Innovation and R&D in the Services sector of an emerging economy: some micro evidence from South Africa

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Extended Abstract

South Africa is an emerging economy with unique characteristics – a freely traded currency, large securities exchange, and a key supplier of strategic minerals and associated expertise. The first economy of this young democracy is relatively open with exports equivalent to 28% of GDP (Statistics SA, 2005). Contrary to popular belief it is the services sector with its 69% share rather than mining that is the largest contributor to GDP. Even the contribution of manufacturing exceeds that of mining.

Over the last two decades the services sector has shown considerable dynamism both in its ability to grow during the years of political and economic sanctions, and to expand and prosper domestically and internationally once those sanctions were lifted. While its resource companies have a long history of global activity, the services sector is a relative newcomer and is expanding aggressively. Five South African retailers are now in the world top 250 (DTT, 2007 They are subjects and objects of mergers and acquisitions *vide* Old Mutual of South Africa's purchase of Skandia Insurance and the Barclays Bank takeover of South African ABSA. Old Mutual was founded in 1839, a full thirty years before the onset of the local version of the mining-fueled industrial revolution.

It is thus important to seek an understanding as to how these transnationals innovate. Relevant data is now becoming available through the revived time series of R&D Surveys (Frascati compliant) as well as the 2002-2004 Innovation Survey (CIS4 compliant) that allows one to examine in some detail the innovation and R&D behaviour of the leading firms in the services sector. In many respects the overall R&D behaviour of South Africa resembles that of the

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lower income and low R&D intensity member states of the European Union (Kahn, Molotja and Vlotman, 2006) though its business sector is closer to that of the 'EU-15.'

That the services sector makes a significant contribution to gross expenditure on R&D in industrialized countries is largely settled (Gallaher, Link and Petrusa, 2005). Their study for the National Science Foundation and National Institute for Standards and Testing shows that in 2002 services R&D in the United States accounted for 39.1% of business expenditure on R&D (BERD) and has steadily climbed over time as a result of changes in definition and improved survey technique. Services sector R&D accounted for 27% of South African BERD, below Australia at 41% and Canada at 38% but above Italy and Hungary's 21% and Poland at 17% (OECD, 2006a: Table 44a). R&D in services is concentrated in financial services with another large component for contract research organisations. South Africa's 27% of BERD is above the OECD median of 21% and places it among the wealthier member states.

In South Africa business performers of R&D are identified through a purposive survey that in 2004/05 sampled 1548 firms yielding a response rate of 84% including 511 actual performers of R&D. In order to gain a fuller picture of services sector R&D prior to going to the field with the 2005/06 R&D Survey, a set of case studies was conducted across the twenty leading public firms in banking, insurance, retail and logistics with the intention of finding previously undetected R&D as well as understanding something of the technological learning approaches of these firms.

These case studies detected significant R&D in the services sector, especially in the area of software development, and the existence of complex R&D value chains extending beyond firm boundaries. It should be noted that these twenty firms with one exception have largely domestic origins. Furthermore most of the firms are more than two decades old so that they have the experience of development under sanctions that occurred at in the 1980s at the very point that the ICT revolution took off. The 'constructed crisis' of apartheid (Kahn, 2006) thus drove them to *build or die*. In many fields build or buy was no longer an option and associated R&D expertise survives to the present. It is difficult therefore to agree with De Wet (2000) that South Africa is a 'technology colony.' It might be more apt to call it a technology 'island.'

It is shown that the main characteristics R&D activities of the service sector firms are similar to those in industrial countries. Paradoxically this may arise through the local ownership and development of these firms during the years of political isolation.

The extended R&D value chains include researchers employed in firms that remain undetected through the main R&D Survey. This highlights the problem of determining researcher headcounts in emerging economies where business registers are rare, or even if they exist, are unreliable.

It was also found that very few doctoral level researchers were present in the firms that were sampled. This accords with the Frascati Manual observation that '(services) R&D is not always organised as formally as in manufacturing companies (i.e. with a dedicated R&D department, researchers or research engineers identified as such in the establishment's personnel list, etc.). The concept of R&D in services is still less specific and sometimes goes unrecognised by the enterprises involved.' (OECD, 2003: 48). This is a problem in both advanced and emerging economies.

An unexpected finding from the case studies was that firms were not experiencing a shortage of skills. They had sufficient access to talented entrants that were able to meet their requirements for system and software development. The lack of PhDs was not a limiting factor for business effectiveness. In fact this flow of talent to the services sector away from science, engineering and (hard) technology, compounds South Africa's technological skills crisis, especially its shortage of engineers.

The third source of data arises from the highlights of the nearly complete 2002/04 Innovation Survey the first official innovation survey with a stratified random sample drawn from the Statistics South Africa Business Register. The survey elicited a 37% response and was augmented by a non-response survey. Its coverage by SIC is similar to that of the R&D Survey with the exception of agriculture and construction that are excluded for the Innovation Survey. The Innovation Survey highlights (DST, 2007) report that product and process innovation occurs in 52% of firms, a level above the European Union average. (This is not the same as claiming that the composite Summary Innovation Index (EU, 2006) for South Africa is above the EU average. It surely is not.) This similarity with industrialized Europe is also found for attributes such as sources and effects of innovation, and the bottom line value of services innovation. One surprise is that the services sector demonstrates a lower value for customers and clients as sources of innovation push compared with industry and instead relies more on professional sources.

What is especially gratifying is that the estimates and for BERD in the Innovation Survey and that obtained by the R&D Survey are within 5% of one another.

The strong reliance of services firms on the extended R&D value chain for technological learning is also confirmed.

In conclusion the South African business sector R&D, which at macro level demonstrates strong similarities with EU-15 parameters, includes a services sector that is both international peer and competitor, yet does so without a highly academically qualified research staff.

We also consider the implications of new innovation policies in respect of tax allowances for R&D expenditure, and new intellectual property legislation. These may in fact have unintended consequences for R&D in the services sector since important areas of R&D may be excluded. This would be counter-productive and could encourage firms to shift their R&D activities offshore. Policy makers need to take care that the learning behaviours of the different sectors are properly taken into account in policy formulation.

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1. Introduction

In this paper we seek to understand the R&D and innovation behaviour of firms in the South African services sector. To do this we turn to three sources of primary data as well as the literature on R&D in the services sector.

South Africa's democratic elections of 1994 followed decades of conflict, including political, economic and cultural sanctions. The state reaction of 'total strategy' achieved self-sufficiency in food, chemicals, and materiel, weapons of mass destruction and niche expertise in command and control systems. Of relevance to this paper were the mid 1980S disinvestments by computer and software companies that encouraged local software and systems development. The standard business decision 'build or buy' became build or die.

The country now exhibits a relatively open economy with exports equivalent to 28% of GDP (Statistics SA, 2005). Its trans-nationals operate freely on the African continent and globally. They are subjects and objects of mergers and acquisitions *vide* Old Mutual of South Africa's purchase of Skandia Insurance and the Barclays Bank takeover of LOCAL ABSA Bank. In many respects the formal economy resembles that of the middle income and low R&D intensity New Member States of the European Union (Kahn, Molotja and Vlotman, 2006).

South African mineral resources companies have a long history of global activity whereas the services sector is a relative newcomer. It is expanding aggressively so much so that five homegrown retailers are now in the world top 250 firms (DTT, 2007). This reflects the fact that services comprise 69% of the country's GDP (Statistics SA, 2005).

Though regarded as an emerging economy South Africa displays some characteristics more typical of an advanced economy namely a heavily traded currency and the 14th largest securities exchange by market capitalization. It remains a key supplier of strategic minerals and associated mining, civil engineering and project management expertise.

Our first source of primary data is the revitalized set of R&D Surveys that commenced with that for year 2001/02. The second is a set of case studies of the major players in the services sector. The third is the country's first official innovation survey for years 2002/04. We commence by describing present R&D measurement processes highlighting the difficulties presented in emerging economies where registries of business and R&D performers may be incomplete or even non-existent. We then consider the literature on measuring R&D in services. The services sector case studies then follow with a discussion on the meaning of R&D in this sector and some evidence of these firms' approach to technological learning. These case studies also provide imputation norms for firm R&D expenditure that may be applied where direct observation is impossible. Lastly we turn to the Innovation Survey findings. That survey provides another example of the difficulties that the construction of survey samples presents in emerging economies. The high-level results of the innovation survey further serve to illuminate the similarities and differences regarding R&D and innovation behaviour between the South African services sector and that of its international peers. As relevant we situate the discussion in the context of emergent innovation policy pointing to unintended consequences or inconsistencies.

In the final section we offer a comparative analysis and discuss three policy issues. The comparative analysis shows that there are more similarities between South African services sector R&D and innovation behaviour and its peers abroad than there are differences. In terms of policy the paper points to the need for decision makers to appreciate the importance of R&D in the services sector. Moreover that there is likelihood that the new R&D tax incentive may have limited impact on the service sector because of the exclusion of research and development in the social sciences and humanities. The second policy issue is the extent to which the better-paying services sector is attracting talent away from the sciences, engineering and technology. The third is a concern that policy needs to be more carefully tuned to sectoral needs.

2. Getting the measure of R&D

South Africa has a four-decade history of measuring gross expenditure on research and experimental development (GERD). However the government and system restructuring of the post 1994 transition led to the erosion of institutional survey capability that was only re-established in 2002 when government set up the HSRC Centre for Science, Technology and Innovation Indicators. Up to that juncture more emphasis was laid on establishing a new leadership cadre, setting the framework principles for the system of innovation and defining new science and technology missions. Given the loss of survey capability (Blankley and Kahn, 2005) the immediate task was to construct both methodologies and registers. Awareness of the R&D Survey among potential respondents in the business sector was very low, especially as there was no official requirement to capture R&D expenditure to company accounts. Although there was a tax incentive for capital expenditure on R&D this was poorly utilized and no useful database of claimants existed. This R&D information nexus is typical of emerging economies.

Today the R&D Survey conducts a census of higher education and government research institutes, and purposive surveys of firms (and the not-for-profit sector). A purposive survey is necessitated, as no central register of R&D performers exists. The survey register is built incrementally survey by survey, being especially conscious of the need to avoid double counting. Useful sources of information regarding R&D performers include recipients of grants, financial incentives, lists of competitors for technology excellence awards, lists of those licensed to perform trials of GMOs, firms certified to carry out clinical trials, and word of mouth referrals. Membership lists of science, engineering and technology professional bodies remain an as yet untapped source of information.

The 2005/06 R&D Survey is the last to be performed prior to the inception of a new R&D tax incentive. Legislation (RSA, 2007) now provides for the flow of information on such tax claims from the South African Revenue Services to the Department of Science and Technology. It is expected that this information will then pass on to CeSTII that performs the survey on an agency basis for the Department. We shall yet see how much information will flow through this new channel. In principle the pieces of the R&D information jigsaw are now complete, and the Department is bullish that firms will increase their R&D expenditure.

However, this assumes that only one policy change is in the air, which is not the case. There is a parallel process to stop the perceived leakage of intellectual property (IP) generated through publicly funded R&D. The scope of the draft IP legislation is broad enough to persuade large firms that it may be safer to take their R&D activities abroad. So we have a rather fluid policy formulation situation, but one that is amenable to representation and modification. A case in point is where the draft R&D tax incentive legislation embodied a clause that would have discouraged collaborative R&D, again for reasons of IP control. After representations were made that clause was deleted.

The 2004/05 R&D Survey (DST, 2007) found a GERD: GDP ratio of 0.87%. Business expenditure on R&D (BERD) comprised 56% of GERD and was largely funded from domestic sources with some 20% of funding for R&D coming from abroad. These attributes of business are similar to the European Union average (EU, 2006). The first results of the 2005/06 R&D Survey report GERD: GDP at 0.91% with BERD making up 59% of the total. Put simply the country exhibits a small system of innovation with R&D characteristics similar to the European Union 15.

Services sector R&D (SERVERD) defined as non-manufacturing R&D accounted for 27% of South African BERD, below Australia at 41% and Canada at 38% but above Italy and Hungary's 21% and Poland at 17% (OECD, 2006a: Table 44a). R&D in services is concentrated in financial services with another large component for contract research organisations. The R&D survey instrument includes the usual items on research fields, socio-economic objectives, industrial classification and location of activity, as well an item on R&D collaboration. The services sector firms show a concentration of effort in three fields: mathematics, statistics and software. Unfortunately no service sector firms provided information on R&D collaboration.

We now turn to a brief scan of literature.

3. Services sector R&D

The service sector is now the dominant component of GDP in most 'industrialized' economies and by 2000 had reached an average level of 70% in the OECD member states, accounting for two thirds of economic value added (OECD, 2004). Services R&D across the

OECD countries grew from 15% of BERD to 23% over the period 1991 to 2000. Given the acknowledged link between innovation and economic growth, it is obvious that innovation in services must be an object for concerted study. So Gault (1998) points out that R&D in and of itself is a service activity, and that the bulk of Canadian R&D occurs outside of mining and manufacturing.

The OECD Frascati Manual guidelines recognize that measuring services R&D presents definitional problems since '(services) R&D is not always organized as formally as in manufacturing companies (i.e. with a dedicated R&D department, researchers or research engineers identified as such in the establishment's personnel list, etc.). The concept of R&D in services is still less specific and sometimes goes unrecognized by the enterprises involved.' (OECD, 2003: 48). Miles (2003: 63) reminds us of the lack of attention that has been paid to technological change in the services sector, it being viewed as populated by 'innovative laggards' so that ' … few services were recognized as exceptions to this rule by the relatively few researchers who have examined the services economy.'

Definition and specification is a problem in both advanced and emerging economies. Sundbo and Fallouj (2000) offer a six fold categorization of services R&D patterns ranging from classic R&D, consulting and services firms, to 'organized strategic innovation,' and what they term entrepreneurial, artisinal and network patterns.

Miles (2001) in describing the situation in the United Kingdom draws attention to the finding that 10% of R&D spending is accounted for in the R&D consulting, technical testing and analysis fields. Using Community Innovation Survey 2 data he found the percentage of 'turnover' devoted to R&D to be 0.14% for financial intermediaries, for wholesale it was 0.08%, while both retail and insurance were reported as zero. Miles argues that the nature of innovation activities in manufacturing and services is converging especially as both use IT as a platform technology.

In Australia publicly funded R&D now shows (AGPC, 2007:40) a decline relative to business that typifies a ' … shift in balance in the allocation of research resources to business globally (with) … growing orientation to R&D within the service sector, reflecting its increasing importance in the economy. This re-orientation has been particularly marked for Australia compared with the European Union.' Australian services R&D has risen from 10% of BERD to over 40% in the past twenty years.

To improve their understanding and coverage of services sector R&D the US National Science Foundation and National Institute for Standards and Technology commissioned an investigation by Research Triangle International. This involved interviews with a limited number of key players in telecommunications, financial services, systems integration and the research and development and testing service sectors. At issue was the redesign of the Department of Commerce R&D survey questionnaire. The researchers (Gallaher, Link and Petrusa, 2005: B-11) found that the standard concept of R&D ' … did not resonate well within the financial services industry. None of the firms interviewed indicated that they conducted activities in either basic or applied research.' Only the largest retail banks felt that they undertook development work. They also reported that customer demand was the main driver of innovation, and that most development work was outsourced. Since most development work was IT related, they recommended as a yardstick for the presence off R&D expenditure, the ratio of cost of maintaining ICT to the cost of introducing new technology. Real development was felt to be occurring when this ratio was at least 30: 70 in favour of introducing new technology. In general it was observed that more intellectual capital was bought in than arose from internal sources. The investigation provides some insights into the world's leader in services.

At the other extreme is the case of Hungary (Mosoni-Freid, Orisek and Tolnai, 2003) where services as a component of GDP underwent astronomical growth as FDI poured into the country after economic liberalization. The GERD: GDP ratio however did not show concomitant rise. The researchers' explanation for this is the difficulty of defining and measuring services sector R&D that constitute what are termed 'hidden capacities' in firms that include both R&D expenditures and the inputs and costs of numerous skilled staff.

Using the data of the CIS3 surveys for Germany, Italy, the Netherlands, Portugal and the United Kingdom, Evangelista (2006) identifies wider variations regarding innovation behaviour within the services sub-sectors than those found across manufacturing sub-sectors. He concludes that 'CIS data confirm that R&D activities play only a marginal role in services while less formalized activities such as marketing, the acquisition of know-how and other disembodied technologies are much more important' (Evangelista, 2006: 665).

This brief scan of literature shows a divergence of reported levels of services sector R&D by country and industry sub-sector.

Given the broad similarities in R&D behaviour between South African firms and the EU-15 the key question for us was to determine how different the services sector in the 'emerging economy' of South Africa might be. The comparative study also allows one to explore the use of the 'technology colony' concept introduced by De Wet (2000), popularized by Oerlemans and co-workers and seemingly adopted by the National Advisory Council on Innovation and the Department of Science and Technology (NACI, 2007).

4. R&D in the services sector of South Africa

In South Africa business performers of R&D are identified through a purposive survey that in 2004/05 sampled 1548 likely performers of R&D. This yielded a response rate of 84% of those that reported R&D activity for 511 performers, including some from the services sector. In order to gain a fuller picture of services sector R&D prior to going to the field with the 2005/06 R&D Survey, a set of case studies was conducted across the twenty leading publicly-listed firms in banking, insurance, retail and logistics (sections 50-59 of ISIC Rev. 3.1) with the intention of finding previously undetected R&D as well as understanding something of the technological learning approaches of these firms. The companies are their respective sub-sector leaders with total revenue of USD 60 billions (median USD 2,5 billions) and a median number of employees of 21,000.

In all cases we found that the firms had some focal point for R&D or technology acquisition, frequently in the office of a technology manager or 'head of research' though only half had an R&D division. These divisions typically comprise a handful of individuals so that the question 'how much do you spend on R&D' would typically generate a response based upon the cost of this division in isolation and might be ¼ million USD. For a firm with revenue of USD 5 billions that seemed to be too low an estimate.

Virtually all interviewees had difficulty understanding what might count as R&D. Even where they recognized that their company performed R&D the generally dispersed nature of R&D effort across divisions created a second problem of how to estimate it.

Another reported difficulty was the ephemeral nature of R&D projects that might include external CROs, management consultants or software houses. So the problem of an extended R&D value chain appears. In the case of application development issues of appropriation of jointly developed intellectual property and cost sharing compound this problem.

None of the firms made direct reference to the involvement of higher education or government research institutes in such value chains. This was also found to be the case in the Norwegian OECD KISA study (Broch and Isaksen, 2006). The relatively low importance accorded to higher education and government research institutes is confirmed in the South African innovation surveys (Oerlemans e.a. 2004, HSRC, 2007). Instead there were claims that collaborative work occurred with foreign peers as well as foreign suppliers. These unstructured relationships constitute knowledge transfer that may be better described as ‘connect and develop’ (Dodgson, Gann and Salter, 2005: 47) than conventional ‘R&D’ activity.

All the companies in the case studies operate extensive in-house legacy computer systems alongside proprietary information systems. This observation poses the question: do South African firms conduct R&D in information systems in the same way as their peers in the North, and if so how to measure this?

South African use of computer technologies has deep roots: a case in point is Old Mutual that purchased its Ferranti Perseus mainframe computer as early as 1959. This is another example of South Africa’s role as an early adopter of technology since in this case the mainframe was only second to be installed outside the United Kingdom. Indeed Old Mutual could have been the first but the supplier installed the first in Sweden since it was closer by and allowed for easier monitoring. The expertise that underpins the IT legacy systems received further stimulus during the anti-apartheid sanctions era of the 1980s when companies such as IBM and Apple Computer disinvested. A ‘constructed crisis’ driven by the climate of sanctions and secrecy forced IT managers to 'build or die' as the 'buy' option was either too attenuated or costly.

Given the massive usage of information systems the interviews required sharp focus on the way that information technology is maintained and developed in the firms. So for example one interviewee had declared R&D expenditure of USD 0,5 millions to the 2004/05 survey. A few months later the company issued a press release announcing migration to a proprietary enterprise resource planning (ERP) system, since their 'previous three-year in-house investment of USD 40 millions had been unsuccessful.' So it was clear that the company had under reported to the survey and must have had considerable systems development capability with the expertise to engineer an equivalent to the commercial ERP. Two further questions arose: 'what had become of the system analysts and developers and what level of expenditure should have been recorded?' The answer to the first was– 'they are still with us. The ERP will only take care of certain aspects of our business. We shall continue to maintain and develop other legacy systems. These include forecasting software as well as customer profiling packages. In any case one cannot integrate something as complex as ERP without your own skilled people.' It turns out that the company employs fifty software engineers and another fifty technical staff and the answer to the second question is 'R&D expenditure around USD 15 million.'

We also studied the banking and insurance industries. These financial services show quite different customer interaction one to another. Banking involves frequent transactions; insurance by intent anticipates less frequent interaction with customers. Both require extensive IT systems, and rely on careful risk analysis to manage debtor books and customer profiles. Actuarial services are paramount for both. The range of research activities that were reported spans the social sciences (econometrics, management, customer behaviour, product development, pricing research, competitive intelligence, technology scanning, regulatory and tax compliance) and the natural sciences (mathematical modeling, system and software development).

There is no real computer hardware industry so large items of hardware are generally sourced from the international market. The decision that the R&D or technology managers face regarding software is 'build or buy?' and it is clear that the capability to go either route still exists. All of the large financial service companies host large IT divisions that are in part a legacy of the previously closed economy. As one staff member puts it: ‘we banks have to maintain our own security. Even if we could buy everything there are certain features we must control.’

Staff in these divisions hold a range of qualifications from a school-leaving certificate through to industry qualifications (Microsoft, Cisco etc.) or university degrees. The members of staff that manage the portfolios are typically chartered accountants often with an MBA.

In general the managers regarded their approach to innovation as being that of early adopters of technology. They often referred to ‘looking at what our competitors are doing.’ This is perhaps an understatement since many new financial products have been invented in this community. These include a range of ATM enhancements, Internet security and mobile phone banking. The banking industry as a whole has had to re-think its approach to risk, most notably in developing a banking model for those with very low incomes, the so-called ‘Mzansi’ clients (Standard Bank, 2007). The banks and insurers also recognize the weight of history and sunk investment in systems – ‘(upstart) X is more nimble than we are – they don’t have a legacy to hold them back’ was one ironic comment.

5. Some common threads

A sample of eighteen firms is modest, but its size and scope compares well with the NSF study cited above. Our assumption that services sector firms were probable large contributors to BERD ERD turned out to be correct.

The first commonalty across the firms was the low awareness of what might count as R&D activity and the parallel failure to record the amount of effort attributable to it. Yet all showed considerable innovative ability. It appears that innovation is a normal part of business.

The second regards the low number of ‘researchers’ that hold doctoral degrees in these companies. The grand total for the firms in the sample was a dozen, leading one to conclude that doctoral degrees were the exception rather than the norm. Put differently, the availability of PhDs does not appear to be a precondition for the conduct or existence of R&D in the South African service sector. This is contrary to the Frascati view that the presence of a concentration of PhDs is an indicator of R&D capability. Much of the R&D in the sample is in software and system development for which the PhD seems to be non-essential.

None of the firms expressed concerns of a shortage of the requisite skills to maintain the R&D function. This suggests that supply from higher education is adequate, which may be counter-intuitive given the widespread belief that a high-level skills shortage prevails in the country (Lunsche, 2006). This apparent contradiction may be explained as follows. While it is true that the production of school leavers with the requisite grades to enter tertiary level science-based careers is inadequate, a significant proportion of this elite stream opt to pursue studies in business science, accounting, economics and law, through which routes they find themselves in the business environment working in software, modeling or marketing roles. I

Traditional science and technology-based careers are unable to offer a strong enough pull to attract all the school leavers with excellent grades in mathematics and science. The static and even declining level of enrolments in science, engineering and technology streams in higher education reflects this new market reality. Scarcity is exacerbated by re-allocation.

All the companies in the sample claimed to be undertaking software development of a complexity that qualifies as ‘novel.’ Indeed the discussion regarding the nature of their software development activities and what component thereof might be countable as R&D turns on this issue. We often put the question: ‘would the loss of this intellectual property damage your company and would you therefore seek legal redress?’ An answer in the affirmative helps the respondent to recognize the existence of the IP and then to decide how it was generated, what it cost and how much to attribute to R&D expenditure.

Another probe that we use to unpack management or marketing research is to ask whether the product of their work might be of a quality that in a university environment could lead to its publication in a peer-reviewed journal. An affirmative response would suggest that the work is countable as R&D.

We also sought to determine the source of technological learning for the firms. The first finding was that the firms ranked their own R&D division as the most important source of new ideas, followed by ‘Management.’ Given that half the firms do not have an R&D division *per se* and recognizing the seniority of the technology managers it is reasonable to combine these two groups as 'senior management.' The next most important source of technological learning was customers, followed by 'other staff.' What this suggests is a very strong emphasis on learning through one's own people, rather than from external sources. Next on the list are competitors, suppliers and public sources. The least mentioned sources were government research institutes and universities. The lack of links with the former makes sense since their work is highly sector specific and far removed from the type of services the firms engage in. But low engagement with the universities is surprising given the high profile of business schools and computer science departments at the leading universities. These findings are consistent with those of *South African Innovation Survey 2005* (DST, 2007).

Regarding differences across the sub-sectors we found that the banks regarded their own managers as the most important source of technological learning. The two banks that regarded themselves as leading innovators had no R&D department, while the others that claimed to be first followers did. Insurers on the other hand generally saw themselves as first followers and all had R&D departments. They thought their R&D personnel were most important as the source of technological learning. Retailers on the other hand assigned equal importance to management, R&D personnel, customers, competitors and suppliers.

6. The Innovation Survey

What can innovation surveys tell us about the services sector? First we look at the problems such surveys face in an emerging economy. In South Africa there were two unofficial innovation surveys (FRD-ISP, 1996; Oerlemans et al, 2004) prior to the 2002/04 Innovation Survey. The first was a joint project between the then Foundation for Research Development and the University of Cape Town; the second between the universities of Pretoria and Eindhoven. These produced response rates of below 10%. Both were resource constrained, and both had problems with constructing a representative sample. FRD-UCT was a mix of purposive surveying and a random sample, using a commercial database. Pretoria-Eindhoven used a commercial companies database as their sample source and fieldwork heavily reliant on the return of electronic questionnaires.

In the case of the official survey we were able to work with Statistics South Africa who agreed to generate the stratified random sample. However we had to be content with accepting that it was impossible to stratify by number of employees, as is the CIS norm. The only available database of firms was that for VAT payments, and we accordingly received a sample stratified by firm turnover. A conventional business register is under construction and may be available for the next innovation survey. So one has had to accept the proxy of revenue for firm size and develop the survey methodology to achieve the best fit between revenue and employee numbers.

Our prior experience with the R&D Surveys informed us that any attempt at a pure 'knock and drop,' no matter how sophisticated, would fail and so we set up a call centre to perform two main tasks. The first was to clean the database by ensuring correct contact information and most importantly to eliminate anomalies; the second was to do the actual fieldwork and follow-up calls.

The outcome was a 38% response rate, the highest yet received. However for us to be able to benchmark with the CIS4 results a 70% response rate was the recommended level, without which a non-response survey was demanded. The non-response survey yielded a satisfactory return rate of close to 85%. The non-response survey led to some adjustment of cell weightings.

The political decision was taken that to establish a baseline, the South African survey instrument would follow CIS4 as closely as possible. There is of course considerable pressure on the survey for it to cover innovation activity in the second economy, such activity being largely service oriented. Such country specific modification will have to wait for the next survey.

The detailed analysis of Innovation Survey 2005 is not yet to hand so we shall have to concentrate on the high-level results. The first finding is that 52% of firms report innovation activity, comparing well with Belgium at 51%, Spain 33%, Poland 25% and Hungary 22%.

Service sector firms report that products new to the market contributed 7.5% of turnover, while manufacturing industry reported the contribution at 14%. Is this evidence that the services sector are the laggards that Miles refers to? Secondly manufacturing industry relied more on in-house R&D than extra-mural R&D (factor of 3:1), while for the services sector this ratio was closer to 3:2. Thirdly the services sector spent R15.2 billion on innovation activity compared with industry at R12.8 billion. A surprising finding was that the R&D expenditure determined by Innovation Survey 2005 was within 5% of the 2004/05 R&D Survey value. Finally about 10% of firms reporting innovation activity claimed to have accessed state grants or incentives. However this flow of funds is almost entirely to manufacturing industry.

What do these high level results undifferentiated by firm size reflect back on our previous findings from the R&D Surveys and the case studies?

In absolute terms the services sector spends 20% more on innovation than does the manufacturing sector, and even normalized in relation to contribution to GDP the services: manufacturing ratio of innovation spending is 1:1.25. Whichever way one looks at it the South African services sector does not appear to be a laggard when it comes to spending on innovation.

Regarding R&D expenditure the services sector was found to spend 43% of the total intra-mural R&D, a proportion higher than the 27% determined in the R&D Survey. It appears that the discrepancy arises in the classification of defence and aerospace R&D activity. For the R&D survey this is ‘manufacturing,’ while for the innovation survey it is ‘services-transport.’ The defence aerospace expenditures are sufficiently large to account for much of the discrepancy between the two surveys.

Regarding the sources of innovation the main distinguishing behaviour is that industry generally relies on internal sources, while services reports that external sources are more important. Lastly the services sector was far more likely to introduce organizational and marketing innovations than industry. And finally universities and public research institutes barely feature as sources of innovation, a finding consistent with the CIS series.

7. Anomalies and parallels

Now to put it all together. Our case studies of large services sector firms show R&D activities generally dispersed within the firms, a finding that fits with the Sunbo and Fallouj characteristic of ‘organized strategic innovation.’ Leadership in the firms is active in driving innovation in processes and products but does not operate a centralized facility toward this goal. The firms all performed measurable R&D, but prior to being interviewed many did not recognize it as such. The banks, insurers and retailers perform R&D at the ‘D’ end in information systems. In general the bulk of their KISA was provided internally, which concurs with the findings of the OECD (2006b) study and the 2002/04 Innovation Survey.

Instead of developing R&D expenditure metrics based on ‘revenue’ we distinguished interest income, premiums written and turnover as the appropriate denominator for the three sub-sectors respectively. These metrics differ from those reported by Miles and the NSF-NIST studies in terms of the sub-sectors doing R&D and their intensity level. Both in the UK and US it appears that the insurers and retailers report zero in-house R&D. In South Africa, possibly because of the legacy of the closed economy both sub-sectors perform substantial R&D.

Our study confirms the central role of information technology in the services sector with the need for algorithm construction, programming, and/or reverse engineering of competitor software solutions. These require in-house skills both to conduct and manage R&D. So managing the shift to a proprietary ERP requires integration with company information systems as well as ensuring one is not taken to the cleaners. R&D on IT comprises a large component of SERVERD, be it provided internally or externally. The Research Triangle International 30:70 ‘metric’ referred to earlier is arbitrary. Our interviews suggest that in the South African case it is closer to 50/50. This still implies considerable R&D expenditures on information systems.

While all the firms conducted some R&D in IT there were also strong differences in their R&D portfolios. Clothing retailers have different ways of introducing new product lines to those selling fast foods. The former spend considerable resources on modeling customer behaviour to get optimize stock levels. The latter operates a traditional product development facility with an R&D component.

The case studies detected significant R&D in the services sector, especially in the area of software development, and the existence of complex R&D value chains extending beyond firm boundaries. It should be noted that these firms with one exception have largely domestic origins. And most of the firms are more than two decades old so that they have the experience of development under sanctions that occurred in the 1980s at the very point that the ICT revolution took off. The 'constructed crisis' of apartheid (Kahn, 2006) thus drove them to *build or die*, in a manner similar to that experienced by the automotive and arms industries. The opening up of the economy appears to be leading to a hollowing out of R&D activity in the latter two sectors as foreign players return or enter the market through buy-outs (Gastrow, 2007). With the exception of ABSA there has as yet been no major FDI takeover in the services sector.

De Wet and Oerlemans have described South Africa as a 'technology colony' perhaps appealing for inspiration to Dependency Theory with its centre-periphery model. We are not convinced that the evidence from the surveys and case studies would support their contention and its resonance with the enforced techno-nationalism of the sanctions years. It is true that much innovation activity in South Africa is incremental, but that is a necessary part of technological learning. On the other hand there is ample evidence of adaptive and creative innovation as in the case of the advanced catalysis engineered in the solid and gas hydrocarbons to liquid fuels industry. Similar evidence is to be found in defence-aerospace, human, animal and plant sciences, and in heavy engineering. While there may be industrial sectors that do accord with the technology colony attributes of De Wet, this is scarcely the case for the services sector.

It might be more apt to label the country a 'technology island.' In support of this contention we refer first to the buoyancy of the domestically owned services sector that owns the market space in the 'colony' and that is actively colonizing new markets abroad. At worst this is cheeky behaviour by the colonials; at best it is evidence of a vibrant free market economy. Second it should be noted that Gauteng Province, the country industrial and financial heart records provincial R&D expenditure to provincial Gross Geographic Product at 1.42%, a regional R&D intensity slightly higher than the Centro region of northern Italy. This level of R&D intensity correctly earns Gauteng the title of 'innovation hub' of the country, and indeed of the African continent. The system of innovation is modest in size and scope, but it has come through the political transition remarkably well (Kahn and Blankley, 2006; OECD, 2007). Vibrant market; expansion abroad; innovation hub - these are hardly the attributes of a colony.

The attribute that distinguishes the South African system of innovation from those in OECD and EU-15 Member States concerns human resources. Firstly the absence of staff with doctoral degrees in the sampled firms belies the presence of considerable R&D. Second is the outlier status in country human resource data where recorded R&D expenditure per researcher is a high outlier. It is believed that the outlier is a statistical artifact arising from the difficulty in measuring R&D in extended value chains.

This study raises three issues for policy. The first is that there is considerable R&D in the services sector. Some of that R&D would be classified as ‘software development,’ but there is also considerable work occurring in statistics and econometrics, as well as customer modeling. Government policy makers have tended to ignore the important contribution that R&D in services actually makes to the overall outputs of the system of innovation. In particular the new R&D tax incentive specifically excludes the humanities and social sciences from the tax incentive scheme. This implies that econometric analysis and customer behaviour modeling, not to mention organizational process development that is common research activities in the services sector would be excluded. This would disadvantage the service sector in relation to agriculture, mining and manufacturing with their ‘hard’ R&D bias. We have already noted that government R&D grants do not flow to the services sector; the tax incentive may also have limited impact.

The second relates to human resources in that the services sector, the most buoyant component of the economy, does not report skills shortages. The sector appears to be attracting talent away from careers in the sciences, engineering and technology. Yet the output from schools of students with grades in mathematics and science that allow them to embark on SET careers has remained almost static over the last decade, while the economy has undergone services led growth. The implication is that school outputs must be boosted as rapidly as possible by improving science and mathematics education, and that student financial support for tertiary education may have to be more selective by subject area.

Bar one short-term insurer the firms in the case studies have global footprints and earn significant income abroad. Yet none of the firms in the case studies appear to operate an R&D facility abroad so that their foreign activities amount to Kuemmerle's (1997) 'home base exploiting.' Given the possible disincentives identified above government may have to recalibrate the incentives to support this home base. Accordingly innovation policy needs to be nuanced according to sector needs and characteristics. R&D in the services sector appears to be alive and well, despite science and technology policy, not because of it.

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