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Innovation to Impact: Research Commercialisation in Uganda's Higher Education Institutions

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ABSTRACT

The commercialisation of research outputs and innovations is critical for bridging the gap between academia and industry. Notwithstanding its significance, research shows persistently low levels of commercialisation in Uganda, reflected in a widening Technology Balance of Payments (TBP) gap. Hence, this study examines the institutional, collaboration, and transformational leadership factors that enable or constrain the commercialisation of research and innovation within Institutions of Higher Learning (IHLs) in Uganda. Whereas available studies have explored drivers and barriers to research commercialisation, most focus on developed-country contexts, overlooking institutional dynamics specific to developing economies like Uganda. Utilising a mixed-methods approach, the study analyses perspectives from researchers, heads of research and graduate studies, and heads of finance and administration across selected IHLs. Using Analysis of Moments Structures (AMOS, V.23), Structural Equation Modelling (SEM) was performed for quantitative analysis, while NVivo V.10 was used for the analysis of qualitative data. The findings reveal significant fragmentation in research and innovation commercialisation, driven by the involvement of multiple government agencies, policy incoherence in funding mechanisms, inadequate research infrastructure, weak industry collaboration, and limited institutional incentive structures and entrepreneurial culture. The study recommends the adoption of a nationally coordinated commercialisation framework aligned with university and research institution agendas, increased domestic and multi-year funding for research commercialisation, strategic investment in research infrastructure, strengthened incentive and performance management systems, and deliberate efforts to cultivate an entrepreneurial culture within IHLs.

Keywords: Drivers, Barriers, Commercialisation, Research outputs, Innovations, Institutions of Higher Learning, SEM.

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1. Introduction

In the knowledge economy, Institutions of Higher Learning (IHLs) are increasingly acknowledged as seedbeds for modern knowledge generation, technological innovation, and value creation, with significant potential to stimulate economic growth and address societal challenges. As a result, the commercialisation of research outputs and innovations has gained prominence in academic, policy, and institutional discourse (Damian & Manea, 2019; Reichert, 2019; Ssebuwufu et al., 2012; Namdarian & Naimi-Sadigh, 2018). Globally, the Sustainable Development Goals, particularly Goal 17, highlight technology transfer, scientific capacity building, and innovation as central to sustainable development (United Nations, 2016). Similarly, the African Union's Agenda 2063 and the East African Community Vision 2050 underscore science, technology, and innovation as critical pillars for socio-economic transformation (African Union Commission, 2015; East African Community, 2015). Within IHLs, research commercialisation involves converting knowledge and technologies into marketable products and services through mechanisms such as licensing, spin-offs, patents, joint ventures, consultancy, and partnerships, thereby contributing to wealth creation and sustainable economic development (Bansi, 2016; Research Council of Zimbabwe, 2018).

The commercialisation does not occur through the direct conversion of research findings into market-ready products. Evidence shows that such a direct and almost linear relationship between research and market success exists only in a small number of cases (Research Council of Zimbabwe, 2018). Hence, the greatest benefit of research lies not only in generating innovations and knowledge necessary for continued profitable economic growth and social transformation, but also in enabling the conversion of this knowledge into technologies, interventions, and strategies that drive the socio-economic advancement of society.

Despite the importance associated with the commercialisation of IHLs' research output, evidence suggests low commercialisation (Cornell et al., 2020). Globally, IHLs register large amounts of research outputs with limited commercialisation, resulting in low returns on investment (Doanh et al., 2021; Cornell et al., 2020). Research and innovation contribute up to 3% of the Gross Domestic Product (GDP) of developed and emerging industrialised countries (Schwab & Zahidi, 2020).

Uganda's widening technology balance of payments (TBP) gap highlights a persistent dependence on imported technologies, reflecting limited translation of domestic research into market-ready innovations (National Planning Authority, 2024). This positions the country largely as a consumer rather than a producer of technology, despite the presence of IHLs with significant research potential. In response, the Government of Uganda has prioritised science, technology, and innovation (STI) as a central pillar of structural transformation, as reflected in the National

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STI Policy-2009, Uganda Vision-2040, and the Innovation, Technology Development, and Transfer (ITDT) programme under the Third National Development Plan (National Planning Authority, 2024; National Planning Authority, 2013). The Fourth National Development Plan (NDP IV, 2025/26–2029/30) further recognises the commercialisation of research outputs from science, technology, engineering, and innovation (STEI) as a key driver of industrialisation, enterprise development, and job creation (National Planning Authority, 2024). Complementary initiatives, including the Buy Uganda, Build Uganda (BUBU) policy, seek to strengthen demand for locally generated innovations, underscoring the strategic role of IHLs in advancing endogenous technological capability and sustainable economic growth.

Universities have implemented several interventions, including increased research funding (UGX 149 billion from government and UGX 621.6 billion from external grants between 2020/21 and 2024/25), improved staff remuneration, the establishment of research directorates, staff development programmes, research and innovation strategies, supportive policy frameworks, and investments in incubation centres, centres of excellence, and industrial parks to accelerate commercialisation (Office of the Auditor General, 2021; National Planning Authority, 2024). Despite existing relevant frameworks, structural and systemic constraints and fragmentation of Uganda's Research and Innovation (R&I) ecosystem continue to hinder knowledge transfer, resulting in duplication of efforts and inefficient resource allocation (Tweheyo et al., 2024; Jjagwe et al., 2024).

Previous research has investigated the barriers and drivers of research commercialisation, as noted by Butnik-Siverskyi et al., (2024) and, Shcherbachenko and Kotenko, (2022), with most of these focusing on developed countries and limited attention to less developed contexts such as Uganda (Biranvand & Seif, 2020; Amarante et al., 2022; Bansi, 2016; Shcherbachenko & Kotenko, 2022). However, research commercialisation in IHLs is shaped by country-specific institutional processes, making the direct replication of models from other contexts ineffective (Ayisi et al., 2017; Kerefu & Machuve, 2026; Vladyslav, 2024; Reichert, (2019).

This study examines the drivers and barriers to commercialisation within Institutions of Higher Learning (IHLs), recognised as key contributors to research-based socio-economic development. A mixed-methods approach is adopted, integrating quantitative and qualitative data. The quantitative component analyses relationships among commercialisation variables and identifies significant drivers and barriers. The qualitative component explores the underlying reasons, contextual influences, and institutional dynamics that explain why these barriers persist. Together, the findings inform the development of practical, context-specific commercialisation pathways for Uganda's research and innovation ecosystem.

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This study examines the institutional, collaboration, and transformational leadership factors that enable or constrain the commercialisation of innovations within Institutions of Higher Learning (IHLs) in Uganda. Specifically, it seeks to: (a) identify institutional practices, collaboration mechanisms, and leadership attributes that drive or hinder effective research commercialisation; and (b) develop practical, evidence-based recommendations to guide interventions by IHLs, government, and other stakeholders aimed at accelerating research-to-market pathways and innovative enterprise development. Analysing the interactions among institutional structures, private-sector collaboration, and transformational leadership is critical to strengthening Uganda's research and innovation ecosystem, particularly as the country positions itself to align its aspirations with the demands of the Fourth Industrial Revolution (4IR). By contextualising the findings within Uganda's innovation system, the study proposes policy-relevant insights that reflect national realities while offering lessons applicable to comparable developing economies.

The following sections of this paper will discuss the relevant literature, research methodology, study findings and discussion, strategies to surmount the hindrances, and the conclusion.

2. Review of literature

2.1 Drivers and Barriers to Innovation Commercialisation

In the context of the Fourth Industrial Revolution (4IR), advanced economies have accelerated the transformation of production systems through digital technologies, mainly artificial intelligence and machine learning, to improve efficiency, quality, and cost-effectiveness (Delera et al., 2022). Fundamental to effective commercialisation in this transition are research, innovation, and entrepreneurship (Piñeiro-Chousa et al., 2020). This shift bolsters the "third mission," which goes beyond teaching and research to incorporate knowledge transfer, innovation, and engagement with industry through strategic partnerships for Institutions of Higher Learning (IHLs).

The involvement of IHLs in commercialisation developments is modelled by manifold institutional pressures that may empower or inhibit engagement (Reichert, 2019; Tweheyo et al., 2024). The Institutional Theory classifies these pressures into regulative, normative, and cultural-cognitive dimensions (Dimaggio & Powell, 1983). Regulative pressures comprise laws, policies, and incentives that shape organisational behaviour; normative pressures concern values, standards, and role expectations; while cultural-cognitive pressures indicate mutual beliefs and deductions that inform the perception and enactment of commercialisation within IHLs. These institutional forces jointly affect organisational behaviour and IHLs' capacity to convert research into profit-making outputs.

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Regulatory frameworks are especially significant in determining commercialisation outcomes. Supportive national and institutional policies, such as distinct intellectual property regimes and inducements for academic entrepreneurship, have been proven to advance research commercialisation, as displayed by reforms in the United States and parts of Europe (Organization for Economic Co-operation and Development, 2019; Bansi, 2016). Conversely, weak or ambiguous policies amplify uncertainty and administrative challenges, discouraging engagement. Subsequently, research commercialisation is progressively perceived as a collective obligation among IHLs, industry, and government, aligned with the Triple Helix Model, which underscores coordination, complementarity, and collaboration among these actors (Cai & Etzkowitz, 2020; Leydesdorff & Ivanova, 2016; Etzkowitz & Leydesdorff, 1995). Cooperation with industry and government augments the relevance, scalability, and IHL research's impact on society. All-encompassing innovation ecosystems enable access to balancing capabilities, funding, infrastructure, and market knowledge, thereby confronting shared commercialisation failures (Kasozi, 2017). Effectual partnership also demands collective visions and trust that balances academic and commercial rationalities. Strong university–industry–government connections help align research agendas, lessen replication, and support efficient resource utilisation, eventually solidifying innovation outcomes (Tweheyo et al., 2022; Abbas et al., 2019).

Leadership performs a pivotal role in determining institutional environments for commercialisation. Thus, effective research output commercialisation requires transformational leaders who influence organisational culture, align motivations, and motivate academics to engage beyond traditional scholarly roles (Tweheyo et al., 2025; Kasozi, 2017). By conveying a clear vision and nurturing supportive norms, such leaders can moderate institutional inflexibilities and encourage innovation and entrepreneurship. However, many IHL leaders continue to prioritise academic prestige and publication outputs over commercial impact, limiting institutional responsiveness to market opportunities (Parker, 2024).

Conceding that experiential studies reliably show the impact of institutional factors on research commercialisation, many adopt direct approaches that neglect the mediating role of leadership (Abbas et al., 2019b). Evolving evidence implies that transformational leadership is a vital means through which institutional pressures are deciphered and ratified, influencing commercialisation behaviour within universities (Kasozi, 2017).

Several persistent barriers further inhibit commercialisation efforts. Dissemination mechanisms that favour scholarly journals over practitioner-oriented channels further limit industry awareness of academic research (Kariuki et al., 2019). Negative perceptions about the pertinence or applicability of university research, combined with faint recognition of universities as innovation partners, equally lower industry engagement (de Wit-de Vries et al., 2019). Internally,

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bureaucratic structures, rigid administrative processes, and inadequate structural flexibility slow decision-making and responsiveness to commercial opportunities.

Extra limitations include communication gaps between academics and industry, ethical strains resulting from perceived divergences between commercialisation and traditional academic values, and misalignment between academic reward approaches and market-driven outcomes (Research Council of Zimbabwe, 2018). Financial drawbacks, such as inadequate funding for technology transfer infrastructure, limited prototyping resources, and insufficient enterprise capital, further encumber progress. Moreover, many academics lack principal business skills, including market analysis and customer engagement, which hinder the conversion of research into feasible outputs (Research Council of Zimbabwe, 2018).

Commercialisation outcomes are similarly shaped by broader policy and market conditions, such as weak institutional strategies, underdeveloped intellectual property systems, and inefficient patent regimes, which weaken innovation efforts (Reichert, 2019). Market-related barriers, including regulatory complexity, uneven demand, technological ambiguity, and interminable endorsement processes, further constrain the successful approval of university-generated innovation outputs (Research Council of Zimbabwe, 2018; Jjagwe et al., 2024).

Overall, the literature indicates that valuable research commercialisation in IHLs is not driven by isolated factors but by the interaction of institutional frameworks, collaborative ecosystems, and leadership capacity.

3. Theoretical Perspectives

IHLs are increasingly recognised as key drivers of knowledge creation and technological innovation, contributing to economic growth and national competitiveness. Thus, Institutional Theory and the Triple Helix Model have emerged as prominent models for explaining IHL-led research commercialisation (Cai & Etzkowitz, 2020). Institutional Theory rationalises how regulative, normative, and cultural-cognitive pressures influence organisational behaviour, including IHLs' engagement in commercialisation (Amarante & Crubellate, 2019). However, it offers inadequate awareness of inter-organisational collaboration processes (Tweheyo et al., 2024; Amarante & Crubellate, 2019; Adegbile et al., 2023). The Triple Helix Model complements this limitation by stressing active interfaces among universities, industry, and government, which reinforce the translation of research outputs into economic and societal value (Cai & Etzkowitz, 2020; Leydesdorff & Ivanova, 2016). Increasing societal and economic demands have triggered an entrepreneurial transition within IHLs, driven by mutual institutional pressures from Triple Helix actors (Scott & Amarante, 2016). These partnerships are moulded by institutional contexts that impact organisational structures, norms, and governance structures,

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resulting in diverse collaboration patterns across settings (Reichert, 2019; Nguyen & Ng, 2020). Within the research-commercialisation ecosystem environment, transformational leadership aligns institutional pressures with collaborative efforts by shaping supportive norms, encouraging strategic risk-taking, and inspiring stakeholders. As such, leadership strengthens IHLs' commercialisation capacity and enhances the effectiveness of university–industry–government interactions (Leitner et al., 2021; Kasozi, 2017). Drawing on the theoretical framework and underpinning theories discussed above, this study adopts the conceptual model presented in Figure 1 below.

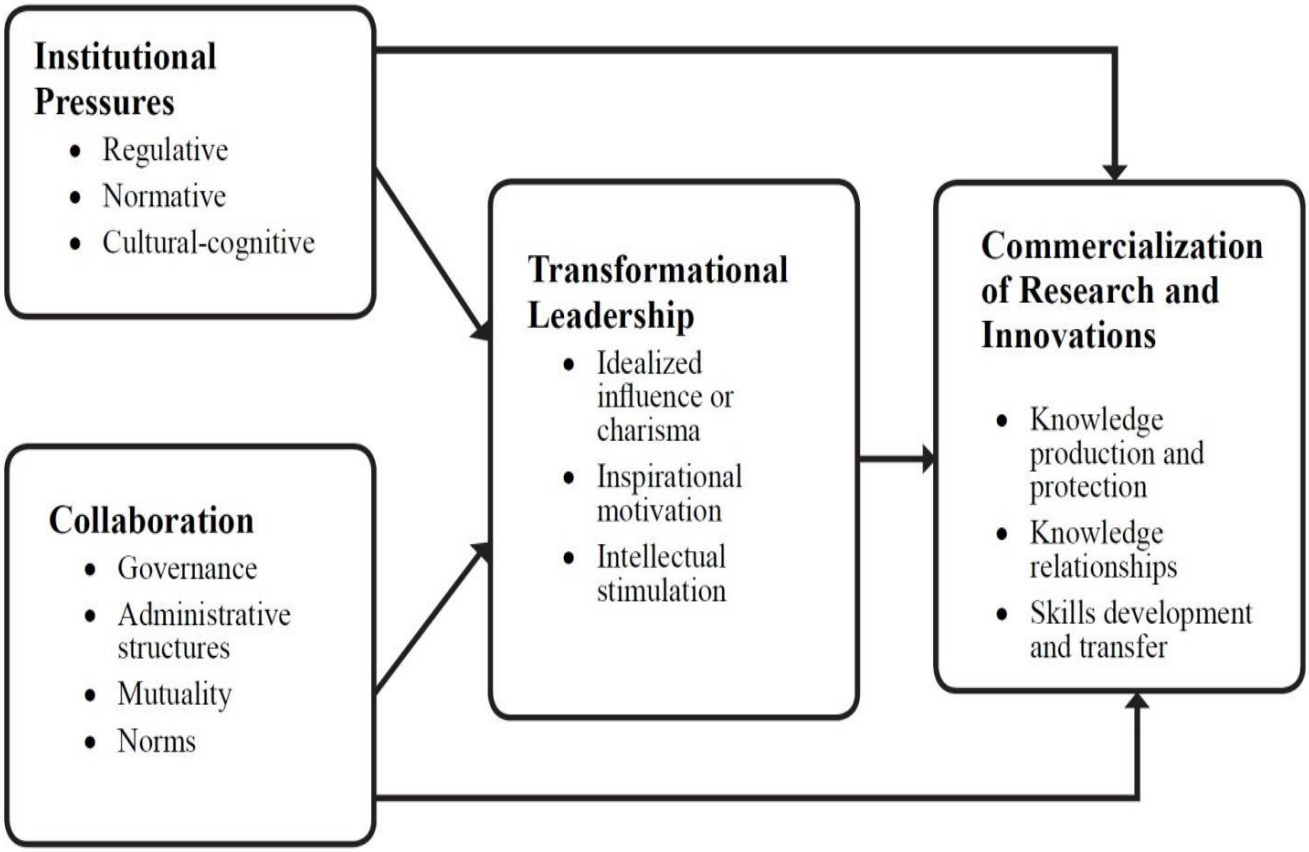

Figure 1: Conceptual framework for commercialisation of university research outputs. Source: (Leitner & Bergner, 2011; Rybnicek & Königsgruber, 2019; Sonka & Ashok, 2020; Sri Gustina Pane, 2020; Kenzhaliyev et al., 2020; Casani, 2018; Scott & Amarante, 2016; Bansi, 2016; Kauppila et al., 2015; Yadollahi, et al., 2020; Anbardan, 2013; Etzkowitz & Leydesdorff, 1998; Dimaggio & Powell, 1983).

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4. Method

4.1 Study design and approach

A mixed-method design was used to address the complexity inherent in commercialisation; this method integrates quantitative trends with qualitative insights, thereby strengthening the analysis through methodological triangulation (Jogulu & Pansiri, 2011). While earlier research has identified key factors influencing the commercialisation of innovations commercialisation (Butnik-Siverskyi et al., 2024; Shcherbachenko & Kotenko, 2022; Jjagwe et al., 2024; Tweheyo et al., 2024), existing literature provides limited comprehensive analysis of institutional practices, collaboration mechanisms, and leadership attributes as collectively interacting determinants within the Ugandan context. This study seeks to address this shortcoming by adopting a mixed methods design to systematically examine both the drivers and barriers to commercialisation in an integrated manner. In addition, a cross-sectional design was adopted due to time limitations and the absence of a need for prolonged observation or experimental control associated with longitudinal studies (Creswell, 2009; Kasim & Antwi, 2015).

4.2 Study population

The target population comprised researchers; heads of research and graduate studies (or equivalent); and heads of finance and administration in Ugandan IHLs recognised by the National Council for Higher Education (NCHE). A total of 284 institutions where 64 publics and 220 privates were considered, as they are actively involved in research, funding, and commercialisation activities. For the quantitative component, the study applied Yamane (1967)'s formula for sample size determination, which provides a straightforward and statistically robust method (Nanjundeswaraswamy & Divakar, 2021). This yielded a sample of 168 institutions.

Therefore, based on this approach, with a population of 284 IHL, we obtained a sample of 168 responding institutions as per the formula below.

$$n = \frac{N}{1 + N(e)^2}$$

Where n= sample size; N= population size; and e= level of precision (0.05)

Therefore, n = 284 ÷ [1 + 284 (0.05)2] ≈ 168

Data for the qualitative component were collected from researchers, including Deputy Vice-Chancellors responsible for academic affairs and research, and researchers who had commercialised or were in the process of commercialising their outputs. Sampling was sustained until the required data were obtained, following the recommendations of Miles and Huberman as

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hypothesised by Schwandt, (1994) and Rithirun et al., (2021). In total, 11 researchers from 11 universities (7 public and 4 private) were purposively selected and interviewed using a semi-structured guide, with questions designed to capture experiences pertaining to the commercialisation of research outputs and innovations.

4.3 Data collection and analysis

Quantitative data analysis was conducted in three main stages. First, preliminary data screening was performed to assess accuracy, missing values, outliers, and normality. Second, the data were organised, analysed, and presented using SPSS version 24 to facilitate interpretation. Data normality was examined using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The findings revealed that all variables were non-significant at $p > 0.05$, confirming that the data were normally distributed and suitable for subsequent parametric analyses.

Cronbach's alpha coefficient was used to measure internal consistency, where values closer to 1 indicate stronger reliability (Sekaran, 2003). The alpha constants for all study constructs ranged from 0.76 to 0.89, surpassing the recommended lowest limit of 0.70 (Nunnally & Bernstein, 1994).

To establish the validity of constructs, Confirmatory Factor Analysis (CFA) was conducted using the Analysis of Moment Structures (AMOS) version 23. CFA was utilised to assess the degree to which the operationalised assumptions correctly reflected the fundamental theoretical notions according to Sarantakos' postulation by Jinks, (2005). Independent measurement models were estimated for the commercialisation of research outputs and institutional pressures. Construct Validity was measured using convergent and discriminant validity tests.

Convergent validity was determined following the guidelines proposed by Hair et al. (2010) and Borror, (2004). Specifically, three criteria were examined: (i) factor loadings of 0.40 or higher with statistical significance and strong loading on a single factor; (ii) average variance extracted (AVE) values of 0.50 or above, indicating adequate convergence; and (iii) construct reliability values of at least 0.70, although values between 0.60 and 0.70 were deemed acceptable where other validity indicators were satisfactory (Taber, 2018) and (Taherdoost, 2018).

Model refinement was undertaken to improve overall model fit. This process involved examining factor loadings, standardised residuals, and modification indices. According to Hair et al. (2010) standardised residuals exceeding ±2.58 suggest model misspecification, while modification index values greater than 3.84 indicate that estimating the associated parameter would significantly reduce the chi-square statistic. Model modifications were guided not only by statistical criteria but also by strong theoretical justification (Kline, 2005). Following the

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validation of the measurement model, Structural Equation Modelling (SEM) was applied to analyse the structural relationships among the study constructs.

The mediated and non-mediated models were compared to identify the most appropriate model for testing the study hypotheses. Model evaluation followed the criteria proposed by Morgan & Hunt, (1994), which recommend assessing four key aspects of Structural Equation Models. These included: (i) overall model fit, as indicated by the Comparative Fit Index (CFI); (ii) the proportion of hypothesized paths that were statistically significant; (iii) the explanatory power of the model, measured using Squared Multiple Correlations (SMC); and (iv) model parsimony, evaluated using the parsimonious Normed Fit Index (PNFI). Based on these criteria, the mediated model demonstrated superior performance and was therefore selected as the most suitable model.

For qualitative data analysis, interview transcripts were examined to identify patterns and relationships prior to coding. Themes were developed based on the study's research questions. Content analysis was employed due to its suitability for analysing data from multiple sources. The transcribed interviews were analysed using NVivo version 10, which facilitated systematic data organisation, comparison, and visual mapping of key themes and relationships.

5. Results and discussion

The findings from SEM show that Institutional Pressures (IP) are positively and significantly linked to the commercialisation (CMM) of research outputs and innovations in Uganda's Institutions of Higher Learning (IHL). Collaboration (CO) also shows a noteworthy affirmative connection with commercialisation. In addition, institutional pressures are positively associated with transformational leadership (TL), collaboration is positively linked to transformational leadership, and transformational leadership has a good relationship with the commercialisation of research outputs and innovations, as detailed in Table 1 below.

To examine whether transformational leadership mediates the link between institutional pressures and commercialisation, the Maron & Kenny, (1986) mediation criteria were applied. First, institutional pressures had a significant direct effect on commercialisation ($\beta = .103$, SE = .054, $p < .05$). Second, institutional pressures did not have a significant effect on transformational leadership ($\beta = .058$, SE = .067, $p = .275$). Third, transformational leadership significantly predicted commercialisation ($\beta = .291$, SE = .046, $p < .001$). Since the relationship between institutional pressures and transformational leadership was not significant, mediation was not corroborated.

The SEM approach was used to prove whether transformational leadership mediates the relationship between collaboration and commercialisation. Collaboration had a significant direct

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impact on commercialisation (β = .331, SE = .034, p < .001) and a significant positive effect on transformational leadership (β = .368, SE = .040, p < .001). Transformational leadership also significantly predicted commercialisation (β = .291, SE = .046, p < .001). When transformational leadership was included in the model, the effect of collaboration on commercialisation decreased from β = .331 to β = .107 but remained significant, indicating partial mediation. These results are further validated by the path coefficients in Table 1 below.

Table 1: Path coefficients for the hypothesised measurement model

Path	Unstandardized Coeff (B).	SE	CR	Standardized Coeff (β).	P-value	Supported
TL <--- CO	.275	.040	6.927	.368	***	YES
CMM<---TL	.255	.046	5.561	.291	***	YES
CMM<---IP	.114	.054	2.121	.104	.034	YES
CMM<---CO	.217	.035	6.297	.331	***	YES
TL <--- IP	.073	.067	1.087	.058	.227	NO

5.1 Institutional Pressures and Commercialisation of Research Outputs and Innovations

The findings demonstrate that institutional pressures are positive and significant predictors of the commercialisation of research outputs and innovations among Institutions of Higher Learning (IHLs). Regulative, normative, and cultural-cognitive pressures jointly foster commercialisation, consistent with Institutional Theory, which emphasises organisational adaptation to external expectations through these mechanisms (Dimaggio & Powell, 1983). These findings align with earlier research confirming the role of institutional pressures in influencing research commercialisation (Bansi, 2016; Ayisi, 2016; Scot, 2016). Regulative pressures, including research commercialisation policies, intellectual property (IP) structures, tax inducements, and incubation hubs, guide universities toward commercialisation and reinforce harmonisation among Triple Helix actors. However, qualitative data highlight a lack of a coherent national framework to coordinate planning, implementation, and monitoring of research commercialisation across IHLs. Instead, the lack of a centralised commercialisation platform in IHLs has led to institution-specific research priorities, resulting in disintegrated endeavours and restricted information sharing (Jjagwe et al., 2024).

Notably, qualitative data indicated that many IHLs lack or have shaky important institutional policies, including IP policies, research agendas, grant management systems, and incubation

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guidelines. At the national level, unclear regulations governing research commercialisation and IP management undermine long-term strategic focus. As a result, research programmes are often informed by funding calls rather than sustained institutional or national priorities. Asked how the absence of key research policies and structures has affected the commercialisation of research outputs and innovations, a senior researcher replied:

"… the problem we have is that there is no systematic way of doing group research or university-led research that is focused from the beginning to the end over a long period of time. We don't follow a streamlined research plan; we are investigating malaria this month, and next month it is tuberculosis because of the absence of a clear policy framework. What should be commercialised in a five-year strategic period for a university and the nation is not aligned at any level.

Qualitative data indicated that funding limitations substantially impact commercialisation outcomes. Over 80% of research funding in IHLs comes from development partners targeting particular projects for a short-term, which may not be aligned with national development needs, thus limiting continuity. A greater percentage of allocations for government funding goes to salaries and infrastructure, with a smaller allotment to commercialisation. Even then, the distribution is selective, with public universities taking priority while excluding private IHLs (Office of the Auditor General, 2021). Short budget cycles and rigid financial management procedures further restrict innovation continuity.

For example, one respondent remarked:

"… I wrote a project to work on the problem of malaria in Kiruhura, the next project was on HIV prevalence in West Nile, while another one was on Ebola in western Congo. We write based on the call, not what needs to be commercialised or key for the country because of funding…"
"… as a university, we get a lot of money for research and development from development partners, but most of the funding does not focus on engineering things, drugs and medicines, and overall commercialisation. The market for technologies is dominated by first-world countries, which are again the funders …"

Normative pressures encourage professional accountability and moral obligation; however, feeble motivation systems, unclear patent ownership and revenue-sharing measures, and inadequate infrastructure hinder their effectiveness (Tweheyo et al., 2024; Amarante & Crubellate, 2019). Findings also showed inadequate infrastructure to be a main hindrance to commercialisation. Interviewees cited the shortage of specialised laboratories, incubation centres, practicum spaces, and essential equipment, noting that the available facilities largely support teaching and basic research rather than commercialisation. As a result, researchers do

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tests externally, thus increasing the cost, prolonging time-to-market and increasing the risk of being surpassed by their competitors. Participants emphasised the critical role of incubation centres in enabling innovators to test and refine products or services prior to market entry, thereby strengthening the commercialisation potential of university research. One of the respondents said:

"… when I developed one of the products, the university management wanted to own the patent, but when I went to ARIPO to patent, I was told that it is me the researcher, to own the patent, but the university acts like the address for the patent …" "…we are still grappling with setting up the research policies and structures for the sharing of revenue from the commercialisation of research outputs. I clashed with university management on the sharing of proceedings from the commercialisation of my research output…" "… the laboratories in this university are just for teaching, not research, and they are not specialised. I, as a Professor dealing with malaria, should have my specialised laboratory working on malaria parasites …"

Cultural-cognitive pressures also shape commercialisation outcomes. The dominant "publish or perish" culture prioritises publications over patents and prototypes, discouraging market-oriented research. Promotion and appraisal systems remain misaligned with commercialisation goals, reinforcing low engagement. In their pursuit of global rankings, universities tend to prioritise international publications and externally driven research agendas, often at the expense of local and indigenous knowledge with strong commercial potential.

In light of this, two respondents remarked:

"… I submitted a journal article on the solar water heaters to reduce the problem of collecting firewood, and the journal wrote back saying the research is too applied …"

"…people who have done publications have nothing tangible to show, but they become Professors before those who have commercialised their products on the market …"

Despite mixed evidence on the relationship between institutional pressures and commercialisation in prior studies such as those of Minbaeva & Minbayev, (2024) and Gibson & Foss, (2017), this study discovers that institutional pressures explain a substantial proportion of variance in commercialisation outcomes. Excessive focus on internationalisation and rankings further diverts attention from locally relevant innovations and indigenous knowledge.

5.2 Collaboration and Commercialisation of University Research Outputs and Innovations

The findings reveal a positive and significant relationship between collaboration and the commercialisation of research outputs in Ugandan IHLs, consistent with the Triple Helix Model (Dzisah and Etzkowitz, 2008; Leydesdorff, 2010; Dzisah and Etzkowitz, 2008). Collaboration

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enables resource sharing, joint knowledge utilisation, funding access, and problem-driven research, which promotes commercialisation. Governance and administrative structures, such as grants management offices, IP policies, and incubation hubs, improve coordination and align stakeholder interests, corroborating earlier studies (Kanaabi et al., 2022; Dollinger et al., 2018). However, collaboration, particularly between IHLs, communities, and industry, remains fragile due to limited engagement in technology transfer in larger firms in Uganda and financial and scaling constraints affecting small enterprises. Although Memoranda of Understanding exist, many are poorly implemented. Moreover, commercialisation support structures within IHLs are often newly established and managed by personnel with limited expertise, constraining their efficacy.

One respondent said:

"…we have set up clear offices to spearhead commercialisation of research, such as the Intellectual Property Rights Office and the Coordinator Incubation Centre. But most of these structures do not collect enough data to detect the commercially viable research and the staff in these offices lack commercialisation expertise …"

5.3 Institutional Pressures and Transformational Leadership

Contrary to expectations, no significant relationship was found between institutional pressures and transformational leadership. While this contrasts with some prior studies such as those of Kasozi, (2017) and, Rybnicek and Königsgruber, (2019), it aligns with evidence of weak associations in similar contexts (Alves et al., 2017; Gibson & Foss, 2017). This finding reflects Uganda's weak institutional environment, characterised by unclear regulatory frameworks, ambiguous IP policies, and limited national coordination, which renders research commercialisation optional rather than strategic.

Asked about the commercialisation landscape in the university, a senior researcher replied:

" … management focus is on teaching because there is much pressure from students. Research commercialisation is optional. In addition, the monitoring and evaluation framework for research commercialisation is deficient at both IHL and national levels, and the absence of a joint organ to oversee and regulate research initiatives in the country…."

5.4 Collaboration and Transformational Leadership

Results from SEM indicate that collaboration was found to be a significant predictor of transformational leadership. Collaborative practices enhance trust, shared vision, participation, and coordination, thereby strengthening leadership effectiveness. Governance and administrative

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structures empower leaders to motivate staff and foster innovation, consistent with earlier findings (Zhang & Chen, 2021).

5.5 Transformational Leadership and Commercialisation of Research Outputs and Innovations

The SEM results confirm a positive relationship between transformational leadership and research commercialisation. Leadership behaviours such as inspirational motivation, intellectual stimulation, and individualised consideration create an enabling environment for innovation, risk-taking, and knowledge sharing. This study validates the relevance of transformational leadership in the Ugandan university context, consistent with prior research (Leitner et al., 2021; Tweheyo et al., 2025). Transformational leadership also supports the development of an entrepreneurial university culture, which remains weak among academic staff due to limited entrepreneurial skills and risk aversion (Research Council of Zimbabwe, 2018). Strengthening mentorship, entrepreneurship training, and industry engagement is therefore essential.

5.6 Mediating Role of Transformational Leadership

SEM results in Table 1 above indicate that, transformational leadership did not mediate the relationship between institutional pressures and commercialisation, as institutional pressures exert a direct influence on outcomes. Weak regulatory and normative environments, unclear IP regimes, and limited performance incentives constrain leaders' mediating capacity (Jjagwe et al., 2024). In contrast, transformational leadership partially mediates the relationship between collaboration and commercialisation by translating collaborative initiatives into actionable commercial outcomes. Leaders play a critical integrative role by aligning stakeholder interests and strengthening coordination across the Triple Helix. Leaders take up a critical integrative and advisory role by aligning stakeholder interests, fostering a shared vision, and enabling effective coordination across the Triple Helix of universities, industry, and government.

> *"…we have skilled research staff, but we do not have the technical staff, mainly laboratory technicians. There is no university with a clear staff mix. Recruitment in a public university is based on the wage bill. This has affected our capacity to improve our innovation for commercialisation …"*

Overall, the findings highlight that while institutional pressures directly shape commercialisation, collaboration and transformational leadership jointly enhance the effectiveness and sustainability of university research commercialisation. Thus, the role of institutional pressures, collaboration, and transformational leadership in furthering the commercialisation of research outputs and innovations is illustrated in Figure 2 below.

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Figure 2: Paradigm Shift for Commercialisation of Research Outputs and Innovations in IHL based on both Quantitative and Qualitative findings

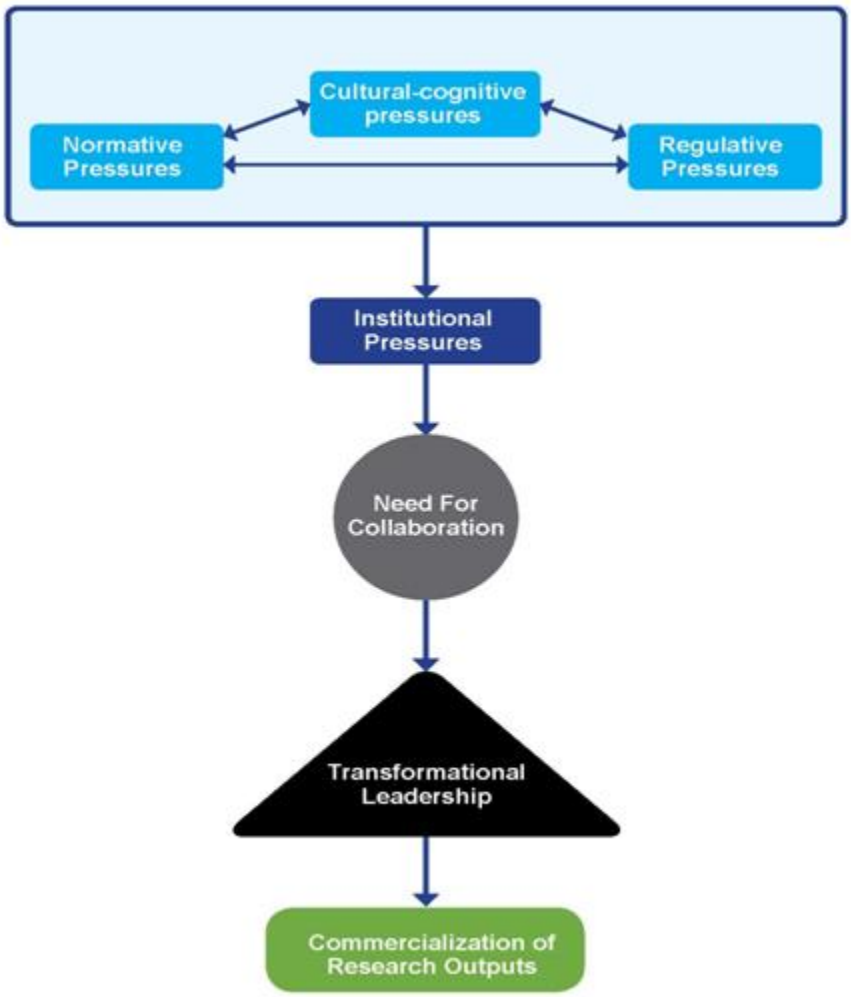

Figure 2: The relationship between Institutional Pressures, Collaboration, Transformational Leadership and Commercialisation of Research Outputs and Innovations. Normative, Regulative, and Cultural-cognitive influences shape the collaboration process, encompassing mutuality, administration, and governance practices. This is the process by which transformational leaders result in the commercialisation of research outputs and innovations (Source: Authors).

Thus, the commercialisation drivers and strategies to accelerate the commercialisation of research outputs and the innovation agenda can be summarised in Figure 3 below.

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Figure 3: Summary of Commercialisation Drivers and Strategies to Accelerate Commercialisation in Uganda

Key commercialisation drivers		Salient elements of the commercialisation drivers	Strategies to accelerate the commercialisation		
Institutional	Policy Framework	• Lack of a dedicated national-level agency for coordinating research commercialisation initiatives • Uncoordinated research agendas among national stakeholders • Lack of harmonised regulations and guidelines for research commercialisation, ownership of patents and revenue sharing resulting from commercialisation • Absence of one-stop centre for information on research and innovation commercialisation	• Identify and operationalise a national-level agency for coordinating research commercialisation initiatives • Develop a harmonised framework that guides research commercialisation in IHLs • Identify and support niche areas for each institution • Develop and operationalise one-stop platform for all the information about the commercialisation of research and innovations	→	Enhanced Commercialisation of Research
	Capacity of Institutions	• IHLs quantitatively and qualitatively have inadequate STEM/STEI staff • Limited entrepreneurial culture among IHLs staff • Limited IHLs-industrial collaborations on R&D • Limited structures and skills for detecting commercially viable research outputs • Lack of infrastructure in terms of specialised laboratories, practicum areas, incubation centres, instruments and equipment to drive the innovations forward	• Develop local capacity through partnerships with premier national and international universities/institutions • Train staff and students in entrepreneurship and mindset change • Develop research jointly with industry • Partner with the private sector and research institutions • Setup designated offices for research commercialisation • Set specialised infrastructure for promoting research and development	→	
	Financing	• Limited financial resources for Research and Innovation • The duration of the funding financial year for the Government, while commercialisation takes longer • Limited systematic continuity in research since much of the research funding is project-based from development partners • Lack of understanding of financing requirements by the private sector • Limited knowledge of forms of financing • Limited knowledge of forms of financing and sources at different innovation stages	• Operationalise the National Research Fund as recommended in NDP IV • Develop business cases for all innovations and secure patents • Establish minimum requirements for partners • Develop a financing strategy to attract financing for different stages of innovation • Promote the creation of research chairs in collaboration with industrialists and other development partners	→	
Collaboration	Collaboration/Market Access	• Weak research-led industrialisation • Industry lacks knowledge of Universities R&D capability • Differing objectives of the private sector • Limited financial resources for commercialisation cycle	• Develop research jointly with industry through strengthening the community engagement function • Set functional Business Incubation centres • Create a digital platform to showcase achievements in the R&D outputs in all institutions	→	

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Transformational leadership	**Governance**	• Lack of deliberate policy on protecting local innovators from external competitors • Performance management framework heavily pegged on knowledge generation • Bureaucracy in decision-making • Lack of documented processes and guidelines • Poor record keeping of the research development process • Lack of incentives for the commercialisation of research	• Develop and implement a deliberate policy on protecting local innovators from external competitors • Institutionalize research commercialisation targets into the staff performance management framework • Market innovations to both local and international partners • Develop and implement incentives for the commercialisation of research • Develop and implement guidelines for keeping records on the research development process. • Strengthen autonomy in universities • Setup and build capacity of Technology Transfer offices	→
	Internationalization	• Limited documentation of indigenous knowledge • Craziness for international publications and knowledge generation • Limited co-innovation with international players in commercialisation • Strategic alignment of development partner funding to national competitive advantage	• Develop incentives for documentation of indigenous knowledge • Develop partnerships with premier national and international universities/institutions in commercialisation • Research and innovation commercialisation to form part of performance management of staff • Balance between knowledge generation and research commercialisation	→
	Skills and Knowledge	• Limited entrepreneurship skills • Insufficient knowledge of standards and regulations applicable in specific industry sectors	• Support entrepreneurship mentorship and training for staff and other key stakeholders • Training stakeholders and staff in innovation-market-business related activities to conduct due diligence processes • Align the higher education curriculum with skills required research and innovation commercialisation • Cooperative and interactive relations between and within research institutions and industry	→

(Source: Authors)

6. Conclusion

6.1 Theoretical implications

Prior studies have drawn on Institutional Theory, the Triple Helix Model, and transformational leadership to explain IHL-led research commercialisation (Amarante & Crubellate, 2019). Contrary to much of this literature, the study findings reveal no major link between institutional pressures and transformational leadership. Whereas this finding differs from studies reporting positive associations, it aligns with studies that have identified weak or insignificant links between these constructs (Alves et al., 2017; Gibson & Foss, 2017). This divergence can be explained by Uganda's relatively weak institutional environment, characterised by unclear

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regulatory frameworks, ambiguous intellectual property policies, and a fragmented research output and innovation commercialisation ecosystem (Jjagwe et al., 2024).

These results complement a recent study by Tweheyo et al., (2024), who emphasise the role of institutional elements such as patent policies, revenue-sharing mechanisms, and entrepreneurial education in shaping university commercialisation outcomes. Similarly, the Research Council of Zimbabwe (2018) emphasises the significance of technology transfer offices (TTOs) and appropriate organisational structures in enhancing commercialisation success at research universities. Combined, these perceptions imply that institutional pressures affect commercialisation more directly through organisational and policy mechanisms than indirectly through leadership in weak institutional frameworks.

The study also broadens the Triple Helix literature, which emphasises university–industry–government collaboration as the foundation of innovation ecosystems (Noya et al., 2023; Abbas et al., 2019b). The findings indicate major fragmentation within Uganda's research and innovation ecosystem, characterised by inadequate infrastructure and weak policy consistency. This disconnect between policy intentions and implementation highlights shortcomings in the applicability of the Triple Helix Model to developing country contexts, suggesting the need to adapt it to the context, accounting for institutional fragility and coordination failures.

Furthermore, the findings contribute to the emerging literature on innovation financing in developing economies. The full dependence on external funding and lack of a national research and innovation fund highlight persistent challenges in obtaining sustainable financing for commercialisation (Moon, 2022). These limitations reveal broader organisational issues, including ever-changing government priorities and lack of an approved policy for long-term research and innovation funding. As such, the study underscores the need to improve existing theoretical models to effectively capture the financial realities determining innovation commercialisation in environments with limited resources.

Finally, the conceptual implications point to the importance of a holistic approach to research commercialisation that integrates institutional frameworks, entrepreneurship education, and effective technology transfer mechanisms (Tweheyo et al., 2024). In addition, the findings reinforce the need to incorporate community needs into commercialisation notions, as innovations may create unintended impact on societal norms and practices, as illustrated by Namugenyi et al., (2023). Incorporating these contextual dimensions enhances theoretical understanding of commercialisation processes and identifies avenues for further research and policy development.

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6.2 Policy implications

Achieving a competitive and sustainable research and innovation value chain is a long-term process that requires coordinated policy action and sustained commitment (Research Council of Zimbabwe, 2018), but current disintegration in research and innovation commercialisation, amplified by the involvement of multiple government agencies, weakens effectiveness (Jjagwe et al., 2024). The study therefore recommends a nationally synchronised intervention model aligned with the universities and research institutions' research agendas. Such a model should give a clear commercialisation direction, reduce duplication, and be supported by a unified commercialisation monitoring and evaluation framework.

In this regard, the National Research Fund should integrate both research and innovation-to-commercialisation components aligned with national development priorities. To ensure sustainability, the government should increase funding for domestic research commercialisation by adopting multi-year funding cycles rather than relying largely on external funders and annual budget allocations. Dedicated funding mechanisms should support start-ups and strengthen university–industry linkages across the commercialisation value chain.

Policy inconsistency in research and innovation funding, often stemming from poor cooperation between ministries and competing priorities, remains a predominant hindrance to technology commercialisation (Jjagwe et al., 2024; National Planning Authority, 2024). An integrated funding approach is needed to utilise policy collaborations and institute a referral system that enables smooth progression across support mechanisms. Sufficient resources should be allocated to all stages of the commercialisation process through balanced public–private participation. However, pre-commercialisation support, including market validation and marketing activities, remains weak due to undersized seed and start-up financing networks. Although angel investors, venture capital, and crowdfunding platforms offer capital, expertise and networks, innovation in the early stages is seen as high-risk, discouraging private investment. In addition, Uganda lacks such funding mechanisms.

Major gaps are evident concerning the research infrastructure, which is poor with less multiplier effect, there is a need to purposefully improve the national research infrastructure, including incubation centres, specialised laboratories, and workshops, to support advanced and impactful research and innovation. Therefore, infrastructure development should be built on distinctly specified niches and shared among institutions and researchers in similar fields, rather than duplicating underutilised facilities. A desegregated approach to ensure that infrastructure supports each stage of the commercialisation process is needed.

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Undeniably, enhanced networks and partnerships with leading universities and industry can foster synergies that support competitive research and innovation outputs, attract globally competitive researchers, and strengthen the national research and innovation value (Skjølsvik & Kaloudis, 2023) chain. Thus, strengthening collaboration remains indispensable, for such partnerships can also stimulate market demand and guide commercialisation strategies for research outputs.

At the institutional level, incentive structures for research excellence should be strengthened, and commercialisation targets embedded within staff performance management systems, including appraisal, promotion, and reward frameworks. Institutions of Higher Learning (IHLs) should establish clear technology transfer, innovation, and commercialisation policies, supported by strong leadership and strategic alignment with national and industrial priorities. In addition, transparent and consistent revenue-sharing models for commercialised research should be institutionalised across universities.

Finally, cultivating an entrepreneurial culture is essential for sustained commercialisation (Sandström et al., 2018). This requires integrating entrepreneurship, innovation, and intellectual property (IP) training into academic curricula; promoting interdisciplinary programmes linking research, business, and industry; providing legal, business development, and market analysis support to researchers; and strengthening technology transfer offices to facilitate patenting, licensing, and spin-off creation. Aligning higher education curricula with the skills required for research and innovation commercialisation is likely to generate significant multiplier effects across the economy.

6.3 Limitations and areas for further study

This study employed a cross-sectional research design, which constrains the ability to verify conclusive causal connections between the variables examined. Well aware that cross-sectional data capture relationships at a single point in time, the perceived links may be influenced by unmeasured factors or reciprocal validities (Scott & David, 2007). To strengthen causal deductions and validate dynamic processes over time, future studies are encouraged to adopt longitudinal or panel research designs (Ployhart & Vandenberg, 2010).

From the HLs' perspective, further comprehensive investigation into input–output models for the commercialisation of research outputs across different sectors is also required. Such studies would enhance the perception of how institutional resources, capabilities, and external linkages translate into commercial and societal outcomes (Dzisah & Etzkowitz, 2008; Leydesdorff, 2010). Moreover, future research should explore how research and innovation infrastructure can be strengthened across sectors and institutions, and utilised in a streamlined manner to minimise

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duplication and maximise efficiency and impact (Organization for Economic Co-operation and Development, 2019).

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