University Innovation without the Industry:

The case of Makerere

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List of Acronyms

ADF	African Development Fund
ARMS	Academic Records Management System
AU	African Union
BS	Biological Sciences
BTVET	Business, Technical and Vocational Education and Training
CAES	College of Agriculture and Environmental Sciences
CEDAT	College of Engineering, Design, Art and Technology
CoNS	College of Natural Sciences
CRTT	Center for Research on Transportation Technologies
DUI	Doing, Using and Interacting
EV	Electric Vehicle
EVS	Electric Vehicle Summit
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GTZ	Germany Technical Cooperation
ICT	Information and Computer Technology
IMF	International Monetary Fund
MAK EV	Makerere Electric Vehicle
MAKAPADS	Menstruation, Administration, Knowledge and Affordability Pads
MESA	Mainstreaming Environment and Sustainability in Africa
MFPED	Ministry of Finance, Planning and Economic Development
MIT	Massachusetts Institute of Technology
MoES	Ministry of Education and Sports
NCHE	National Council for Higher Education
NEPAD	New Partnership for Africa's Development
NIS	National Innovation System
NORAD	Norwegian Agency for Development Cooperation
PACF-ISCP	Pan-African Competitiveness Forum - Innovation Systems and Cluster Programme
PEAP	Poverty Eradication Action Plan
R&D	Research and Development
S&T	Science and Technology
Sida	Swedish International Development Cooperation Agency
SMEs	Small and Medium Enterprises

SPEDA	Skilling, Production, Enterprise Development and Academics
STI	Science, Technology and Innovation
TH	Triple Helix
UBOS	Uganda Bureau of Statistics
UIRI	Uganda Industrial Research Institute
UNBS	Uganda National Bureau of Standards
UNCST	Uganda National Council of Science and Technology
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
VDS	Vehicle Design Summit

Abstract

The contention between the National Innovation System (NIS) and Triple Helix (TH) on what and how universities should contribute to innovation has stood for some time now. Developing countries recently instituted innovation policies or incorporated innovation into their previous science and technology policies. Universities in such developing countries are critical resources for research. They are the option now for the pursuit of innovation and technology transfer. This paper considers the case of Makerere University in a least developed country: Uganda. Several historical and present conditions have made university-based innovation an option.

The paper finds the undertaking as reasonably justifiable in the context of the prevailing economic structure and the broader national challenges. The university can play a greater role in the country's technological transformation which should be beyond only passing out graduates as framed in the reformulated 'developmental university' of Brundenius et al (2008). The internal university status however does not support the need for reorganization and transformation that TH advocates for. TH rather has to appreciate the challenges faced by universities in developing countries which it has not conceived in its framework. Prevailing fears over loss of institutional autonomy and integrity, university privatization and knowledge commodification may not necessarily be outcomes of university-based innovation. Issues of public support and system coordination require redressed within national policy which should arise out of clear understanding of the university's significance to national development. The *'entrepreneurial university'* and the reformulated *'developmental university'* bear insights but both hold extremes. Each if taken in full measure might not be most helpful to developing countries' technological efforts.

Relevance to Development Studies

Studies on Local Innovation Systems are already widespread just as is the debate over university-based innovation. This paper makes a small contribution to the understanding of the challenges of the least developed countries in innovation. They are relevant experiences to inform innovation studies broadly.

The paper adds to the debate on the role of universities in view of the current competing frameworks. There has been little effort in general research to look at the two frameworks (NIS and TH) as critically juxtaposed. Particular attention is given to issues prevailing in the global South as compared to those in the global North in the divergence of the two approaches to innovation.

Keywords

University's role in innovation, National System of Innovation, Triple Helix, Science, Technology and Innovation, Uganda, Makerere University

Chapter 1 Introduction and methodology

1.1 Background

The demand for universities to directly contribute to development keeps strengthening both in developed and developing countries. The trend recently shows a transformation from social outreach to more demand for technology development and transfer to the industry (Göransson and Brundenius 2011). An encounter with the varying perspectives on the role of the university in innovation introduces one to contentions that not only render views, but deliver frameworks for the study and practice of innovation. Triple Helix (TH) and 'entrepreneurial university' proposition has kept pushing for universities with increased business-like environments. The National Innovation System (NIS) and the recent 'developmental university' reformulation have stood against university-based enterprises. Each of these frameworks has their specific details of propositions that we shall explore later. There is a third category on a balanced position supporting increased university-industry linkages, knowledge and technology transfer but insist on public support for universities (see Conceicao et al. 1998a; Conceicao et al. 1998b; Conceicao et al. 2001; Conceicao and Heitor 2003; Conceicao et al. 2004). This paper's discussion focuses on the two divergent strands (NIS and TH) as the specifically competing frameworks for the study and practice of innovation - university innovation inclusive.

The "third mission" of the university as is popularly referred to is not new. Coleman (1984) offered a historical map of the how universities contributed differently to their local and national development in Germany, United States of America (USA), Japan, Russia and others that followed the Soviet state model. Being referred to as a *'developmental university'* model, it was being adopted in several developing countries' strategies for national development. International agencies like the United Nations Educational, Scientific and Cultural Organization (UNESCO), Common Wealth and United States Agency for International Development (USAID) strongly supported it. The several issues that were not critically addressed including the government's developmental orientation, competence of the university management, balance of tasks with size of human resource and the most crucial point of slackened critical perspectives did not necessarily make the 'third mission' irrelevant. Coleman asserted that the need for the university's contribution is hardly disputable. Clear definition of the limits should be the issue. As it seems we have done no better so far. It has become increasingly difficult to agree upon those limits both in scholarship and policy.

The one side (TH) persistently promotes university entrepreneurship. It presumes it as a normal transformation induced by perspectives in recent innovation studies. The rise of the notions of knowledge-economy, initiatives of the universities to cope with resource challenges and increased demand from stakeholders in government, community and industry (Etzkowitz et al. 2000) have been rendered to justify the push. It has motivated other innovation schools particularly the NIS to argue against university-based innovation itself. Lundvall in his 'university in the learning economy' is sceptical of the ideological and political (neoliberal) tendencies to "squeeze" universities and com-

modify knowledge (Lundvall 2002 16). The intrinsic concern is apparently about the environment rather than what the university could do otherwise.

Other intermittent views have taken issue with the frameworks of innovation themselves rather than the political environment. NIS is attacked as being the cause of the current rise of innovation in the policy agenda (Godin 2007; 2013). Godin contends NIS marketization of innovation and the seemingly mobilization by innovation policies of everyone around the firm. Critics of the entrepreneurial university on the other hand like Lorenz (2006) trace the interests of current university transformations in neoliberal processes started in the 1980s. The restructuring of universities in Europe is associated with the objectives of managerial interference, tendencies toward financial stringency and privatization. This perspective to a degree concurs with Lundvall's fears.

In principal NIS takes the firm as its central innovation agent other than the university. Lundvall as a key NIS proponent disputes the transformation of universities into profit seeking entities; competing in international markets with knowledge as a commodity (Lundvall 2007: 38-41). His standpoint is that universities need to focus on passing out to the market sufficiently skilled graduates with interactive capabilities as their best knowledge transmission channel (Lundvall 2009a). The overemphasis by some researchers and policy makers on advancing high-technology agenda through science, technology and innovation (STI) is feared as limiting doing-using and interacting (DUI) mode of learning (Lundvall 2007). An outcome of these positions has been the tabling of a reformulated 'developmental university'. The features of this version cut off university-based innovation. Those included are 'generalization of life-long' advanced education which seeks to address enrolment gaps by providing opportunities, connecting research to development in the specific form of social inclusion, applies problem-based learning, encourages social interaction and balance amongst all the units of training (Brundenius et al. 2008).

In juxtapose, the 'entrepreneurial university' coming from Etzkowitz and Leydesdorff (1995), later advanced in Etzkowitz and Leydesdorff (2000), Etzkowitz et al. (2000) and Etzkowitz (2003) among the early initiatives puts the university as the principal agent in innovation. The university becomes a more "privileged" economic actor. University research then needs to be focused on patentability, potential for commercialization and at the same time being theoretically fit for publication. It involves team building and re-organization of systems so that more resources can be given to the research enterprise.

Clark (1998; 2001) takes the same tone although he does not build a model of integration with the rest of the innovation actors. Emphasis on entrepreneurial and adaptive behaviour, willingness to take risk, self-organization for change and getting to the frontier of the waves driving change. Both highlight the need for opening up of knowledge transfer units in universities for interaction with industry and community, diversification of sources of funding and promotion of an institutional enterprising culture.

The varying levels of emphasis on STI and DUI between NIS and TH makes a substantial difference between these competing frameworks. It potentially carries implications for developing countries that aspire to their propositions. Lundvall et al. (2002: 226) refute the usefulness of STI as a mode for innovation in developing countries. Contrary to than argument, evidence is that both STI and university-based innovation are currently being adopted widely in the least developed countries.

1.2 Problem Statement

African countries under the umbrella support of African Union (AU) and its development arm – The New Partnership for Africa's Development (NEPAD) recently launched innovation policies and strategies formulated in the STI approach. Uganda approved its STI policy in 2009, formulated the STI strategy and operationalized it in 2012 and has ambitiously embarked on it.

The country has a very weak industrial establishment with the most meagre R&D capacity. Government R&D workforce and facilities are similarly thin on the ground to reasonably impact on industry. The STI effort amid high unemployment pressures have instigated measures to spur entrepreneurial start-ups from the university. University engagement in broader R&D for innovation, technology development and transfer are observably among the most vibrant steps in the STI policy and strategy implementation.

With the case of Makerere university this paper explores the productivity of these undertakings and implications for the state of the university. Taking the divergence between NIS and TH as the departure point, it draws into the realities in the least developed countries on university-based innovation.

1.3 Objectives

The paper's overall objective is to put depth into the understanding of the challenges Uganda as a developing country faces with regard to innovation.

In so doing, it attempts to relay how Uganda's technological challenges have structured innovation practice with regard to the university's role.

The aim is to bring empirics to inform the theoretical debates on differences between innovations and how they relate to the university's institutional status.

1.4.1 Research Question

Is university-based and STI mode of innovation counterproductive to Uganda's university professionalism and national innovation effort?

1.4.2 Sub-questions

a) *What factors at the individual innovators, university, national and global levels give rise to university-based innovation in Uganda?*
b) *What is the nature of innovation being undertaken and how is it managed?*
c) *What have been the outcomes and effects on the innovators, university and the country?*

1.5 Methodology

The study was approached using a case study design. This sought to capture actual cases of innovation in their practical occurrence. But appreciate them in light of the general context in which they occurred rather than as isolated and independent of their environment. Yin (2009) specifies that case study designs as dealing with 'operational links needing to be traced over time rather than mere frequencies or incidence'. He defines a case study as an 'empirical inquiry' into 'a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident'. It utilizes multiple sources of evidence to triangulate its data.

Makerere university was purposively selected basing on available evidence that it is Uganda's only university with acknowledged research capacity (Brar et al. 2011), where university-based innovation is currently being pursued and publicly funded (Ministry of Education and Sports (MoES) 2013). Two cases (electric car innovation in the College of Engineering, Design, Art and Technology (CEDAT) and the food and medicinal products under Biological sciences in the College of Natural Sciences (CoNS)) were also purposively selected within Makerere. This selection was based on the prominence given to their fields in STI policy strategy and the level of advancement of the innovations themselves.

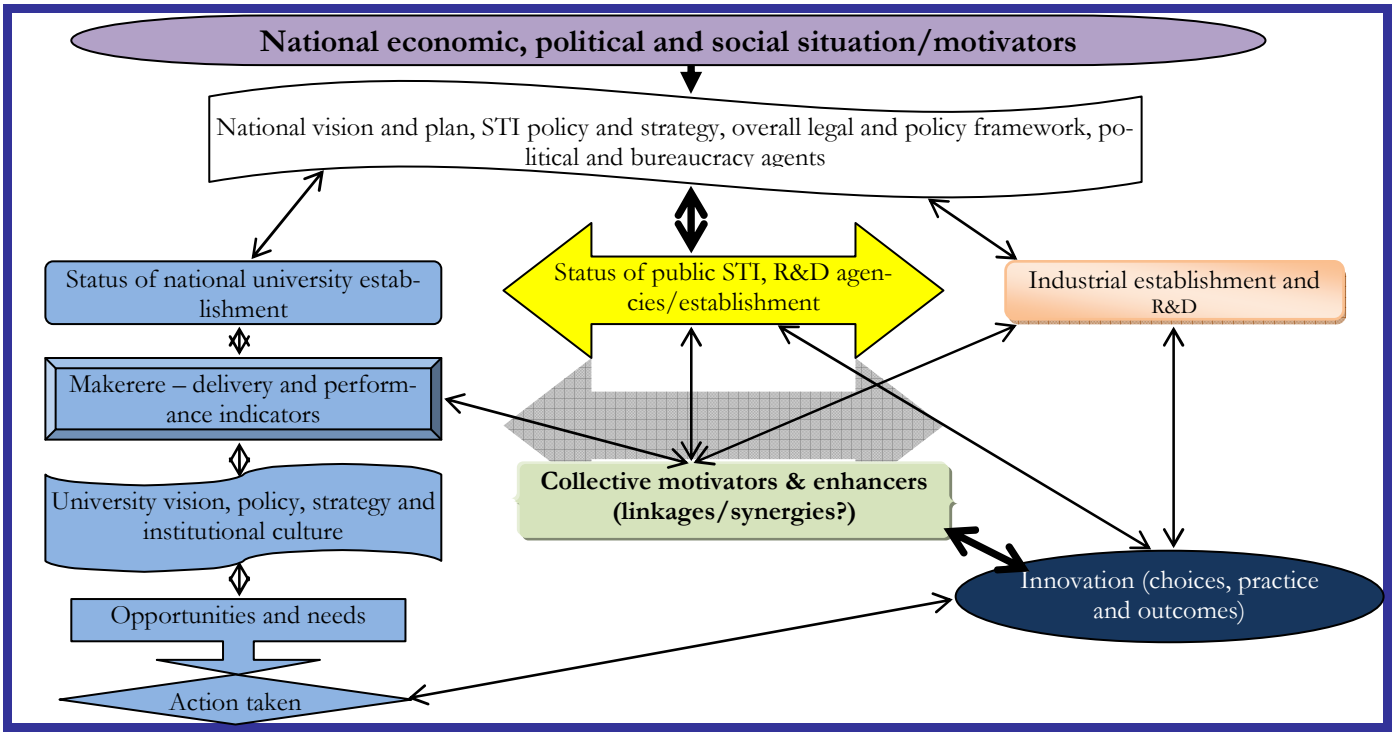
In-depth interviews were the major source of data collection from innovators and institutional officials. Secondary data was obtained from official institutional sources.

1.6 Analytical framework

Analytically, the framework applied was aligned to that used by Göransson and Brundenius (2011) to study the changing roles of universities. A mix of quantitative and qualitative methods were employed to analyze the country context and where demand for the roles of the different actors may incline. This involved use of popular STI indicators of R&D expenditures and personnel (headcount and full-time equivalents (FTE)). The university's conduct of its three roles (teaching research and service/development) is then looked into based on university enrolments (contrasted with national gross enrolment ratios and disciplines enrolled in), staffing (for staff-student rations and qualifications), financing (by source and allocation) and currently prevailing issues.

I augment the national context analysis by introducing the STI policy and strategy that shape the current practice of innovation. This is based on Lundvall (2004)'s argument that processes need to be studied for their effect on technical innovations and also technical innovations for how they affect organizational structures.

The broader context of higher education and issues in the country is incorporated with regard to implications for research and innovation. At the case level of Makerere, I add the university's own definition of its 'third mission' and its transformations. Disaggregation of graduate versus undergraduate studies is employed since it has implications for university research and knowledge extension. I then bring in two cases of innovation in practice from different university units to highlight the actual direction of and issues around the innovations themselves. The framework is mapped below.



1.7 Limitations and challenges

This study coincided with Makerere university staff threatening a strike over salaries. After one week of data collection in the university, the university closed and the lecturers refused to resume duty at the beginning of the new semester on 17th August, 2013. My travel time reached before the stand-off was resolved and had to return to the Netherlands. Two research assistants had to be employed to do the rest of the data collection. Obtaining interviews increasingly became hard. The numerous return visits by the research assistants besides finally providing the necessary information for the case analysis made the process very costly.

It was not also possible to have all data on other R&D infrastructure like laboratory facilities in different sectors which might have added information on the capacity of each sector to actually conduct research.

1.8 Structure of the paper

This paper is divided into six major parts. This first chapter has introduced the divergence over the role of the university in innovation in a global perspective. It also stated Uganda's problem, the questions being addressed and how.

Chapter two handles the detail of the two competing theoretical perspectives on innovation systems and the role they assign to universities. In chapter three, Uganda's country context is brought to perspective with specific emphasis on STI analysis. The fourth chapter covers the country's higher education state in relation to STI and then analyses Makerere university. Chapter five presents the two cases of innovation that are outcomes of all the above contexts and structures. A synthesis is made in chapter six with reflections. A conclusion is then drawn to sum up.

Chapter 2 Universities and Innovation

2.1 The concept of innovation

Innovation is one concept that has a multitude of references. In its simplest sense it has been appreciated in terms of 'novelty' – that something new to one's practice or character; 'creativity' - resolving and doing unique things; and a change from ones past/traditions - actually putting to use new mechanisms and devices (Godin 2008). Lala et al. (2005) makes reference to innovation by the levels at which it happens: individual, team or organizational innovation. This involves changing and introducing new devices, practices, arrangements or modalities of how things are done at those levels. It could be changing from having information disseminated by paper to using an online platform by the individual, group/team or organization as a whole. Nelson (1992: 349) adds a useful perspective that products or processes counted as innovation may not necessarily be new in the global sense. They may be new only to the nation or the local market. For example one who is extending their fruit farm forward by setting up a fruit processing and packaging plant is not introducing something new to the word but to their enterprise or possibly the locality.

A difference is drawn on innovation also by the level of knowledge and technological intensity hence: radical or incremental. Introduction of a telephone that uses no sim-card and does not rely on conventional networks and satellites but possibly on other atmospheric forces would be a globally radical innovation as compared to designing housing casements with different colours for existing models of telephones. Innovation can further be looked at from the outcome of either a new product like a model of a car or a new process like a new assembly line.

Such technical attribution of innovation is sometimes traced back to Karl Marx's views on capitalist transformation of production and the role of technology in increasing productivity. The stronger influence that persists in economics today though is seen to draws from Joseph Schumpeter's perspectives of technical change and the role of innovation and the entrepreneur (Godin 2008). Schumpeter defined innovation in the aspects of:

- Introduction of a new product/good
- Introduction of new processes/methods
- Opening of a new market
- Conquest of a new source of supply
- Introduction of new forms of organization

(in Sweezy 1943; Cooke and Morgan 1998; Croitoru 2012; Hageman 2013).

Separation of organizational and technical innovation in Schumpeter's conceptualization is necessary (Lundvall 2004: 8). Technical innovation as separate from organizational refers to making of a new product like new fashion of cloths or shoes or technology like a new machine. Processes like value chain creation and management fall under organizational innovation. To Lundvall separating the two enables appropriate linkage of their effects to economic performance: how organizational change influences performance in technical innovation and the reverse. Innovation in that regard is:

- Discontinuity in the technical characteristics or in the use of a new product or process
- Introduction, diffusion and adaptation of the new artefact

(ibid. 9)

Lundvall makes an elaborate argument on these points that performance in the achievement of the two (being able to change technical quality and realize the utilization of something new) depends so much on the knowledge in people of what and how ('wetware'). That is further affected by how they relate within organizations ('orgware'), and how they relate with others in other organizations ('socware'). This is the central feature of the "interactive innovation" held in innovation systems. The argument is that you cannot fully account for innovation without giving attention to these processes. They affect innovation just as they are affected by it. NIS in its basics thus was targeted at refuting the neoclassical position that attributed economic competitiveness to natural resources, prices and wages and ignored such processes of learning and knowledge diffusion (Lundvall 2004). There are of course other things emphasized in NIS including the role of the state and the collective force of the public and private entities, knowledge infrastructure and institutions to influence processes of technical change and innovation.

In the particular sense of this paper focus is directed to technical innovation in the university. Processes that introduce new products, technology or consumable items into the market. The interactive factors help to derive the influences (both negative and positive) behind the choices of innovation models and effects on their performance.

2.2 The role of the university in innovation

As alluded to in the previous chapter, the role of the university in national and local development is not recent. It is the current divergence over what and how that is different. This could apply to the disagreements over the STI and DUI modes of learning too. Fischer (1978) accounts of times when the impact of sciences on technological change was less acknowledged including in England's industrial revolution. The overriding belief was in in DUI; that based on demand craftsmen designed the needed technology. The thinking was changed with the growth of the chemical industries in Germany, the scientific discovery of the sugar content in beet and the consequent role of the Prussian Academy of Sciences under Franz Karl Achard that turned laboratory research into industrial sugar production. Professors with both scientific and practical knowledge were the desired. Some university professors were appointed on the basis of their possession of a laboratory. Professors did not stop acting in economic enterprises. University professors from Friedrich Wilhelm Hermbstaedt as head of the new Berlin university, Karl Weltzien of the Poly-technical school at Karlsruhe to Justus Liebig at the University of Giessen worked very closely with and advised industrialists, firms and laboratories and by themselves too established chemical plants and laboratories near the universities.

DUI and STI concurrently run. Fischer stresses the importance of scientific sharing, economic and cultural exchange in Central Europe in facilitating Germany's learning. These involved migration and rotation of cultural elites. On the other hand Germany's success also came from the 'deliberate government policy of promoting science, technology and industry' (ibid. 81).

The points highlighted in Germany's case are what we come across in a lot of university and innovation literature today. The promotion of engagement of universities in technology transfer is a promotion of interactive learning (Conceicao and Heitor 2003; Conceicao et al. 1998a; Conceicao et al. 1998b). Evolutionary economic theories have had a big influence on these perspectives even if such collaboration existed before. The promotion of higher education and universities is further tagged to promotion of competence building; argued to increase inclusive growth and sustainability of innovation (Conceicao et al. 2001). The quality of human resource is a determinant of the competitiveness. This point is used to rationalize the need for public funding of universities. It not only ensures institutional integrity of a university, but is public policy effort to build capabilities and increase science and technology education focus (Conceicao and Heitor 2003).

Studies of successful cases like USA certainly show that much as privatization is chanted by USA, its universities have remained receiving high public funding (Conceicao et al. 2004). It makes a significant strategic difference in national competitiveness. These models of the "third mission as the 'Land-Grant Universities' referred to by Coleman (1984), Reddy (2011), Massachusetts Institute of Technology (MIT) and Stanford University referred to by Etzkowitz (2003) have stood on a solid public base.

This strategic nature of knowledge for national competitiveness corroborates the argument that the capabilities of firms have national traits and can be built by "national action" (Nelson 1992). Freeman (1982 – reprinted 2003) who is behind the development and indeed first used the concept of NIS so much repeated the importance of 'mental capital' for national competitiveness. The point is strongly carried on by Lundvall (2004) asserting that knowledge in innovation is the most essential resource and the processes of learning as the most important process.

But to link up its importance, NIS stresses the embededness of some aspects of knowledge in people. Knowledge as different from information can be documented and disseminated in literature. Information on the other hand may not be possible to document (Lundvall 2009a). NIS thus considers the various dimensions through which firms learn. The firm in the NSI logic is a knowledge basket and the locus of innovation. It is around this 'core' that the system builds. The firm then innovates in interaction with other firms and other 'knowledge infrastructure'. This is the critical point of difference between NIS and TH: the location of innovation and hence cause of divergence over what the university should do.

Lundvall as the key NIS proponent has elaborately dealt with the issue of the role of the university. A genuine point he has made that is often not or always never discussed in TH is the composition of the university and what is possible in the different units. Lundvall argues that not every unit of the university can or should collaborate with industry just as not all industries have to collaborate with universities. The best the universities should do is to produce more graduates equipped with a proper aptitude in problem solving and interaction with other people in organizations (Lundvall 2002: 9; 2009a). He is critical of high-technology research in universities that may not be absorbed by local firms. To him, skills from the university get transferred to the industry in form of the graduates. Firms can do both STI and DUI learning and are more innovative (Brundenius et al. 2008).The last point here takes little consideration of the context of the poor countries where the problem is actually absence

of industry and the unwillingness of the existing industries to engage in training or hire graduates with less practical skills. Their conclusion is a proposal of a developmental university without on-campus enterprise start-ups, incubators or actual technology development oriented research as indicated in the first chapter.

In the general innovation research practice especially on university-industry interlinkages, little attention has been offered to this difference between and NIS and TH. It is not uncommon to find analysis of such linkages mixed between the two. Several elements separate these frameworks. There are dominant ones though such as the locus of innovation.

TH bases innovation in the university as the core agent. The university takes an enhanced economic privilege. The authors do away with distinct boundaries of the three entities such that they are no longer separate but overlapping. The roles performed by one can be done by the other two in hybrid structures. The fusion of these three actors produce what are called tri-lateral arrangements that generate

> 'university spin-off firms … strategic alliances among firms, government laboratories and academic research groups'
>
> (Etzkowitz and Leydesorff 2000: 112).

The model is seen as shifting such that constant dynamic changes determine the innovation agenda just as the innovation outcomes determine the landscape of collaboration. Collaborations are envisaged as possible across national borders and the driving force is profit. The structures are not fixed such that stability is not guaranteed. Leydesdorff (2012) adds on to this that each of the players is left to determine their own 'differentiating mission'. Broadly stated thus, innovation in TH is research driven and science based. It is also the cause for interaction or collaboration. Outcomes of the research are supposed to be patentable. Etzkowitz (2003) gives more depth to this point by relating academic research groups as potential enterprises ("quasi firms"). The university in that regard is a default incubator by its very nature.

The execution of these processes seem to hold a lot of contentious extremes first for what we regard as academic professionalism and ethics in the exercise of the "third mission". Wang and Zhou (2009) as a case example studied China's Tsinghua and Beihang universities with reference to NSI even if their depiction of the university was one more of the TH model (entrepreneurial) - with university-based innovation. The enterprises started up and run by the universities suffered managerial interferences from the university staff: some of who wanted to manage both sides. Publication and passing out of research findings was interfered with by the interests of the university-run enterprises.

This presents a challenge in considering university-base start-ups in a context of a poor country where the staff are already underpaid. But such findings are also countered by some recent positive outcomes in other developing countries. Maculan and de Mello (2009) analysed Brazil's universities. They were in a situation typically suffered by most poor countries especially in Sub-Saharan Africa. The country only began its innovation pursuit recently (from 2004). The industrial sector was hardly innovative, less willing to collaborate with universities, wanted already-made skilled manpower, relied on imported technology even if the possibilities of having locally made ones existed, the education quality was distrusted and qualified engineers and researchers were

scarce. The reforms by the government of Brazil to strengthen collaboration started with introduction of university-start ups. It finally helped transform the innovation environment into one where actors would come together and share efforts. The question that prevails then is whether we should universally fear university-based innovation or that there are possibilities of success. Exclusive and particular as they may be. In which sense modalities through which context factors are addressed need to be the subject of discussion; similar to Coleman (1984)'s proposal for the definition of limits of involvement.

Delineation may have its own challenges because the academics who chose to engage with the industry have several personal motivations driving their actions. It could as well fail the promotion of interaction and the specific extent to which they as persons chose to go. This the point d'Este and Perkmann (2011) use to counter the position of TH that every academic can transform and become entrepreneurial. They found that some engaged with industry only because they wanted to extend their research in which sense treating them as commercially motivated may be wrong. Others wanted to commercialize their research output although these were the least. Others interacted because of the funding or access to industry facilities for learning purposes. These varieties of motivations make it a challenge still to treat every academic as the same and so every university and country context as similar and able to follow universal principles.

The variety of contexts and lack of a universally suitable model may have been best represented by Göransson and Brundenius (2011). Besides the several cases they complied (one already mentioned above), they also indicate the different understandings and some misunderstandings of the "third mission" in various countries. The same applies with the approaches being taken by governments, their historical experiences, the shape such experiences have given to the conduct of research and development (R&D) and the capacity of the industry, government and universities to contribute to R&D in various aspects. In other cases, universities were disappointed that there was not much engagement and they felt their research and generated knowledge was not adequately valued and utilized. The different situations presented alternatives that would not necessarily be relevant or most useful in other contexts.

In sum, we can state here that the divergence between NIS and TH is broader than sometimes recognized. As models for innovation in developing countries, there are challenges to be faced. The inspiration of the successful cases of the use of universities for technological development is still alive in many circles both government actors and universities. Few recent cases of success continue to create similar motivations in other developing countries. The understanding of the "third mission" and its actual acceptance and undertaking relies so much on the motivations of the actors as well as the actions taken by national governments as the case in Brazil. Extremes appear in the frameworks especially with regard to TH. The concept is sweeping and presumes to insert every academic into entrepreneurial activities. NIS and 'developmental university' proposal on the other hand may become limiting to a degree in cases of underdevelopment and lack of industrial establishment. There is need for critical considerations of contexts, motivations, institutions and governance.

Chapter 3 Science, Technology and Innovation (STI) in Uganda

This chapter explores Uganda's STI policy evolution in the first part. It compiles the processes which have shaped the policy. The second part focuses on the current R&D status and innovation efforts. It addresses factors rationalizing the extended role of the university in Uganda's innovation efforts.

3.1 The STI Policy process

Uganda's Vision 2040 is of 'A transformed Ugandan society from a peasant to a modern and prosperous country within 30 years.' The country has to multiply its GDP 30 times from US $ 17 billion in 2010/2011 to attain Upper Middle Income status by 2040 (Republic of Uganda 2010a: 2). The country has however experienced little economic transformation. This situation has increasingly raised concern (Selassie 2008). In 2009, 65.6% of the Ugandan working population was employed in agriculture, only 6% in industry and 28.4% in services (World Bank 2013). Uganda has suffered a prolonged non-prioritization on the part of government and diversionary interests on the side of donors in attending to Uganda's industrial sector (Lall and Pietrobelli 2005).

The STI policy process dates back to the 1980 UNESCO sponsored African Ministers for Science and Technology (S&T) meeting. Its product, the Lagos Plan of Action (LPA) required every African country to put in place an STI coordinating agency. Uganda due to political and economic downturns only established the Uganda National Council for Science and Technology (UNCST) in 1990. The STI policy formulation started in 1994 but could not be approved. A repeated attempt made in 2001 also failed (Ministry of Finance, Planning and Economic Development (MFPED) 2009). The main cause given was the Structural Adjustment Programmes (SAPs) from World Bank and IMF (Ecuru et al. 2011). SAPs were followed by Poverty Reduction Strategy Papers (PRSPs) as preconditions for aid. STI could hardly find acceptance in the Poverty Eradication Action Plans (PEAPs 1997 to 2007/2008) priorities, objectives and framework (ibid.: 35). For a second decade, STI activities and processes remained marginal, scattered and uncoordinated in several government agencies, a situation being grappled with till now (MFPED 2009: 1; 2012a: 7; Brar et al. 2011: 9, 69-70).

An African regional meeting organised by NEPAD and the South African Department of S&T (DST) in February 2003 hatched the idea of having a common roadmap for S&T among the member countries. Its resolution caused the meeting of ministers of S&T in November 2003 in in Johannesburg. A draft outline of a S&T action plan was adopted that got consolidated through various workshops in each of the five regions. East African region had in February 2004 (NEPAD 2005: 5; Ecuru et al. 2011: 17). From those meetings the Uganda government began giving significant attention to STI.

The last PEAP period 2004/2005 in Uganda subsequently suffered less political commitment as a framework for national development. The government introduced parallel development programmes and approaches, a practice not common in the previous PEAPs. This culminated into the 2006 declaration by President Museveni of his own development strategy for poverty alleviation: 'Bona bagagawale' (Prosperity for all) during his 2006 electoral campaign. The manifesto priori-

ties were no longer confined within the PEAP priority sectors. When these issues were raised in the PEAP 1997-2007 evaluation, the response of the government referred to PEAP as only a framework without specific strategies or budgeted operations (The Republic of Uganda 2009). Determination of the national development agenda from this point on slowly got forced through by local interests over donor preferences: A scenario the IMF study of Uganda's efforts at industrialization later cited as "a quiet rebellion underway" (Sellassie 2008: 3).

The government undertook studies of the country's STI from the financial year 2004/2005 and followed with several stakeholder consultative workshops for STI policy drafting. The draft was discussed from 2006 and finally approved in August 2009 (MFPED 2009). With more attention given to STI, R&D funding rose by more than double in a period of five years (from 31 to 82 billion Uganda Shillings between 2003/2004 and 2007/2008) (Nabudere 2009: 64).

Among other measures, the government changed its admission criteria to university in favour of sciences – 65% of overall government sponsorship from 2005/2006 (UNCST 2012: 13). Between 2006 and 2010, it revised and incrementally introduced new 'Thematic' curricula from primary one through primary seven (National Curriculum Development Center (NCDC) 2009; 2013). All science subjects in addition to English and Mathematics were made compulsory at lower secondary, subsidiary ICT and compulsory sub-maths introduced at upper secondary (NCDC 2013; UNCST 2012: 11-12). The government also commissioned reform programmes for the long marginalized technical and vocational education sector. A BTVET act was passed in 2008 and instituted the Uganda Vocational Qualifications Framework (UVQF).

The closure of the last PEAP framework in 2007/2008 enabled thereafter the outright introduction of STI in the national development strategy, with targets that would not have gained consideration under PEAP. The National Development Plan (NDP 2010/11-2014/15) that followed provided a longer time frame (5 years instead of three). It put emphasis on S&T with objectives to promote STI and ICT to enhance competitiveness. Attention was drawn on issues such as the stocks of researchers, S&T graduates, R&D funding and scientific publications among others (The Republic of Uganda 2010b: 4, 137-141). STI entered prominently in the national political discourse with President Museveni's State of the Nation Address on 1st June, 2010 statement of support to it. Pro-active steps towards innovation in collaboration with Makerere University and UIRI were announced. The President's posture of financial commitment to STI started with directives for enhancement of remuneration for scientists as a retention strategy (Museveni 2010).

With support from the Belgian government and World Bank in 2010 the BTVET sector study was done and the strategic plan formulated. It got released in 2011 by Ministry of Education and Sports (MoES). Emphasis was made that it marked a "Paradigm Shift", moving away from educational certificates to productive competences development. Thus, the plan focused on producing requisite skills for industrial production and self-employment (MoES 2011). The 2nd to 4th December 2010 stakeholders' policy dialogue had meanwhile also set rolling the national STI strategic plan formulation process (Nording 2010).

Teams were sent to India, Malysia and Finland on study tours for lessons on STI formulation, implementation and management modalities (MFPED 2012a: 2-3). A World Bank team concurrently carried out a country study of key sectors and best frameworks for STI policy execution from 2010 and released its report in 2011 (Brar et al. 2011). The process ended with the national STI plan 2012/2013 - 2017/2018 released in March 2012 by MFPED.

Uganda's STI policy and strategy moved swiftly in the last bits of formulation. The trend behind though had been one subjected to several external and internal forces (Ecuru et al. 2011). Each of these has left their mark that can be traced in the state of the STI infrastructure, place and characteristics of the actors, the R&D system, university's place in it and nature of relations among them. Some are rapidly changing, others less so.

3.2 State of STI today

A country's STI can be studied using several indicators. But focus here is given to the R&D human resource and expenditure. From the UNCST 2011 STI statistics publication the total full time R&D personnel excluding support staff in Uganda were 895. 524 researchers and 371 technicians and equivalently qualified persons in the different sectors.

Table 3.1: Uganda's FTE R&D manpower 2009/2010

Sector	Researchers	Technicians/equivalent	Total
Public research agencies	274	90	**364**
Higher education	175	188	**363**
Business enterprises	13	13	**26**
Private non-profit	62	80	**142**
Total	**524**	**371**	**895**

(UNCST 2011: 48)

With Uganda's national population of about 36 million this gives a proportion of approximately 14 researchers per million inhabitants. We start from the point of size here. In general, this force is small to cause significant impact on industry as well as attend to all other sectors of the economy that require their services. In comparison with contemporary late-industrializers like China when it formulated its S&T strategy in 1985 and initiated the '863 programme' in 1986, China had 15,000 researchers. By 1997 they were 1,800,000 researchers in the R&D system. I,000,000 in research institutes, 500,000 in universities and 300,000 in business enterprises (Jian 1997: 95). Impact on industry can be less doubtful with such a big R&D workforce. Uganda's case even by head count remains meagre.

Table 3.2: Uganda's R&D manpower 2009/2010 by Head Count

Sector	Researchers	Technicians/equivalent	Total
Public research agencies	808	371	**1179**
Higher education	631	573	**1204**
Business enterprises	100	69	**169**
Private non-profit	164	181	**345**
Total	**1703**	**1194**	**2897**

(UNCST 2011: 48)

Compared with the least developed countries covered in the UniDev study (Göransson and Brundenius 2011) - (Tanzania, Vietnam and Uruguay), Uganda has to put together all its Head Count to measure with Tanzania's FTE. Uruguay's FTE is close to twice Uganda's FTE. Vietnam's FTE on the other hand is 17 times Uganda's FTE. Previous studies like the African Development Fund (ADF) assessment described Uganda as the weakest in STI compared to all its East African Neighbours (ADF 2012: iv). Although Uganda's distribution between public R&D agencies (40.7%) and higher education (40.6%) is balanced compared to Tanzania's

72.6% in higher education and only 21.8% in public R&D agencies. Or Uruguay that has 63.2% in higher education and only 9% in public research agencies. Uganda is such a manner has to balance between public research agencies and universities that each take near half of the total R&D workforce.

In the business/industry sector Uganda has only 2.9% of the R&D workforce. As a comparative example, this is 10 times weaker than Uruguay. In absolute numbers, only 13 FTE researchers and 13 FTE technicians in business/industry sector R&D. Taking the head count, they are 100 researchers and 69 technicians in absolute numbers. This is a handful that becomes unhelpful to discuss the limits of its impact further than this.

But it makes the big difference between developed and developing countries in general and needs to be considered as a critical factor in innovation policy decisions. Denmark, Sweden and Germany for example each have over 60% of their R&D workforce in Business/Industry sector out of the total FTE of 28,653 for Denmark, 279,800 for Germany and 55,729 for Sweden in 2006 (Göransson and Brundenius 2011: 340-342). It makes it logical to rely less on government research agencies and universities in such developed countries. The impact of the business/industry R&D workforce alone is significant and university contribution may be less demanded.

A critical factor playing against strong growth of industrial R&D in the South includes the reliance of Multi-National Corporations (MNCs) on foreign sources of technology and R&D functions retained in the North. That puts higher barriers to technology access and learning for local firms. Such situations potentially explain why the Danish innovation system (repeatedly referred to by Lundvall 2002; 2009a; 2009b) is not very ambitious in pursuing high-technology sectors or pursuing radical innovations. Access to technology is comparatively easier from the neighbourhood especially with the European integration. The same applies to information where proximity permits easier interaction with the technology sources. DUI without ambitious STI becomes a relatively comfortable option in the North. Lall (1992) argued succinctly on the cost of access to technology for developing countries that makes it imperative to build local technological capabilities.

If the big industries were sufficiently doing their role in local technology development and innovation, Uganda's universities might not have been trying what they are doing today. R&D financing shows industry's poor role.

Table 3.3: R&D financing in Uganda by source

Year	Government	Higher Education	Business / industry	Private non-profit	From abroad
2009	48.1%	17.6%	8.2%	0.1%	26.1%
2008	52.3%	N	4.3%	0.1%	43.2%
2007	41.7%	N	7.5%	0.0%	50.7%
2006	50.1%	N	N	0.0%	49.9%
2005	41.5%	N	1.7%	n	56.9%

(UNCST 2011: 55)

R&D financing by industry is marginal. The standard argument NIS and most of Lundvall's literature has applied in such cases is to refer to it as a prevalence of DUI learning, preferred to the STI mode. The reformulated 'developmental university' is thence asked to only produce skilled graduates as most learning takes place on job (Brundenius et al. 2008; Lundvall 2009a). The truth in it is that universities need to produce skilled graduates. What is contentious are the potential outcomes

of the two modes of learning. Struggling to overcome barriers to technology access (as Uganda's case is), demands struggling to develop technology, not only learning to use it efficiently (Lall 1992). In the event that graduates are not equipped with sufficient skills (Katunguka 2005; Brar et al. 2011: 47-97), which is a result of immense educational challenges (ADF 2012), Uganda's technology development needs to be looked at differently. DUI alone may yield dismal outcomes toward local technology development, although it remains essential for concurrent and further learning. Faced with the challenge of low R&D investment by industry in that regard, the government necessarily has to strengthen STI for the purpose of local technology development. The university becomes very essential for such efforts.

Lundvall (2009a: 21-27) has argued that ignoring on-job training for high skilled/graduate employees and focussing on less skilled/low level workers is mistaken. Talk of ready-made skilled workers is erroneous. The argument is valid. The situation Uganda as supposedly most developing countries faces is not simply selectivity of the levels to train but non-cooperation by industry in training of the workforce. Industry looks at in-school and on-job training as not areas for its investment. An official from UNCST expressed in the interview for this study thus:

> 'Because of the weak infrastructure, it is very difficult to go through a solid practical training let's say for a science graduate, it is really expensive to do an experiment, we can't afford it. Much of the learning would be in the industry if they can offer those opportunities when students go for internships, that's when you would learn most skills. When you get out of the university, the first six months you are in the company, you should be able to learn the skills. The problem is that companies always say that we want ready-made people. But you can't get ready made people. You have to tailor people to your system'.

The double problem to the above is the minimal numbers of such industries by field of enterprise and location. The government's current STI effort therefore and its going through the university may not necessarily be the optimum but responses to challenges from the industrial structure.

Besides the industrial structure, historical factors create a path-dependent separation of industry from other local knowledge sources. Government had ceased funding university R&D for over 10 years and only resumed in 2009/2010 as we can see from Table 3.3. All university research was funded at that point by donors and a bit from universities themselves using internally generated revenue (NCHE 2010: 20-21). The demerits of limited amounts of funding from these sources, being short-term projects and with donor programme orientations included little attention to industrial technology issues (Lall and Pietrobelli 2005; Nabudere 2009; Brar et al. 2011). Donor programme areas and approaches tuned the universities to collaborate with the government agencies and international development agencies and less with industry. The gap created between universities and industry in research and technology development and learning by these processes remains wide.

Makerere University had the only exceptional donor supporting outward linkage to industry (Gatsby Trust). A center for technology development and transfer (CTDT) was opened at Makerere's Faculty of Technology that linked the Faculty with SMEs and established two industrial parks. This remained limited to GTZ own capacity although government lately realized its usefulness (Nabudere 2009). At the university level, the STI strategy intensification today shows shifts towards a more institutionally organized university-industry linkage. Makerere has planned this academic year (2013/14) to establish a central coordination unit for knowledge

and technology transfer partnerships (MoES 2013: 300). It remains to be seen how much interaction grows with the broader industrial establishments.

Uganda's major STI today predominantly coming from international sources maintain the centrality of the university. The Millennium Science Initiative (MSI) ended in 2012 worked with universities and schools. Others are the IST-Africa (European Union and African Union - EU-AU) supported ICT projects with various components of eGovernment to extend internet access to government facilities, Technology-enhanced Learning in universities and schools, eHealth, eCommerce and ICT for Rural Development. The USA's ResilientAfrica Network (RAN) is running the Technovation Challenge in collaboration with Makerere university for disaster response innovations. AFRISA projects promoting animal resources in collaboration with the College of Veterinary Science in Makerere and Sida supported Pan-African Competitiveness Forum (PACF) Innovation Systems and Cluster Programme (ISCP) focused on communities and enterprises but still in collaboration with Makerere university. The government's own effort to promote commercialization of innovations has mainly been through incubation. Several incubatee enterprises are at UIRI. Makerere University however also has three incubation facilities for enterprises in food technology, animal products and ICT innovations.

In essence, the picture is that the university in Uganda became a central actor in innovation through various historical processes. These have taken structural features prevailing over policy choices. The small public R&D infrastructure and the weak input of the industry especially toward local technology development make the university the resort. The tendency here is to counter the hold-back position fronted in the reformulated "developmental university" of Brundenius et al. (2008). The university will not appropriately be responding to actual national technological and development challenges by fencing off nor can it easily change the industry's modes of operation. Potentially the government may equally be challenged in righting the situation if it focused on industry. Although the NIS and the reformulated 'developmental university' proponents also used the broad national level of analysis as we have chosen in this chapter, only national challenges and needs can be depicted but little if any about the university's internal status and issues. They are essential aspects to consider in such a debate.

Chapter 4 Uganda's Higher Education: Makerere in context

The chapter is broken into two parts. The first part expresses the broad higher education scenario and the second part deals with Makerere as a university. Both NIS and TH have not dealt with inner institutional contexts in discussing their propositions except the reorganization of the professoriate and overlapping of boundaries proposed by TH. The discussion here applies broader standard indicators relevant to STI.

4.1 General Higher Education Landscape

Uganda's higher education subsector can be said to have started with the establishment in 1922 of Uganda Technical College, later to become Makerere University - fully independent and running its own programmes in 1970. Today the institutional distribution by ownership has greatly changed.

Table 4.1: Higher education institutions by ownership in Uganda

Institution level	Public	Percentage	Private	Percentage	Total
Universities	6	17%	29	83%	**35**
University affiliated colleges	9	82%	2	18%	**11**
Degree-awarding non-university institutions	2	67%	1	33%	**3**
Other tertiary	54	47%	60	53%	**114**
Total	**71**	**44%**	**92**	**56%**	**163**

(National Council for Higher Education (NCHE) 2010; NCHE website; MoES 2013)

Access to higher education has grown by 15 percent average over the last ten years. But the gross enrolment ratio is still low: 5.4% of the eligible population (NCHE 2010: 13). The private universities have multiplied so tremendously. The greater burden of university education still remains however with public universities. Sawyerr (2004) indicated that private universities took 24% of total enrolments. The remaining 76% was by public universities. Makerere's enrolment is in the range of 4 to 600 times the total enrolment of each single other university annually; the exception being Kyambogo University that is about one third below it (NCHE 2010: 47-48). The bigger proportions of enrolments in these two public universities however come by private sponsorship.

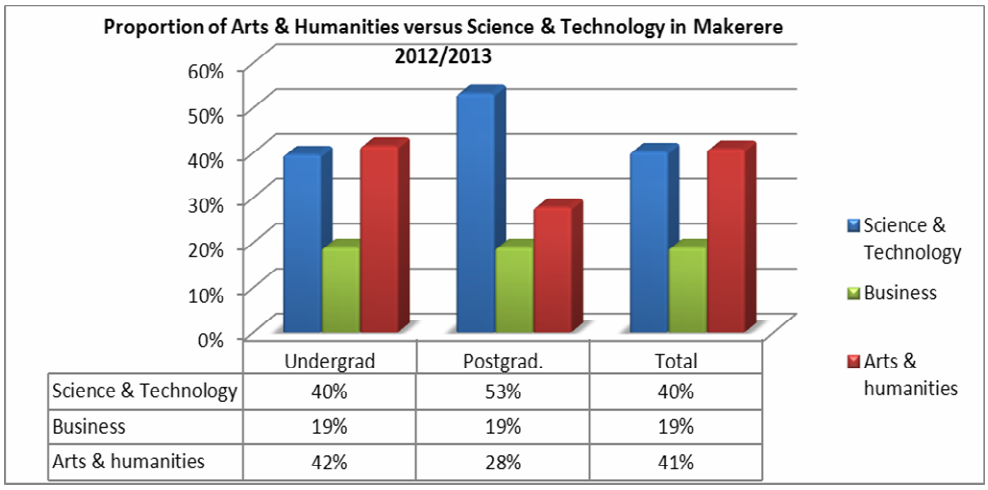
This largely private nature of university education access is higher at postgraduate training except if one accessed scholarships that are mainly offered by international organs. The implication has been the very limited growth of postgraduate training in the country and universities as such. Universities conduct more diploma programmes than PhDs: 189 compared to 97 respectively (ibid.). This relates to financial factors. Only Makerere offers PhD programmes in S&T. The other PhD awarding institutions (Uganda Martyrs University (UMU) and Uganda Management Institute (UMI)) conduct doctorates in development studies and public administration fields respectively.

The above scenario has made differentiation of universities between research and teaching, undergraduate and postgraduate hard to realize even if it is being advocated for (Mamdani 2008). Makerere has performed the research function cir-

cumstantially while its undergraduate teaching load is unreduced beyond any other university. There is also little disciplinary differentiation among universities. Mbarara university was established in 1989 to specialize in S&T. Coming at the time of SAPs and a general lack of focus on STI then let it hardly grow to take leadership in that regard. Six out of all the 27 universities by 2009 offered S&T courses (MFPED 2009: 3-4). But only three of these universities produced 97.5% of all S&T graduates – (Makerere 90%, Mbarara 4% and Kyambogo 3.5%) (Brar et al. 2011: 5). Considerations of profits, enrolments and capital investment have pushed private proprietors to settle for arts programmes (Birungi 2008; UNCST 2011: 33; Nuwagaba 2012).

In the whole university system staffing has remained greatly wanting. The highest staffed are Makerere currently at 47%, Gulu university 43% and Mbarara university 35.6% of the required (MoES 2013: 18). NCHE recently stated that if taken by strict standard, all universities in Uganda would have to close. The university system is short of 2000 professors. The weakness of Uganda's STI is (almost obviously) blamed on the weak training in public universities (ADF 2012). But the problem we see broader than public universities alone.

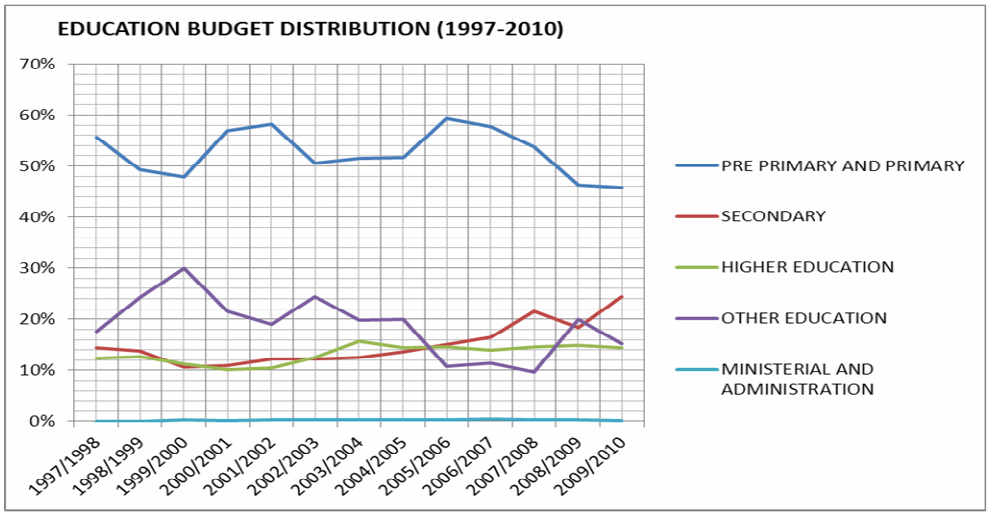
The overall STI enrolment ratio despite the efforts from 2005/06 is still below the desired 40% (ibid.). The shift in policy towards STI has nonetheless reduced the gap. Arts have dropped as a proportion of total enrolment into universities from 80% in 2005 to 65% in 2010. Science and technology rose from 20% to 30% within this period (NCHE 2010: 13-14) Makerere the highest enroller and S&T producer scored remarkably well despite its challenges.



	Undergrad	Postgrad.	Total
Science & Technology	40%	53%	40%
Business	19%	19%	19%
Arts & humanities	42%	28%	41%

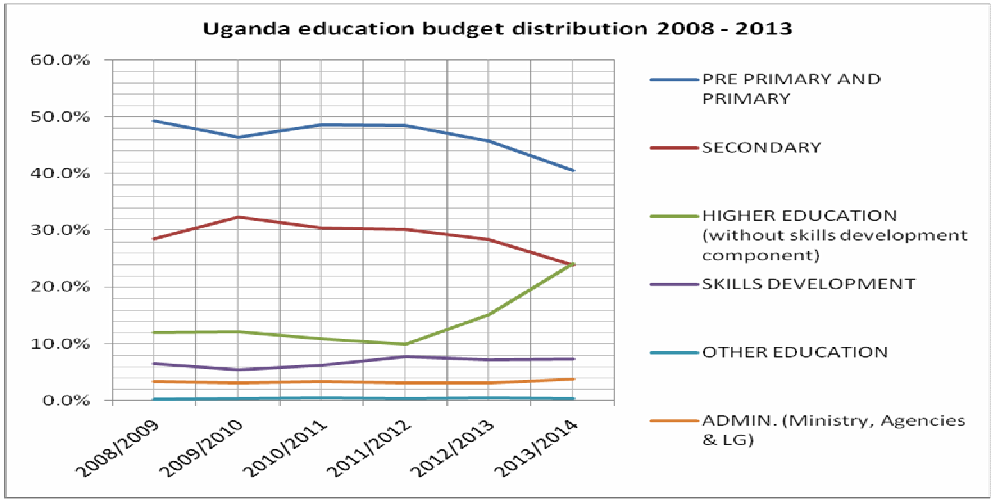
(Makerere University 2013b: 25)

The significance of government policy action in such transformations is indisputable. From the same STI effort arguably, a change from the past financial neglect of higher education has recently (2013/2014) emerged as compared to the period between 1997 and 2010.



(Data of budget allocations got from Guloba et al. 2010: 30-31).

A continuous downward trend in allocations to primary education may have started around 2008/2009 falling from 49.3% to 40.5% in 2013/2014. Then correspondingly appears a recent leap in higher education from 15.2% in 2012/2013 to 24.1% in 2013/2014.



(MFPED 2010; 2011; 2012b; 2013a; 2013b).

Skills development is now assigned a separate budget line. There is a mix though of informal training as well as secondary education partly, especially at the Local Government levels within skills development. We cannot thus add it all into the higher education allocation.

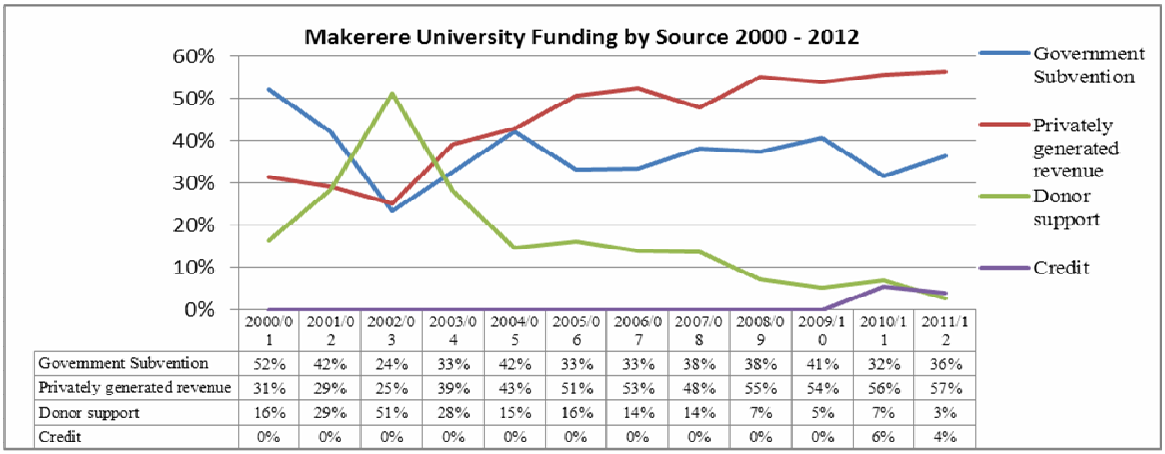
On the overall landscape as Teferra (2007: 557) argues, higher education is just getting reborn in most of Sub-Saharan Africa. Uganda's scenario is no different. There is still need to push for S&T and change the direction of private investors toward STI strategic areas. Other public universities need to be strengthened. An increased focus on postgraduate education and research is needed with a possible differentiation and articulation of roles amongst the institutions especially between research and teaching as well as fields of specialization. The improvements so far have been enabled by state policy shift to STI and will continue to be so for the foreseeable future.

The contention by NIS against STI may have to be interpreted differently: as narrowly refuting STI productivity in firm-based innovation rather than the efforts of developing countries to apply STI in the broad sense of building a science base (human and infrastructural); a gap that currently pulls down the whole system. Uganda's concurrent efforts at local technology development through the university and the implication of using the STI approach to innovation has more to do with the circumstances covered in the previous chapter more than those in this one. They are alternatives when the NIS as structured in its propositions, does not function in reality and cannot easily be in the near term.

On the other side, TH proposals for a reduced university reliance on public support (Etzkowitz and Dzisah 2007) may become inappropriate. Private universities as seen, despite their mushrooming have not attained any significant competitiveness in STI disciplines, not in research nor postgraduate training. As Lundvall's argument has been, there are limits to which universities and which units can collaborate with industry (Lundvall 2009; Brundenius et al. 2008). In this case, all Uganda's universities with the exception of Makerere in their present state may have limited viability of technological innovation and TH as such.

4.2 Makerere University Context

Makerere moved from being one of Africa's flourishing intellectual centres in the post-independence years (Sawyerr 2004) to a commercialized and vocationalized school after the descent of SAPs (Mamdani 2007). By functional appraisal Makerere as a university has been Uganda's most developmental institution; performing a daunting bulk of the university sector tasks from teaching (as the largest single enroller), research (university-based and with public research agencies), public sector capacity building (during decentralization and several current programmes), to community extension in agriculture and other technologies (as with the several national and international STI projects going through it now). The 'dilemmas' as Mamdani called them, that Makerere was thrown into turned it to the most commercial and entrepreneurial university whose consequences have been controversial. It still suffers funding challenges with a budget now funded more by private incomes than all other sources. Donor support has equally kept declining.



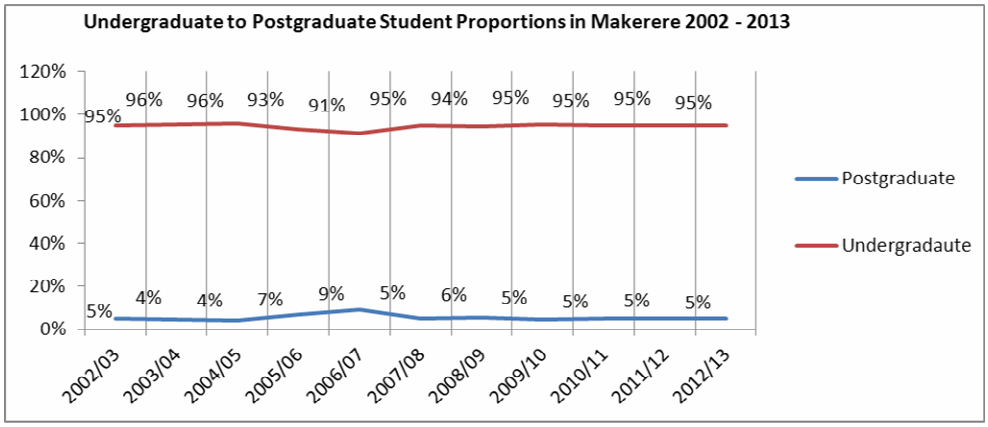
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Government Subvention	52%	42%	24%	33%	42%	33%	33%	38%	38%	41%	32%	36%
Privately generated revenue	31%	29%	25%	39%	43%	51%	53%	48%	55%	54%	56%	57%
Donor support	16%	29%	51%	28%	15%	16%	14%	14%	7%	5%	7%	3%
Credit	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	4%

(Makerere University 2013b: 53)

In 2007 Makerere entered the formulation of its current strategic plan with a feeling of the situation ahead not being far better than the past. The university contemplated on its responsibility to the government, market and academic commu-

nity, and the question of whether to shift to graduate training and research - cutting on undergraduate teaching. Resource uncertainty evidently remained prevalent. Considerations had to be made of contexts of the fast transformations in the world with knowledge-economy ideas but also pay attention to the national political interests and the weak university sector where Makerere still towers as the one with greatest intake capacity. The university chose to serve all the three groups of stakeholders with balance. On the other hand it would gradually scale up postgraduate enrolments while lowering undergraduate; which it had to contain meanwhile (Wabwire 2007).

Undergraduate students were 94% then and postgraduate were 6%. Makerere University Strategic Plan 2008/2009 – 2018/2019 projected to raise postgraduate enrolments to 11% in 2013 and reach 14% by the close in 2018/19 (Makerere University 2008a: 35). But that trend is very far from being realized. The same levels have been sustained till date.



(Makerere University 2013b: 24)

The TH matrix of the ease of reorganizing the professoriate, increasing research and commercialization while reducing reliance on public financing (Etzkowitz 2003; Etzkowitz and Dzisah 2007) seems so simplistic with regard to realistically dealing with these challenges. It would call for a drastic reduction on undergraduate teaching. In Makerere's case undergraduate enrolments sustain the university's finance. TH matrix may have to discuss further the logical resolution of these challenges. Using the proportions of undergraduate versus postgraduate enrolments as a simple proxy for the load between teaching and research, Table 4.3 shows that most colleges are near full time of teaching.

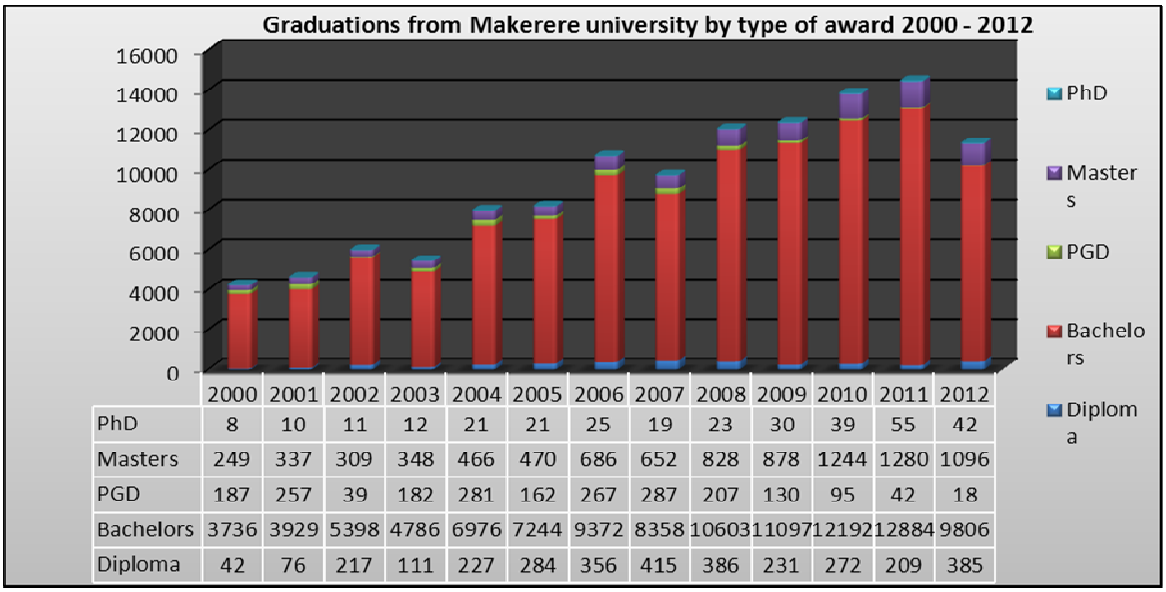
Table 4.2: Makerere University 2012/2013 Student Population by College

College	Undergraduate students	%age of undergrad.	Postgraduate students	%age of postgrad.	Total
Agricultural & Environmental Sciences	1,579	93%	126	7%	**1,705**
Engineering Design Art & Technology	3,088	97%	111	3%	**3,199**
Education & External Studies	6,386	99%	72	1%	**6,458**
Health Sciences	1,132	74%	392	26%	**1,524**
Humanities &Social Sciences	8,608	96%	389	4%	**8,997**
Business & Management Sciences	5,810	93%	431	7%	**6,241**
Computing & Information Sciences	5,724	97%	192	3%	**5,916**
Natural Sciences	1,127	93%	80	7%	**1,207**
Vet Medicine & Bio security	554	98%	14	2%	**568**
School of Law	1,270	96%	48	4%	**1,318**
Fort-portal Campus	17	100%	0	0%	**17**
Jinja Campus	112	100%	0	0%	**112**
Total	**35,407**	95%	**1,55**	5%	**37,262**

(Makerere University 2013a: 15)

The 'entrepreneurial university' in Clark (1998) proposition calls for more strengthened/broadened 'steering core', increase outreach units, 'interdisciplinary project-oriented research centers', broad resource base, adaptive and risk-taking behaviour, engaging in commercial enterprises and promoting entrepreneurial culture. But when faced with the situation of Makerere above and is not appropriately addressed, the risk of undermining academic delivery is high. Makerere's failure on quality as outcomes of such processes are documented (Sawyerr 2004; Kwesiga and Ahikire 2006; Mamdani 2007; 2008; 2012).

Based on the above challenges Makerere has had to device several ways to raise its research output. Its Research and Innovations Policy now requires that all PhD students publish at least one paper before they graduate (Makerere University 2008b: 8). This positively adds something. But the size of PhD enrolments and graduation rates from 2000 to 2012 reasonably tell the miniature output achievable. The numbers reached 50 only in 2011. On the other hand stands the fact that the conduct of innovation is an uncertain and costly enterprise (Mazzucato 2011; Lazonick 2011; Lazonick and Mazzucato 2012). Not all the output in its meagreness will always score success in patents and commercialization. If the university must continue running as a national educational institution but public support is reduced as it wholly sells into entrepreneurship, the risk posed here needs no much emphasis.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PhD	8	10	11	12	21	21	25	19	23	30	39	55	42
Masters	249	337	309	348	466	470	686	652	828	878	1244	1280	1096
PGD	187	257	39	182	281	162	267	287	207	130	95	42	18
Bachelors	3736	3929	5398	4786	6976	7244	9372	8358	10603	11097	12192	12884	9806
Diploma	42	76	217	111	227	284	356	415	386	231	272	209	385

(Makerere University 2012: 20)

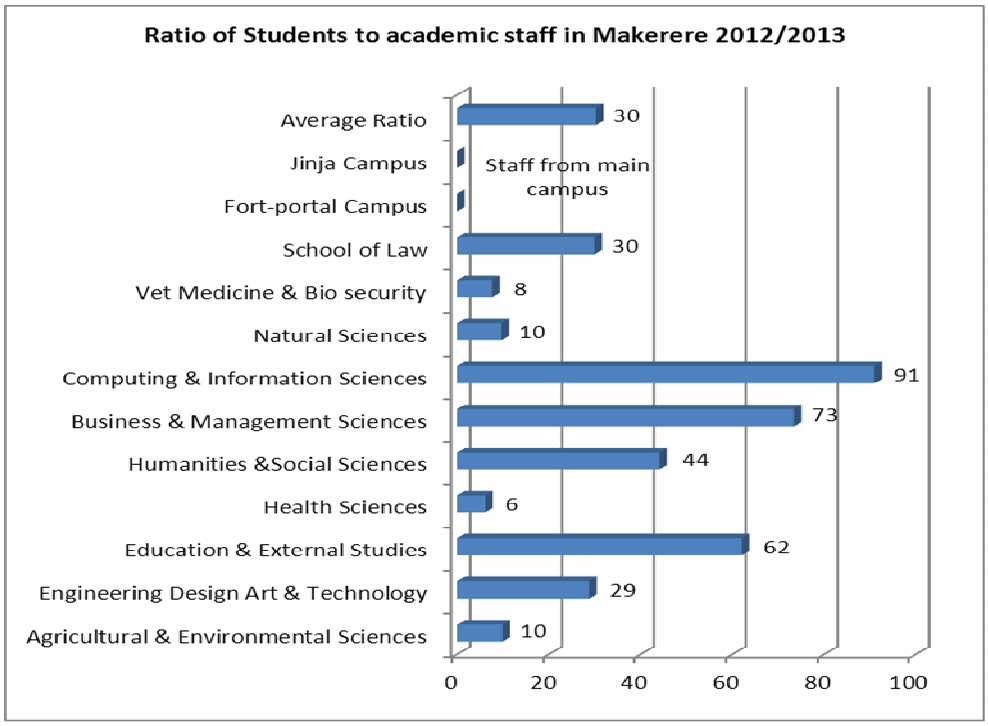
Makerere experienced a rapid expansion of the Bachelors level and to some degree Masters with exception of the general drop in 2012. Over the 13 years, the Bachelors graduations grew at an average of 10 percent, almost quadrupling enrolments of 2000 between 2010 and 2011. Other levels evenly followed or multiplied by more times but by proportion still remain low. While student numbers multiplied by thousands, academic staff did not add by a single hundred in any college. The highest increase was in Health Sciences with 79. Others were either very marginal or instead reduced in some colleges.

Table 4.3: Makerere University staff increase between 2005 and 2013

College	Staff by 2005	Staff by 2013	Change
Agricultural & Environmental Sciences	134	172	38
Engineering Design Art & Technology	112	111	-1
Education & External Studies	84	104	20
Health Sciences	168	247	79
Humanities &Social Sciences	210	204	-6
Business & Management Sciences	75	85	10
Computing & Information Sciences	49	65	16
Natural Sciences	114	124	10
Vet Medicine & Bio security	68	74	6
School of Law	45	44	-1
Total	**1059**	**1230**	**171**

(Makerere University 2013b: 41)

Two external study centres were additionally opened in Jinja and Fort-portal for the same staff to commute to. Taking the 2012/2013 total student populations in table 4.3 and the 2012/2013 staff numbers in table 4.4, the average student to staff ratios remain high in the university and unimaginably high in some colleges like Computing and Information science, Business and Management and Education and External studies.



Figures confirmed with Makerere University (2013b: 38).

Uganda's National Council for Higher Education (NCHE) set a standard staff to student ratio of 1:20 as the acceptable level of quality. Only four colleges here fall within that range. There is a reliance on part-time staff that are not reflected in the university staff list that we need to take to account. Makerere University Fact Book 2011/12 shows that there were 154 part time staff and 268 teaching assistants in 2011/12 (Makerere University 2012: 23). If these still exist and are added, the total staff number comes to 1,652 and lowers the overall average staff student ratio to 1:23. But the distribution of the part-timers by college, their levels of qualification and labour-time given could not be ascertained. Using the overall average bluntly as it is also potentially blankets the disparities we see among the colleges.

The university's strategic plan indicates earlier intentions to cut the overall ratio of students to full-time staff down to 1:19 by 2009/10, lower to 1:18 in 2012/13 and finally to 1:17 in 2015/16 (Makerere University 2008a: 38). These have proved elusive; just as was the failure to cut down undergraduate teaching. The point again is that TH presuppositions of easily transforming a university are not based on real experience of challenges the institutions face. Makerere has had the will and made its own efforts but in vain.

The university Research and Innovations policy specified that the staff spend 20 percent of their time on research and dissemination. The policy promised to ensure appropriate student to staff ratios in line with the university establishment policy (Makerere University 2008b: 8). Only 15% of staff time so far has been spent on research and dissemination (MoES 2013: 300). Makerere in commitment to research also stipulated at least 3 percent of its internally generated funds to go to research and innovations annually by policy. But only 1 percent has been delivered (Makerere University 2013b: 54). Last academic year (2012/13) the research vote lost 12.714 billion Uganda shillings (US $ 4.9 million) that was re-allocated to teaching and training apparently because the teaching load increased beyond the initially provided (MoES 2013: 354).

Still considering the TH proposal of re-organizing the university, the high profile staff (professors and associates) that are the target of the entrepreneurial university model are minimal in Makerere's case.

Table 4.4: Makerere full time academic staff by rank and qualification 2012/13

Rank	Qualification				
	PhD	Masters	Bachelors	Unspecified	**Total**
Professor	66	5	0	2	**73**
Associate Professor	100	11	0	4	**115**
Senior Lecturer	113	55	7	2	**177**
Lecturer	106	157	15	8	**286**
Assistant Lecturer	54	404	111	12	**581**
Total	**439**	**632**	**133**	**28**	**1232**

(Makerere University 2013b: 43)[1]

Professors constitute only 6 percent and Associates Professors, 9 percent. Much as Makerere drives Uganda's research which by itself is a heavy load, it still has a small human resource base, minimally increasing and overwhelmed with high undergraduate enrolments which will not simply be cut down overnight.

The general picture running through this Makerere case by use of objective performance indicators reflects unanswered questions in the TH framework for universities. There are several realities the TH and entrepreneurial university model have not taken to account. In Makerere's case, the failure to transform has not been due to system rigidities as Etzkowitz (2003) argues, but rather incapacities that cannot be resolved by what has been provided in TH. The recommendations for African universities to use TH and reduce reliance on public financing (Etzkowitz and Dzisah 2007) without looking into these internal complexities has possibilities of harming delivery of education as Makerere has already experienced.

The problem with TH just as the 'entrepreneurial university' model are indeed their reference to MIT and Stanford University (Etzkowitz 2003) without relaying the internal situations of those institutions on areas universities in developing countries have challenges. Because analysis of the intramural state of the university is ignored, the arguments in TH have not perceived (if really not) the possibility of them getting infatuated with promotion of national innovative competitiveness at the expense of university education delivery. Considering further possibilities requires that we see the innovations in Makerere since the reality also is that they exist.

[1] There are two additional staff here who were not included in Table 4.4 and were not specified in the university report which college they belonged to. Attempts to obtain that information were unsuccessful.

Chapter 5 Innovation in Makerere

Two cases of actual innovation are covered in this chapter. They highlight the differences in several aspects that are comparatively reflected upon in the last section of the chapter. They matter significantly in determining the institutional productivity of the "third mission". In this first section though, we introduce innovation broadly in Makerere University.

5.1 Overview

Technical innovation may have been in Makerere a few years after it becoming an independent university. The Faculty of Agriculture designed and built a tractor as part of the agricultural mechanization efforts in the early 1970s. Its commercialization got cut by the ensuing economic and political instability (College of Agriculture and Environmental Sciences (CAES) Innovation Catalogue 2012: 59). CAES Innovation Catalogue now shows a predominance of food and beverages. Apart from that only (ox-drawn) ploughs, threshers and harvesters mix in.

In latter times innovation as a concept got popular in Makerere with the introduction of "Innovations at Makerere" (I@Mak) in 2000. A project arranged by the initiative of the governor of Uganda's central bank together with the head of the Rockfeller foundation in Uganda; that later funded it together with World Bank. I@Mak undertook capacity building of local government staff during decentralization that had started in 1997. It re-emphasized the social relevance of the programmes in Makerere, trained Makerere staff on local government and decentralization and funded research on the same, encouraged and supported inter-disciplinary teaching, facilitated community-based internship placements and introduced more courses in the subjects of poverty alleviation, universal primary education, agriculture modernization and local government (I@Mak.com 2001; MESA University Partnership 2011). We shall not go beyond this as we can see that it falls outside the technical innovation criteria earlier set. But i@Mak was significant in initiating a new partnership between Makerere, government agencies and donors and influencing what would be Makerere's "third mission" thence. Looking at technical innovation thus requires that we see such underlying processes as Lundvall (2004) stressed: the organizational innovation influencing technical innovations.

Makerere's "third mission" stuck to dealing with government, NGOs and sometimes the community. Makerere's previous strategic plans and reports in the early 2000s did not explicitly reflect technical innovation, knowledge and technology transfer partnerships, knowledge economy or university-industry linkages. The direction of the strategic plan 2000/01-2004/05 that was revised to 2000/01-2006/07 in 2004 - as Mamdani (2007) argued of the academic practice in the whole university - went commercial. The university spelt out its 'third mission' as community extension and service. The undertakings included thereunder were improving community access to specialized services commercially, providing specialized competencies in areas the university had competitive advantage to generate funds, institute a deliberate policy to encourage staff to undertake consultancy, capitalization of university consultancy units and delivery of short-term courses on a commercial basis (Makerere University 2000: 15; 2004: 24). Makerere's 'third mission' during this time was purely entrepreneurial and commercial to its clients.

By objective indicators in the previous chapter we saw little logic for an entrepreneurial university in Makerere's context without addressing pertinent internal

issues. But we see here that the university actively built its own entrepreneurial culture while in that state. This was not necessarily the optimum direction but a condition of financial starvation. Instead of bettering delivery as the TH supposition is, it led to massification of enrolments for purposes of private fees and instigated "moonlighting" by the lecturers compromising the 'first mission' (Sawyerr 2004; Kwesiga and Ahikirire 2006; Mamdani 2007; 2008; 2012; MESA Universities Partnership 2011). The consultancy culture that was promoted took toll on the rigor and engagement with literature required in academic research, corroding the 'second mission' (Mamdani 2011; 2012). Among those in support of the processes in Makerere then, common claim run that the innovations saved Makerere from collapse; and Makerere was able to take more enrolments without additional funding (Court 1999).

In some way the university showed a change of the 'third mission' when it moved into its current 10 year plan 2008/09 - 2018/19. Emphasis was made of a shift from the outreach paradigm to knowledge transfer partnerships and networking. It articulated the other two missions as turning into learner-centered pedagogy and being a research-driven university. Under research it added innovations. Specific strategies were drawn to increase knowledge transformation and innovations, promote commercialization of innovations and exploitation of intellectual property. In partnerships and networking the university aimed to involve the private and public sectors in its operations and collaborate in joint research projects. Projects conducted with the private sector, business and technology incubation centers and joint field work attachment and supervision were introduced into the plan (Makerere University 2008a). Makerere moved from this point into more technical innovation and outward linkages.

In pursuit of that plan Makerere has been sizeably supported by the government. It has facilitated the establishment of three incubation centers. One at the College of Information and Communications Technology for ICT related innovations, at CAES for food technology and business and the third one at the College of Engineering, Design, Art and Technology (CEDAT) for renewable energy. These are mostly funded by the Presidential Initiative for STI (a fund only Makerere among all universities currently accesses). The university has recruited and trained staff for the incubators. 30 enterprises received support last year and this year there are 12 being supported in-house and 20 on virtual incubation. Makerere is in the process of formulating a policy for incubation centers. A potentially big project also is the ongoing construction of a diary and meat processing plant at the universities agricultural training farm/institute in Kabanyolo. Besides enterprise incubation the government has engaged on an ambitious entrepreneurship promotion strategy with Makerere through a training project 'Skilling, Production, Enterprise Development and Academics' (SPEDA). The programme has trained people both from the community and the university. 300 university staff received training on entrepreneurship with 240 entrepreneurs from the community last year. A mobile fruit processing plant has been procured that conducts outreach to farms and enterprises for fruit extraction and packaging.

In brief Makerere university from its initial experiences of financial subversion entered into a deliberate and systemic entrepreneurial culture in all its 'third mission'. This was getting re-shaped into a more industry-oriented technology development and transfer in 2007/2008. The direction has coincided with the government's interest in promotion of innovation and entrepreneurship in the STI policy and strategy pursuit. The university has matched with the government with regard of interests and prevailing institutional culture. It is now more engaged in technol-

ogy-oriented innovation and enterprise promotion as its 'third mission' but industry per se remains less closely interacted with. The university has planned in the new academic year (2013/14) to open a central coordinating unit for knowledge transfer partnerships. It remains to be seen how much university-industry interactions will get formalized and (or) intensified through it and the difference it will make on the institutional character of the university.

5.2 Innovation Case One: Electric Car

The Electric Vehicle (EV) Design Project is one of the ten innovation projects funded under the Presidential Initiative for STI since 2010. I will highlight the other projects too each briefly so as to give the trend of the whole initiative.

The ten projects all fell under one college: CEDAT. The distribution was a result of the nearly surprise manner in which this particular funding was given. President Museveni visited Makerere on 12th December 2009 and requested to see the projects going on at CEDAT (still the Faculty of Technology then). He was impressed and asked the Faculty members to go to State House on 28th December 2009 with proposals for funding. Officials of MoES and MFPED were invited to that meeting. The Makerere delegation carried projects they had been doing for some time. In their count:

1. Centre for Research in Energy and Energy Conservation (CREEC) set up in 2001 researching on energy management, solar photovoltaic (PV), Hydropower and Biomass projects.
2. The Centre for Technology Design and Development (CTDD) initiated in 2002 under GTZ support had solar water heaters research project.
3. Innovative Clusters earlier mentioned under PACF-ISCP started in 2005.
4. Academic Records Management System (ARMS) project started in 2007 to design an online e-learning environment.
5. Low-Cost Irrigation Project which designs and manufactures low cost water pumps. It has so far made pumps being sold at the college.
6. Community Wireless Resource Centre (CWRC). Its operations target internet delivery to communities, designing novel connectivity mechanisms.
7. Industrial Parks Project earlier highlighted under GTZ support for SMEs to acquire properly designed and serviced premises, improve their working conditions and foster their survival and growth.
8. MAKAPADS, the short form for 'Menstruation, Administration, Knowledge and Affordability' Pads. The project started in 2008 funded by ADF. It developed the first ever sanitary pads made in Africa. It was intended to alleviate girls' absenteeism in schools due to menstrual problems. An on-campus registered company: Technology for Tomorrow (T4T) handles its products.
9. iLabs is a collaborative research project with the Massachusetts Institute of Technology (MIT), Obafemi Awolowo University (OAU) and the University of Dar-es-Salaam. It is meant to develop online laboratory facilities that supplement the conventional ones in the participating universities. It is now extending training to secondary schools in robotics and other ICT areas, and connecting other public universities in Uganda onto iLabs facilities.

The tenth project, the EV was still a nascent idea. It had not started by the time of funding. The reason identified was financial constraints but the idea was a little recent too. According to both the mentor and supervisor of the project, EV design concept would not have survived if funding had not come. It would have

remained a wish or be forgotten. Its coming to the stage of Uganda's STI thus seemed accidental rather than initiated deliberately from scratch or situation analysis. 'The idea was ripe but there were no funds'. At the meeting in state house, the President gave directives to the ministry of finance and that of education to give the Faculty 25 billion Uganda Shillings for the period 2010/2014, 9 billion going to EV design.

President Museveni asked that the car be named Kiira, the indigenous name of river Nile. The research team had earlier thought they would call it MAK EV because in their initial conception, the innovation was meant to be an on-campus transport facility. Makerere had developed this problem of perceiving technology development inwardly - for its own institutional purpose rather than the broader public - from its past experiences with reforms and donor/internally funded research (Nabudere 2009). They suddenly realized this was to be a national enterprise.

The President bore a sense of national pride that something spectacular was in making that had to assume national symbolism. More importantly, the President found openings for a broader STI strategy pursuit in Makerere. He added 5 billion shillings to be given to the School of Food Technology, Nutrition and Bio-Engineering and 1 billion for the College of Veterinary Medicine, Animal Resources Development and Bio-Security to support skills development in the animal sector annually for five years. This was the beginning point for Makerere becoming the university of Uganda's innovation pursuit.

The EV concept originated in 2007 from the Faculty's collaboration with MIT on iLabs. The Principal Investigator in iLabs at Makerere visited MIT where he met the student leader of Vehicle Design Summit (VDS 200). Makerere got invited to join the VDS from the interaction of these two researchers and became the only participating African university. The Makerere initial student team had to be expanded by an addition of 10 more members in 2008 to bring in more competencies. An engineering professor and also the Deputy-Vice Chancellor in-charge of Finance and Administration together with the Operations Manager and Principal Systems and Business Analyst of the ARMS project came on as mentors and providing oversight. They successfully participated in the VDS 200 that designed a 6 passenger plug-in hybrid electric vehicle exhibited at the dream exposition in Torino in 2009. Makerere team took the role of designing the power train and in-vehicle communication network.

Inspired by their mentors they got it in thought to come and set up a Centre for Research in Transportation Technologies (CRTT) in 2009. A little different from the perception we tend to have of university innovators as simply interested in commodifying their knowledge, the aspiration of the EV design team was to put to use the acquired skills from their involvement in VDS 200. Making their involvement in VDS 200 an achievement, while retaining and furthering the competencies and talents of the students was a reasonable inspiration.

The team got further motivated in their idea from Uganda's transport challenges. According to one of the mentors, the idea kept on getting inspire cumulatively by different events. Still in 2009 Hiroshi Shimizu of Keio University Japan who had led the design of the Electric Lithium Ion Car (Eliica) visited Makerere and shared his work with the team. When President Museveni later mentioned to them about taking proposals to State House it was like grace unexpected. They got funding and started constructing Kiira EV in 2010. While they were going on, President Obama in his state of the Union address in 2011 hit them with yet another motivator. Obama's promise to put 1.2 million electric vehicles on US roads by 2015 drove the anxiety of the EV design team to full conviction of the useful-

ness of their efforts. This series of motivations portrays a different side of what makes university-based innovation attractive to innovators or academics. As d'Este and Perkmann (2011) found of university-industry interactions in England, there may not always be solely pecuniary drives.

All the work was done in the CEDAT workshop. In November 2011 a 2-seater complete electric vehicle prototype was launched. The design team besides their anxiety, treated it as their proof-of-concept. At the launch President Museveni remarked that the innovations at Makerere 'are a renaissance', a wake "from 'a deep slumber' that has taken its toll on the African continent". The president repeated his promise to increase remuneration of scientists to international standards and increase support for the university and its innovations.

The Professor leading the team delightfully remarked that he wants by the time he retires there should remain behind him a team of skilled, competent and well-equipped engineers to steer Uganda to industrialization. This was a uniting point for the innovator and the national leader. Both sides had got motivated in nationalistic terms, seeing local capabilities to undertake innovation.

EV had come to finish before 2014, the period for which the centre's funding was planned. With the president's commitment to support the university, the car design team turned to make a 5-year proposal. It included making improvements on the Kiira EV prototype into a market-ready product. That would come in a 5-seater Sedan branded Kiira-SMACK. They also embarked on building a passenger bus. The vision of addressing Uganda's public transport challenges was coming to realization. By the time of this paper's data collection, the design was complete and had been inspected by the Minister for Education and Sports who visited the university. Finishing and testing of the bus power train, work on the chasis, frame and off-board configuration were awaiting release of funds. The bus was scheduled to be unveiled last October (2013) but the delayed procurement of components did not allow construction to be finished within that time.

With assurance of government's commitment the team designed a plan for a fully-fledged research center physically separate from CEDAT. CRTT campus is meant to occupy 100 acres of land for which government has so far provided 50 acres. The design provides for housing facilities for the required auto-motive research and production including an assembly plant, ware houses, research laboratories, offices and conference halls. By the time of data collection the construction was awaiting release of funds which equally had been provided in the national as well as university budgets.

The government together with the Makerere and the CRTT team have further embarked on an aggressive competence building programme. Under this year's budget a specific goal has been made to boost technological education and innovation for industrialization. Two CRTT staff have been sponsored to undertake specialised MSc. training in vehicle electronics and industrial design. Two other researchers on power train and charging infrastructure from the team have been placed for internship at Kettering University. Another two researchers on vehicle electronics and information systems have been placed on internship at MIT.

Staff in addition were facilitated to go to the automotive SAE World Congress and exhibition in Detroit USA in April and a visit SAE management workshops. Provisions were made for the November Electric Vehicle Summit (EVS27 2013) attendance in Barcelona. Collaborative exchange visits with General Motors and Ford were planned. The EV project has created a lot of enthusiasm for training both in government and the university. Efforts are equally being strengthened at the lower levels. The university with support from the government has provided spon-

sorship for 11,876 students to go on industrial training and workshop practice. This has been spread to the various disciplines of civil engineering, electrical engineering, mechanical engineering, architecture, construction economics and management and survey.

Other actors have continuously been drawn around the project. Officials including the minister with his political and technical team from the ministry of Industry and Trade visited in January 2012. They were inspired and sought to integrate the project into the broader national industrial development strategy; and promised the ministry's hand in furthering the initiative in the national agenda. Supporters from industry have showed up. The Insurance Company of East Africa (ICEA) visited CEDAT also in January 2012 and offered EV comprehensive insurance worth 4.6 million Uganda shillings. This covers for all eventualities of fires, burglary or accidents. The company promised to support the next project, the electric bus similarly and further work of CRTT. The university has also provided funding for the patenting of the bus and the electric cars in its budget this year.

The case among all others stands out as a big inspiration for all actors. It seems to demonstrate possible new pathways to industrial development which had not been aggressively pursued before. And yet it all started out of unplanned and chance events. The further strengthening of zeal found basis on the skill factors. A proper match has emerged with government as opposed to the university struggling alone. Makerere and the government are strengthening collaborations and networking locally, regionally and globally. Besides the internships, training sponsorships and visits to international exhibitions, closer partnerships have been established with universities in Japan, China, Israel, Russia, USA, Turkey, Egypt, Saudi Arabia, Ethiopia and Rwanda among others. They add to those with Swedish and Norwegian universities that have existed on research collaboration through Sida and NORAD.[2]

5.3 Innovation Case Two: Biological Sciences

The innovations in the department of Biological Sciences (BS) are more advanced in market readiness and distribution than CRTT. Key products include:

- Cleansers for naturally detoxifying the body
- Herbal tea for people with asthma without preservatives
- Ointments for skin infections
- Body immunity boosting tea
- Stimulant that boosts brain function and reduces memory lapse
- Mosquito repellent in crème form
- Nutritional supplements made from mushroom, millet and other nutrient rich foods
- Porridge flour from simsim, millet, moringa and other herbs

While the previous EV received broad support from design, production, capacity building, insurance and patenting, this one ends with the funding got at different times for different specific research projects. Some from the university's

[2] Part of the story on top of which interviews and other research were added are published in detail by CRTT on its official website at http://crtt.mak.ac.ug/?page_id=14

internally generated revenue others from donors like Sida, NORAD and the Carnegie Corporation. The actual production, packaging and marketing are all financed by the lecturers involved. The products have been developed over years from research done by both lecturers and students of the department. Two lecturers run the enterprise. They consider all their products as prototypes even if they have marketed most of them for some years. There are some though that are still at trial levels; being given to hospitals from where feedback is got.

Research on these products is based on market demand. 99% of their research is undertaken when they have got substantial requests for certain types of products from the community and clients. For most of the time except when they go to trade shows, they have only displayed the products in the shelves at their department veranda and in the offices. Both lecturers had just returned from the Jinja Source of the Nile exhibition two days before the interview. Besides that, their only other agent is in the Islamic university (IUIU) in the eastern region of the country.

From the marketing in exhibitions they receive orders especially from people who have consumed the products. Some as in the case of the flour return and take up to 20 packets (about 60 kilograms). Old customers keep referring other people. World Vision recently expressed interest in adopting the flour for its food aid programmes because of the calcium composition and other minerals. It wants to deliver it to pregnant women, breastfeeding mothers and under-age children. They have not followed up seriously so far.

The team is constrained from reaching out to the broader market; the biggest constraint being time considering their core duties of teaching. It becomes straining on top of teach to add research, make the products, market them, collect the materials and all other tasks they said. There have been conferences and trainings at the university promoting entrepreneurship, STI, biotechnology and other opportunities. But their duties do not allow them engage in most. One said:

> 'It is not that I am avoiding them deliberately. Some of those things like on Thursday, there is a workshop running where I am going to present two papers, one in the morning and one in the afternoon. Many times there are so many things happening ... you are travelling, you are doing research, you are teaching ... Some documents come in emails but the emails are also so many. Some say read this, make comments and sometimes you cannot keep up with all. You have to prioritize which one is more urgent. Now that one would not have been very urgent to me because I have students who are supposed to graduate and the deadline is coming.'

This team has sought private partners in the market but have not found any reliable one so far. Some people they met in various exhibitions expressed willingness to help them improve the products for easier marketing by packaging such as teabags and capsules. Some of these are private market-based, others work in government agencies like UIRI. But these have expressed their will as individuals who also have private businesses on the side or know someone else who can help. But it all comes at a cost of the inputs and those helping expect to benefit. Hence:

> 'At the end of the day these people are also looking at how they are going to benefit. It is a two way thing 'scratch my back, I also scratch yours'. If you give them what they want, they will also do for you what you want.'

The team remains struggling to balance tasks but also resources. Besides money for packaging they need money for opening up a company. They have not

been able to market out of the university because of their lack of a registered company. Uganda National Bureau of Standards (UNBS) restricts any of their products being marketed outside their premises unless if there is a separate company doing so. The lecturers have however had no time and money to open up one. The products have remained being marketed within the two universities, with a Makerere university logo even if the enterprise is purely private.

They have failed to patent the products for similar reasons. The cost of patenting as compared to the returns from the local market does not make patenting an immediately viable option to them. It would require large scale production and marketing in the near term, possibly even beyond Uganda. Due to their financial limits and non-establishment in the market they cannot produce on large scale yet. There are also complications to sort out patenting issues for herbal products that require one to prove their formula as totally unique. Yet some herbs are universal and used by Chinese, Indians and other people. If one patents, everyone else comes claiming rights.

They have sought support from the government to advance their production but have not yet received any. Three years back during an exhibition, President Museveni got interested in their products and took their contacts. He called them at night when they were at the hotel and had a lengthy discussion. He asked them to write a proposal concentrating on two or three products where they thought Uganda had a competitive advantage. They would improve on them to a level where they can be exported and the President would give funding. They wrote a proposal but are not sure if it got through to him since they had no feedback yet.

Working out of the university is less an option because the lecturers find it hard to access laboratory and other necessary facilities. Their production has depended on the university laboratories and facilities. This is most with the preliminary stages of component extraction and screening. After the formulation they can do the rest of the work at home. Where industrial equipment exist they said, the expenses are too high. The only other laboratories they have been able to access are of public research agencies like Natural Chemotherapeutics Research Laboratory (NCRL) in Wandegeya. When they work under the university they can access laboratories in partner universities in other countries that may have the equipment for advanced independent verification ('good second opinion').

5.4 Perspective on the two cases

Depending on ones viewpoint, anyone can argue differently about the two cases above. For that reason I chose not to argue within the cases but present them as they are and give reflective views under. Differences between the two that objectively stand are on the source of funding for various stages, levels of support and extent of commitment, the university and government role, the ease of finding industrial partners, the nature of technologies, the actual innovators (size of team and structure/composition by either staff or students), modes of communication at initiation and consequent steps.

The 'entrepreneurial university' and TH arguments have not been specific about financing of innovation and the implication it has for success as well as perspectives of the actors on appropriation of benefits and contributions these can elicit. The contention of this paper from the above experiences is that if university innovations are privately funded and appropriation of benefits is solely the individual innovators/academician's discretion, not only will the success rates be lower but the values and motivations held risk compromising professional practice.

The BS team have not moved beyond seeing their innovations as potentially public so that they can pass them on to the university. In which case, they would not need a company or patenting on their own. Their benefits from the university as a share of the returns would be a relief from the several constraints, allowing them to continue comfortably on their duties and still have use of the university facilities that they rely on for further innovation.

The nature of innovation/technology seems to affect perceptions of other actors right from the start. The government's response has not been swift to BS. Meanwhile the government is promoting commercialization of such innovations in the incubators found in the university. The problem may still be that the BS team is not able to let go of the innovations into the institutional mainstream; although the operational frameworks for the incubator facilities is still in making. The consequent issue is their limited time to follow up the opportunities available even on-campus. It relays the actual constraints to entrepreneurship in the university with the core functions of teaching heavy on one's back. This is inescapable in the case of a university with enrolments and staffing levels like Makerere's.

CRTT on the contrary started with students as the core team and the two staff only came to back up. The skills have diffused to and built up in agents that are not necessarily tied down to teaching as their core duty, but committed and motivated on the basis of these skills and national development insights. It did not require the form of university re-organization Etzkowitz (2003) proposes. The professor has not abandoned his teaching position or that of Deputy-Vice Chancellor nor has he had to shift to fully manage the project.

BS has not been able to mobilize such a team from the old students mostly due to resource constraints but also the knowledge and will/motivation to do so. In their view it would imply open and broad-based marketing and having trusted partners; for which they have no company yet, have not got private partners able to engage with them without financial implications and have not patented their innovations. The worry about the market viability of their type of innovations prevails. If their uncertainty indeed represents the reality, it is possible that such innovations be disregarded by the university as in the NIS and 'developmental university' framework. The university can then concentrate on giving students sufficient skill to go and find for themselves places in the market.

CRTT innovations otherwise cannot be left to such general training and expect the innovations to grow by themselves in the market especially where there are such high entry barriers, immobilized market forces and hardly any non-price support. Deliberate and systematic government involvement was vital. Equally reasonable was the option of starting from the university. It would have counted differently if the research center had been built before proof of the capabilities in the university; which in turn would not have been possible if the university or government culture was to disfavour on-campus innovation. This is not to justify Makerere's previous 'commercial university' culture but to reflect the possible balance with proper involvement of the actors and public support that applies innovation to national development rather than sheer personal profit.

It is therefore possible to argue that national policy and support/action matter in determining the nature and direction of innovation in universities. On-campus location of innovation in itself may not count as the problem but rather state inactions that leave the university to fumble its own way without certainty every subsequent day. Such a situation prevailed in Makerere when starved of public funding. EV itself before funding lingered around the same uncertainty and the thinking was of a university artefact, not its broader national potency. It would

most likely have ended in narrow profit exploitation if it had not taken the national developmental orientation. The same currently prevails over the BS case where the lecturers are looking at helping themselves as individual entrepreneurs. The outcomes from national inactions and orientations apparently have more in raising the innovator's potential to treat their work in a narrow pecuniary and commoditized manner.

The fear of government financial squeeze and privatization as feared by the NIS proponents (Lundvall 2002) may not be a universal trend. Government appreciation of Makerere's significance has increased more than previous perspectives that underrated the university's relevance; a situation Makerere suffered from grievously. The concern we would have is about the commercialization and marketing. But the CRTT team as is constituted of students who have now graduated, some are receiving further training and following undergraduates are being channelled to the project. Such arrangements other than the TH proposed model of professors in research teams as "quasi firms" (Etzkowitz 2003) may be more relevant.

Meanwhile Etzkowitz's proposal of creating the industry from the university and producing companies (ibid.) holds viably for CRTT but not for BS. In the event that the skills were identified, the team was mobilized to undertake the work, but there was no motor factory in Uganda, it would have been developmentally negative for Uganda to wait until a private corporate comes to open up a motor industry and use such competences. The government's commitment, capacity and closeness keep progressive steps to retain and employ the skills. Such skills would otherwise flow out of the country and the scenario would be like that related in Brundenius et al. (2008: 10) of Latin America's public expenditure on university training and R&D as subsidizing innovation in developed countries. Such action though cannot apply universally to all innovations. It would be highly risky to take similar steps in the case of BS.

Chapter 6 Conclusion

The findings in each chapter reflect the fact that the orientations of the arguments presented in literature between NIS and TH miss or hold on to specific situations viewed at specific levels of analysis without necessarily introducing other levels. When the scenario of Uganda is analyzed from the national context as we did in chapter three, we note how impulsively the need for the university to extend its role in the 'third mission' stands out. The challenges faced historically and continuing to the present make it easily justifiable to demand more of the university.

The moment we draw that analysis down to the university specific level, a need for caution emerges. The arguments of TH and the 'entrepreneurial university' and the strategies for reorganizing the university become largely superfluous. They do not reflect what needs to be done in reality with the situations of universities in developing countries. In fact, Clark (1998)'s version of entrepreneurial university will only return Makerere to its destructive commercial state it entered into under SAPs. For as long as TH does not come to terms with these realities and express understanding of such situations in its propositions, it remains a harmful tool for innovation in universities. Uganda's universities are held down more by incapacities than rigidities as TH presumes (Etzkowtz 2003). Their learning and innovativeness needs no conflict-ridden reorganization. The resource issues in them would not require a commercial university model to resolve. Makerere has been through it with unappreciable consequences. Innovation in the university needs to be supported publicly with a solid direction to national development rather than sheer institutional or individual profiteering.

At the level of the specific innovations, the EV case offers substantial reason to believe in the potential of the university to cause the needed technological transformation in developing countries. Not by simply training graduates but actively overcoming the barriers to technology access suffered in the South. Articulate public support differentiates its status from the survivalist levels of success and pecuniary motives of entrepreneurship that trap the BS case. There is reason to believe that university-based innovation with objectives directed to national development efforts have more potential for success that those preconceived in "quasi firms" of academics for themselves. These are realities which TH and the 'entrepreneurial university' literature have to study and explain further in their models.

Historical and present situations that have shaped the industrial structures (physical and human) on the other hand make the withdrawal of the active university role potentially disadvantaging to development in the South. The problem with Makerere and Uganda for that matter is that the government has been so slow to appreciate this situation. State decisions with regard to staffing and remuneration of lecturers particularly have (and in their present state, continue to) countermined the university's delivery.

Developing countries need to mobilize their thin forces from all corners (public agencies, academia, community and impress a change in current industry too, prevailing challenges notwithstanding), to overcome barriers to technological development. University-based innovation with committed public support is not a negative option per se, but can be if quality delivery indicators are not bettered. State inaction and less consciousness towards such quality issues are the actual problems that need to be tackled more than anything else. With the current state of industrial establishment, developing countries as has been said have got to 'run

while others walk' (Mkandawire 2011). The university has more to do in this case than only passing out graduates.

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