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policy brief

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Exploring and harnessing the economic and social benefits of open innovation in South Africa

Executive summary

Innovation has become an important factor in the competitiveness of firms and to countries. There is evidence for innovative firms having engaged in open practices. This policy brief evaluates the openness of innovation processes and systems of South African business enterprises to external cooperation partners. Further, it explores how open innovation is supported by existing South African innovation policies/strategies. On the basis of these analyses, a review of relevant literature, and the findings of a research study on open innovation, this policy brief makes recommendations for harnessing the economic and social benefits of open innovation.

Open innovation among South African business enterprises was evaluated on the basis of a research study conducted using data from the National Innovation Survey 2008, covering the period 2005–2007. The following key findings were generated:

- Both product and process innovative enterprises tended to 'close' rather than 'open' their innovation activities/process to other enterprises and institutions, aside from certain specialised and integrated collaborators.[1]
- These innovative enterprises mainly collaborated with and sourced information on innovation from suppliers, clients or customers, and competitors, and less so with universities and research institutions.

The study findings are in line with those of studies in Organisation for Economic Co-operation and Development (OECD) countries which showed similar patterns of collaboration on innovation by companies. The empirical findings of the study, combined with evidence derived from the analyses of current policies and strategies, indicate that these policies and strategies do not directly and adequately support open innovation. Such policies and strategies include the South African government's Ten-Year Innovation Plan; the Intellectual Property Rights (IPR) Act of 2008; the Information Communication and Technology (ICT) Research, Development and Innovation (RDI) Roadmap; the Human Resource Development Strategy for South Africa (HRD-SA) 2010–2030; the establishment of the Small Enterprise Development Agency (SEDA) in 2004; open-innovation initiatives by the Gauteng provincial government, the Eastern Cape provincial government and the Technology Innovation Agency (TIA); other local open-innovation initiatives; and the Southern African regional open-innovation initiative. The combined evidence of the analyses and literature review in this policy brief leads to the following key recommendations for supporting the growth of open innovation among South African business enterprises:

- Innovation policies and strategies should specifically support collaboration with external partners and an increase in the number and type of partners by focusing on and promoting the use of phases of the innovation process that exploit external sources.
- To support open-innovation practices, more should be done to create a conducive policy environment for South African firms to readily source and acquire technologies from both outside the firm and abroad.
- The acquisition and retention of highly skilled personnel, including knowledge exchange with other countries, should be supported by

1 Specialised collaborators were defined as firms that mainly develop their own innovations but enrol diverse types of partners, most likely on specialised components of their innovations. Integrated collaborators were defined as those firms whose innovations are developed with or mainly by other enterprises, and that collaborate with a very homogeneous set of partners.

the Department of Home Affairs; the Department of Higher Education (DHET); the Department of Science and Technology (DST); and research and development (R&D) and innovation agencies. This should be geared towards a skills transfer to South Africans rather than just filling a gap. Exchanges could include temporary work/study exchanges between South Africans and nationals from other countries for purposes of acquiring skills.

- Provision for both an increase in the number of technology parks and improved links to universities should be supported by the DST and the DHET to encourage collaboration and thus support open-innovation processes between industry, government and universities. In turn, this would advance the application of knowledge generated in universities and research institutes, and increase the impact of technology on firm growth and on society more broadly. Similar suggestions have been made in studies and analysis done by the Educational Skills and Development (ESD) Programme of the HSRC.
- Further shifts towards the sharing of intellectual property rights (IPR) should be supported in order to encourage open innovation.

Introduction and background

Companies in all countries of the world are increasingly faced with competition and increasing R&D costs. As a result, they are unable to survive on their own R&D efforts alone and are seeking more open modes of innovation to source novel technologies or processes in a relatively short period of time. In addition, firms have to seek new markets for their technologies in order to survive (Huizingh 2011). This forces companies to seek partners, ideas and knowledge from more diverse networks of researchers, competitors, suppliers and customers – both locally and from abroad.

Although prepositions and discussions about the ramifications of inter-firm cooperation in R&D date as far back as the 1960s, the term 'open innovation' was first coined by Henry Chesbrough, who defined it in the following manner: 'Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open Innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model' (Chesbrough 2003: xxiv).

> A more recent and preferred definition of open innovation is 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively' (Chesbrough et al. 2006: 2).

As described by Chesbrough and colleagues, open innovation ranges from forming relationships that enable flows of knowledge, to incorporating external technology into the establishment while giving other enterprises access to unused internal ideas and, finally, to redesigning the business model. A true open-innovation system is characterised by bidirectional flows of information and technology comprising both 'inbound open innovation, which is the practice of leveraging the discoveries of others', and outbound open innovation, where enterprises 'look for external organizations with business models that are better suited to commercialize a given technology than the firm's own business model' (Chesbrough and Eichenholz 2013). 'It is the logic of open innovation that the most successful innovators integrate all their ideas, expertise, and skills and deliver the results to the marketplace, using the most effective and efficient means possible. Whether using ideas from inside or outside the organization, those practicing open innovation will create new value and accelerate their time to market' (Chesbrough and Eichenholz 2013).

There are four key elements that are required to fully implement open innovation: developing networks to enable the flow of knowledge; strengthening knowledge exchange; establishing structures for intellectual property (IP) protection that allow open exchanges; and establishing a business model that supports openness (Chesbrough 2003a: xxiv).

This review of the concept of open innovation has so far largely covered the 'what' and 'how' aspects of the concept. The 'why' aspect of the concept needs further elaboration. Huizingh (2011) uses an 'effectiveness' lens to examine the benefits of open innovation. He argues that research on the benefits of open innovation should move beyond the obvious benefits, such as lower costs, shorter time to market and more sales, and include the effectiveness of open innovation. Such research would thus take into account the fact that effectiveness can be considered with respect to a number of aspects such as innovativeness, number of innovations, and combinations of financial and non-financial benefits. Improved methods of measuring the valued added by an innovation or increased clarity about the key competencies of an enterprise are examples of the soft and intermediate benefits that can be assessed in measures of open-innovation effectiveness (Huizingh 2011). Alternatively, the intermediate- or long-term chain of strategic effects of open innovation – such as gaining access to new sources of technology and access to new markets – can be assessed. In addition, the possible strategic risks of open innovation need to be explored (Huizingh 2011). It is clear that a wide-ranging and sophisticated research agenda on the economic and social benefits of open-innovation systems is being developed.

Windrum (2011) argues that an open-innovation system is needed for several reasons: (1) the increased complexity of products and services requires innovators to engage with, and draw upon, a wider range of external sources for relevant information and knowledge; (2) globalisation necessitates open innovation because 'in a globally competitive environment, the generation and transfer of knowledge are key to sustainable competitive advantage' (Windrum 2011: 5); and (3) scarce resources are also better utilised in an open-innovation system. With reference to Windrum's second reason, the international division of labour and knowledge, coupled with geographical diversity of knowledge sites, inevitably pushes multinational companies toward more open innovation systems. With respect to Windrum's third reason, improved IPR protection increases the incentive for information sharing and transfer without the risk of losing out on IP benefits. Under these sorts of conditions and in such environments, enterprises have imperatives to open up to external partners in order to share the costs of innovation, and to negotiate the mutual benefits resulting from such synergies (Windrum 2011).

The evidence for the positive impact of open-innovation practices on innovation production is extensive. An OECD study based on Community Innovation Survey-4 (CIS-4) data shows that collaboration on innovation is important in manufacturing as well as in services. Enterprises in such sectors as chemicals, pharmaceuticals, and ICT (including software) typically show higher levels of open innovation. However, enterprises tend to collaborate on innovation with suppliers and customers, while collaborations with universities and research institutions are less important (OECD 2008). For UK manufacturing firms, more openness to external sources or search channels is found to be positively correlated with higher levels of innovative performance (Laursen and Salter 2004). Using data from Irish manufacturing plants, Love et al. (2011) also found that the current 'breadth' or scale of openness is associated with higher levels of new and improved products as a percentage of sales.

According to the OECD (2008), the discussion on open innovation could benefit substantially from more systematic empirical evidence from companies. According to the Facebook social network company profile in 2010, which represents a fast-growing network spanning across all traditional borders (approximately 350 million connected users in January 2010), Web 2.0 technologies that enable crowd sourcing and open-innovation platforms are becoming critical factors in business management. It is becoming clear that networks, connectivity and knowledge are key to driving the sustainability of businesses into the future (Chesbrough 2007). However, there has been very little focus on the understanding of open-innovation structures and dynamics in South Africa. Among the available literature, Gastrow (2009) investigated the kind of open-innovation structures that exist in the South African context in the fields of nanotechnology, biotechnology and open-source software development. Using R&D Survey 2005/06 data, Gastrow found that nanotechnology, biotechnology and open-source software technology are highly networked, with each reporting much higher collaboration modes, proportionally, than recorded for the overall R&D Survey. However, open-source software technology was less intensely networked compared to nanotechnology and biotechnology R&D. All three technologies were found to have a greater propensity to collaborate with other firms, within firms and with higher education institutions. All three technologies were found to engage in global collaborative networks via multiple modes of collaboration.

The path to and support for open innovation in South Africa

Policies/strategies

Through its Ten-Year Innovation Plan of 2008, the South African government seeks to accelerate and sustain the country's economic growth, and to help drive South Africa's transformation towards a knowledge-based economy in which production and dissemination of knowledge leads to economic growth. The advance of innovation as part of building a knowledge-based economy is supported by a national system of innovation (NSI) policy framework that promotes innovation. In the post-apartheid era, great strides have been made in putting in place structures to improve governance of the South African innovation system, and here the DST plays a key role. The DST oversees science and technology development from a public policy and funding perspective. Leading up to the Ten-Year Innovation Plan, the South African government refined the concept of the NSI through a series of strategic documents. The series began with the 1996 White Paper on Science and Technology, followed by the National Research and Technology Foresight of 1999 and the National Research and Development Strategy of 2002. The latter underscored the need to reinforce the position of R&D, as the backbone of innovation, in the economy.

As part of its initiative to monitor science and technology indicators and policies, the DST commissioned agencies such as the Centre for Science and Technology Innovation Indicators (CeSTII), the TIA and the National Advisory Council on Innovation (NACI) with its mandate to support Science and Technology Indicator (STI) policies in South Africa. Other structures, policies and initiatives that the government has put in place to promote R&D are presented below:

- With respect to the promotion of human capacity development,

innovation in developing countries focuses mainly on learning rather than invention (Kraemer-Mbula 2006). It is therefore strategic to put in place capacity to learn, adopt or adapt technologies through a skilled and qualified workforce. As such, the South African government's prioritisation of investment in higher education to increase the number of researchers with PhDs is s recognition of the fact that human capital development and knowledge generation are core elements of a knowledge-based economy.

- As part of its commitment to scientific development, the South African government funds nine science councils spanning different sectors of the economy to help drive scientific research. In addition, there are 23-state funded universities that are also active in research to differing degrees. The institutional landscape thus allows for private firms to collaborate with science councils and universities in their innovation processes.
- The government has set an R&D expenditure target of 2% of gross domestic product (GDP) by the year 2018. A tax system that rewards R&D performers is in place to incentivise R&D investment. The R&D intensity target was set at 1.00% by the financial year 2008/09, but it had reached only 0.76% in 2014.
- In May 2013, Cabinet approved the ICT RDI Roadmap, aimed at bolstering ICT R&D in South Africa.
- SEDA was established in December 2004 within the Department of Trade and Industry through the National Small Business Amendment Act (No. 29 of 2004) with the aim of supporting and promoting small enterprises, and was an acknowledgement of the role of small enterprises in economic development and in innovation. SEDA now falls under the new Ministry for Small Business Development, which was created in May 2014 to foster small enterprise development.
- The IP component of the South African National R&D Strategy of 2002 supported the sharing of IP derived from publicly funded research. This led to the IPR Act of 2008, which was enacted through its regulations released in 2010. The main objective of the IPR Act is to 'make provision that IP emanating from publicly financed R&D is identified, protected, utilised and commercialised for the benefit of the people of the Republic' (section 2(1)). The IPR Act and regulations were also partly a response to the recommendations of a study on the utilisation of publicly funded research. Among other recommendations, the study suggested promoting university–industry research linkages and encouraging the creation of research networks. In this context, important emergent policy objectives were to improve bidirectional knowledge exchange of this nature as well as the capacity of higher education institutions (HEI) and science councils to engage with the private sector, entrepreneurs and communities (Kruss et al. 2013).
- In terms of skills transfer and knowledge exchange, Strategic Priority Eight of the HRD-SA 2010–2030 is 'to ensure that the balance of immigration and emigration reflects a net positive inflow of people with priority skills required for economic growth and development'.

Table 1 provides a summary analysis of whether open innovation is supported by existing South African innovation policies/strategies.

Table 1: Support for open innovation by existing South African innovation policies/strategies

Year	Policy/strategy Name	Type: Policy/strategy	Support for open innovation (yes/no)	If yes, what policy tools or instruments?
1996	White Paper on Science and Technology	Policy	No	
1999	National Research and Technology Foresight			
2002	National Research and Development Strategy	Strategy	Yes, partly	• The IP component of the strategy supports the sharing of IP for publicly funded research. • The IP component of the strategy led to the IPR Act of 2008.
2008	IPR Act	Policy	Yes, partly	• The IPR Act supports the sharing of IP for publicly funded research. However, the Act provides for access to the IP only to creators of the IP, recipient institutions, the state and funding organisations, which does not fully support the concept of open innovation.
2008	Ten-Year Innovation Plan	Policy	Yes, indirectly	• The IPR Act was contextualised within the framework of the Ten-Year Innovation Plan.
2013	National Development Plan (NDP)	Long-term strategy and policy options	Yes, partly	A framework to: • Coordinate knowledge production and guide investment of public funds to support networks and partnerships between universities, science councils, state-owned enterprises and industry. • Include strategies and incentives to encourage business to form industry clusters for increased competitiveness and wealth, as well as contribute to science and technology capacity development.

Specific open-innovation initiatives

Initiatives that are specific to open innovation in South Africa include the open-innovation portal initiatives launched by government entities such as Eskom, the Gauteng provincial government, the Eastern Cape provincial government and the TIA.

- The Open Innovation Pilot Project launched by Eskom in 2011 is an initiative by the parastatal to 'turn innovation into business value'. Under this project, Eskom cooperates with external stakeholders to address four defined challenges: (1) to permanently reduce domestic energy use by 10%; (2) to develop technology for early detection of sagging, slipping or fallen overhead conductors used for distributing electricity; (3) to improve water utilisation and management for industrial purposes; and (4) to peer-review the company's modelling and methodologies focusing on social, environmental and economic impact. In this project, Eskom is partnering with Research Institutes for Innovation and Sustainability (RIIS), a local innovation management company, and NineSigma, a US company that facilitates the solving of challenges, through which Eskom accesses approximately 2 million innovations globally.
- The Gauteng provincial government's Department of Economic Development incorporated open innovation in its strategies to achieve the objectives of its overall Innovation and Knowledge Economy Strategy of 2012. The specific strategy that is most relevant to open innovation is 'the development of an information and knowledge exchange network, with characteristics of both social networks, as well as open-innovation systems; including high speed ICT access at a household level' (GPG 2012). The prominence given to social innovation, as well as open innovations, means the strategy is not restricted to narrow economic outcomes, and helps to create an inclusive innovation system.
- The Innovation Hub (TIH), a subsidiary of the Gauteng Growth and Development Agency, which is part of the Gauteng Department of Economic Development, launched a web-based Open Innovation Solution Exchange Platform at the end of 2012 with the aim of connecting innovators with solution seekers to tackle service delivery in government and to improve competitiveness of the private sector. Through the platform, researchers, innovators and entrepreneurs, as well as small and medium enterprises (SMEs) and large companies, are able to respond to challenges and promote their technology products.
- Three open-innovation initiatives in the Eastern Cape province stand out: Openix, Connect + Solve, and AIMday. The Openix initiative was launched by TIH, and works in a similar way to the TIH's Open Innovation Solution Exchange Platform mentioned above. The Connect + Solve initiative was launched by the East London Industrial Development Zone as the first Open Innovation Solution Exchange Platform in the Eastern Cape. The Regional Innovation Forum and Nelson Mandela Metropolitan University organised and hosted the AIMday Advanced Manufacturing, held on 24 March 2015 at the Nelson Mandela Metropolitan University. The aim of this customised platform was to bring the region's manufacturing industries and researchers together to discuss challenges that arise in advanced manufacturing whose solutions could be developed cooperatively.
- South Africa became the first government to use the Pool for Open Innovation to stimulate R&D of drugs for neglected diseases when the TIA joined the pool in May 2010. The aim of the pool was to motivate innovative and efficient drug discovery and development by opening access to IP or know-how in the area of neglected tropical diseases (tuberculosis, malaria, leprosy and yaws) in the world's least developed countries. TIA intended to use IP and know-how from the pool to accelerate its efforts to grow the South African biotechnology sector and improve the quality of life of those affected by these diseases, initially focusing on developing new medicines for tuberculosis and malaria.
- The Council for Scientific and Industrial Research (CSIR) in December 2013 launched the R90 million Biomanufacturing Industry Development Centre (BIDC) Programme as an open-innovation hub supporting start-ups and small, medium and micro-sized enterprises (SMMEs) in the development of biological products for industrial veterinary and human applications.
- In the southern Africa region, Regional Connect, an open-innovation platform, was launched on 30 June 2014 as a result of a collaborative partnership between the University of Namibia, the Research Institute for Innovation and Sustainability (RIIS) in South Africa, the National Business Technology Centre (NBTC) in Zambia and Eduardo Mondlane University (UEM) in Mozambique.

Findings from the research study on open-innovation practices

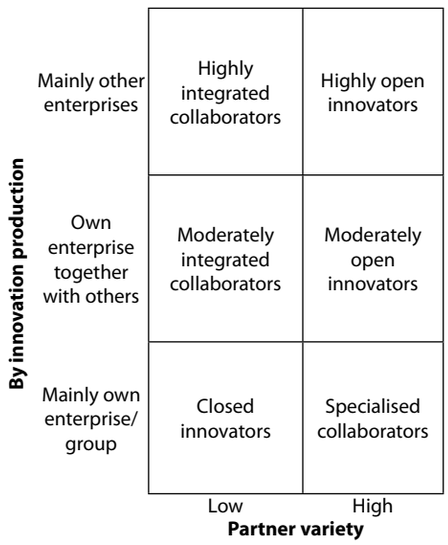
The study undertaken in 2013 sought to evaluate the openness of innovation practices within South African innovation-

active business enterprises using relevant data from the South African National Innovation Survey 2008, which covered the 2005 to 2007 period. The survey questionnaire was directly comparable with the core questionnaire for round 4 of the OECD Community Innovation Survey (CIS 4). The survey design was based on the guidelines of the Oslo Manual. It was also informed by the structure of the Business Register of Statistics South Africa, from which a stratified random sample (by sector and size of enterprise) was drawn. The results reported here are not intended to represent the population of all business enterprises in South Africa. Instead, only the realised sample of 757 enterprises that responded to the survey is represented. Thus the generated statistics are purely descriptive.

Modes of open innovation

The research study on open-innovation practices in South was conducted using an adaptation of the theoretical framework on the measurement of the degree of openness of innovators put forward by Lazzarotti and Manzini (2009), as proxies had to be used for a number of variables. The adaptation of the modes of innovation in Lazzarotti and Manzini (2009) is presented in the matrix in Figure 1.

Figure 1: Different modes of open innovation based on who developed the innovations



The matrix shows:

- open innovators, whose innovations are developed with or mainly by other enterprises and that collaborate with diverse types of partners;
- specialised collaborators, who mainly develop their own innovations but enrol diverse types of partners, most likely on specialised components of their innovations;
- integrated collaborators, whose innovations are developed with or mainly by other enterprises and that collaborate with a very homogeneous set of partners (typically suppliers and/or customers); and
- closed innovators, who mainly develop their own innovations and collaborate with a very limited set of partners.

An example of a firm that would be classified as a specialised collaborator is one that involves a wide set of actors (customers, experts, suppliers, research centres) in the idea phase of the innovation process but limits the actual development of the innovation mainly within itself or own enterprise group. On the other hand, a firm that has access to external prototyping services only in the new product development process would be classified as a closed innovator.

Tables 2 and 3 on the next page map 'innovation production' and 'partner variety' variables to show the relative proportions of each mode of innovator amongst South African firms.

Types of innovation partners and sources of information

The second part of the study sought to determine which types of innovators collaborated with which types of partners and which sources of information were highly important. In the findings below the 'innovation production' variable is tabulated against (1) type of collaborative partners and (2) the enterprise's highly important sources of information for its innovation activities. The sources of information included the types of collaborating partners listed above with the addition of (a) conferences, (b) science journals and (c) professional/industry.

Key findings

Of the total of 86 product innovators that formed part of the study, 39 were in the manufacturing sector and 34 were in the wholesale and retail trade sector. The remaining 13 were distributed across the following sectors: transport, storage and communication (6); financial intermediation (1); and computer and related activities (6). With respect to size, 48 were large, 20 were medium, 9 were small and the remaining 9 were very small. A total of 97 process innovators formed part of the study, and these were distributed by sector as follows: mining and quarrying (4); manufacturing (38); wholesale and retail trade (42); transport, storage and communication (8); financial intermediation (1); and computer and related activities (4). In terms of size, 61 were large, 16 were medium, 9 were small and the remaining 11 were very small.

The findings below examine:

1. The proportion of South African firms adopting different modes of open innovation according to the above model.
2. The types of partners with which South African firms are collaborating and from which they are sourcing information.

Modes of open innovation in South African firms

Product innovators

The majority of product innovators that formed part of the study were closed innovators (43) (see Table 2). The total number of integrated collaborators was relatively high (18 + 10 = 28), suggesting that firms that are opening up their innovations tend to do so with a relatively

Table 2: Distribution of successful product innovative enterprises by innovation production and collaboration partner variety

Innovation production	Partner variety		Total
	Low (0–2 types of partners)	High (3 or more types of partners)	
Mainly other enterprises	10	3	**13**
Own enterprise together with others	18	2	**20**
Mainly own enterprise/ group	43	10	**53**
Total	**71**	**15**	**86**

Table 3: Distribution of successful process innovative enterprises by innovation production and collaboration partner variety

Innovation production	Partner variety		Total
	Low (0 – 2 types of partners)	High (3 or more types of partners)	
Mainly other enterprises	19	5	**24**
Own enterprise together with others	22	4	**26**
Mainly own enterprise/ group	40	7	**47**
Total	**81**	**16**	**97**

uniform type of partner. There was a considerable number of specialised innovators (10), indicating that firms that open up their innovations to a widely diverse type of partners tend to do so on limited and specialised phases of the product development process. Only 5 firms in total were open innovators. Overall, the key finding is that South African product innovators tend to close rather than open up their innovations. Those that open up their innovation processes tend to do so with a uniform type of partner, or, if they engage with a widely diverse type of partners, they do so on limited and specialised phases of the development process.

Further analysis showed that there was no evidence of a link between the degree of novelty of product innovations (new to the firm or to the market) and

- the number of cooperation partners; or
- innovation production in terms of whether the innovations were developed by mainly own enterprise or own group of enterprises, own enterprise together with others, or mainly other enterprises.

Process innovators

Like the product innovators, the majority of process innovators (47) developed their innovations in-house or within the same enterprise group. In only 24 cases were innovations developed by other enterprises (see Table 3). Similarly, most of these process innovators collaborated on innovations with fewer (0–2) types of partners (81) compared to the number (16) that collaborated with 3 or more partner types. The bulk of the successful process innovative enterprises (40) were closed innovators, compared to a few (5) that were closed innovators. A substantial number (41) of the enterprises were integrated collaborators in the sense that their innovations were developed with or mainly by other enterprises, and they collaborated with a very limited set of partners.

Types of innovation partners and sources of information

Further analysis of the data was aimed at finding out whether the degree to which an enterprise developed its own innovations was linked to the type of collaborating partners and the sources of information on innovations. These findings are given below.

Product innovators

- Type of collaboration partners: Compared to own product innovation producers, innovators whose innovations were mainly developed by other enterprises tended to collaborate more with the following types of partners: enterprises in the same enterprise group, suppliers, clients or customers, and competitors.
- Source of information: Enterprises in the same enterprise group, suppliers, and clients or customers were regarded as the key sources of information for product innovators, while universities, public research institutes, conferences and journals were not highly rated. Firms that mainly depended on other enterprises for the development of their innovations tended to use these information sources more than own innovation producers.

Process innovators

- Type of collaboration partners: Compared to own process innovation producers, innovators whose innovations were mainly developed by other enterprises tended to collaborate more with the following types of partners: enterprises in the same enterprise group, suppliers, clients or customers, competitors, universities and government.
- Source of information: As with product innovators, the majority of process innovators indicated that their key sources of information were enterprises in the same enterprise group, suppliers, and clients or customers. Compared to process innovators whose innovations were mainly developed by other enterprises, own process innovation producers depended more on these sources of information, with the exception of suppliers where the converse was true.

Discussion

South African firms tend not to collaborate with other enterprises, and most of their innovations result from their own internal efforts. The findings also suggest that the innovators that do open up their innovation process prefer to collaborate with suppliers, clients or customers, and competitors, and less so with universities and research institutions. These types of partners also serve as the key sources of information for innovative South African firms. This corroborates similar findings of the OECD (2008) study. The findings of Gastrow (2009) suggest that R&D in nanotechnology, biotechnology and open-source software development was highly networked, more so than all R&D put together. This indicates that R&D-based innovations tended to be more open in these technologies than in the broader economy. The lower tendency to open innovations to external partners in the broader economy was confirmed in the study reported in this brief.

Meanwhile, as mentioned earlier, studies have shown a positive link between open-innovation practices and innovation production of firms (Laursen and Salter 2004; Love et al. 2011; OECD 2008). It is therefore apparent from this study that South African firms need to be sensitised about the value of embracing open innovation. In addition, there is a need to encourage firms to increase not only the number or scale of open-innovation engagement but also their variety by increasing collaborations with universities and research institutions, potentially as a source of more radical innovations or innovations that are 'new to the world' as opposed to 'new to the firm'.

Creating an enabling policy environment for South African firms to source and acquire external technologies can assist in realising the benefits of open innovation. Policies related to the importation of advanced technology (equipment) into South Africa should be such that firms in need of such technologies are not disadvantaged. Appropriate technology is key for South African firms to compete competitively in the global arena. Even though open innovation is mostly driven by business, the South African government is in a better position to influence the adoption of open innovation through the introduction and/or strengthening of policies that focus on product and labour markets, competition policies and public research. In countries where open innovation has been supported through enabling policies, significant economic improvements have been noted. China is a good example. The open-innovation models that have been employed in China since the 1980s have led to the great economic transformations that we see in the country today (Fu and Xiong 2013). While recognising that differences in innovation ecosystems, and in local and national contexts, do exist and thus matter, adoption and adaptation of experiences and lessons from the Chinese have the potential to boost South African firms' global competitiveness in innovation.

In some countries the bond between industry and universities is strengthened through the creation of vibrant and well-funded university research parks. These parks support collaboration, and thus support the open-innovation approach between industry, government and universities by enabling a flow of ideas between the universities where the technology is generated and the technology companies that are usually located within the park or surrounding area. The products of such collaborations are then commercialised with potential for new revenue for collaborating partners. New companies can result from spin-offs of research from technology parks, which is a welcome development for the South African economy.

The provisions of the IPR Act (and regulations) imply that the players in the innovation space who have access to the IP are the creators of the IP, recipient institutions, the state and funding organisations. This approach does not accommodate the concept of open innovation in which IP may be made widely available to the community of scientists/researchers for catalysing R&D, with reasonable restrictions for the protection of public interest (Chesbrough et al. 2006). Protecting the IP of individuals and firms is a worthy ideal, but excessively strong IPR can be a barrier to innovation. A shift towards IPR sharing should be supported in order to encourage open innovation. Fu and Xiong (2013) propose the need for platforms and repositories for 'intellectual commons' that are supported by government regulations. This strategy has worked for firms in Korea, where small firms were supported to imitate technologies by large global players (Fu and Xiong 2013). There are quite a number of practical interventions that can lead to accessing and using IP, even by small firms. For example, the University of Stellenbosch is running an 'Instant Access' licensing process that will give firms quick access to certain IPR (Wild 2012).

Although the South African policies and strategies mentioned earlier in this brief do not directly address promoting open innovation among firms, some do include approaches that would significantly contribute towards this cause. However, a deliberate incorporation of components that support open innovation in these documents would greatly improve open-innovation activities and their impacts on development and competitiveness of firms and the country.

The key findings of the study on which this brief is based indicate that the majority of current collaboration (and information exchange) is between firms and clients/customers and suppliers. The exchange of knowledge between these actors has been extensively reported in the literature. An example is the study by Egbetokun and Siyanbola (2011), which shows that Nigerian manufacturing

firms' innovation activities are strongly determined by relations between themselves and their suppliers and customers.

There are usually trade-offs or challenges with any new practice, including innovation. For example, in open innovation small firms are encouraged to share their (relatively limited) IP with large firms, but the question is, how can this be managed to ensure the small firms are protected but still encouraged to engage with new opportunities? Correct management processes are needed to support the firm's staff in their open-innovation efforts.

Open innovation as discussed in this policy brief is largely focused on R&D and firm-related innovation. However, open innovation is also relevant to the public sector and enrolling communities in social innovation processes. The broadening of innovation participation to 'citizens' is one of the branches of open innovation (as highlighted, for example, in the Gauteng Innovation and Knowledge Economy).

Policy recommendations

The findings of the study reported in this policy brief indicate that firms in some sectors of the South African economy tend to close rather than open their innovation activities. These sectors are mining and quarrying; manufacturing; wholesale and retail trade; transport, storage and communication; financial intermediation; and the combined sectors of computer and related activities, R&D, architectural and engineering activities and related technical consultancy, and technical testing and analysis. In this respect, the DST, the DTI and partner agencies at both national and provincial levels can enhance and accelerate the implementation of existing policies and strategies and add new ones to support open innovation as follows:

a) Enable increased number and diversity of partners

Innovation policies and strategies should support an increase in the number and diversity of partners, from pairwise partnerships to networks; from traditional supply chain relationships to collaboration with suppliers of equipment, materials, components, or software; clients or customers from the public sector; competitors or other enterprises in the industry; consultants; universities or other higher education institutions; and government, public or private research institutes.

There should be a shift to more/diverse partners which also involves a change to more networked forms of interaction rather than just linear supply chain relationships. Policies to support this may include building public open-innovation platforms (physical or virtual) that can facilitate these types of interactions. In addition, the use of open innovation may be approved by the DST for claiming on R&D tax incentives. Finally, agencies such as the TIA and the Industrial Development Cooperation (IDC) may consider subsidising open-innovation activities through innovation vouchers or similar instruments.

b) Support the development of innovations by external enterprises

Current innovation policies and strategies should be amended to include support for the increase in the number of innovations that are developed either together with or mainly by other enterprises. The use of phases of the innovation process that exploit external sources could also be incorporated (Lazzarotti and Manzini 2009). These are the phases of the innovation process which are 'open' to external contributions – that is, to significantly different approaches to innovation.

c) Support for university research parks

While some university-linked research parks have been established in South Africa, there is need to for the DST and the DHET to increase the visibility of such parks as well as outline their benefits. This would support collaboration and open innovation between industry, government, universities and communities, and would increase the social and economic impact of knowledge generated in these institutions.

d) Acquisition of technologies from outside South Africa

Some current South African import regulations monitored by the International Trade Administration Commission of South Africa (ITAC) impede foreign trade, including the acquisition of foreign technology. For example, there are key categories of products in which the US faces a tariff disadvantage compared to European Union (EU) countries, including fibre optic cable. South Africa also imposes anti-dumping duties on two products, poultry products and acetaminophenol. Policy in this regard should ease access to technologies developed in other countries, thereby supporting a more effective approach to open innovation in South Africa.

e) Support acquisition and retention of highly qualified personnel

Some sectors in the South African economy have been able to identify critical skills that are not readily available in the country. The government has supported these sectors by issuing work permits to highly skilled expatriates to take up these positions. The government should continue driving the process of identifying critical skills and creating conditions that support the transfer of skills to South Africans. For example, the DST must work hand in hand with the Department of Home Affairs to ensure

that, as stated in the HRD-SA 2010–2030, 'the balance of immigration and emigration reflects a net positive inflow of people with priority skills required for economic growth and development'. In the same vein, the long-term objective should be to encourage knowledge transfer and accelerate capacity development locally to develop critical capabilities.

Another way for South Africans to acquire knowledge of and skills in new technologies from outside the country's borders is through student exchange programs. The South African government should therefore create an environment that supports regional cooperation in the area of skills exchange/human capital development.

f) Intellectual property rights (IPR)

The draft National Policy on IP should be signed into law and enforced, as it reflects a shift towards IPR sharing and hence has the potential to increase and enhance the openness of innovation among South African firms.

It is important for government to ensure an effective implementation of the IPR Act of 2008 in such a way that publicly funded research benefits the South African society socially, economically and otherwise as intended by the Act. This should be accompanied by research and monitoring and evaluation, including around IP access and sharing, to measure the effect of the Act on open-innovation practices. Such studies will inform amendments of the Act if necessary.

There are also various open-access research publishing initiatives on the continent, such as BioMed Central. Such initiatives could be explored as a way of encouraging information sharing.

g) Systems approach to innovation

The need for a systems approach to innovation cannot be overemphasised. Policies can act on firms (through tax, education, mobility incentives, etc.) or on framework conditions, leading to linkages which matter in open innovation.

Concluding recommendations

The analyses and research findings on which this policy brief is based lead to the following conclusions and overall recommendations:

- By increasing the adoption of open innovation, the firms in the sectors identified in this brief would be able to build global competitive advantage. Through an open-innovation approach, firms are able to collaborate more and seek ideas and knowledge from clients and customers, suppliers and world-class researchers, and gain access to various technologies that would generate increased revenue on new products.
- However, innovative firms in the identified sectors tend to follow a closed rather than open innovation approach by developing innovations in-house rather than with or by other firms, and by having fewer types of partners.
- Further, South Africa's current policies and strategies do not visibly and directly promote open innovation among firms. There are several open-innovation initiatives that do not seem to be centrally coordinated.
- In terms of South Africa realising its full potential as a developing country with rapid economic and social growth, open innovation can play a significant role, and the policy recommendations proposed in this brief would promote and support its adoption by firms.
- The above conclusions, however, are based on a limited group of firms. Further research should be undertaken to verify the relationships identified in this brief, and to validate the suggested framework in the South African context in terms of its applicability and the identification of differences among open-innovation modes.

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