergence. Third, construct reliability should be 0.70 or above, although reliability between 0.60 and 0.70 is considered adequate and acceptable provided other indicators in a model's construct validity post good results (Taber 2018; Taherdoost 2018; Gwet 2008).

Through model trimming, modifications were done to ensure that the model adequately fits the data. This involved checking the factor loadings and then examining the normalized residual, also called the standardized residual, together with the modification indices. Hair *et al.* (2010) argues that residuals more than ± 2.58 are suggestive of model specification error, whilst a modification index value greater than 3.84 indicates that the χ^2 statistic would be fundamentally lessened when the corresponding parameter is estimated. Besides the statistical guidelines for the examination of the measurement model, we were further guided by theoretical justifications in model fitting (Kline, 2005). This suggests that the final goal is to fit a model that is both essentially rational and statistically fits data and theory well (Jöreskog, 1993). Holmes-Smith *et al.* (2005) observe that in an attempt to ensure that the model fits the data reasonably well, scholars should refrain from effecting changes on a model based on singular data-driven grounds. The convergent validity results are presented as follows:

4.4.1 CFA Measurement Model for Commercialization of Research Outputs

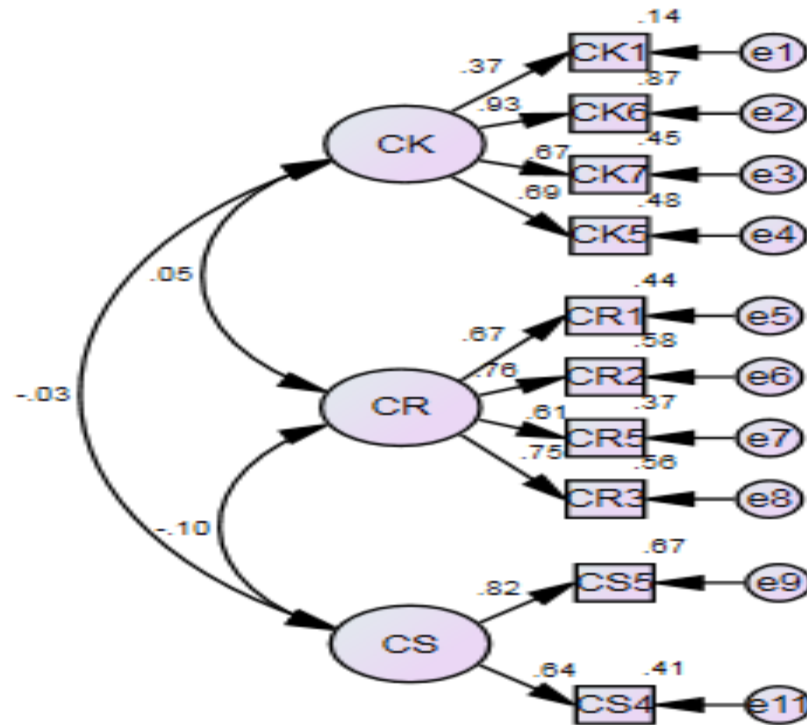
The commercialization of research outputs was measured using three factors knowledge production, knowledge relations, and skills development transfer. At initial verification of the inter-item correlation matrix, we removed items that were poorly correlated (correlation coefficient as low as .12) with other items in the scales. The remaining items were subjected to

CFA. Results of the initial CFA revealed that while the standardized parameter estimates were all significant ($p < .001$), the fit statistics were below the acceptable levels suggesting a poor fit of the commercialization measurement model. This required a re-specification by iteratively deleting items to meet an acceptable parsimonious model. Inspection of the modification indices (MIs) revealed mis-specifications associated with 'CR2', 'CR5', 'CR6', 'CR7', 'CR8', 'CK2', 'CK3', 'CK5', 'CK7' and 'CS2'. Eight out of eighteen items in total were iteratively weeded out in the final model before further analysis. Although the number of deleted items was substantially high relative to the total, their elimination did not alter the content of the construct as initially conceptualized. This is because the retained items had significant and standardized factor loadings in excess of the recommended level of .40 implying that the meanings of theoretical factors as earlier conceptualized, were preserved. The model findings confirmed the validity of the final model with outstanding model fit statistics for this construct commercialization of research output measure as reported in Table 3. Given that the model fit the data well and the correlation between the underlying factors was less than .85, no further adjustments were required.

The Model in Figure 1 shows a Normed Fit Index (NFI) of .961 which demonstrates strong convergent validity. The chi-square value of 32.380 is non-significant at .05 level: $p = .448$ suggesting that the commercialization of the research output model fitted the data adequately well. The Average Variance Extracted (AVE) is .50 which has been collaborated by other fit indices: Root Mean Square Error of Approximation (RMSEA) = .006, Tucker Lewis index (TLI) = .999, GFI = .979, Adjusted Goodness of Fit (AGFI) = .964, and Comparative Fit Index (CFI) = 1.000. All critical Ratio values (CR) were greater than 1.96 and $p =$ values were less than .001 alluding to significance.

The observed factor loadings contrasted with their standard errors showed evidence of the link between the commercialization of research and its respective constructs (knowledge production, knowledge relations, and skills development). For the case of item reliability, multiple regressions in this case R^2 were used. Generally, an R^2 value in excess of .5 is considered to be adequate to conclude the reliability of each item (Bollen, 1989). Apart from the ten weeded-out items as indicated above, the remaining met the reliability criterion. The composite reliability for the commercialization of research output is .80, well above the acceptable level as suggested by DeVellis (2003) and Nunnally (1978).

Figure 1: Measurement Model for Commercialization of Research Outputs



Source: Primary Data

Table 3: CFA for Commercialization of Research Output Model

Item Code	Item Label	β	C.R
Knowledge Production			
CK1	There are new research products and research outputs that exist in this university	.374	---
CK6	There are licenses arising from research in this university	.932	5.85
CK7	The university receives revenue from the commercialization of research	.673	6.02
CK5	There are patents arising from research in this university	.690	6.09
Knowledge Relations			
CR 1	There are research contracts signed with outside	.667	---

	parties such as development partners geared towards commercialization in this university		
CR2	The university has several projects and research linkages	.759	9.92
CR5	The university organizes several multi-stakeholder seminars on the commercialization of research	.605	8.67
CR3	The university receives funding from development partners for the commercialization of research outputs	.752	10.13
Skills Development Transfer			
CS5	Senior staff regularly conduct peer review research reports	.641	---
CS4	The university has many skilled staff to meet the research supervision requirements of students	.820	1.17
Achieved Fit Indices RMSEA = .006; CMIN/DF = 1.012; GFI = .979; AGFI=.964; CFI =1.000; TLI=.999; NFI=.961			
Composite Construct Reliability .80, AVE .50; $\chi^2= 32.380$; d/f- 32; $p =.338$			

Source: Primary Data

4.4.2 CFA Measurement Model for Institutional Pressure

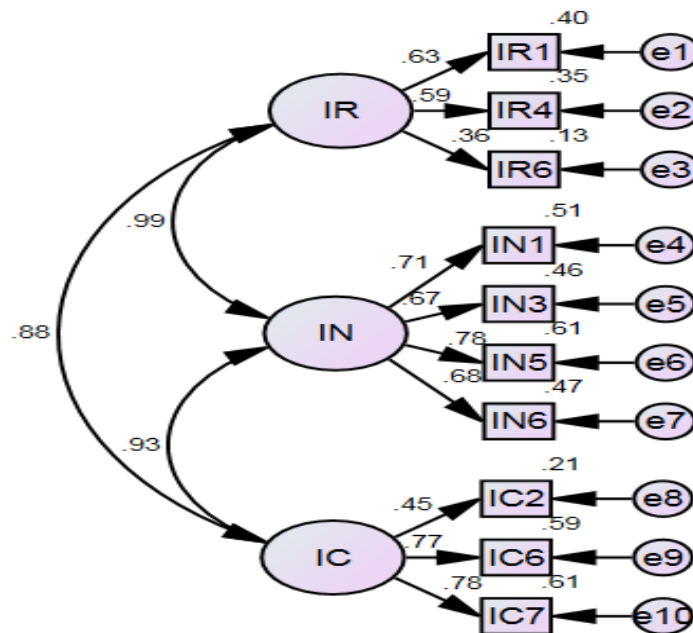
Institutional pressure was measured using three factors *inter alia*: regulative pressures, normative pressures, and cultural-cognitive pressures. At initial verification of the inter-item correlation matrix, we removed items that were poorly correlated (correlation coefficient as low as .12) with other items in the scales. The remaining items were subjected to CFA. Results of the initial CFA revealed that while the standardized parameter estimates were all significant ($p <.001$), the fit statistics were below the acceptable levels suggesting a poor fit of the institutional pressure measurement model. Therefore, re-specified the model by iteratively deleting items to achieve an acceptable parsimonious model. Inspection of the modification indices (MIs) revealed mis-specifications associated with ‘IR7’, ‘IR2’, ‘IR8’, ‘IR3’, ‘IR10’, ‘IR9’, ‘IR5’, ‘CK5’, ‘IN2’, ‘IN4’, ‘IC1’, IC3’ and ‘IC5’. Thirteen out of twenty-three items in total were iteratively deleted in the final model prior to further analysis. While the number of deleted items substantially appears high relative to the total, their elimination did not significantly change the content of the construct as initially theorized. This is because the retained items had significant and standardized factor loadings in excess of the recommended level of .40 implying that the meanings of theoretical factors as earlier conceptualized, were preserved. The model findings confirmed the validity of the final model with outstanding model fit statistics for this construct of institutional pressure as reported in Table 4. Given that the model fit the data well and the

correlation between the underlying factors was less than .85, no further adjustments were required.

The Model in Fig 2 indicates an NFI of .960 which illustrates strong convergent validity. The chi-square value of 44.433 is non-significant at .05 level: $p = .071$ suggesting that the institutional pressure model fitted the data adequately well. The Average Variance Extracted (AVE) is .45 which has been supported by other fit indices: RMSEA = .036, TLI = .984, GFI = .972, AGFI = .952, and CFI = .988. All critical Ratio values (CR) were greater than 1.96 and $p =$ values were less than .001 suggesting statistical significance.

The observed factor loadings compared with their standard errors showed evidence of the association between institutional pressures and their respective factors (regulative, normative, and cultural cognitive pressures). For the case of item reliability, we relied on multiple regressions, in this context- R^2 . Normally, an R^2 value in excess of .5 is considered adequate to conclude the reliability of each item (Bollen, 1989). Apart from the thirteen deleted items above, those that remained met the reliability criterion. The composite reliability for the commercialization of research output is .84, well above the acceptable level as suggested by DeVellis (2003) and Nunnally (1978).

Figure 2: Measurement Model for Measurement Model for Institutional Pressure



Source: Primary Data

Table 4: CFA- Institutional Pressure Measurement Model

Item code	Item label	β	<i>p</i> value	C.R
Regulative Pressures				
IR1	The government provides incentives for the commercialization of research outputs	.62	***	---
IR4	Existing policies in this university allow staff to innovate and commercialize their research outputs	.59	***	8.67
IR6	The university has a committee that handles research, innovation, and knowledge management	.36	***	5.62
Normative Pressures				
IN1	Turning new ideas into products and services is a priority for this university	.71	***	---
IN3	Researchers who commercialize their research outputs are recognized in this university	.67	***	10.90
IN5	Staff are rewarded for innovation and commercialization of research outputs	.78	***	12.52
IN6	The university has a mentorship and coaching scheme for research-related activities	.68	***	11.13
Cultural-Cognitive Pressures				
IC2	The staff are allowed to develop a particular product/process that has a possibility of being commercially viable	.45	***	---
IC6	Many researchers in this university earn a reputation by effectively commercializing their	.76	***	7.40

	research outputs			
IC7	This university builds capacity for research commercialization	.78	***	7.54
Achieved Fit Indices RMSEA = .036; CMIN/DF = 1.389; GFI = .972; AGFI=.952; CFI =.988; TLI=.984; NFI=.960				
Composite Construct Reliability .84, AVE .45; χ^2 - 44.433; d/f- 32; p =.071				

Source: Primary Data

4.4.3 Hypothesis Testing

SEM statistical modeling technique was used to simultaneously examine a scale’s reliability, validity, and relationships between variables (Hair *et al.*, 2010). SEM tests for both models fit as well as individual parameter estimates. SEM was used to estimate whether the assumed relationships (commercialization of research outputs affected other the institutional pressure variable). Through the model estimation procedure, the fit statistics were assessed to determine if this relationship existed.

The results testing revealed a measurement model for institutional pressures and commercialization of research output. This model posited an NFI of .973 which indicated strong convergent validity (Mark & Sockel, 2001). The model also generated a χ^2 of 3.971 significant at the .05 level with a p -value of .137 suggesting the model reasonably fit the data well. These results are further supported by the RMSEA = .057 and TLI result of .598. Further, GFI = .994, AGFI = .968, and CFI= .986 mirror model findings of earlier research using AMOS analytical strategy (see Kim, 2007). According to Kim (2007) and Hair *et al.* (2010), a GFI >.90, AGFI > .85, CFI > .90, and RMSEA < .08 is sufficient to judge a model as robust on account of fitting the data adequately well. Based on these benchmarks, the computed comparative fit indices are considered appropriate and the generated measurement model mirrors a good fit and thus is acceptable. As well, all the unconstrained parameter estimates were significant at p (two-tailed) < 0.001. In light of these findings, H1 is accepted. These results are further validated by the path coefficients in Table 5 below.

Table 5: Path Coefficients for the Hypothesized Measurement Model

Estimated Path	B	SE	CR	β	p -value	Supported
CMM<---IP	.114	.054	2.121	.104	.034	YES

Source: Primary Data

4.5 Testing direct relationships

Hypothesis (**H1**) sought to investigate the relationship between institutional pressures and the commercialization of research outputs. The results reveal that the association is positive and statistically significant ($\beta = .104, p < .05$), thereby supporting hypothesis one (**H1**). This finding means that positive variations in the commercialization of research outputs in universities are a result of institutional pressures.

4. Discussion and Implications

The study hypothesis sought to investigate whether institutional factors are associated with the commercialization of research output and innovations among universities. The findings of testing H1 revealed that institutional factors are positive and significant predictors of the commercialization of research output and innovations. These results indicate that it is when there are effective institutional pressures as underpinned by the domains of regulative, cultural-cognitive, and normative factors that we begin to appreciate and realize the commercialization of their research outputs among universities. The findings of this study provide empirical support for literature, for instance, DiMaggio & Powell(1983), Scott and Amarante (2016), Ayisi et al (2016), and Odei (2017) established the vital role of institutional factor elements (regulative, cultural-cognitive and normative) in influencing commercialization of university research output and innovations through institutions' entrepreneurial turn.

These results, therefore, point to the overarching role of regulative, cultural-cognitive, and normative factors in promoting the commercialization of research output and innovations. Through the regulatory framework as evidenced by the existing rules; research agendas; and policies such as research and innovation policy, intellectual property rights policy, grants management policy, and structures like innovation and incubation centers have guided on the commercialization path which has promoted harmony among the triple helix prayers (government-industry-university) leading to enhanced commercialization. These factors have created an enabling environment and provided support effects for enhanced commercialization of research output and innovations.

However, in some universities, the regulative framework or influences are characterized by serious ambiguity and some national policies still have some gaps to the extent that it fails leadership initiatives required to promote the commercialization of research outputs. Some policies such as the appraisal of academic staff miss the critical components of research commercialization such as patenting but focus mainly on publications. The intellectual property rights, as well as revenue-sharing policies arising from commercialization, are not clear which creates conflicts during execution. In addition, by examining the performances of

commercializing university research in empirical settings, it is not difficult to find that regulative changes at the macro level do exert certain influences on commercializing university research. Without driving forces from national policies, universities have no motivation to actively participate in commercialization activities. In Uganda, research is coordinated by different ministries, departments, and agencies without clear roles which confuses the key stakeholders in the research commercialization ecosystem.

Through normative pressures, the leadership of universities as well as staff and other stakeholders have been able to pay more attention to duty and moral obligation which are integral components for positive change with respect to the commercialization of innovations and research outputs. As pointed out by Yoshioka-Kobayashi (2019) that researchers usually lack business and market knowledge. The finding suggests the need for the leadership of universities to organize the regular capacity building of staff on commercialization, undertake commercialization training and mentorship schemes, and reward and recognize outstanding staff whose contribution to research-related activities is manifest. This will ultimately improve the commercialization of research output and innovations among universities as members will be conditioned to adjust their behaviors based on what they feel members of their social network (e.g., government, the international community, and regulatory bodies deem appropriate. Thus, this pillar has been able to motivate the universities to engage in the commercialization of their research consistent with the pressures resulting from the other players of triple helix players.

In addition, through normative pressures, universities were able to set structures such as innovation incubation centers, offices in charge of technology transfer, and holding companies among others. However, some of these structures are non-operational because of a lack of staff or the staff recruited do not have the required skills.

Finally, the cultural-cognitive factors that denote motives, beliefs, and perceptions have been instrumental in creating a team working environment that has promoted the commercialization of university research outputs and innovations. Therefore, institutional culture and beliefs will have to be oriented toward the successful commercialization of research outputs and innovations. The slogan of publish or perish needs to change to commercialize or perish if commercialization is to be enhanced. Staff thus, ought to be allowed to experiment by supporting them to produce or process innovations with the risk of being commercialized or not.

5.1 Theoretical Implications

This study expands the academic body of knowledge in several ways: the first key contribution is the focus of this specific study on factors for effective institutional influences in a developing country and with emphasis on Uganda's universities adds new insights into the roles of

institutional forces on improving the commercialization of research outputs. This contributes to the scarce literature on the role of institutional forces in shaping commercialization efforts using the perspective of Uganda's Universities in developing countries. This study, therefore, contributes to the growing body of institutional literature and debate in the pursuit of improvements in the commercialization of research outputs and innovations in universities.

Through the regulative pillar, universities have been able to advance coercive procedures that set rules, monitor performance, and sanction activities to guide the actions of universities pertaining to the commercialization of research outputs and innovations (DiMaggio and Powell 1983; Scott and Amarante 2016). Put simply, institutional pressures- regulations (laws, rules) have affected the commercialization ecosystem of universities. Also, the normative pillar that describes desirable conduct regarding values, norms, and roles (Scott & Amarante, 2016), has provided legitimacy to valued ends such as the commercialization of research outputs. Through the normative pillar, organizational members have felt and recognized the need for change and that this need must emerge out of a sense of duty and obligation even when members neither recognised the foundation for change nor believe in its success (Palthe 2014). Through cultural-cognitive influences, improvement in the commercialization of research output and innovations will demand a culture in which universities inspire their staff not only to venture into research efforts but also to commercialize the outputs. Universities must, therefore, be prepared to positively deal with a certain level of commercialization-associated risks and at the same time accept failures (Asmawi et al., 2013) since this partly drives commercialization efforts. Also, through culture, organizations have shaped the working relations among staff by encouraging teamwork, sharing common goals and ensuring effective communication which practices aid commercialization of research outputs.

5.2 Practical Implications

In light of the study findings, and reviewed literature, the results of this study also produce important practical implications. The study findings inform policymakers of the need to set research policies such as intellectual property, research agendas, revenue-sharing guidelines, and guidelines for the incubation and commercialization of research since these are vital for the commercialization of research outputs. These research policies are expected to provide direction, continuity, and consistent focus on research areas that increase the rate of commercialization. These policies might also provide a clear environment for setting a clear institutional vision and mission for the commercialization of research outputs and innovations. The lack of policies on ownership of patents and revenue sharing framework for innovations demotivates researchers engaged in commercialization as they are not sure of expected returns. Universities therefore should develop policies that are critical in enhancing the commercialization of university research outputs. There is a need to create awareness among researchers about pitching their

research in the right context of application to the industry to create an impact. This will require training of staff and students in entrepreneurship and involving the whole change of mindset. In addition, universities need to institutionalize commercialization policy targets into the performance management framework of staff such as staff appraisals, rewards, and promotions among others. Other commercialization indicators such as patenting, and licensing among others should form part of the staff performance management system.

The coordination of research and innovation funding through different government agencies such as the Office of President (Science Technology and Innovation), National Council for Science and Technology (UNCST), Public Universities, Uganda Industrial Research Institute (UIRI), Ministry of Information, Communication Technology and National Guidance (MoICT) among other. Government should institute a committee to coordinate and collectively undertake strategic planning for research and commercialization in line with national development frameworks. The committee should also have segregated roles for research and commercialization.

5.3 Conclusions

The study obtained supporting evidence that institutional pressures serve as a significant predictor of the commercialization of research outputs. Institutions with incentives and structures such as incubation centers, intellectual property rights offices, and grants for the promotion of research and innovations can commercialize their research outputs at least with ease. In addition, the universities should balance the burden of high expectations of citizens to provide a public good by ensuring an academic and commercial bicultural culture. That is to say, universities should not change their organization to only become entrepreneurial universities but let the two cultures coexist.

5.4 Limitations

This study has several limitations, which offer alternative routes for future study. First, this study adopted a cross-sectional survey for data collection. Therefore, drawing definite conclusions from the causal inferences between institutional pressure and the commercialization of research outputs is impossible. Common method variance might also have influenced the observed links (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Harman's one-factor test was conducted to manage this issue of common method variance. Therefore, the study findings cannot be solely ascribed to common method variance. Although common method variance does not pose a substantial challenge in data interpretation in this study, upcoming studies should obtain resources from other sources (for instance, data of engineering departments in tertiary institutions) for external validation. Finally, longitudinal designs should also be used to study

how institutional pressure in higher educational institutions leads to the commercialization of research outputs such as employees' changing their perception of job insecurity and other consequences.

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