Research on Higher Education and Science and Innovation Policy: Policy Implications

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Introduction

The purpose of this paper is to provide a summary review of the most robust findings from two areas of research: i) higher education and science and; ii) innovation policy; and to provide some of the policy implications that may be drawn from these findings. The policy contexts to which the discussion is directed are the African, Caribbean and Pacific (ACP) countries. The paper is divided into five sections excluding this introduction. The section which follows this will outline the key findings from research on higher education; section three will discuss the policy implications of these findings. Sections four and five will discuss the findings from research on science, technology and innovation policy and their policy implications respectively. The last section will be devoted to concluding remarks.

Science, Technology and Innovation Policy Research: A selection of our most robust findings

The late 1980s ushered in a new era in science and technology policy and this was the integration of innovation concerns. Previously, most countries treated innovation issues as part of industrial policy. The integration of innovation into science and technology policy is attributed to the adoption by policymakers of the innovation systems approach as a leitmotif for conceptualizing, planning and implementing science, technology and innovation policies. This shift to systems of innovation thinking has been prompted by among other things, the realization that innovation neither occurs in a vacuum nor is it the outcome of a single actor's input. Scholars in the SI tradition as well as influential policy actors such as the Organisation for Economic Cooperation and Development (OECD) have converged on the finding that innovation requires cross sectoral collaboration. This insight both explains and justifies the plethora of instruments for promoting collaboration that are now popular in STI policy. Some examples of types of collaboration include specific funding for university-industry collaboration e.g. innovation vouchers for small and medium sized enterprises or stipends to facilitate short and medium term

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secondments between universities and firms. So important has this issue become, that in some countries, it is already integrated into evaluation of academic performance. For instance, the number of articles co-authored with non-academics is used as an indicator to track collaboration between universities and other sectors of society.

Performance based public funding and research capacity

Apart from the focus on collaboration or perhaps in pursuit of this ideal, many OECD countries have gradually increased the portion of funding for research that is allocated in competitive schemes. Emerging economies such as India and South Africa are gradually adopting this approach as well. Performance based funding is in part popular because it offers the possibility of ensuring that resources are allocated in the way that the funder intends. This works well when the funders know something about how research is organized and what incentives trigger which behaviors. Ironically, although systematic public funding of research has been a feature in most countries since the end of WWII, ministries and funders did not need to know much about how these organisations managed the process of knowledge production. This was one of the more positive features of the linear model of innovation. The coupled action of moving to a systems approach and the increased interest in steering has increased the amount of knowledge needed by the funder. Thus, evidence based policies are becoming just as important for the public R&D sector as they are in other parts of the public sector.

While much of research has focused on the connection between competitively allocated funding and increased steering (Hicks, 2012; Abramo *et al.* 2011) or alternatively accountability, research has also shown that competitive funding has an additional function. This is the institutionalization of new behaviors and modes of organization in the research context (Cohen *et al.* 2001; Hellström and Jacob, 2005). Many read the Mode 2 thesis advanced by Gibbons and colleagues (1994) as a prescription which recommended that all knowledge production had to be collaborative and interdisciplinary. Research, however, shows that Mode 1 and 2 have coexisted and there is reason to believe that they are co dependent (Shinn, 2003; Gibbons, 2013). Several efforts to investigate the purported shift to Mode 2 have yielded inconclusive results (see Martin, 2011). A strong Mode 1 knowledge production capacity is often needed to support knowledge production in the other Mode. For instance, there is reason to believe that disciplines are still better at training researchers in method and how to do research than theme focused ways of working. Mode 2 should, therefore, not be taken as a substitute but a complement to Mode 1. However, as Gibbons notes, Mode 1 research has to be restricted in part because of costs. What this actually means for policy is dependent on the context. However, a global reading would argue for institutional heterogeneity, i.e. a mix of universities, research institutes, etc. Institutional heterogeneity is not, however, the whole story as the ability to sustain this may well be dependent on the size of the R&D system. Low capacity or small population size may restrict the ability to promote institutional heterogeneity at the level of organisations but may instead speak for building heterogeneity into the same organization. Universities may therefore be called upon to perform several different types of research and teaching.

One of the outcomes of policy interest in Mode 2, Triple Helix and systems of innovation perspectives on research and innovation has been the attempt to use the competitive allocation of funding to change patterns of behavior in the research community. Thus, the tradition of collaborating with users and other non academic actors has been promoted via the system of performance based research funding for more than two decades in European Union research framework programmes. This has been achieved by employing a variety of modalities and research funding instruments which force researchers to include collaboration with non academic actors in different stages of their research. The specific outcomes of these efforts have not always been welcome or beneficial to the research community (Garret-Jones, *et al.* 2005). In the greater scheme of things however, these efforts may have been successful in so far as they have led to increased interest in collaboration on the part of researchers and non academic actors.

A second objective of performance based funding has been to promote better management of research and finance at public universities. By changing the way in which funding is allocated, governments are able to steer funding to those who have demonstrated research capacity. This approach bypasses the issue of forcing universities to change how they allocate resources internally to personnel for teaching and research. This approach has two additional advantages. The first is that there is an inherent incentive effect. The second is that, it inevitably leads to changes in financial management practices at universities because funders require more detailed financial reporting on performance based funding than those applied to institutional funding.

Innovation, R&D and S&T capacity building

The preoccupation with the knowledge economy/society in policy circles may create the impression that R&D is an indispensable condition for creating economic growth however; there is no research which supports this claim. There are many firms that innovate without performing R&D themselves. Research shows at least three ways in which firms innovate without performing R&D themselves. These are: (i) by making minor modifications products and processes, relying on engineering knowledge (Kline and Rosenberg, 1986; Nascia and Perani, 2002); (ii) imitation and reverse engineering (Kim and Nelson, 2000) and (iii) combining existing knowledge in new ways, which can include industrial design and engineering projects (Grimpe and Sofka, 2009; Evangelista *et al.*, 2002). There is also evidence which shows that the straitened circumstances in developing countries have stimulated innovation in some sectors. A paradigmatic case of this is the banking sector where developing country users have driven the introduction of mobile banking services (Van der Boor *et al.* 2014). This is a variation on user led innovation (von Hippel, 2005). Yet another is the transferal of call time credit between cell phones pioneered in the Philippines and now used globally (Mendes, *et al.* 2007). The mobile phone is a classic example of how different user needs may be leveraged to repurpose a technology without reconfiguring it. Thus, in Northern markets, the cell phone developer must add new functionalities which are more or less exclusively related to leisure and convenience while in Southern markets, the phone is a platform for banking, buying prepaid electricity, water, etc. While poorer countries are not in the business of developing the basic technology, many of the service innovations they have introduced using this technology as a base have become

global successes in their own right. This implies that there is in some instances a circle of innovation which may have its initial point in an R&D intensive effort in the North, migrate to the South as a finished product and return to the North with new service functionalities that could not have been imagined in the North. This may be seen as a 21st century version of the initial notion of 'reverse engineering' which was launched in the age of import substitution development economics in India (Bound and Thornton, 2012). While the above shows that firms may innovate without being R&D performers themselves, this innovative capacity still relies on the possession of enough absorptive capacity to be able to understand and build upon extant S&T knowledge.

Additionally, countries may still find that some public expenditure on R&D is necessary in order to maintain the scientific and technological capacity necessary to survive in the modern world. Here I refer to the baseline knowledge needed to conduct a sustained effort in providing citizens with primary, secondary and tertiary education. While a great deal of the scientific and technological knowledge needed to run a modern society is available globally, many countries have specific national problems that may require them to make a local effort if they are to find a solution. This is particularly true for sectors such as health where epidemiological profiles can be unique to a particular region or country. Additionally, R&D investment can be invaluable for increasing value added in commodity dependent economies. A number of different demands such as decreasing energy inputs and other sustainability requirements speak for R&D investments aimed at adding value to commodities. One of the insights gained from investments in science based technologies in OECD countries is that far from only being the source of new firms, these technologies are often key to renewing or revitalizing traditional areas (Bound and Thornton, 2012). Two well-known examples are the contributions of biotechnology to the beer and wine making industries and the input of ICTs in transforming the automotive sector.

Policy implications of STI research findings

The task of deriving policy implications from research findings is not always a straightforward or simple process even in fields like STI policy research where the context of discovery for many research problems is policy. In the next paragraphs, this paper will devote attention to tease out what the above implies for policy. If we begin with the finding that there is an increased need for knowledge about how R&D performing organisations function in order to better steer their input to innovation. This implies a need for capacity in technologies of governance. Here I refer to statistics, surveys, and other planning competences. The capacity to access information about the population, firms, universities and their interactions with the rest of the economy presumes a level of information collection and retrieval that is currently beyond the capacity of many developing countries. The focus on science, technology and development introduced by the UNCSTD conference in 1979 has not been followed up by systematic capacity building efforts in developing countries to acquire these basic planning competences. This in part explains the inability of many of these countries, several decades after the so called decade of development, to successfully take policies from conceptualization to implementation. This is one of the areas where capacity could be quickly developed and where the skills are generic which implies their ability to yield benefits to several different sectors. Improving statistical capacity may be of use, for example, in developing better fiscal policies which can in turn provide the prerequisites for building capacity in other areas.

One interesting paradox for science and technology policy in contexts of development is that efforts to conceptualise and implement policies for development are hampered by the absence of, or reduced scientific and technological capacity. This brings us to an issue that the current focus on innovation may be an impediment for identifying. By this I refer to the fact that S&T capacity begins with education and an approach to education in which the notion of system is the appropriate point of departure. Thus, rather than see education as a capacity that is composed of three levels, primary, secondary and tertiary, we should see these as being integral components in a system. Quality must be nurtured and monitored at each level in order to be able to manage the sustained scientific and technological effort that would create innovative capacity. Many countries at the present time are critically in need of rebooting their education systems. The last two decades of focus on increasing impact and employability from university graduates have not left resources for paying attention to the fact that the output from primary and secondary education has been worsening (OECD, 2008). Many developing countries have the additional problem of limited access to education at all levels. Low accessibility due to fees or other issues related to skewed income distribution increases the chances that poverty will be transferred across generations, further it reduces the potential effectiveness in other sectors such as primary health care, maternal health, HIV prevention, etc. If policymakers wish to promote innovation they will have to begin with increasing access to education at all levels.

The second finding is that of promoting inter sectoral collaboration. The policy efforts in this regard have to be informed by the understanding that investments in this regard pay off only in the long term. The reason for this is that such partnerships depend on the actors in question developing the necessary trust to sustain their collaboration. This is supported by yet another robust research finding which is that proximity (geographical, organizational, cognitive, social and institutional) is still an important determinant of collaboration (Boschma, 2005; Arundel and Geuna, 2004). One of the barriers facing developing countries in terms of university-industry collaboration is the low level of R&D intensity in the business sector. Another is that those firms that perform R&D may have such activities located offshore. The importance of local S&T capacity building cannot be overemphasized. The low levels of PhD graduates among university staff in the bulk of African, Caribbean and Pacific (ACP) countries means that much of the effort is quite rightly devoted to teaching. Staff cannot and should not be encouraged to do research if they are not trained for so doing. A first step would be to raise the levels of competence of university employees to increase the number of Phd educated staff. While capacity building efforts are evolving, it may be useful to build internships into existing under and postgraduate degree programmes as much as possible in order to build collaborative competences in the next generation. These could be incentivized by giving extra resources to universities that incorporate some internship or practical elements into their educational offerings.

Much attention is given to the need for universities to collaborate with firms however, it is not always obvious that firms wish to collaborate with universities. Research reveals that small and mediums sized enterprises prefer to go to larger firms in their sector for knowledge. There are exceptions to this rule of course, for instance high tech and university start ups are sometimes coterminous with the university departments from which they were originally spun out. Policymakers in developing countries are not always aware of the difficulties firms face in

attempting to collaborate nor are they always fully cognizant of the fact that learning takes time and time costs money which is often in short supply in SMEs. The firm may very well be keen on collaboration but does not have the resources in terms of staff numbers to allow some members of staff, time to spend collaborating. The same is true on the university side, collaboration with firms is one additional activity in the life of a university teacher or professor. This means that all the other tasks that filled that person's day will continue to remain his/her responsibility even as s/he engages in collaboration.

Last but not least is the notion that R&D spending is not a prerequisite for promoting economic growth or even innovation. What type of policy opportunities does this reflection create, given that eschewing an R&D centred innovation policy, does not free a country from having to develop S&T competence. Currently, many ACP countries, particularly those in Africa, have innovation policies that are complex shopping lists based on desired future states. All of these lists and the desired future states that they are intended to support are rooted in sound assessments of what **should** be done but few have any anchoring in what **can** be done given the resource situation. The first step for policy at this point is to go from grand visioning to developing policy support that can create policies that are implementable within the current resource situation. Two important messages may form a point of departure here. The first is that policymakers need to resist the temptation to treat S&T policy documents as part of a general communication strategy to inform the populace that all the important problems will be addressed. A second key message is that it is better to start from the assumption that S&T capacity building is too important a priority to leave to the whims of donors. That being said, many ACP countries may still have to design policies that assume some degree of donor support. This support may be either financial or in terms of skills, partnerships, etc. The ideal would be to have a mix of both types of donor support with less actual money and more competence and a plan for reducing donor support on all levels over time.

Given the foregoing, the next step would be to decide on a timeframe for the S&T policy. It is critical to understand that the point is to create a vision that is a snapshot of the longterm vision, not a vision of the ultimate future that one would want to achieve. Currently, policymakers are caught in the trap of their 2020 and 2030 visioning efforts. Many are now beginning to realize that we are only six years away from 2020 and 16 years from 2030. Few are in any position to claim that the visions they outlined will be realized given the time frame. This is a state of affairs that is all too common for S&T capacity building in the developing world. It is a state of affairs that needs to be changed. One step in this direction is to decide on concrete targets for short to medium term and accept that capacity cannot be built on all fronts simultaneously, choices need to be made and sometimes this means that country X may not be doing what all other countries are doing at the point in time that they are doing it. For most countries, the priority needs to be that of building capacity in order to support capacity building. This implies a focus on generic competences and giving priority to investments with cross sectoral resonance. For instance, agriculture may be the focus of our development effort but investing in improving the transport system will not only help other sectors but will reduce time to market for farmers transporting goods, it may even increase the size of the market for rural farmers who are often restricted by poor transport to local markets. A good transport system may also be an infrastructural investment that allows better planning and reach in cases of emergencies such as food

shortages, etc. This example is deliberately local rather than focused on the export market because often planners delude themselves into thinking that channeling all resources into export markets will raise funds that will then trickle down and make things better in national settings. This assumption has proven to be erroneous for several reasons. The simple rule of thumb for prioritization would be synergies across several sectors. In the next section, the focus will be on findings from higher education research.

Higher education research: a summary of key findings

It has become commonplace to refer to higher education as going through a situation of crisis. This is true in many respects for the OECD countries but statistics show that in China, India and many other parts of the developing world, the demand for higher education is increasing rapidly. In Africa, the supply is certainly below that of demand and if access issues were to be corrected, it is doubtful whether the current infrastructure could manage to meet the needs that would be unleashed. Ironically, the preoccupation with the knowledge economy has created a preoccupation with higher education as an instrumentality rather than a value in itself. For many EU and OECD countries, this instrumental approach has meant a shift away from treating higher education as a right of every citizen to an investment that individuals make in their own future earnings (Nkrumah-Young and Powell, 2011). Adopting this approach is not likely to be helpful for countries seeking to build S&T capacity or in improving access because it tends to be accompanied by a move towards user fees for higher education and a curriculum focus which shifts emphasis to skills acquisition. While skills acquisition certainly has its advantages in terms of encouraging universities to focus on ensuring that graduates are employable, it does tend to deemphasize the broader aspects of higher education. The latter skills are critical for supporting fledgling democracies, promoting good citizenship and increasing scientific literacy.

Higher education as a commodity

Higher education is increasingly being inserted into the global capitalist economy. The most immediate evidence of this is the increasing importance of global rankings for institutions of higher education. Universities and academics are generally very competitive and rankings are now a strategic tool for a privileged few institutions but a concern for the entire sector. Several scholars have reported that rankings exert a homogenizing influence to the extent that policymakers feel pressured to push their universities in the directions that would give favourable results in the ranking tables (Hazelkorn, 2011; Kauppi and Erkkilä, 2011; Marginson & van der Wende, 2007). The vast majority of university vice Chancellors categorise ranking among those ‘issues that matter but it is not clear how’ (Erkkilä, 2014). By this, I mean that while all universities are somehow compelled by the rankings list to aspire to get in to the top 100, this is by and large an unrealistic and confusing ambition for the majority. This is frustrating for many developing countries since the perception is that few such countries have the resources to support universities that can have a reasonable chance of making it into the top 100. At the same time, policymakers are not above using the rankings as a stick to beat their universities into submission. Rankings are currently most useful for the countries that are net exporters of higher education. For these countries, rankings inform potential students and their parents of the relative quality of the universities that are bidding for their custom. Some universities have now

started arranging annual offsite marketing events to present themselves to potential students and their parents.

Developing countries can also use rankings to inform their capacity development efforts. The Shanghai ranking was originally developed as a source of information for China to position itself and its universities. The Chinese government now uses it to decide on where to send students. Apart from deciding on what universities are credible knowledge providers for potential overseas scholarship holders, rankings may be used to decide on collaboration partners for capacity development. Many established universities are now developing foreign subsidiaries as part of efforts to increase student numbers. These subsidiaries may be used as mechanisms for capacity development. This is not a substitute for developing local capacity but can be a good short to medium term measure for increasing the pace of capacity development efforts. Further, it may be used as a stepping stone for developing more high end collaborative efforts in research that may otherwise be out of reach. Higher education researchers are just beginning to perform research on the phenomenon of multinational universities and while this is still an emerging research specialization, the results available thus far converge on the fact that multinational universities are subject to some of the same issues that one observes in firms (Wilkins and Huisman, 2012; Editorial Nature Neuroscience, 2008). Universities engage in overseas endeavours for a variety of reasons as well and while increasing income is still a decisive driver, research has pointed to a number of other drivers which may be of interest. One of these is the need to enhance the quality and attractiveness of the educational offerings to home students by providing them with an opportunity to do part of their degree abroad. Thus far, business schools are those who report most enthusiasm for this idea. Internationalisation is one of the criteria used in accreditation programmes for business school education particularly the MBA. Another is the fact that students are keen to develop their competence in navigating other cultures in order to increase their employability.

Mission differentiation and capacity development

The combinations of increased pressure for access, students and policymakers' interests in employability skills as well as the increasing costs of research all speak for a need for mission differentiation among higher education institutions in the same country. In other words, not all universities have to perform the same tasks or have the same capacities. The discourse on mission differentiation is not a new one and began as early as the 1950s in some countries e.g. USA (Bastedo and Gumport, 2003). Despite the age of the debate and the fact that the practice of mission differentiation in several countries offers plenty of opportunity for empirical studies, policymakers and academics alike prefer to treat this as a completely new issue when it is introduced in their context. Perhaps this tendency is encouraged by the fact that higher education contexts are still, despite increasing internationalization, intensely national. Context differences aside, the crux of resistance to mission differentiation is the idea of research based teaching. Accepting this argument does not imply that all academics employed at universities are to be given time for research nor that research infrastructure needs to be available at all universities. Policymakers have a range of options available to them in this regard but the combination of lack of knowledge combined with widespread resistance from the academic community has meant that this issue often gets sidelined. For instance, all teaching staff need to

have a certain percentage of their time to devote to updating their knowledge and keeping abreast with the scientific results in their specific areas of teaching. This type of activity is a step in all research but it is not the same as research. Another approach to mission differentiation is at the organizational level where some universities may be treated as primarily teaching organisations or may have research only in a few selected areas rather than in all subjects present in the teaching curriculum. In countries where the numbers of PhD graduates on staff are already low and resources are generally scarce, mission differentiation may be imperative.

Internationalisation and capacity development

Internationalisation is undoubtedly an important aspect of higher education at the current point in time. Previously, the discourse on internationalization has been primarily focused on student mobility and developing countries have been concerned about brain drain issues associated with mobility. The game has however changed significantly on this issue. Brain drain cannot be used as an excuse for lower than acceptable levels of investment in higher education any longer. Ironically, it is poorer countries who have the most to lose from not engaging in internationalization. A key reason for this is that the costs of engaging in higher education are increasing. Another is that engagement in internationalization is now a performance criterion that signals quality in higher education. This is particularly true for the vocational education offerings such as business and engineering that developing countries are likely to prioritise. The omnipresence of rankings has also intensified this trend towards internationalization. Emerging economies such as China and India have also embraced developed country universities' interest in internationalization to complement their own capacity development efforts and to build educational programmes of international repute. Increasingly international accreditation programmes are being used to provide legitimacy and quality for educational offerings if the institution's reputation cannot provide this guarantee. It however costs to participate in these programmes and the benefits in terms of attracting students are unclear for those institutions that are not already at the top of their game. Emerging economies are leveraging international partnerships as strategic tools to bypass some of the barriers involved in this regard. ACP countries may be able to emulate these practices.

Policy implications

The financial crisis has reinforced the need for countries to invest in the skills needed to sustain their economies and keep people in jobs. One of the tools that policymakers have at their disposal for achieving this is S&T. S&T policymaking is a complex issue and one which intersects with several other areas of policy. One such area is education policy. The foregoing has focused mainly on higher education research but a key policy message that may be distilled from this is that higher education is a corner stone of science and innovation capacity building efforts but primary, secondary and other types of education are important determinants of the quality of higher education. The demands and expectations of higher education have changed qualitatively in all countries since the 1960s when many ACP countries started building capacity in this area. An important example of this qualitative shift is that access is increasingly being defined as a layered issue in so far as the need to make arrangements for access sensitive to gender and minority concerns is recognized as a policy issue. Likewise, the problem of institution building has become more differentiated, as countries now have a range of options

apart from simply promoting the development of strong national or local higher education institutions. The key challenge that faces policymakers in this respect, is to design and implement policies that can promote and sustain a national higher education structure, that includes a mix of institutions with global reach and those with more local and national ambitions. This challenge is all the more complex given that at all levels, excellence must be maintained, as the lessons learnt from the past suggest that institutional diversity is not a substitute for promoting broad based excellence. Reasoning from this, policymakers may wish to treat higher education as part of a broader system in which the reach and strength of primary and secondary education institutions are important prerequisites for building a strong higher education sector. Additionally, countries may wish to bear in mind that continuing education after the higher education experience is also a requirement for maintaining S&T competence. Continuing education is often a mixed set of educational offerings which include professional and skills upgrading types of competences. These types of activities are often paid for by individuals or their employers. Their function in the S&T system should not however be underestimated.

The advantage of treating education as a system in which attention and resource allocation to each part is made with reference to the targets and ambitions in the other is that it avoids waste and inappropriate use of resources. A common example that is experienced the world over is that problems left unaddressed in the secondary school education system are transferred to the university level. The consequence of this is somewhat similar to paying professors in mathematics to teach arithmetic in primary schools. Thus, upgrading the quality of secondary school education is a key priority. Policymakers the world over have converged on the idea that higher education should be socially relevant. For developing countries, this message must be expanded to include increasing access to education. Critical to this effort is finding formulae for financing broad based access without sacrificing quality. There is some research available to guide this effort and there are available examples among ACP countries that may be accessed and interrogated. Finally, the ACP platform may be leveraged for effectively for partnering with European higher education organisations through programmes such as ERASMUS MUNDUS and others. There are more options available than before but as often in the presence of increased choice, confusion prevails. The diaspora may be a solution for providing expertise and guidance for navigating these choices. Whatever the choices made, the answer to building strong national institutions is broad international engagement.

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