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Firm-level innovation: implications for policy and practice

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Theme 1: Innovation, research, technology transfer for mutual advantage, entrepreneurship and collaborative development in the information society

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Table of Contents

1. Introduction ........................................................................................................................................ 1

2. Managing Innovation .......................................................................................................................... 1
   Innovation Strategy .............................................................................................................................. 2
   Developing country firms ..................................................................................................................... 5
   Funding innovation ............................................................................................................................... 9
   Linkages, networks and interaction ....................................................................................................... 11
   Recent thinking on innovation strategy ............................................................................................... 12

3. Conclusions and Recommendations .................................................................................................. 16
   Key Findings ....................................................................................................................................... 16
   Policy implications ............................................................................................................................... 17

References ............................................................................................................................................... 20
1. Introduction

This paper provides reflections on private sector perspectives on innovation and suggests that deeper understanding of the nature of the process of innovation, its dynamics, contribution to economic development and prospects for improvement requires greater focus on the productive units that perform innovation. This paper introduces material on firm-level perspectives on innovation and as will be shown illuminates some key features of innovation policy and practice that have previously received insufficient attention. In the view of the author, the state’s ability to influence positive developments in the innovation landscape will be significantly influenced by deeper understanding of the nature of innovation management processes within private sector firms, the decision making processes involved in funding innovation and the central importance of linkages and interaction for innovation as seen from a private sector perspective. The intention of the paper is to identify and synthesise key features of the state of thinking on private sector perspectives on innovation drawing from academic and practitioner literature and to draw conclusions and make recommendations.

This paper is organised in three sections, which are described in the rest of the introduction. Section two, which follows the introduction presents a synthesis of academic and practitioner conceptual material on the role of the private sector in innovation and the process of innovation management at firm level. It summarises key insights from innovation studies and strategic management literature as well as focused material on the distinctive process of innovation management in developing country firms. This section is organised around the themes of innovation strategy, funding, and interaction. Section two also includes a treatment of the emerging area of interest, which has been termed frugal innovation, reverse innovation and constraint-based innovation. As will be shown, this writer believes that the findings within this stream of work contain important insights for developing countries with key policy implications. The material provided in section two draws from theoretical and empirical work across the world. The paper ends with a set of conclusions and recommendations based on the analysis of the material contained therein.

2. Managing Innovation

This section discusses the approaches to managing innovation from a firm perspective and does so with a specific intention of identifying where there have been blind spots and disconnections between policy level understanding of the process of innovation and the reality of how these processes are managed at the coalface. The process of managing innovation from a firm level perspective is closely related to the process of strategy development and implementation. Thinking about how firms effect strategies has evolved and an influential body of work the resource-based, capabilities approach to understanding the pursuit of competitiveness and growth is in the view of this author, most appropriate for considering issues of strategy and of management of innovation.

The section reviews work around innovation strategy, funding of innovation and the central importance of interaction and knowledge flows in innovation at the firm-level. The discussion then moves to an emerging body of literature referred to as frugal innovation,
reverse innovation or constraint-based innovation. Finally, the section identifies a number of key conclusions, which are explored more fully in the concluding section of the entire paper.

**Innovation Strategy**

Resource-based strategies define a firm’s core business development process as consisting of a series of decision-making and implementation steps that seek to search for resources and apply these in ways that add value and generate advantage over competitors. Among these resources are knowledge assets and a range of complementary assets that enable the firm to use knowledge effectively. Strategy therefore becomes a process of building complementary assets, referred to as capabilities and deploying them in directions that add value. Strategy making is inherently risky and initial conditions or starting points significantly influence the outcome of the process. Successful firms are those that have a deep stock of resources, built over time and the capabilities including decision making processes to effectively deploy these over time. Firms improve their abilities to search for, acquire and deploy resources over time and this process has been termed organisational learning. Resources and assets used by firms are varied and including financial, physical, natural, intellectual, human, and social capital. The relative importance of these various types of resources is linked to the nature of the production and consumption process in the industry in which the firm operates and also to factors such as the lifecycle of the technologies in use, and socio-economic conditions in which the firm is embedded. The implications of considering innovation at firm level from this perspective, one that is linked closely to strategic management, is that the following become clear:

- Industry characteristics have a significant influence over the nature of the innovation process and its effectiveness
- Private sector firms manage innovation as a series of decision making processes in which the optimisation of financial resources and other assets take priority over other considerations
- There exist a variety of innovation positions and paths; firms select from among these based on the resource endowments of a firm and its strategy for learning (growing the stock of resources) and competitive dynamics. The implication of this is that at an aggregate level of a region or a nation, there will be extensive variation in innovation performance at firm level, which then translates into different requirements and expectations from the ecosystem and from public policy agencies and actors. This is a critical realisation for policy effectiveness which is of concern here.

The evolution of academic thinking on how firms manage innovation is summarised in a critical review based on research in the industrially advanced countries (Hobday (2005). This presentation uses the notion of five generations of innovation processes developed by Rothwell (1994); the main characteristics of which are summarised in Table 1 overleaf.

The majority of developing countries display features that are best described by the third generation or coupling model. In this context, firms do not yet have high degree of
cross functional integration associated with fourth generation models nor a high degree of linkage with external actors such as other companies including suppliers, customers and in some cases, universities and government agencies. For most firms in developing countries active learning through distributed networking process in which firms learn through interaction within a highly differentiate network including strategic alliances and collaborating competitors is being developed. There is not as much reliance on sophisticated ICT tools as implied by fifth generation models. In order to improve innovation performance, firms would have to deploy these higher level models and would reap benefits such as speed of innovation, cost reductions and the associated market leadership.

The models suggest that the innovation process consists of three dimensions, namely: exploration, innovation and diffusion. The firm level models acknowledge that the nature of technological processes, government policy and the socio-economic environment exert an influence, but focus on intra-firm processes, milestones and decision making priorities. These models suggest that within firms, innovation is not a rational, deterministic process but one of experimentation and contingencies. Despite the tendencies of management consultants to try to reduce strategy to simple if not simplistic heuristics, evidence suggests that there is no one single approach to securing competitive advantage within a sector. Effective firms manage the processes of discovery, search and application and do so in a variety of ways, for example in the pharmaceutical industry search generates many new options, which have to be selected through drug trials, innovation in software proceeds iteratively and through modular production processes whereas in passenger aircraft prototyping is a costly, time consuming activity which requires physical investment.
Table 1: Evolution of firm-level innovation models – a summary

<table>
<thead>
<tr>
<th>Generation</th>
<th>Time Period</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>1950s to mid-60s</td>
<td>Simple linear sequential process. Emphasis on R&amp;D push. Market 'receives' the results of the R&amp;D.</td>
</tr>
<tr>
<td>2nd</td>
<td>Mid-1960s–1970s</td>
<td>Market (or need) pull; again a simple, linear sequential process. Emphasis is on marketing. The market is the source of ideas and provides direction to R&amp;D. R&amp;D has a reactive role.</td>
</tr>
<tr>
<td>3rd</td>
<td>Mid 1970s–1980s</td>
<td>Sequential model, but with feedback loops from later to earlier stages. Involves push or pull-push combinations. R&amp;D and marketing more in balance. Emphasis is on integration at the R&amp;D–marketing interface.</td>
</tr>
<tr>
<td>4th</td>
<td>Early 1980s–1990</td>
<td>Parallel development with integrated development teams. Strong upstream supplier linkages and partnerships. Close coupling with leading edge customers. Emphasis on integration between R&amp;D and manufacturing (e.g., design for manufacturability). Horizontal collaboration including joint ventures and strategic partnerships.</td>
</tr>
<tr>
<td>5th</td>
<td>Systems integration and networking model Post-1990</td>
<td>Fully integrated parallel development supported by advanced information technology. Use of expert systems and simulation modelling in R&amp;D. Strong linkages with leading edge customers (customer focus at the forefront of strategy). Strategic integration with primary suppliers including co-development of new products and linked CAD systems. Horizontal linkages including: joint ventures, collaborative research groupings, collaborative marketing arrangements etc. Emphasis on corporate flexibility and speed of development (time-based strategy). Increased focus on quality and other non price factors.</td>
</tr>
</tbody>
</table>

The evidence suggests that there is no one best strategy and rather “Different firms appear to generate alternative paths, based on their resources, size, past experiences, culture, history and particular capabilities (p.133)”. The approaches to understanding innovation draw on resource-based theories of strategic management which leads to fruitful lines of enquiry. These approaches permit investigation of the internal dynamics of the innovation process and distinguish between innovation positions, paths and processes. Positions are defined as actual market relations and resources of a firm at any point in time, dividing resources into technological and complementary and it is argued that it is necessary to understand how the current position has been shaped by historical internal learning processes, corporate history, key strategic decisions and past successes and failures, which is in fact its paths. Paths refer to the past and future strategies of the firm as expressed in actual patterns of innovation, organisational learning, investments and market achievements. In other words, the understanding of the current position is considered to be a factor of the past and to condition the future possibilities. Processes refer to organisational, managerial and operational practices that affect the technological dimension of a firm as well as set the tone for how business is done.

**Developing country firms**

While these models adequately describe innovation in advanced economies, they need to be adapted to deal with the realities of latecomer and developing countries, where firms operate within small underdeveloped markets, educational and research institutions are weak and technology often has to be acquired from outside the national context. Based on his experience with Asian markets, in which foreign direct investment in a variety of forms has been a significant aspect of economic life, Hobday (2005) also points to the need to understand the implications of various forms of ownership on innovation practice and performance. Latecomer innovation theory needs to take account of the disadvantages faced by firms and cannot take for granted the existence of technological resources and complementary assets. However, it should also recognise that there is a potential for rule-breaking and for non-imitative strategies.

There is a distinct body of thinking on innovation management that considers the nature of the innovation process for firms in developing countries. Figueiredo (2010) provides a comprehensive treatment of this literature, which he terms the “learning school”. This approach has existed for over 40 years or so, and especially from the late 1980s, there has been a profusion of studies on capability building and learning in local firms and subsidiaries of multinational enterprises (MNEs) operating in developing and emerging economies. The focus of this scholarship (see Box 1 below) has been to understand the nature of the capability building process in firms that start off with low levels or even the absence of innovation capabilities. These firms typically are initially imitative and are frequently dislocated from markets and sources of technology. For developing country firms, the process of innovation management often involves the firms first becoming familiar with various ways of acquiring knowledge even before they are able to apply this knowledge for production and then to innovation. Developing country firms are also embedded in “increasingly pervasive international networks of potential sources of technology”.
**Box 1: The learning school: focus on innovation capability building at firm level in developing countries**

| Asia | Amsden, 1989; Hobday, 1995; Kim, 1997; Mathews, 1997; Mathews and Cho, 1999; Ariffin and Bell, 1999; Ariffin, 2000; Choung et al., 2000; Lim and Lee, 2001; Mathews, 2002; Amsden and Chu, 2003; Hobday et al., 2004; Mu and Lee, 2005; Lee et al., 2005; Choung et al., 2006; Feng and Ling, 2007; Yu, 2007; Zeng and Williamson, 2007. |
| Latin America | Dutrénit, 2000; Figueiredo, 2001, 2003; Ariffin and Figueiredo, 2004; Tacla and Figueiredo, 2006; Torres-Vargas, 2004 |
| Africa | Marcelle, 2004 |
| Europe | Tsekouras, 2006 |

Source: compiled by author based on Figueiredo (2010)

Marcelle (2004) focused on how developing country firms that operate in industries with fast moving technological change manage the process of innovation. She argues that in order to compete effectively in these setting they must master the process of ‘technological learning’ which is defined as the accumulation of the capabilities needed to change and apply technologies, in contrast to the more formal type of knowledge that emerges from lab-based research and development. Her analysis developed a conceptual framework the technological capability building system and applied this to cross-sectional data drawn from twenty-six firms in four African countries, operating in the telecommunications sector suggests that the critical success factors in this process include the ability to manage strategic change and implement technological learning systematically, focussing *simultaneously* on internal and external processes.

This study found that for developing country firms there are five critical factors and achieving these require firms to invest time, effort and scarce management talent:

- **allocating financial resources** to technological learning, typically to invest in the purchase of technological hardware, employing technical personnel, delivering training, skills development and other learning routines.

- **fostering management practices** that support technological learning; for example, they employed executives who combined technical and management skills, and designed job functions that enabled these executives to bridge general line functions and technical disciplines. In addition, these companies used recruitment, reward and retention programmes to keep their technical talent both highly motivated and innovative. Such companies often have formal technological ‘scan and search’ functions, in other words procedures to monitor technological developments elsewhere. They also carried out detailed technological evaluation and assessment of both their internal capabilities and
externally available technologies. Technological activities were not relegated to a single department -- such as R&D -- within the firm. Rather, they were considered to be central features of the business strategy, thus receiving attention from the highest level of decision-making in the company.

- **developing an organizational culture to support innovation**: firms paid attention to the human aspects of technological mastery. Companies that were effective in integrating technologies into their business strategies had champions who understood technological trends in the industry, and could communicate these with enthusiasm at all levels within the firm. These champions were seen as visionaries and ‘thought leaders’ within the firm. They were not only an important source of technological knowledge and know-how, but often also acted as the lead problem-solver. Their technological expertise provided a basis for legitimising a culture of learning and creativity, and was also an important factor in spreading this culture throughout the firm. The most effective firms did not leave organisational culture to chance. They encouraged individual experimentation and creativity as organisation-wide values, along with a readiness to make mistakes and learn from them. They also built confidence, supported open learning, integrated learning across the whole firm, and aligned such learning with the overall business strategy of the company.

In addition to these factors that take place within firms, and are generally under their control, What makes innovation management particularly difficult for companies in developing countries, however, is that the technological inputs they require are often generated externally, far from their local innovation systems. Success also therefore requires firms to be able to master external factors that are outside their control. For example, it is particularly vital for such companies to manage relationships with suppliers of equipment and services. These relationships need to be managed in a way that ensures critical knowledge flows regularly and effectively between the supplier and developing country client.

- **accessing external technological capabilities from suppliers**, for example, firms are increasingly improving innovation performance by establishing joint technical teams with suppliers, and working hard to ensure that all team members enjoyed mutual respect and trust. These teams provide a supportive environment not only for the flow of knowledge that is codified in written documents, but also for the knowledge that remains tacit, and is embodied in the skills of technical personnel, and

- **accessing the local and global innovation system**: besides specific links with suppliers, linkages with the wider innovation system are also relevant. Developing country firms have the potential to access technological knowledge from a rich and diverse number of sources, which include universities, commercial suppliers, technological communities of practice (groups of people who share a common interest on a subject), international development institutions and standards bodies, industry associations, and trade fairs and exhibitions. Effective firms were able to obtain technological knowledge from these sources and to evaluate and differentiate among these sources. An additional challenge faced by companies in the developing world is that their local sources of technological information and knowledge are usually out of date, and may well be largely irrelevant. Therefore path breaking developing country firms usually found ways to interact directly with the global innovation system. Indeed, the most effective companies become a source of knowledge for
their national innovation systems. They do this, for example, by sponsoring training programmes, assisting with curriculum development and undertaking joint research with national universities and training institutions. At the same time – and primarily through the activities of their knowledgeable technological champions – they interact with their peers at the technological frontier not by publishing research papers (although this may be useful) but by actively seeking publicly available sources of technological knowledge.

This study found that that there is no trade-off between the internal elements and the external elements of this strategy. Firms in developing countries must be concerned simultaneously with developing a range of internal learning routines, and with managing assets outside their own boundaries. Companies that can strike a balance between the two will have found the formula for competitiveness. None of the five factors above are sufficient on their own to guarantee economic success. Technological learning only yields maximum benefit when it is managed as a balanced, systematic, coherent and integrated effort. In summary Marcelle (2004) concludes that developing country firms need to master internal approaches to learning and capability development similar to those used by world-class firms, while putting in place specific mechanisms to cope with the challenging local environments in which they have to operate, and with rapid technological change.

Figueiredo (2010) provides some important analytical clarifications that are relevant for taking forward work on innovation in developing country firms. He states that:

learning is defined as the various costly and deliberate processes by which additional technical skills and knowledge are acquired by individuals and by the organisation. It is cumulative and increases the firms’ stock of knowledge (or capabilities) which, in turn, permit firms to undertake innovation activities (Bell, 1984 and Malerba (1992). More specifically, it invokes considerations that relate to the intensive, persistent and effective effort to manage and invest in the process of acquiring and creating the human resources and knowledge bases that they need to conceive and implement the necessary innovative strategies. In other words, it refers to wide range of mechanisms for acquiring knowledge from external and internal sources as inputs to the process. Firms acquire knowledge, skills and other cognitive resources needed to engage in innovative activity.

As made clear in Figueiredo (2010), ‘learning’ is not restricted only to incremental innovations derived from efforts of introducing changes in technical and organisational aspects of production and product design (Scott-Kemmis and Bell, 2010). Neither is it only a mechanism to acquire knowledge from external sources – usually meaning both external to the local economy as well as external to the technology-using firm, rather than knowledge acquired via internal knowledge-creation activities (e.g. Amsden, 1989; Viotti, 2002). Further, ‘learning’ does not only refer to the acquisition of knowledge from extra-firm sources as in the influential Cohen and Levinthal (1989) treatment. Figueiredo (2010) identifies a number of important characteristics of learning and innovation management and these include:

- Issue of discontinuity in learning paths requires and need to pay more attention to the relative importance of different learning mechanisms, particularly over time as firms deepen their innovative capabilities and move on various paths of accumulation.
Need to expand the focus beyond “high-technology” industries and the “high-tech exports” to include natural resource industries such as forestry and pulp and paper industries. Figueiredo’s own work emphasises the importance of integration between external and internal learning mechanisms.

In terms of measurement issues, he suggests that traditional indicators based on R&D expenditure, and on personnel and patenting statistics, which is sometimes influenced by convenience need to be extended. He states:

Despite their merits, innovation surveys tend to capture how innovation occurs and hardly captures (if anything) aspects about the nature of the process of creating capabilities or ‘knowledge sources’. Such kinds of approach, consequently, contribute to the recent scarcity of analyses of the nature of learning mechanisms underpinning latecomer firms’ path of innovation capability building (Figueiredo 2010, page 6).

Figueiredo argues that the integration of internal and external learning which has been shown to be important for innovation being undertaken by firms in advanced economies that have already accumulated significantly deep innovative capabilities is also important for latecomer firms in emerging markets. He calls for systematic analyses that focus specifically of how latecomer firms manage more and less effectively the kinds of learning mechanisms or about how differences in the effectiveness of that management may affect the capability accumulation process.

Mushataq Khan (2008) and World Bank (2011) provide empirically based analyses of technological capability accumulation at firm-level. These studies do not explicitly draw on an innovation studies perspective, but the results point to interaction between learning and the external environment, including policy landscape and political arrangements between government and productive agents. The World Bank (2011) study does not place as much emphasis on domestic capability building and by defining the purpose of their study as technology absorption in the view of this paper, risks underestimating the agency of developing country firms, assuming that there are always beneficial impacts from FDI and understating the blockages to capability building.

**Funding innovation**

Literature on the importance of financing, and in particular the role of venture capital in fostering innovation is typically drawn from studies in developed countries that are characterised by well functioning capital markets (e.g., see Sahlman, 1990; Megginson and Weiss, 1991; Lerner, 1994 & 1995; Gompers, 1995; Amit et al, 1998, Zider, 1998; and Hamao et al, 2000 cited in Ojah 2011, p. 1). These studies confirm that venture capital in addition to providing financial capital, plays an important role in mitigating information asymmetries, Effective venture capital investment combines finance and management advice and the VC principals often play an important role in shepherding start up companies through difficult stages of development. Scholars looking at the functioning of venture capital also emphasise the need for fund and investment managers to have specialist knowledge and a depth of understanding of the nature of the industries in which they fund, including regulatory frameworks. This is particularly true in the pharmaceutical industries and in energy and clean tech where government sets the rules for adoption of the goods or services and licences for production are often long in duration. Bertoni et
al (2011) in studying the effect of VC financing on firm growth and performance make an important distinction between the ability of VC firms to select high performing firms and to treat firms that they finance in ways that enhance their performance. Their study of Italian firms found a large positive effect attributable to injections of finance, to provision of coaching and other types of non-financial support. They did not find support for the claim that VCs were better at identifying high performing firms.

Ojah 2009, Ojah and Mokoaleli-Mokoteli 2010, and Ojah 2011 provide a good assessment of the role of venture capital in enterprise development in an African context. They conclude that VC financing produces the expected general effects and further that this role is particularly important in environments such as South Africa where there is evidence of risk averseness in the formal banking sector and capital markets are relatively thin. Ojah (2011) provides an important empirically based assessment of the role of venture capital in the South African market from which this paper derives a number of important points. The study found that venture capital finance enhances the performance of firms when the VC firms are motivated by removing information asymmetries rather than maximising returns on exit and contributed to improvements in corporate governance among VC backed firms. Interestingly the study also finds that the job creation potential of venture capital financing is maximised post-exit when the firms supported by VCs graduate to other forms of financing such as becoming publicly traded. While under the supervision of VCs, a period, which for South African firms averaged two-five years, the number of employees was relatively low at eight. Data analysed by Ojah (2011 Table 2, page 10) showed that venture capitalists and non-venture backed IPOs had the same industry distribution, except in the case of manufacturing companies. Finance and technology being the most highly represented sectors for both venture backed and non-VC financed IPOs.

As shown in the table below taken from Ojah (2011 p. 24) the structure of venture capital financing has shifted dramatically over the last decade with late stage funds coming to dominate

Table 2: Venture Capital in South Africa

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funds under management</td>
<td>34.70</td>
<td>35.90</td>
<td>37.00</td>
<td>39.30</td>
<td>30.70</td>
<td>42.50</td>
<td>59.30</td>
<td>86.30</td>
<td>103.10</td>
</tr>
<tr>
<td>Funds raised</td>
<td>1.70</td>
<td>1.20</td>
<td>1.30</td>
<td>4.90</td>
<td>2.30</td>
<td>2.2</td>
<td>14.50</td>
<td>15.40</td>
<td>7.20</td>
</tr>
<tr>
<td>Early stage funds as % of funds raised</td>
<td>41</td>
<td>50</td>
<td>15</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Late stage funds as % of funds raised</td>
<td>59</td>
<td>50</td>
<td>85</td>
<td>86</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>99</td>
<td>92</td>
</tr>
</tbody>
</table>

the type of financing (in 2008 accounting for a whopping 92% of all funds raised), up significantly from 59% in 2000. The quantum of funds under management by the SA venture capital market is not large and the growth has not been impressive; its composition being so heavily skewed towards late stage funds also means that firms operating in industries where risky, early stage funds are required are not being well served.

In terms of recommendations and specific implications for fostering innovation these studies confirm that more segmentation is required in the risk financing markets, so that large, risky projects can gain access to financing from financiers who possess a wealth of experience and can support firms’ operations, while there is a role for government or NGO backed types of private equity funds with a focus on financing cottage industry type venturing in the informal economy. The structuring of private venture capital funds on late stage funds has left a gap in the market for early stage finance, which might be closed through risk-partnering arrangements between the state and quasi-public institutions such as the IDC and TIA. Private venture capital firms in developing countries are increasingly partnering with large global foundations, multilateral organisations and governments to structure risk-sharing arrangements. There are many successful examples in the health care, pharmaceutical sector in particular and private sector actors present in this field welcome greater participation from government in novel arrangements. In private communication for this research, one respondent lamented the infrequency with which there are smart partnerships in South Africa and pointed to experience in other African markets for models. Other studies of the biotech sector in South Africa have pointed to restrictive intellectual property regimes serving as a constraint on financing and investment by non South African firms, wishing to partner with local companies.

Recent work by Filippetti and Archibugi (2011) points to the importance of cyclical effects in funding innovation in their examination of the effects of the financial crisis on innovation investment. This is a line of enquiry that should be explored in order to test for the persistence of innovation. The policy implications arising from these findings calls for government backed VC investors to avoid crowding out private sector VC financing unless they can match the sophisticated skills provided. In Europe, the existence of public subsidies and other fiscal incentives has led to a reduction in the likelihood of new ventures searching for VC finance and this may have led to them no receiving the added benefits.

**Linkages, networks and interaction**

The innovation strategies of private sector firms puts considerable emphasis on interacting with a range of other organisations, most importantly to source inputs such as equipment, knowledge and specialist advice. The relative importance of different sources of these inputs is industry specific and also relates to the type of production process and the nature of knowledge required.

Freeman (1991) provides an insightful synthesis of research on linkages and networking, in which he identified ten types of network that are important, these include: joint ventures; joint R&D agreements; technology exchange agreements; direct investments; licensing; subcontracting, production sharing and supplier networks; research associations; government sponsored joint research programmes; computerised information networks and value added services for technical and scientific interchange and finally informal networks. This typology presupposes complex and sophisticated infrastructure on the part of companies and the actors with which they network.
Linkages deliver value for firms when there is bi-directional interaction in which knowledge circulates freely and can be applied to improve innovation performance. This requires actors in the knowledge circulation process to have shared meanings, understanding, and objectives. Governments around the world have designed agencies that aim to support the innovation performance of firms – both small and large – and the most effective have paid attention to the need to have active, meaningful linkages and interactions with firms. There are also efforts to improve the extent to which firms interact among themselves. These interactions are considered as useful sources of knowledge about technological trends, production processes, and competitive intelligence and may extend to joint projects of technology development and exploitation. It also includes communication between suppliers of goods and services and their customers.

Arnold and Thuriaux (1997) emphasise the need for segmentation by first providing a generic typology of four types of firms ranging from firms with no meaningful technological capability, through to firms with minimum capability, onto firms with some technological components and finally to firms who are research performers. Building on this typology, these authors also provide an important recommendation by suggesting that in designing networks and interaction interventions, government agencies should take into account the segmentation of firms, particularly in terms of size and capabilities. These authors suggest a progressive approach starting with proactive mentoring, moving to basic capability development, on to specific capability development before transitioning to technological development and research services. This approach is highly recommended in the case of developing countries because it recognises the issue of the importance of gaps between the suppliers of innovation support services and their “users” the firms that actually operate in the productive sphere. Recent research in developing countries such as the findings of periodic Innovation Surveys confirms that the majority of developing country firms do not regard interaction, particularly with public sector bodies and universities, as being important for their innovation processes. In the view of this paper, this may be explained in part by a failure to have a segmented approach to designing and delivering the services of these public bodies.

Landry (2011) found that structural social capital (business network assets, information network assets, research network assets, participation assets and relational assets) and cognitive social capital are important for innovation. Some of these are more amenable to policy intervention, while others are features of social and cultural systems and deeply encoded.

**Recent thinking on innovation strategy**

This paper argues that there is an exciting opportunity to revitalise innovation public policy and stimulate private sector-led innovation-centred growth by taking account of recent thinking on innovation strategy. These advances are classified by academic scholars, using various terms, including: frugal innovation; constraint-based innovation; reverse innovation; innovation at the bottom of the pyramid; grassroots innovation and user-centred innovation focused on economically deprived groups. What is clear despite the range of definitions is that there is a major emerging trend in innovation strategy at firm level within developing countries. Here the paper wishes to make an important distinction between these for-profit strategies and many social innovation experiments that are also aimed at addressing the needs of the poor and marginalised communities.
Very recent empirical work points to the growing variety of innovation strategies that are particularly well suited to the context of developing countries such as a potential customer base with low relative income levels, infrastructure challenges and unreliable supply responses. The evidence shows that successful developing country firms are approaching these conditions not as barriers to innovation, but as an opportunity to use local knowledge and understanding of context to better serve these markets. Observations also suggest that developing country innovators are hyper-interactive and pursue knowledge search and acquisition more intensively than their counterparts in wealthy countries.

In a much cited special issue in the Economist, Adrian Woolridge (2010 p.) states:

Developing countries are becoming hotbeds of business innovation in much the same way as Japan did from the 1950s onwards. They are coming up with new products and services that are dramatically cheaper than their Western equivalents: $3,000 cars, $300 computers and $30 mobile phones that provide nationwide service for just 2 cents a minute. They are reinventing systems of production and distribution, and they are experimenting with entirely new business models. All the elements of modern business, from supply-chain management to recruitment and retention, are being rejigged or reinvented in one emerging market or another.

In this article the author suggests that the common features of this new management paradigm pushes two familiar ideas beyond their previous limits: that the customer is king, and that economies of scale can produce radical reductions in unit costs. He states that in emerging markets, companies are starting with the needs of some of the world’s poorest people and redesigning not just products but entire production processes to meet those needs. The evidence included in the Economist survey pointed to an interest trend of emerging-market firms “leapfrogging” Western ones. For example, mobile-phone companies are pioneering mobile money in Kenya and elsewhere. Computer-games makers are introducing several innovations in the emerging world, such as the use of mobile phones for video-gaming and the creation of a market in “virtual” goods such as swords and toys.

Researchers writing in Knowledge@ Wharton (2011) note that firms that are sourcing innovation from within mostly large, rapidly developing economies are now moving beyond supplying end users in home markets, to exporting including to the developed world. The developing country firms that are now suppliers of innovative solutions were once viewed as low-cost copycats, but have over time moved up the value chain, creating innovative products with global appeal. The analysis presented suggests that the financial and economic crisis which has meant that much of the developed world is characterised by high incomes but slow GDP growth in contrast with the explosive GDP growth but low household incomes in rapidly developing economies -- most notably China, India and Brazil. This position is borne out by significant investments made by companies such as GE, which has invested in an integrated multidisciplinary research and development centres in Bangalore. This facility operates as a state of the engineering lab and its experiments are thought to have contributed to cost reductions in production and decreased time to market. Other examples are shown in Box 2.

Vijay Govindarajan, Dartmouth University scholar who is credited with the term "reverse innovation" is quoted as follows:
Historically, innovations have always happened in rich countries.... in the future, innovations will have to take place in countries like India and China, because this is where the bulk of the customers are. The needs are more pressing here and the sheer volumes will justify the investments that will be required for developing the appropriate products (Knowledge@Wharton 2011b p. 1)

Box 2: Examples of reverse innovation, frugal innovation and constraint-based innovation

- Cemex (Mexican cement company) redesigning credit programmes to enable more consistent purchases of cement and use of GPS technology to introduce “just in time” supply to small contractors
- Tata (affordable cars)
- Chinese tablet computer manufacturer has designed a device equivalent to the iPad expected to retail for about $80, or a fifth of the iPad’s $499 base price at launch.
- Haier, Chinese appliance manufacturer that redesigned washing machine to better suit needs of customers which included using the equipment to wash vegetables as well as clothing
- A European carmaker is also midway through a new design -- for vehicles targeting several emerging markets. The company is borrowing design features and manufacturing ideas from its joint venture partner in India.
- Fiat Brazil’s Fiat Mio, an urban-targeted compact car, is being designed in Brazil for global markets.
- GE investment in health care devices and systems
- Eye surgeries and other medical procedures at a fraction of cost in the Western world and Japan

Source: compiled by author based on Knowledge@Wharton (2011 a, b); Sull et al(2004) and Schanz et al. (2011)

The emergence of these cases, even if they are still somewhat isolated and concentrated in the BRIC countries, has also led to rethinking of conventional wisdom on innovation strategy and is leading possibly to what some authors have termed a disruption of technology transfer models (Herstatt et al 2008). Conventional wisdom has suggested that factors influencing the location choices of MNC R&D investment include: market potential, agglomeration, public and private R&D intensity, proximity to leading universities or centres of research excellence, and strong IP policies (OECD 2008), the evidence reported here appears to countries with these locational assets is shifting to Asia and also the perception of Western MNCs regarding where good ideas can be found is also becoming transformed. These trends are important to note and developing countries should consider why and how decisions about the globalisation of knowledge has shifted and where they are positioned in terms of relative attractiveness.

This reconfiguring of knowledge flows and location of R&D also has another important effect in that if provides a basis for questioning some long held assumptions about the role of MNCs in delivering value from local knowledge. Academic writing and even the views of policy makers have put great store on the need to acquire managerial competence of an inward-investing transnational corporation to exploit local knowledge. These examples turn this notion on its head by demonstrating that not only does the know-how exist but it is complemented by advanced skill and capabilities. Firms that are successful in frugal innovation have a capability that is focused on a better understanding of the markets and customers. The world is only on the tip of the iceberg of this trend and in the opinion of this writer, only very few emerging countries will be positioned to
lead in this brave new world. It will be those countries that have invested in knowledge, skills and learning and in so doing conferred the confidence to rely on domestic solutions and turn these into export opportunities. This emergence should also call into question that almost religious approach to reliance on market mechanisms in the purest sense as opposed to other more mixed and pragmatic forms of development strategy, because in many cases the technological mastery and associated confidence to experiment and move into design was undertaken during years of “protection” and with state support. Khan (2008) presents a well researched case of a variety of strategies used by firms to respond to changes in trade regimes and under various ownership forms.

Emerging-market firms have developed unique and effective ways to respond to local conditions, many of which are challenging and representative of deficiencies in demand and supply. These approaches some argue have led to a coherent management system that applicable in rich and poor countries. However, given the purpose of this paper it is worth noting that the theory-building as well as conceptual and empirical research on this phenomenon is largely being led by Western business schools, though with an over representative contribution of non-resident Indian scholars. The geography and the politics of knowledge production on this topic, in this authors view will have implications for how it is taken up in public policy and in corporate strategy. Exhibit 1 provides a summary of the new wave of thinking on innovation.

**Exhibit 1 Summary of the frugal innovation phenomenon**

![Exhibit 1 Trends in globalization and innovation from emerging market firms](source: Bhatti, Y. Page 4, Figure 1)
This opportunity provides what this writer considers to be the most exciting departure for public policy to promote innovation and strategic management of innovation at the firm level. It is also the contention of this paper that the trends that have generated excitement across a number of sectors in the last five years were observable to discerning commentators in the late 1990s, when the African telecommunications services boom was pioneered, not through inward foreign direct investment, but through the entrepreneurial and innovation-driven strategies of local firms. In the view of this author, the decision taken by MTN (then M-Cell) to invest in the Nigerian telecommunications market proved to be a watershed for the application of technology-intensive approaches to business strategy in the African context. That the history of innovation in African and developing country telecoms is being retold as a success story for Vodaphone, is a travesty. There continues to be a dearth of examples in the business and academic literature describing this new wave that credit Africa with any agency in this regard. There are some signs that this is beginning to change, with the performance of the African continent proving to be resilient and less vulnerable to the global financial crisis.

3. Conclusions and Recommendations

This section summarises the key research findings and discusses the implications of these for innovation performance and innovation policy picking up issues that are as relevant for firms as they are for policy makers.

Key Findings

The learning school that draws on resource-based approaches to strategy are considered to be most fruitful for understanding processes of innovation at firm level. In these approaches, the capabilities of firms which include a stock of resources that permit them to undertake production and differing degrees of innovation activity are important. Such capabilities are both in the nature of ‘human capital’ (i.e. specialist professionals, knowledge bases and skills/talents that are formally and informally allocated within specific organisational units, projects and teams) and ‘organisational’ (the firm’s internal and external organisational arrangements such as their routines and procedures, linkages, managerial systems, including the firm’s values, norms and beliefs that are reflected in its management style and behaviour e.g. in the form of entrepreneurial management or ambitious innovation strategies. Using these resources, firms accumulate production-based and innovation capabilities over time in a managed process. It is this capability building process that is central to a firm’s innovation performance since it determines the types and levels of innovative activity that firms can undertake as well as the speed at which innovation improves.

This paper wishes to emphasise that countries do not innovate, firms do. By examining innovation at the firm-level it becomes evident that the usual rules of business strategy apply; therefore an effective innovation strategy also needs to be accompanied by a competitive strategy that is non-replicable and differentiated. This explains that at a country level, even among successful innovators there is considerable differentiation as China has concentrated on manufacturing, India on services, Brazil on energy and Russia on energy and commodities. This understanding of the factors leading to and the benefits of differentiation needs to be further
extended this to the firm level. What is clear is that policy on its own is insufficient and in order to realize success, innovation strategies require firms to have financial resources, management savvy and knowhow. It is also true that these are not equally dispersed across all firms. In developing countries, particularly in Africa there is considerable experimentation outside of the manufacturing and services sector, and therefore it is important to emphasise that the rubric of firms may just as well apply to farms. In fact, there are many examples of institutional innovations that have been reported in the agricultural sector. It is important to convey a message that firms acting with constrained agency can not only affect their innovation performance but can outperform the level that would be suggested by the national policy landscape.

For developing country firms incremental innovation accounts for the largest proportion of innovation activity, which is undertaken in collaboration across a variety of actors including suppliers of equipment and customers. However, the extent of linkage with and interaction between private sector and public sector organisations is still limited and not highly regarded as a source of input for innovation activities. Developing country firms often face difficulties in raising funds to finance innovation both from within and outside their own internal resources. In this context, government funding of innovation related activities in private sector firms is welcomed and not considered to be a crowding-out factor.

Policy implications

This paper calls for a shift in the mindset, the unit of analysis and the work programmes that constitute innovation policy. This writer believes that these changes are highly recommended in order to improve the effectiveness and meaningfulness of innovation. Guidance for this view is provided by the analysis presented here. The writer notes that these views are in line with those of influential scholars who expressed these positions more than forty years ago, influential scholar Nathan Rosenberg with then emerging academic David Mowery had this to say about the study of innovation:

"Until quite recently, economists devoted little attention to the factors which influence the rate and direction of innovation. Much of the formal economic theory on technical change is really concerned with the description of the consequences of technological innovation at a very high level of aggregation or abstraction....Little consideration has been paid to the study, at a less aggregated level, of the specific innovative outputs of industries and firms, and the forces explaining differences among industries, firms, and nations. Serious empirical work on biases and inducements in the innovation process, at an industry or firm level of analysis, is even more conspicuously lacking. (Mowery and Rosenberg 1979, p. 103-104)"

The firm-centred approach to designing and implementing innovation policy is highly recommended but is not an easy option, because it will require state actors to admit and acknowledge that they are not in full control of the outcomes of the process. In this approach the state is required to adopt a posture of facilitation of an emergent process rather than controlling a rational and predetermined process and this takes confidence and organisation. It also requires the actors involved to work together with mutual trust and in partnership. This is because amongst other things, as is stated here:
The innovation process surely comprises an area of economic behaviour in which uncertainty and complexity are absolutely central characteristics of the environment; empirical approaches to the problem must therefore take far greater cognizance of the processes which underlie the output of innovations. Rather than focussing exclusively upon innovational outputs at widely separated times, a more fruitful approach might be that of tracing the growth and evolution of a given organizational form involved in the research and innovation processes, in an effort to provide a somewhat deeper analysis of the evolution of the information flows and processes which are responsible for success (or failure) in the production of innovations over a period of time; changing the unit of analysis in this manner might yield a richer set of conclusions and studies than is currently the case (Mowery and Rosenberg op.cit. p. 146)

The government ought indeed to take whatever steps it can to improve the functioning of the private market and the complex incentive system which is mediated through market forces. But such measures, although eminently desirable, are not nearly sufficient. For the production of new knowledge which underlies and shapes the innovative process is, itself, very inadequately served by market forces and the incentives of the market place. (Mowery and Rosenberg op. cit. p.147)

These reflections confirm that putting firms at the centre of innovation policy and theorising remains intractable. However, there is some progress, as countries appear to be accepting the need for greater segmentation and tailoring of effort in order to better align goals, tasks and measures. OECD (2011) has reported that many countries are making efforts to unleash the potential of firms as producers of innovation outcomes, making the decision on the appropriate centre of gravity for innovation policy will require careful diagnosis.

**Figure 1: Innovation Policy focus**

![Diagram of Innovation Policy focus](source: OECD (2011) p. 264)
Linkages are central in effective innovation systems. However, public bodies are still learning how to interact effectively with the private sector and this remains an important opportunity for learning and policy experimentation. The evidence of this trend are reviewed in countless examples from Europe (see Arnold, E and Thuriaux, 1997), a number of OECD innovation reviews and some studies from developing countries (Khan 2008, Chaminade and Vang 2009, Intarakumnerd, 2002 and Intarakumnerd et al., 2011).

Recent research carried out by the author in South Africa suggests that there is much work to be done to engage the private sector and to place this as a focus (Marcelle 2011). Senior private sector figures are reportedly unfamiliar with the details of the measures and organisational arrangements that exist for innovation policy design and execution. These business leaders call for greater demonstration of the value of innovation and an enhanced role by the state in creating excitement and promotion of an innovation culture. What is also clear is that business leaders consider innovation to be a central part of business strategy and an imperative, which happens regardless of the innovation policy landscape. From a private-sector point of view, the conceptual distinctions between technological and non-technological innovation is a non-issue, precisely because innovation is regarded as a sin qua non to deal effectively with competition, desire for international expansion and the business cycle. Despite the lack of familiarity and regarding policy as not being important, there appeared to be great willingness and disposition to reduce the current disconnections between policy makers and business leaders. There were many positive commendations for policy officials including their accessibility and willingness to engage on issues raised by the private sector, even despite the existence of regular and organised mechanisms. The general sense is that while the innovation policy is not particularly significant as a determinant of innovation performance, it is also not a barrier.

This writer argues that policies that do not include firm-level perspectives are suboptimal. Using recent empirical work in South Africa she shows that without this approach innovation policy approaches both at national and regional levels are blunt instruments which do not acknowledge or respond to variation in innovation positions, paths and processes. These undifferentiated policies result in persistent challenge of funding innovation, even in areas that are earmarked for strategic focus such as the biotechnology industry. These weaknesses despite government intention call for a major departure from current mode of operation is required. In the input papers to the South African government, this writer suggests that constraint-based or frugal innovation presents an exciting opportunity as does large scale innovation programmes in areas such as renewable energies, waste management, housing and transportation. Making these reorientations in the scope and design of innovation programmes will not only foster improved partnerships between market and the state but will contribute to the political problem of demonstrating the relevance of science, technology and innovation spending. As it stands, private sector firms under invest in R&D in important areas and universities and other public research bodies give them insufficient priority. The state can play a major signalling role and stimulating investment including through procurement and leveraging of public funds.

Firm-level perspectives represent a fruitful line of enquiry that has the potential to improve the innovation outcomes in developed and developing countries. The author recommends that UNCTAD and the CSTD take steps in its work programme to explore these areas.
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