

**Towards a BRICS agenda on University-Industry Linkages: reflections from recent research in South Africa**

Paper presented at the 2<sup>nd</sup> International Workshop of the BRICS project, Rio de Janeiro, April 25-27 2007

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**Introduction**

This paper is intended as a kind of meta-reflection of research on university-industry linkages in the South African context over the past five years.

In particular, it focuses on a set of research projects carried out by the Education, Science and Skills Development research programme at the Human Sciences Research Council (HSRC).

The paper will highlight the focus, the conceptual approaches and the empirical sites of a chain of research projects, showing how a small but significant body of research is emerging, which provides a basis for comparative study within a BRICS network. Based on this reflection, the paper suggests a possible research agenda on university-industry linkages across the BRICS countries – but this will require iteration with the current state of research in the other four countries.

**Working partnerships in higher education, industry and innovation**

The HSRC research on university-industry linkages in South Africa was initiated in 2002, through a project funded by the Carnegie Corporation, *Investigating the network society: industry-higher education partnerships in South Africa*. The initial proposal was developed by Andre Kraak and proposed to examine the extent to which the global phenomenon of 'networking' and 'partnership' had taken root in South Africa, and the impact of partnership on knowledge production and on enterprise productivity and innovation. The entry point was from the field of Higher Education Studies, and the disciplinary approach adopted was historical and sociological.

As a novice to the field, I was asked to lead the project. It soon became clear that there was very little precedent to guide the process of developing the research approach and design.

*Policy and data context*

At that time, we knew that the new national policy framework since the advent of a democratic government in 1994 favoured a new role for universities as partners in building a national system of innovation, informed by notions of the knowledge economy, Mode1 and 2 knowledge and so on. In relation to their core function of knowledge generation and dissemination, there was a new pressure for universities to engage in research that was more 'relevant', applied and strategic, in partnership with industry or other science council partners. A growing emphasis for science and technology was to

enhance 'research utilisation' and improve mechanisms of 'technology transfer' to industry, the public sector or impoverished communities (DACST 1996, 2002).

South Africa did not yet have a reliable national R&D survey, nor an Innovation Survey to measure progress towards these goals. The R&D survey has become increasingly robust under the leadership of the Centre for Science and Technology Indicators (CESTI), based at the HSRC, funded by the national Department of Science and Technology (see DST 2004, 2005, 2006). The 'first official' South African Innovation Survey 2005 has been released only very recently, in April 2007, and is planned to be comparable with the fourth round of the European Community Innovation Survey (DST 2007).

However, we knew that the research funding environment was changing, increasing the financial imperative for universities to seek partnerships with industry. There was evidence of a growing trend in universities to fund research from contracts and from direct government subsidy schemes that provided incentives for university-industry linkages and collaboration, such as the Technology and Human Resources for Industry Programme (THRIP). Table 1 illustrates the shift in the sources of research income evident at the time, away from reliance on indirect government research subsidy to the institution, and away from direct research funding agency grants (such as the National Research Foundation), towards a very high percentage of contracts and a rapidly growing proportion of THRIP funding (see Steyn De Villiers 2006 and for more recent trends).

**Table 1. Percentage of source of research income in the South African higher education sector 1996-2000**

	1996	1997	1998	1999	2000
Higher Education Subsidy	18	16	16	15	14
Agency grants	23	21	21	19	18
Technology and Human Resources for Industry Programme	5	7	9	10	10
Contracts	54	56	55	56	58
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

*Source: CENIS, University of Stellenbosch 2001*

This data provided evidence that partnerships or linkages between universities and industry were increasing in scale across the higher education system – but it did not tell us much about the scale, the form and nature of such partnerships, in which universities they were found or in relation to which disciplines and which sectors, nor could it tell us about their impact on knowledge production, enterprise efficiency or innovation.

#### *The research precedent*

In 2002, there were only a very small number of South African research studies that examined university-industry linkages. During the course of the research, a few more studies appeared, but these tended to be influenced by the United States literature to focus on university's role in technology transfer (Garduno 2003, Pouris 2006). At the time the project was framed, there was very little contextualised local precedent other

than studies that focused on UILs as one component of a larger study. For instance, as part of a study of the changing forms of university research centres led by Dave Cooper and funded by TIPS/IDRC, Wickham (2002) conducted interviews to identify factors that inhibited or facilitated collaboration between 13 'best practice' higher education research groups and their external partners in industry, public sector or social development organisations. Industry leaders' perceptions on the common features, processes and problems, as well as outputs and benefits of the partnership were elicited, to focus on identifying 'what do external partners say about these research partnerships?' (Wickham 2002: 3). Similarly, Mouton et al (2003) provided a glimpse of industry research and development practices, by conducting interviews with 112 company managers, as part of a larger study of research utilisation by the Centre for Research into Science and Technology (CREST) at Stellenbosch University. The sub-study attempted to illuminate the demand environment, modes of knowledge production and benefits, and to identify factors that promote or limit R&D and technology transfer.

These studies focused primarily on the perceptions of industry leaders of interactions with universities, and were relatively small-scale. They could not provide a starting point for the proposed research, which attempted to understand the emergence, forms and impact of UILs across the South African higher education system.

The international literature did not provide a great deal of direct guidance for the task of identifying the distinct South African forms of 'partnership' that were emerging. A large number of studies conducted in the United States, United Kingdom and other advanced economies tend to dominate the literature. Appropriating conceptual frameworks had to be undertaken with great caution, given these countries' long history of UILs and their very different highly developed economic and political contexts. Moreover, much of this research focused on measuring the impact of UILs, or on small-scale studies of specific features related to UILs (for example, incubators, science parks, spin-off companies, IPR, patents and licensing)<sup>1</sup>.

What we needed was a way to understand and map out trends across the higher education system in an emerging economy that was undergoing significant political transition, driven by dual goals of enhancing global competitiveness and promoting equitable development and redress. While there was a range of ways used to identify forms of university-industry linkages, most of these were empirically descriptive, arising out of specific advanced economy contexts, and not automatically comparable to the South African case (Smith and Katz 2000, Charles and Conway 2001, Howells et al 1998).

The approach adopted for the study was thus to develop such a descriptive typology of South African forms of partnership, as a basis to address the concerns of institutions, larger policy issues as well as critical questions about national systems of innovation – that is, a way of opening up the research field by defining 'partnerships' and 'networks' contextually.

The empirical focus of the study was very specific. We explored partnership in three high technology bands identified in national foresight studies (DACST 1999) as key cutting

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<sup>1</sup> A recent extensive literature review conducted by Klitkou et al (2007) on 'science industry links' came to broadly similar conclusions, arguing that the publications are largely descriptive and empirical, with little theoretical basis.

edge platforms to be promoted in South Africa, in line with global trends: ICT, new materials development and biotechnology. Each of these platforms also has a potentially important contribution to make to address poverty and specific health or social problems in South Africa.

*An audit of partnerships emerging from government incentives*

The first component of the study was an audit of 'known' UILs – of the research partnerships incentivised by government funding through two main programmes, THRIP and the Innovation Fund. We analysed the programme databases and surveyed recipients of the grants, to map out a profile of the university and the industry partners, the focus and the products or outcome of their interaction, in the three technology bands (HSRC 2003, Letseka 2005). It was evident that there was a group of universities and a set of firms that were engaging in UILs, with distinct mutual benefits as measured by indicators of publications, post-graduate students, and artefacts resulting from their interaction.

*Mapping partnership across the higher education system*

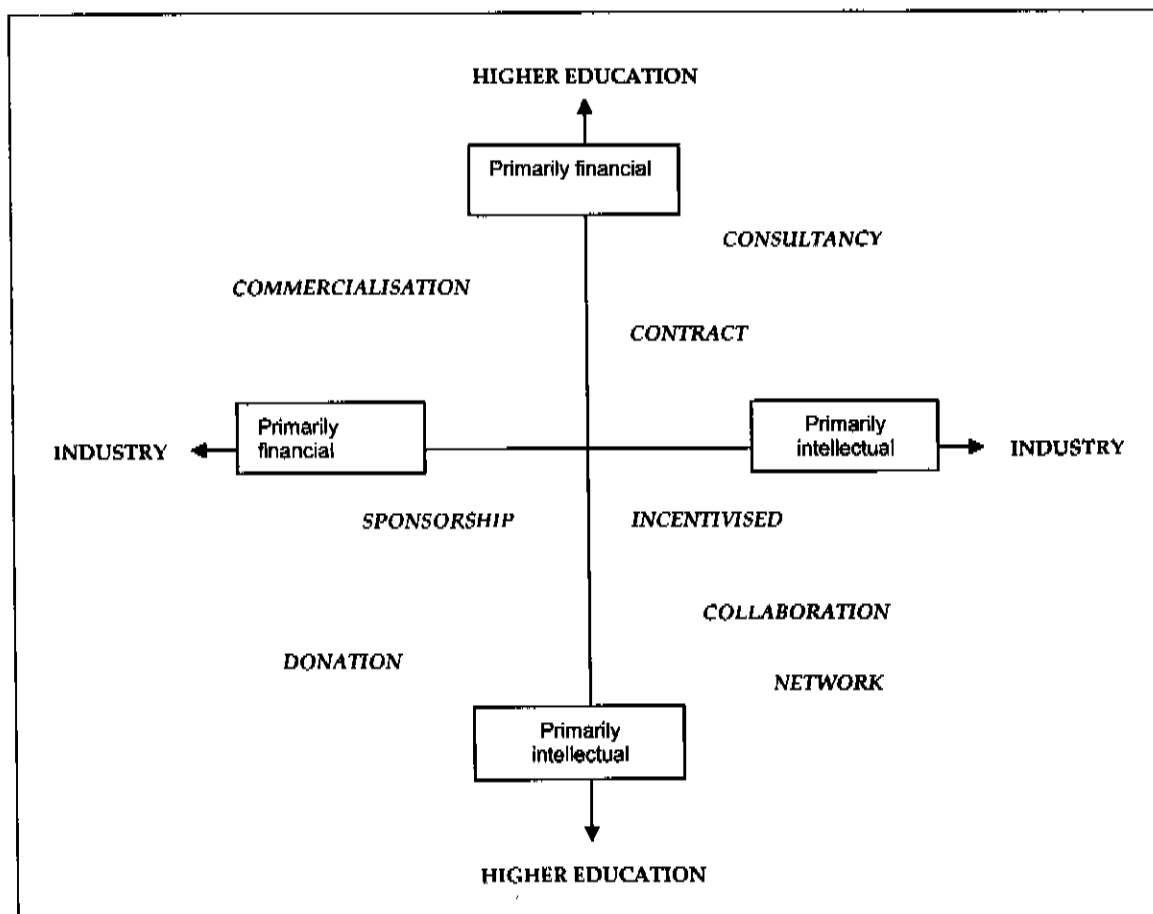
The second, and main, component of the study was an ambitious attempt to map the forms of partnership found in the three technology bands across the higher education sector. In retrospect, this was probably a case of 'fools rush in where angels fear to tread' in terms of the broad scale, scope and depth of the investigation. At the time, there were 35 institutions, 21 universities and 14 technikons with vastly differing historical legacies and research capabilities, spread over seven of South Africa's nine provinces.

The methodology was designed to identify all forms of 'partnership' – defined as any form of linkage of mutual benefit or interest between higher education and industry - in the three technology bands in all 35 institutions. This meant that the study covered interactions in relation to teaching (particularly at the post-graduate level) and research. A profile of the research policies, structures and performance in general and in the three fields was prepared for each institution. A database of active researchers in each of the three fields was compiled (drawing on existing databases of those who had published, or received National Research Foundation grants or THRIP and IF grants). Institutions were asked to verify the list, and to identify those who were involved in partnerships with industry. During site visits to each institution, we interviewed research managers, deans of key faculties and academic project leaders involved in UILs, to map out partnership activity along key dimensions identified from the literature. This was captured in a qualitative report, using a standardised template.

One of the main analytical results of this project was the development of a matrix of South African forms of UIL, distinguished by the extent to which the interaction was primarily shaped by the financial and/or the intellectual imperatives of both industry and higher education partners (see Figure 1 and Kruss 2005 for elaboration).

In general, analysis illustrated the partial and uneven nature of transition in South Africa, and the co-existence of old and new organisational forms, as new policy directions unfold. It was evident that across the higher education system, the majority of UILs took the old forms of consultancies and contracts, with a small number of old forms of sponsorship and donations (which typically related to post-graduate student funding or research infrastructure). There was evidence of a small number of new forms of commercialisation, incentivised partnerships and networks. It was argued that given their

typically short-term, narrow, industry-driven research focus and confidentiality restrictions on publications (even student theses) to protect firms' proprietary knowledge, the unchecked proliferation of contracts and consultancies could have a detrimental effect on the country's knowledge and innovation system over the longer term. There was thus a normative dimension to the analysis, in that the network form of UIL was found to be desirable in terms of its ability to harness potential for innovation in the interests of economic growth but also, of developmental and equity goals in South Africa, and in terms of the long term academic interests of the higher education system (see also Kruss 2006c and 2006d).

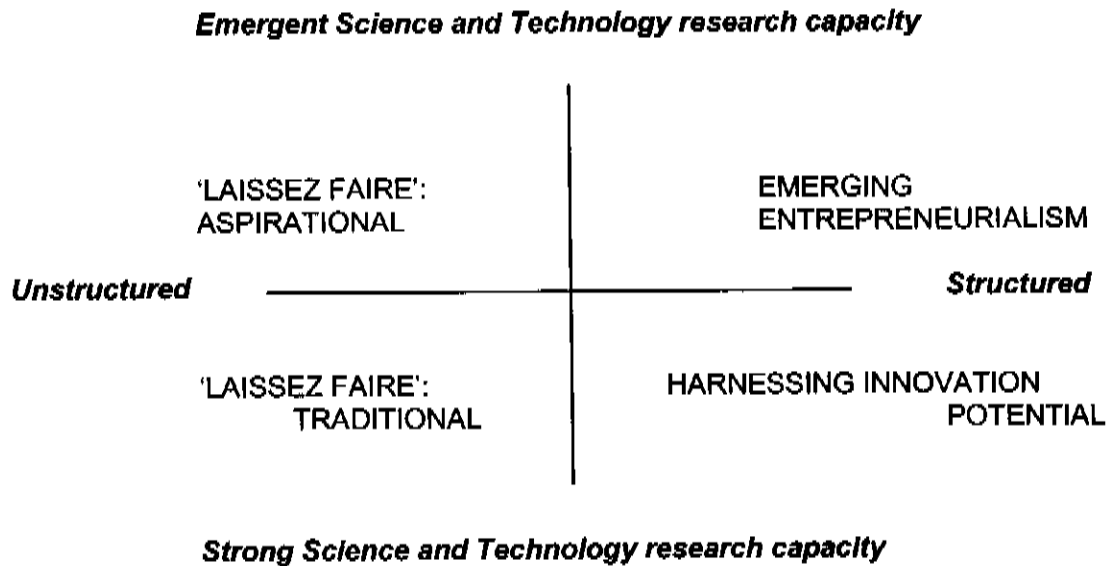


**Figure 1. An analytical matrix of forms of partnership in high technology fields in South Africa**

However, both in terms of the absolute number and of the patterns of specific forms of UIL found, there were significant differences between universities and technikons, between historically advantaged and disadvantaged institutions, between institutions located in urban or rural areas and in different economic regions of the country. (And, only 18 of the 35 higher education institutions could be described as having high technology research capacity as a potential base for UILs in the first place).

A second analytic contribution was thus a matrix of four typical patterns of institutional response to partnership, which could explain the main patterns of UILs found across the South African higher education system. A key distinction was the extent to which

universities had a highly structured and regulated organisational response in an attempt to promote UILs, or whether they had a largely unstructured 'laissez faire' approach. A second key distinction was the extent to which universities had a strong or emergent (or virtually non-existent) research capacity in science and technology in general, and in relation to the three fields of focus specifically (Figure 2).



**Figure 2. Higher education institutional response to the partnership imperative in South Africa**

This analysis yielded analytical description of the institutional policies, organisational and managerial forms that facilitate or constrain UILs, in diverse university contexts (see Kruss 2005 for elaboration).

The experience of three universities that were categorised as 'harnessing innovation potential' was informative, in terms of what is possible – and what is required for universities to pursue UILs on a significant scale. These universities are amongst the oldest and most historically advantaged in South Africa, serving a privileged community for many decades. They have acquired extensive fiscal resources and have long-standing links with business and industry. Two have research roots and expertise strongly shaped by military R&D in the apartheid period. Significantly, they each have a sound science and technology research base (with some scientists of international stature), and evidence of capacity in each of the three high technology fields.

They are not the only universities that display these features – but they stand out because of the highly structured policies and internal and external interface mechanisms, strategically planned (and implemented with varying degrees of success) by institutional management, to promote UILs. At similar research universities with a *laissez faire* managerial approach, we found a higher incidence of contracts and consultancies, a stronger negative perception of the detrimental academic effects of UILs, and less propensity (or a strong resistance) to pursue them.

These three universities aim to harness the potential for innovation inherent in partnership with industry, by *aspiring* to relate to industry primarily in academically beneficial terms, and not explicitly driven solely by financial imperatives. That is not to say that they are entirely successful and that these policies and strategies have permeated uniformly through all levels of the university to influence all individual academics. However, they have the strategic aspiration, and evident academic and institutional capacity, to develop more of the mutually beneficial network forms of UIL.

#### *In-depth case studies of networks*

There were also notable differences in the scale and forms of UIL found in relation to biotechnology, ICT and NMD, which have differing national policy and sectoral contexts.

Thus, the third component of the study was eleven in-depth qualitative case studies to explore the cutting edge, knowledge-intensive, mutually beneficial networks that contribute to innovation, located in an analysis of the context of each of the technology platforms and their related sectors (see Kruss 2006a). The case studies addressed four main questions:

- What are the knowledge, technology and economic needs that have driven a specific firm or research unit to enter into a strategic network between industry, higher education and other intermediary partners?
- What is the nature of the structure and dynamics of knowledge interaction within these research networks?
- In what ways does the knowledge interchange serve the needs and interests of the partners and in what ways are they constrained or limited?
- What are the variations and commonalities between the networks operating in each of the three high technology bands?

Interviews were conducted with key R&D actors in the firm/s, the university research unit/s, and the intermediary partners, such as science councils, industry associations and funding agencies. The focus was on the determinants, structure and interaction of the network form of UIL itself.

An example of such a cutting edge network is a biotechnology network that focuses on the pre-competitive phase of the forestry, paper and pulp industries in relation to preventing the spread of tree pathogens, based in a world-renowned university research institute, and including major forestry and paper producing firms, timber cooperatives of large and small growers, alongside industry intermediary bodies like Forestry South Africa, and the government department of Water Affairs and Forestry. Growing healthy trees that yield quality fibre or timber is the core business of all the firms involved, and there is willingness to collaborate in a pre-competitive forum focused on technological innovation to ensure the competitiveness of the entire industry. In contrast, one new materials development case in a mature industry such as platinum mining in effect operated as a contract form of partnership, governed by strict confidentiality agreements and secrecy. The firm has chosen a strategy of improving recovery operations, to address the inefficiency of a specific upstream operation, in order to enhance competitiveness. Hence, the UIL is essentially limited to supervision of the Masters' theses of two employees of the firm, to gain the required expertise in electro-chemical recovery of minerals that their large R&D department does not yet have.

The case studies thus illustrated that the dynamics of competition in a particular product market or industrial sector are closely linked to the dynamics of network co-operation found, intersecting with the levels of expertise in higher education, in terms of the existence of a critical mass of academics in a research specialism, but equally, with the motivation for and tacit knowledge of, managing UILs. Closely linked is the significance of centralised higher education institutional support, whether financial, legal or administrative, and involvement of an intermediary partner drawn from the public sector (whether government funding such as THRIP, IF or incubator schemes, or a science council or a departmental agency). These provide a further layer of complexity which may intersect to determine whether a network is created, and the specific structure and dynamics of its functioning.

The study thus highlighted the complex and contingent ways in which the structure and the nature of networks are shaped by the contexts in which firms and research units operate, within each of the three cutting edge fields and their related sectors (See Kruss 2006 for further elaboration). Analysis highlighted that further large-scale research from the perspective of firms - of the policies, structures, competitive dynamics and absorptive capacities that promote or hinder UILs in specific sectors - was required to complement the in-depth analysis of UILs from the perspective of higher education institutions.

#### **The next step**

Taken as a whole, the study primarily allowed us to understand the emergent state of UILs in South Africa in cutting edge high technology fields, from the perspective of universities.

We had started the study knowing simply *that* UILs were emerging in South Africa, and we ended it with insight into the *forms* they take, and into the structures, practices and dynamics *within universities* that promoted or hindered their formation, operation and successful performance.

However, we did not have a sense of the scale and forms of UILs in South Africa from the perspective of firms. We did have a profile of those firms that had actively pursued UILs in the three cutting edge fields through THRIP or the Innovation Fund, but we did not know what proportion they represent of the total population of firms, for example. And, it was clear from the mapping study that despite their best efforts and aspirations, some universities were not able to develop UILs given their disadvantageous regional economic location, or given what they perceived as 'industry reluctance' to pursue UILs. The case studies gave some insight into the competitive dynamics that led firms in a few sectors to pursue UILs, but again, it became clear that we did not understand why other firms in the same sectors did not pursue UILs, or what the case might be in other sectors.

The plan for a 'next step' was thus first, to deepen the research in terms of examining the scale and form of UILs in the context of a regional system of innovation in a wider range of sectors. Second, the idea was to pursue more international comparative work, to broaden understanding of UILs and economic development, to inform the South African context.



### *University-industry linkages for development*

At this point, an organisational digression is pertinent. Jo Lorentzen joined our research programme, bringing an economist's perspective and an interest in studying learning in firms and the determinants of innovation. It became evident that we could undertake fruitful collaboration and work in an inter-disciplinary way, particularly on UILs.

During 2006 we began such research on a small scale, through participation in a World Bank project on the role of universities in economic development in Africa. The focus shifted from universities and forms of UIL, to focus on UILs in relation to a regional system of innovation. The empirical site for the new project was the Western Cape province, the second most developed province in South Africa economically, educationally and in terms of research, with a strong university base. By this point, we could draw on economic trend data generated during the province's micro-economic development strategy process, on national R&D data, on a national study of indicators of innovation activity (Lorentzen 2007), on the national mapping study of UILs, and on a provincial study of the determinants of innovation of firms in four sectors (Lorentzen 2006).

The research suggested that while South Africa has a coherent policy framework, its implementation through current mechanisms and instruments is relatively 'blunt' and may require more specific targeting to be effective, based on a more complex and nuanced understanding of the contingent capacities and demands of both industry and university partners. To enhance the general policy commitment to promote innovation, partnership and economic growth is to be able to target specific strategies and mechanisms suited to specific regional, sectoral, firm or higher education contexts in South Africa as an emerging economy, more effectively than at present.

This small-scale project informed and laid the basis for our current work.

### **UILs and development in sub-Saharan Africa**

Currently, we are leading a study in three sub-Saharan Africa economies at different levels of development - South Africa, Nigeria and Uganda. The research is funded by the IDRC through the RoKS 2006 competition, 'The developmental university – a changing role for universities in the South', and this has shaped the focus.

The research begins from the assumption that UILs play a potential role in economic development, but analysis of UILs in developing countries are rare, and there are no systematic comparative analyses. Our research up to that point stressed the significance of taking specific national, regional and sectoral contexts and conditions into account. Engaging in UILs poses distinct challenges for universities in Africa, in terms of changes to their traditional missions, the balance between research and teaching, and their response and accountability to social and economic development needs.

The research questions to be pursued are thus:

1. How and why do relationships between universities and firms differ across countries and regions at different stages of economic development, and across sectors? This question focuses on the incentives for, and constraints on, and the extent, intensity and performance of UILs within each of the three historical and socio-economic contexts.

2. How do these differences influence the contribution universities make to local and national development goals?

The entry point is innovation studies, and the disciplinary approach is economic and sociological, with a common national system of innovation conceptual framework.

The strength of the RoKS programme is that it has encouraged strong synergy and comparability between three cognate projects conducted across developing regions, in Africa, Asia and Latin America. Note that here regions are used in the sense of larger, sub-continental entities encompassing a number of countries, whereas our earlier usage was in the sense of sub-national entities. This was facilitated by prior participation in the 'catch-up' network led by Richard Nelson. The fundamental premise driving the 'catch-up' network is that economic development in a new global context 'requires gaining access to and mastery of the technologies and forms of economic and social organisation used by the leading countries of an era' (Nelson et al n.d :3). A country's system of research, education and training based in universities and public laboratories play a key role in the institutional structure needed for 'catch-up' – and hence, the significance of UILs.

The studies in each region have been set up in such a way that once each country and regional study has been completed in 2009, we have a potential basis for comparability between three regions and twelve countries – in Asia, Korea, India, China, Malaysia and Thailand, in Latin America, Brazil, Argentina, Mexico, Costa Rica, and in Africa, South Africa, Nigeria and Uganda.

The design of the project is such that it will focus on UILs from primarily, but not solely, a firm perspective. Each project begins with an analysis of national policy frameworks, mechanisms and development contexts, and an overview of current R&D and S&T activity. We propose to survey R&D and non R&D performing firms in each country, to determine the scale of UILs across the board, to identify in which sectors they are most commonly occurring, and what the most typical modes or channels of interaction with universities are. Understanding the modes of interaction is critical to define the forms of UIL found in each country. In some of the country studies, a similar survey of universities will be conducted. (In South Africa, we will draw on the mapping study described above). We then propose to conduct case studies of UILs, to examine the nature, form and outcomes of the interaction, as well as what facilitates and what acts as barriers to the interaction. The empirical focus for the case studies will be a single technology platform, the bio-sectors (bio-food and bio-medical), which have a significant share of scientific articles in each country, and which are critical to solving some of the agricultural and health problems specific to these regions.

This study will begin only in April/May 2007 – so there is a great deal that may change as we proceed to implementation.

#### **Other research on UILs in South Africa**

To the best of our knowledge, there is still not a great deal of empirical research on UILs in South Africa. Some new publications are based on a small number of case studies and vignettes of UILs (Abrahams 2005, SAUVCA 2004).

At the HSRC, another research programme, Knowledge Management, is planning to mine and analyse data from the 2004/5 and 2005/6 R&D surveys, to determine drivers of

collaboration amongst firms – whether with universities, other firms, science councils, ngos etc. This will lay the basis for developing a larger scale proposal that will explore the modalities of linkages between firms and universities in more depth.

The national Department of Science and Technology has recently called for tenders to study academia-industry partnerships in relation to four science platforms, targeted areas of basic science where South Africa displays competitive geographic advantage that are being promoted nationally. The four platforms are African origins, Antarctica, Astronomy and Biosciences. DST's concern is to inform more effective policy implementation - to identify existing partnerships, benchmark them against international counterparts, identify challenges and areas that need improvement, and finally, recommend what can be done to mitigate these.

### **Towards a research agenda**

What then are the possibilities for BRICS collaboration around research on university-industry linkages?

There are three suggestions that emerge from this reflection on HSRC research on UILs over the past five years.

First, in much research using a national system of innovation approach, the university is recognised as a key institution, but the focus is on analysing firms and firm activity. Our research illustrates the value of opening up the 'black box' of the university sector to systematic analysis, to show the 'drivers' for academics and universities to pursue UILs, and the institutional conditions within universities that promote, constrain or sustain them. A fresh research avenue could be a comparative study of UILs from the perspective of the university sector across the BRICS countries, and based on a similar methodology to that used in South Africa.

Second, we have highlighted the need in South Africa for more systematic research on UILs from a firm perspective, and in relation to a broader range of sectors and disciplines. This we will begin to address through the vehicle of our RoKS project. Researchers from Brazil, India and China are already involved in country studies under the ambit of the Latin American and Asian regional projects. There is scope for a complementary Russian country study. And, there is scope to extend the case studies of UILs in Brazil, India, China and South Africa to sectors other than the bio-sciences. This could be one or more of the BRICS sectors – ICT, health and pharmaceuticals, energy and oil, or cultural industries.

The challenge however, is to develop conceptual tools to integrate detailed empirical analysis of UILs from both a firm and a university perspective.

This leads to the third suggestion, to develop a comparative BRICS study that links analysis of UILs to the dynamics and organisational forms of the national system of innovation in each country. (In essence, this suggestion combines the first two). This could entail drawing on the BRICS studies of national systems of innovation and of sectoral innovation systems currently being conducted, to identify key determining features. Here, a stronger focus would be on the role of the state in facilitating the development of the national system of innovation and in leveraging interaction between universities and firms. Then, researching the scale and form of UILs found in firms across the board in each of the BRICS countries. How do these forms

of UIL contribute to firm competitiveness, economic growth and national development goals in (one of) the four sectors, in each country? What are the capacities of diverse forms of university to promote distinct forms of UILs, in terms of both research and organisational capabilities, in each country? What is the capacity of the state to leverage distinct forms of UILs in these strategic sectors, in each country?

Such research would enable comparison of the ways in which the growth of UILs is facilitated or constrained by the state of development of the national system of innovation in each of the BRICS countries. It could inform theorisation of the national system of innovation, and of UILs in emerging economy contexts.

Unfortunately, however, each of these suggestions is made in total ignorance of the state of research on UILs, in Brazil, Russia, India and China. Perhaps that comparison alone is a worthwhile first step.

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