Paper to be presented at the DRUID Academy 2012

on

January 19-21
at
University of Cambridge /The Moeller Centre

Firms? Networking and Innovation Performance in Nigeria

Abiodun Egbetokun
Friedrich-Schiller University, Jena
GK-EIC
abiodun.egbetokun@uni-jena.de

Abstract

A consistent positive relationship between firms? networking activities and innovativeness has been established in the recent theoretical and empirical literature on innovation, but with very little contributions on services, different innovation types and especially from the developing world. This paper addresses questions concerning the relationship between networking strategies and innovativeness of firms, using innovation survey data on Nigerian firms. The results show a positive relationship between a firm?s innovation performance and its breadth of external knowledge sources. This relationship varies across different innovation types and between manufacturing and services. In particular, a larger portfolio of knowledge sources is demonstrated to be more associated with innovation. For policy, this implies that it is more useful to encourage broader cooperation rather than merely emphasise on a specific dimension such as university-industry interactions.

Jelcodes:L14,O32

Firms' Networking and Innovation Performance in Nigeria

Egbetokun, Abiodun A.[1]

Abstract

A consistent positive relationship between firms' networking activities and innovativeness has been established in the recent theoretical and empirical literature on innovation, but with very little contributions on services, different innovation types and especially from the developing world. This paper addresses questions concerning the relationship between networking strategies and innovativeness of firms, using innovation survey data on Nigerian firms. The results show a positive relationship between a firm's innovation performance and its breadth of external knowledge sources. This relationship varies across different innovation types and between manufacturing and services. In particular, a larger portfolio of knowledge sources is demonstrated to be more associated with innovation. For policy, this implies that it is more useful to encourage broader cooperation rather than merely emphasise on a specific dimension such as university-industry interactions.

Keywords*: ego networks, collaboration, external knowledge, absorptive capacity, Nigeria, manufacturing, service*

JEL Codes: L14, O32, C30

DRAFT. PLEASE DO NOT CITE.

[1]Graduate College "Economics of Innovative Change", Friedrich Schiller University of Jena, Germany; Financial support from the German Research Foundation (DFG) is gratefully acknowledged.

1. Introduction

When networking is understood as a firm's set of relationships with other organizations (Perez Perez and Sanchez, 2002) or agents such as suppliers and customers (von Hippel, 1988), universities (Laursen and Salter, 2004), competitors and financial institutions (Souitaris, 2001), it becomes apparent that the locus of innovation is shifting away from the individual or even the firm to the network within which the firm is embedded (Powell et al, 1996). This is because in the knowledge-based economy within which firms now operate, change is rapid and no single firm can possibly possess all the knowledge and capabilities necessary to innovate (Chesbrough, 2003a). Firms pursue different strategies to acquire knowledge relevant for innovation from several possible sources. These strategies could be formal (involving active participation in joint R&D and other technological innovation projects (Tether, 2002)) or informal - simply 'talking to' actors (involving the use of actors as sources of information for innovation (Freitas et al, 2011)). It could also be intensive (implying 'depth' or intensive use of certain knowledge sources), extensive (implying 'breadth' or the so-called 'portfolio' approach whereby the firm involves many actors) (Duysters and Lokshin, 2011), or a combination of both.

In the recent theoretical and empirical literature on innovation, a consistent positive relationship has been established between firms' networking activities and innovativeness. By participating in networks or establishing external linkages, firms gain access to knowledge, lower transaction costs, division of labour, shared risks and higher probability of innovation success (Malerba and Vonortas, 2009; Pittaway et al, 2004). Several empirical contributions have indeed shown that the use of external knowledge sources or collaboration partners tend to make firms more innovative (de Man and Duysters, 2005; Laursen and Salter, 2006; Leiponen and Helfat, 2010; Lee et al, 2010; Tomlinson, 2010; Freitas et al, 2011). In general, three major results are established in the existing literature: first, the innovation landscape is now such that firms can no longer 'go it alone'; secondly, firms increasingly network with and draw upon multiple external sources to complement internally-generated knowledge; and thirdly, such networking enhances innovation performance. However, a better and more holistic understanding of the relationship between networking and innovation involves certain dimensions which are relatively under-explored in the existing literature.

One particular example is the relationship between the strategies that a firm adopts in networking and its innovativeness. Previous empirical contributions have shown that a larger portfolio of knowledge sources improve innovation performance (Amara and Landry, 2005;

Laursen and Salter, 2006; Leiponen and Helfat, 2010). More innovative firms typically use larger portfolios of network partners. However, the literature is generally confined to a consideration of the 'breadth' of external knowledge sources. Thus, the understanding on how the size of a firm's 'portfolio' of partners, particularly collaboration partners, relates to innovation performance is limited, especially in the context of developing countries. By employing 'breadth' measures which take into account the total number of actors that a firm interacts with, this paper explores the relationship between formal and informal networking strategies and the probability of a firm to innovate. The emphasis, therefore, is on the ego-centric networks of firms and not on the details of the network structure.

In addition, the question of whether or not there are variations in the relationship of formal and informal networking strategies with different innovation types is taken up in this paper. As noted by Pittaway et al (2004) after reviewing a large number of empirical contributions, the literature until now has focused more on product and process innovations, often placing emphasis on R&D or the development of new-to-the-world products and processes. By using broad definitions of innovation and distinguishing between four types, namely: product, process, marketing and organisational innovation, we test the expectation that formal interactions are more strongly associated with technological (that is, product and process) innovations and informal interactions are more strongly associated with non-technological innovation (that is, marketing and organisational) innovations.

The other issue which this paper analyses relates to the possibility of interaction effects arising from the simultaneous use of both formal and informal networking strategies by firms. In the literature, except for a few exceptions like Bönte and Keilbach (2005) and Freitas et al (2011), formal and informal interactions have generally been considered in isolation. Consequently, the innovation process seems simplified and the possible simultaneity of formal and informal interactions is not well understood. In this paper we take into account the possibility of significant interaction between the choices of the firm's networking strategy, that is, formal or informal.

In addressing all of the research questions, I take into account the absorptive capacity of the firms. Since the acquisition and exploitation of externally generated knowledge has associated costs, mostly in the form of learning and capacity building investments (Cohen and Levinthal, 1994), we expect that the absorptive capacity of firms will play a role in the network-innovation relationship. I also distinguish between service and manufacturing firms to explore any differences that might exist between them as far as the networking-innovation relationship is concerned.

This paper contributes to the literature in several ways. First, much of the evidence presently available is heavily tilted towards the developed country context. The empirical evidence on learning and collaboration for innovation is very thin for the less developed countries even though linkages are fully recognised as important determinants of knowledge flows and firm learning in their context (Goedhuys, 2007a). I note here that this is particularly true for Africa where most existing studies are either based on clusters or case studies. This is highly connected to the scarcity of innovation data on African firms. The analyses in this paper are based on the first CIS-type innovation survey dataset collected first-hand from manufacturing and service enterprises in Nigeria. The dataset allows us to operationalise the research questions by focusing on the ego-centric networks of the individual firms and not on the details of the sectoral or industrial network structure. Secondly, there are very few (if any) micro level studies which explicitly link networking to different innovation types beyond product and process innovations. Thirdly, until very recently, innovation studies have focused on the manufacturing sector. This paper adds a developing country perspective to the growing body of evidence on innovation in the service sector.

The rest of the paper is structured as follows. In the next section the theoretical basis is laid and the hypotheses are presented. This is followed by a brief discussion on the research context. Section 4 contains a discussion of the data and variables as well as the descriptive statistics. The results are presented and discussed in Section 5 before the paper concludes in Section 6.

2. Theory and Hypotheses

2.1. Absorptive Capacity and Networking

Research in evolutionary economics particularly emphasises the role of knowledge from outside the firm's boundaries. External knowledge from the firm's environment is an important source of variety. Such knowledge allows the firm to innovate by making new combinations of knowledge (Nelson and Winter, 1982). For appropriating such knowledge, and to achieve recombinant novelty, firms require a certain level of absorptive capacity (Nooteboom et al, 2007) which is largely determined by in-house R&D (Cohen and Levinthal, 1989). However, many innovative firms now spend little on R&D and yet they are able to innovate successfully by absorbing knowledge and expertise from a wide range of external sources (Chesbrough, 2003b, 2003c). These sources typically include universities and research institutes which are believed to indirectly transfer knowledge via the publication

of research results, technology transfer or graduates offices (Drejer and Holst Jørgensen, 2005; Hoppe and Ozdenoren, 2005). Assimilating and exploiting this knowledge require that firms develop their absorptive capacity which is related to firms' internal R&D efforts (Cohen and Levinthal, 1989, 1990).

For instance, among UK firms, Laursen and Salter (2004) found that R&D expenditure is associated with the use of knowledge from universities. But when the breadth and depth of external search activities were considered together with R&D intensity, a substitution relationship was found (Laursen and Salter, 2006). What one might infer from the foregoing is that although firms require R&D-driven absorptive capacity to internalise spillovers, the need to search far and wide for these spillovers is de-emphasised when firms invest highly in R&D. However, these results were obtained only for product innovation. In developing countries where firms are mostly small or medium-sized with very little R&D resources, the attractiveness of research-based knowledge sources such as universities is questionable. Moreover, given the relatively less radical nature of innovation in these countries, it will be useful to understand how absorptive capacity moderates the interaction between external search for knowledge and other innovation types besides product innovation.

2.2. Innovation and networking in a developing country context

Innovation is an interactive process (Lundvall, 1988) requiring that innovators relate with a broad range of actors (Lundvall, 1992) or even as a social process contingent upon the institutional structures within which it is embedded (Oyelaran-Oyeyinka, 2006). The popular 'innovation systems' approach is actually based on the main idea that firms' innovativeness is strongly influenced by the institutional and socio-economic context within which they operate (Edquist, 2005; Lundvall et al, 2009). This is consistent with the notion of contingency which suggests that *context matters.* Different actions and outcomes occur under different conditions; thus, what works in one context might fail in another (Noteboom, 1994). Consequently, one would not expect that the theoretical and empirical findings from the developed country context will be directly applicable to developing contexts.

In the context of developing countries innovation has been described as a process by which firms master and implement the design and production of goods and services which are new to them, irrespective of whether they are new to their competitors, their countries or the world (Mytelka, 2000). Hence, innovation takes place when products and processes that are new to a country or to an individual enterprise are commercially introduced, whether or not

they are new to the world (UNCTAD, 2007). Consequently, minor and incremental changes, including innovative approaches to organization and marketing, are a major part of innovation in developing countries. In particular, marketing and organizational innovations are of major importance for firms in this context. A very extensive discussion of this can be found in Annex A of the Oslo Manual (OECD, 2005).

One of the main sources of the differences between firms in developed and developing countries is the costly nature of innovation. In backward economies it is much more difficult to muster sufficient financial and knowledge resources for innovation (Schmitz, 1982). In the specific case of Nigeria, Biggs et al (1995) noted that the context for manufacturing is of a harsh economic and institutional nature. One specific way by which firms substitute for their resource deficiencies is through networking. In a Nigerian case study, it was found that, among the many sources of information that was available to the firm, the 'ad-hoc' sectoral network institution created by the firms themselves particularly supported technological learning and innovativeness (Egbetokun et al, 2010). In Tanzania, the evidence presented by Goedhuys (2007a) showed that collaboration can support innovation in local firms in developing countries, even when they invest less in new machinery, training and R&D. In particular, these firms prove to be more embedded in the domestic industrial structure and also source information from the internet. Furthermore, in a comparative study of two enterprise clusters in Nigeria, Oyelaran-Oyeyinka (2005) reported that informal collaboration among enterprises (induced mainly by competitive forces) grew over time.

It is therefore without question that networking is important for innovation, and even more so in developing countries. However, the understanding of how different networking strategies could be associated with different innovation types, and the importance of number of network partners is still limited, particularly so in the context of developing countries. Furthermore, the evidence on the benefits of external interaction is not conclusive even for developed countries. For instance, while there are empirical studies suggesting that firms become better at innovating as they use more external knowledge sources (Leiponen and Helfat, 2010), there are also some suggesting that internal knowledge sources rather than external (particularly via collaborative agreements) are more likely to be effective in increasing innovation performance (Frenz and letto-Gilles, 2009). In this regard, very little is known about developing countries. Interestingly, the literature does seem to agree for both developed and developing countries that the innovation activities of firms are strongly determined by relations between themselves and their suppliers and customers (Laursen and

Salter, 2006; Goedhuys, 2007a,b). In a sense, this calls to question the policy emphasis being placed on university-industry interactions.

2.3. Networking Strategies and Innovation

2.3.1. The role of portfolio size

Many empirical studies have shown that better innovation performance generally arises when firms adopt a portfolio approach to networking. Specifically, firms are believed to innovate more when they interact with and use knowledge from multiple and diverse sources (Duysters and Vanhaverbeke, 1996; Belderbos et al, 2004; Faems et al, 2005; Amara and Landry, 2005). More recently, based on different samples of UK firms, Laursen and Salter (2006) and Leiponen and Helfat (2010) concluded that greater breadth of innovation knowledge sources is associated with greater innovation success at the firm level. This positive relationship has been shown to have a finite maximum beyond which diminishing returns to breadth might begin to appear (Laursen and Salter, 2006; Duysters and Lokshin, 2011) possibly due to the attention allocation problem (Ocasio, 1997). Specifically, some of the results of Laursen and Salter suggest that the benefits of breadth of knowledge sources decrease as the novelty of product innovation increases.

Notwithstanding, the evidence seems conclusive that it is indeed beneficial for firms to engage multiple actors and knowledge sources in their innovation efforts. However, besides being limited in terms of evidence from the developing country context, the empirical literature seems to deal more with the issue of informal network partners – generally conceptualised as the breadth of external knowledge sources. Studies looking at the formal dimension of networking typically isolate each potential partner and focus almost exclusively on the research-intensive sources such as universities (e.g. Jaffe, 1989; Laursen and Salter, 2004; Tether, 2002). Studies looking at both formal and informal networking strategies in combination tend to under-explore the breadth dimension by treating each actor in isolation (e.g. Freitas et al, 2011). But is there any advantage associated with breadth of cooperation especially for manufacturing firms in a developing country? The expectation being tested is as follows:

> *H1: The size of a firm's portfolio of partners (i.e. breadth of collaboration and external knowledge sources) is positively associated with a firm's innovation performance.*

2.3.2. The differential roles of formal and informal strategies

Souitaris (2001) distinguished efforts firms make to establish knowledge flow channels and linkages into two categories: (1) those involving the scanning of external information; and (2) those involving cooperation with external organizations. Thus, the networking strategies of firms is seen as consisting of external knowledge sourcing and collaborations/cooperative agreements with diverse actors which lie within the firm's ego network (Powell et al, 1996; Lundvall, 1988; Chesbrough, 2003a; Laursen and Salter, 2006; Duysters and Lokshin, 2007; Leiponen and Helfat, 2010; Frenza and letto-Gillies, 2009).

The idea of formality (relating to collaborations and cooperative arrangements) is used here to connote established forms, conventions and requirements usually involving firm-level management approval and commitment as well as mutual legally binding documents such as memorandums of understanding (MoUs) and technical agreements. Examples of such would include R&D joint ventures (Hagedoorn, 2002) or technological agreements (Freeman, 1991; Hagedoorn, 1993). Informal networking strategies would then consist mainly in the use of external information sources as 'inputs' into the innovation process within the firm (Souitaris, 2001; Garcia-Torres and Hollanders, 2009) outside any formal arrangements. This occurs mostly by simply 'talking to' potential knowledge sources.

An obvious implication of the foregoing is that in terms of costs, formal interactions will be more expensive and potentially less frequent than informal interactions (Bönte and Keilbach, 2005). Notwithstanding, there is ample evidence of a positive relationship between both types of interactions and the innovation performance of firms (Freeman, 1991; Freel, 2000; Laursen and Salter, 2004; Garcia-Torres and Hollanders, 2009; Tether, 2002). However, with a few exceptions like Bönte and Keilbach (2005) and Freitas et al (2011), formal interactions are usually considered in isolation from informal interactions. This begs the question of whether or not these different networking strategies lead to different innovation types. Tether (2002) had earlier shown that firms that engage in R&D and that are attempting to introduce 'new to the market' products and processes are much more likely to engage in co-operative arrangements. In a developing country, where firms tend to mainly innovate by imitating or making organizational changes and are situated within contexts that thrive on informality (OECD, 2005), it makes sense to expect a positive relationship between informal knowledge sourcing and non-technological innovation.

H2a: Formal networking (i.e. collaboration) is more strongly associated with product and process innovation.

H2b: Informal networking (i.e. use of external knowledge sources) is more strongly associated with marketing and organizational innovation.

2.3.3. The interaction of formal and informal networking strategies

In general, the literature is replete with both anecdotal and empirical evidence in favour of a complementary relationship between internal and external knowledge in innovation. Cassiman and Veugelers (2006) make a review of this strand of literature and deploy a thorough methodological approach to provide conclusive support for this hypothesis. However, an important gap that persists beyond this conclusion is the interaction among different external sources of know-how. Often, firms simultaneously use many external information sources as 'inputs' into their innovation process and at the same time formally collaborate with multiple partners. When this happens, it becomes difficult to tell precisely where the effect of networking on innovation is coming from: formal or informal interactions or an interaction of both?

Recent empirical contributions have examined this question but with limitations. Using CIS data on 18 European countries, Garcia-Torres and Hollanders (2009) showed that the significance of extramural R&D expenditures cancel out in the presence of informal knowledge diffusion. The direct implication of this is that the positive effect of extramural R&D is actually driven by informal knowledge diffusion. However, these authors focus only on product innovation. In contrast, Freitas et al (2011), also using CIS data but for cross country analyses in four countries, include measures for process innovations but they consider each potential partner in isolation. They found a complementary relationship between formal and informal linkages with the same actors.

H3: There is a significant interaction between formal and informal networking strategies.

.

3. The Study Context

Nigeria's industrial sector comprises manufacturing firms of various scopes and sizes. These have over the years ordered themselves into a central industry association - the Manufacturers Association of Nigeria (MAN) - which comprises several smaller industry associations. MAN is organised into 10 sectors which are further disaggregated into 75 sub-sectors and one export group made up of firms with export products (MAN, 2007). At independence in 1960, the contribution of the manufacturing sector to Gross Domestic Product (GDP) in Nigeria was merely 3.8%. In 2007, the sector contributed 4.2% to GDP (NBS, 2007).

Among the Next-11 economies – a group of eleven countries identified by O'Neill et al. (2005) as having the potentials to emerge as some of the world's largest economies by the year 2020, Nigeria presently has the lowest manufacturing value added (UNCTAD, 2006). In 2005, manufacturing contributed only 2.8% to the GDP, compared to 20.3% in Japan, 40.2% in China, 27.3% in Singapore, 28.4% in the Republic of Korea, 20.5% in Cameroon, 19.4 in South Africa and 9.3% in Ghana. In fact, the figure for Nigeria is about 20% below the Developing Economies average of 23.5% and over 3% below the West African average of 6.0% (UNCTAD, 2006). Manufacturing capacity utilisation has also fallen from over 70% in 1980 to about 46% in 2003 (CBN, 2004) and remained below 35% for the most part for the last decade (BPE, 2007). Manufacturing output has also been unstable. Manufactured exports in Nigeria only accounted for 2.1% of total exports in 2005, a marginal increase from 1.5% in 1985. In 1995, manufactured products accounted for just 2.1% of total export; and the figure fell significantly to 0.2 in 2000 (UNCTAD, 2007). This is among the lowest manufacturing propensity ratios in Sub-Saharan Africa, and is the result not only of declining manufactured exports but also an increased dependency on primary exports; particularly oil. In fact, Nigeria's share of oil exports in total exports increased from 95.4% in 1996 to almost 99.6% in 2000 (Albaladejo, 2003). These make Nigeria one of the less export-oriented economies and one of the less diversified economies within the region and in the world.

4. Data and Method

The data used in this paper came from the first comprehensive innovation survey in Nigeria's manufacturing and service sectors.[2] The definitions, method and questions used in the survey were based on the Oslo Manual and the CIS but adapted for the African context.[3] Firms with at least 10 employees were selected via a multi-stage (random) sampling process.[4] The firms reported for the 2005-2007 period, giving information on, among other things, their collaboration partners and external knowledge sources. Using that information, this paper approaches the research questions by considering the ego-centric networks of the firms. I pay no attention to alter-alter ties, inter-ego ties or network structure because the data does not allow for that.

[2] A smaller survey of 250 firms had been carried out in 2007, but this is regarded as the first official innovation survey in Nigeria.
[3] This adaptation derived largely from UNU-INTECH (2004) and the South African Innovation Survey questionnaire which was based on the 3rd Community Innovation Survey.
[4] The industrial classes were based on the 3-digit ISIC Revison 3. Firms were selected from Class 15-37 (manufacturing) and Class 40-93 (service).

The original dataset comprised 207 service and 523 manufacturing firms (representing a combined response rate of about 49%). However, a large number of observations contained missing responses on several variables of interest for the analyses herein. The pattern of missingness was found to be random and well nested in a few cases, often due to skip patterns. In such cases, missing responses were manually replaced.[5] In many other cases, the pattern of missingness was not random. Such cases do not lend themselves to any known imputation technique so they were excluded, leaving a total of 472 observations to be analysed.

4.1. Variables

The table in Appendix 1 lists the variables that were used in the statistical analyses. Using four different questions and a total of 10 items for each of product (2 items), process (3 items), marketing (2 items) and organisational (3 items) innovations, firms were asked directly whether they had introduced an innovation during the 2005-2007 period. They were also asked whether they collaborated in any of their innovation activities. In a follow-up question, seven possible collaboration partners were listed in the survey instrument: associated companies within a firm's corporate group, customers, suppliers, competitors, consultants or private R&D labs, universities or other higher education institutions, and public research institutes. The question asked firms to indicate whether or not they engaged in collaboration or any form of joint activity with each of these actors (1 if yes and zero if no).[6] In another question, ten possible knowledge sources were listed in the survey instrument: internal, suppliers, customers, competitors, consultants or private R&D labs, universities or other higher education institutions, public research institutes, conferences or trade fairs, scientific journals or trade publications, and professional or industry associations. Each firm was asked to indicate on a 0 (not used)-1-2-3 (very important) scale the degree of importance of each source. The core variables used in the econometric analyses were constructed using these seven questions, following previous work such as Laursen and Salter (2006), Duysters and Lokshin (2007) and Leiponen and Helfat (2010).

[5] It was possible for me to do this on the basis of first-hand knowledge of the survey design and data collection process.

[6] This questionnaire item also included a location dimension that allowed firms to indicate the geographical location of their collaboration partners. This dimension is not relevant to the research questions here and was therefore not considered.

4.1.1. Dependent Variables

Innovation is resolved into four different types: product and process innovations being technological; marketing and organisational innovations being non-technological (OECD, 2005, p.47).[7] The variables for product (SPROD), process (SPROC), marketing (SMARK) and organisational (SORG) innovations were obtained as the sum of the items for each innovation type. These variables provide an ordinal measure of the scope of innovation in the firms.[8] The overall scope of innovation, SINNO, was derived as the sum of dummies representing each innovation type.[9] Although the survey distinguished between new-to-the-firm and new-to-the-market product innovations, I do not apply that distinction here for two reasons. First, the distinction is restricted to only product innovation. Second, even though it is possible to apply this distinction only in the analysis of product innovation, subsequent comparison across innovation types will be flawed because the measures would then be dissimilar.

4.1.2. Explanatory Variables

The variable COLLAB is a binary variable indicating whether a firm collaborated with any external actor during the reference period. The variable BCOLLAB captured how many actors a firm collaborated with (the breadth of collaboration), excluding associated companies within a firm's corporate group. It was obtained as the count of all non-zero responses for each collaboration partner, and therefore ranges from 0 to 6. The variable BEXTERN measures the breadth of external knowledge sources. Its construction, using the 9 questionnaire items relating to external knowledge sources, is similar to BCOLLAB. The variable EXTERN, obtained as a binary recode of BEXTERN indicates whether a firm had made use of any external knowledge source. Following Cassiman and Veugelers (2002), I use continuous R&D (CONRAD) as a proxy for absorptive capacity. Measures for human capital and investments are unfortunately not complete enough to be included in the analyses.

---

[7] Annex B of the Oslo Manual (OECD, 2005) gives several clear examples of each type of innovation.

[8] These variables are limited in two respects. First, there is the implicit assumption that all innovations are qualitatively equal. This limitation is overcome by allowing an ordering such that higher scores correspond only to a higher innovation scope but not necessarily to a qualitatively better innovation performance. In this sense, ordinal econometric analyses are much more meaningful than multinomial ones. Secondly, different innovation types are often highly correlated, implying that a scope measure for innovation performance might not be so meaningful. This limitation does not pose a restriction on the types of analyses performed in this paper because these variables are not interpreted qualitatively.

[9] The dummies were obtained by recoding SPROD, SPROC, SMARK and SORG as 0 (for no innovation) and 1 (for innovation). Another dummy indicating whether a firm had implemented any of the four innovation types was similarly obtained by recoding SINNO. The dummy variables were later applied in alternative estimations to check the robustness of the results obtained with the scope variables.

4.1.3. Controls

Obviously a wide range of factors influence firms' decision or propensity to innovate. An extensive body of evidence exists (see Keizer et al, 2002 and Aralica et al, 2005 for systematic reviews) on the fact that activities directed towards innovation show a relationship with a considerable number of variables, the most common of which are firm size (Laursen and Salter, 2004; Cohen, 2005); ownership (Račić et al., 2005); age (Jung et al, 2003); geography (Hoffman et al, 1998); R&D (Birchall et al., 1996), staff characteristics (Romijn and Albaladejo, 2002) and managerial choice (Laursen and Salter, 2004). These findings are already confirmed for developed and developing countries alike. Thus, as far as the data would allow, I controlled for firm heterogeneity using the log of employees (SIZE), and dummies for whether the firm is located within or outside Lagos (LOCATION), exports to at least one foreign market (EXPORT), had staff training programmes during the reference period (TRAINING) and belongs to a group (GROUP). For all estimations involving the full sample, I included a sector dummy indicating whether the firm is from the service or manufacturing sector (SERVICE).[10]

4.2. Descriptive Statistics

Of the over 472 firms in the sample, about 97% had carried out at least one innovative activity (INNO = 1) during 2005-2007. Of these, 26% had been involved in formal cooperation or joint action with one or more actors (COLLAB = 1) and 85% made use of external sources of knowledge (EXTERN = 1) in their innovative efforts. Comparing the share of innovative firms between manufacturing and service reveals weakly significant differences in the prevalence of most innovation types across the two groups (see Appendix 2). The correlation matrix in Appendix 3 shows significant correlations among many of the variables but these are low enough not to result in any serious collinearity problems. The low values of the mean variance inflation factor and the condition number confirm the absence of collinearity among the explanatory variables.

Table 1 contains the descriptive statistics. The proportion of firms that had collaborated during the reference period was similar for both manufacturing and service sectors. Compared to informal knowledge sourcing, formal collaboration was much less prevalent among the firms; its breadth was rather low and not significantly different between manufacturing and services. The pattern of the collaboration partners frequently employed

[10] I did not include sector dummies in the analyses due to the relatively small sample size.

by the sampled firms (Table 2) reveals the apparent importance of suppliers and customers.[11] The pattern is generally similar when compared across manufacturing and service firms, except that the manufacturing firms significantly collaborated more with universities and private research institutions than the service firms. In a few interviews that were carried out as part of the pilot survey, it was found that the main collaborative activities that firms carried out with customers involved the identification and penetration of promising markets. This was particularly prevalent in the fast-moving consumer goods sectors where many firms have several kinds of formal arrangements to reward existing wholesalers/distributors with the highest sales and market expansion within a given year. Under this arrangement, customers bring new markets to the attention of the firms who assess the markets, and advise and support the customers to distribute the firm's product in the identified market. Many firms actually have customer loyalty reward programmes designed for this purpose.

Table 1: Descriptive Statistics

	Total (N=472)		Manufacturing (N=309)		Service (N=163)		Comparison[a]
Variable	Mean	SD	Mean	SD	Mean	SD	
SINNO[b]	2.85	1.11	2.74	1.12	3.06	1.06	-3.11**
SPROD[b]	1.15	0.85	1.16	0.88	1.15	0.77	0.29
SPROC[b]	1.85	1.21	1.94	1.21	1.69	1.18	2.44*
SMARK[b]	0.99	0.88	0.92	0.87	1.12	0.88	2.35*
SORG[b]	1.67	1.17	1.46	1.16	2.07	1.07	-5.56**
COLLAB[c]	0.26	0.44	0.26	0.44	0.25	0.44	0.25
EXTERN[c]	0.84	0.37	0.82	0.39	0.88	0.33	-1.73
BCOLLAB[b]	0.89	1.80	0.98	1.91	0.72	1.57	0.86
BEXTERN[b]	4.93	3.14	4.58	3.12	5.59	3.07	-3.41**
SIZE[d]	4.30	1.33	4.53	1.27	3.85	1.33	5.47**
GROUP[b]	0.28	0.45	0.28	0.45	0.27	0.45	0.34
TRAINING[b]	0.70	0.46	0.68	0.47	0.74	0.44	-1.34
CONRAD[b]	0.20	0.40	0.21	0.41	0.18	0.38	0.92
LOCATION[b]	0.40	0.49	0.23	0.42	0.73	0.45	-10.46**
EXPORT[b]	0.29	0.45	0.27	0.44	0.34	0.47	-1.64

[a]H_0: % manufacturing = % service, *p<0.05; ** p<0.01; [b]Mann-Whitney test [c]z-test of proportions [d]t-test

[11] I had obtained exactly the same trend when only innovative firms were used in this analysis.

Table 2: Pattern of firms' collaboration in Nigeria, by type of actor, year 2005-2007

Collaboration Partners	% Total (N=472)	% Manufacturing (N=309)	% Service (N=163)	$z^{a,b}$
Suppliers	20	21	17	1.00
Customers	18	19	17	0.51
Competitors	15	15	13	0.50
Private Research Inst.	16	19	12	1.99*
Universities	11	13	7	1.97*
Public Research Inst.	10	11	6	1.83

[a]H_0: % manufacturing = % service, *p<0.05; ** p<0.01; [b]z-test of proportions

The results for the entire range of innovation knowledge sources for Nigerian manufacturing firms (Table 3) indicate that the most frequently used sources are customers, then suppliers. Alongside these, a range of other sources such as competitors and industry associations are among key sources of innovation. Of note is the fact that scientific sources are among the least used sources of knowledge to the firms. Similar to UK firms (see von Hippel, 1988; Laursen and Salter, 2006), the results indicate that Nigerian firms' innovation activities are strongly determined by relations with their suppliers and customers. This pattern is consistent among both manufacturing and service firms but seems to be more intense for the service firms.

Table 2: Pattern of firms' knowledge sources in Nigeria, by type of actor, year 2005-2007

Information Sources	% Total (N=472)	% Manufacturing (N=309)	% Service (N=163)	$z^{a,b}$
Suppliers	72	71	75	-0.92
Customers	75	72	80	-1.73
Competitors	66	62	74	-2.59**
Private Research Inst.	45	42	50	-1.78
Universities	32	28	40	-2.72**
Public Research Inst.	33	29	42	-2.83**
Conference, fairs	57	53	64	-2.30*
Sci. journals, trade pub.	52	46	64	-3.62**
Industry associations	61	55	71	-3.21**

[a]H_0: % manufacturing = % service, *p<0.05; ** p<0.01; [b]Mann-Whitney test

While the relatively weak relevance of knowledge centres to firms' innovation efforts might be connected to firm-level absorptive capacity, the result may be an indicator of a deeper challenge in the entire innovation ecosystem. It stands to reason on the one hand that outputs in the universities and research institutes may not be relevant to industrial needs. On the other hand, considering the huge costs of R&D which is usually beyond the reach of most firms in developing countries, the firms should then have incentives to source new knowledge from publicly-funded universities and research institutes; but when these knowledge centres themselves are not well funded to carry out high-quality R&D, they are not capable to meet local industrial expectations.[12] Taken together, the figures in Tables 1 and 2 seem to suggest that formal collaboration with knowledge centres was more important to manufacturing than service firms. In contrast, informal knowledge sourcing from external actors in general was more prevalent among service firms.

4.3. Estimation

For the econometric analyses, ordinal logit regressions were applied. This approach was selected because the outcome variables take on more than two discrete values (otherwise logit models would have been more appropriate), and more importantly because, although the intervals between the values are not qualitatively equal, their ordering is qualitatively meaningful[13] (otherwise multinomial logit models would be more appropriate) (Wooldridge, 2002).[14] To address the first hypothesis, I estimated an equation that related innovation to collaboration and external knowledge sourcing. For the second hypothesis, I distinguished between the different innovation types and estimated equations which related the different innovation types with the breadth of collaboration and external knowledge sourcing.[15] Relevant interaction terms were included in alternative estimations in both cases, first to address the third hypothesis and then to account for the role of absorptive capacity. Also, square terms of the breadth measures (BCOLLAB2 and BEXTERN2) were included to check if there is a finite maximum portfolio size beyond which diminishing returns to networking

[12] Many African researchers…rely on external donors, aid agencies and grant-giving bodies to sponsor their work (Soboyejo, 2006). The direct relevance of these research efforts to local developmental needs is thus not guaranteed.

[13] For instance, a firm with an SINNO score of 4 is not necessarily twice as innovative as one with a score of 2 but is definitely more innovative.

[14] Tests of the proportional odds assumption for a random set of models show no violations

[15] It seems attractive to do this only for the sub-sample of innovative firms but such analysis will neglect the networking behaviour of non-innovative firms. It should be noted that the non-innovative firms in the sample are not necessarily non-innovative persistently; they just have not implemented any innovation during the reference period of the survey. Moreover, the proportion of non-innovative firms is small compared to the innovators so there is no danger of the measures of innovation types being zero-inflated.

could set in. In all cases, I first estimated the models for the full sample and then for the sub-samples of manufacturing and service firms. The significant differences found in the share of innovators and the networking patterns point towards a difference in networking behaviour and innovativeness across the two groups.[16]

5. Results and Discussion

5.1. Innovation and networking strategies

Starting with the binary choice variables which indicate whether or not a firm engages in formal or informal collaboration (Table 3), there is only partial support for the first hypothesis. The coefficients of the formal collaboration variable are insignificant and do not have the expected sign, with or without interaction effects; but the use of external knowledge has positive and significant coefficients. Absorptive capacity plays a positive role in overall innovation performance but has no significant interaction effects on networking (columns 2 and 3 of Table 3). Similar results were obtained for the sub-samples of manufacturing (columns 4 and 5 of Table 3) and service firms (columns 4 and 5 of Table 3). It is worth noting that in all cases, the coefficient of the interaction between continuous in-house R&D and networking has a negative sign, suggesting a substitution effect of networking on in-house R&D. This effect is significant for manufacturing. This result is similar to what Laursen and Salter (2006) obtained for UK manufacturing. Two possible explanations are offered for this substituting relationship between external knowledge sourcing and in-house R&D. First there is the 'not invented here' (NIH) syndrome (Katz and Allen, 1982) which typically occurs within organisations when internal knowledge becomes 'sufficiently overlapping and specialized that it impedes the incorporation of outside knowledge' (Cohen and Levinthal, 1990). Then there is the attention allocation problem (Ocasio, 1997) that arises when firms have to simultaneously consider in-house knowledge creation and multiple external knowledge sources.

When the size of the portfolio of partners is considered (Table 4), little variations in the results are observed. The coefficients of formal collaboration remain mostly negative and insignificant, the absorptive capacity proxy remains positively significant and it is still largely not interacting significantly with formal and informal networking. Meanwhile, informal knowledge sourcing remains statistically significant. However, two new insights are obtained

[16] As robustness checks for the results, logit estimations employing binary independent variables were implemented. In several instances the models were unsatisfactory due to the highly limited dependent variables. But as far as they were successful, the results, not included in the paper, generally confirm the findings reported here.

from the results in Table 4. First, the substitution relationship between own R&D and external knowledge observed earlier is not seen here. The interaction coefficients are negative but not statistically significant. Taking this together with the earlier result, one could interpret the results as hinting that the NIH syndrome may tend to reduce in significance with an increasing number of external knowledge sources. This is likely to be the case since the chances that useful knowledge will be obtained outside the firm's boundary increase with an increasing number of sources used (Leiponen and Helfat, 2010). Secondly, the negatively significant coefficient of BEXTERN2, the quadratic term of the number of informal knowledge sources indicates that there is a limit to the increasing positive benefits of using a larger portfolio of external knowledge sources, at least in the sample analysed here. This diminishing effect is not observed for services but sets in at 3 sources in the full sample and as early as about 2 sources in the manufacturing sub-sample. This early tipping point is partly explained by the low level of innovation performance among the firms. Average overall scope of innovation in the manufacturing sector was just 2.7. Also, if the need for absorptive capacity to benefit from external knowledge is considered, then the early tipping point makes sense. In this regard it is noteworthy that the proportion of firms that performed continuous R&D in the sample is rather low – just about a fifth of all firms and only 18% in services (Table 1).

The results here are consistent with the results of earlier studies which suggest a 'portfolio' approach to the use of external innovation sources. This result also supports Schmitz's (1989, 1995) hypothesis that networking and joint action contributes more to competitiveness than merely bringing firms together within a cluster. By maintaining active interactions with a broad range of actors, firms will put themselves in a better position to achieve and sustain innovation. Moreover, if the choice of network partner is considered as a probabilistic draw, it is easy to show that the more draws are made, the higher the probability to make a very good one over time. However, optimal number of partners ranges between 2 and 3 sources, implying the need for firms to carefully select the types of actors that they will include in their portfolio of knowledge sources.

5.2. Networking strategy and different innovation types

The results of the regression models run for each innovation type is shown in Table 5. The results do not particularly support what was hypothesised. A significant relationship with formal collaboration is observed only for product innovation. This relationship, however,

does not proceed in the expected direction. And as we move from the second to the third column of Table 5, the significance of in-house R&D reduces slightly but the interaction between formal and informal external interaction is positive and significant. This result suggests that, in relation to product innovation, a combination of formal and informal interaction might complement the role of internal R&D. There is also the indication that this combination intensifies the benefits from informal knowledge sourcing but actually negates a need for formal collaboration. In this sense, the firms might be better off in their product innovation efforts just sourcing knowledge from external partners without any formal joint activity. With process innovation, only informal knowledge sourcing is significantly associated. Both formal and informal knowledge search strategies have no significant relationship with marketing and organisational innovations. However, in the models with interaction terms, the results become rather ambiguous. Continuous in-house R&D and external knowledge sourcing both become significant with opposite signs when there is a negative but significant interaction between them.

The results obtained for the manufacturing sub-sample (Table 6a) are very similar to the foregoing, but the service sub-sample shows some differences. For product innovation, two things are different here. First, for nearly all innovation types in services, networking seems not so useful but only when formal and informal approaches are combined. Secondly and surprisingly, formal collaboration is significantly associated with marketing innovation, at the expense of informal knowledge sourcing (column 7 in Table 6b). There seems to be no clear reason for this but when the structure of collaboration (Table 2) is considered, it becomes clearer why this might be so. The firms tend to interact more with suppliers and customers who, in this context, could provide information more relevant for non-technological innovation. The negative sign of the coefficient could be interpreted as implying the need for firms to be more discreet about their marketing innovation efforts within a collaborative framework especially since this involves sales and distribution methods which can only be protected through secrecy.

In Table 7, the results obtained when the portfolio size is accounted for are shown. The importance of a larger portfolio size is observed only in informal knowledge sourcing and for only technological (product and process) innovations. And, as noted before, there is a point beyond which the return to number of external knowledge sources begins to diminish. This point corresponds to about 2 sources for product innovation and 3 sources for process innovation. This difference in the tipping point, in itself, could be taken to mean that when compared to product innovation, process innovation benefits more from a slightly larger

portfolio size. Since it might not be completely realistic for firms to maintain different portfolios for different innovation types, the implication of the foregoing is that firms are faced with the challenge of carefully structuring their portfolio size to derive as much benefits as possible simultaneously for product and process innovations.

The results for the manufacturing sub-sample (Table 8a) are largely similar to the foregoing. Not much is to be seen from the results for the service sub-sample (Table 8b). A very convenient way to interpret the situation would be that although networking is beneficial to service firms, adopting a portfolio approach or, in particular, the number of partners that a firm chooses is not particularly relevant for its innovation performance. Absorptive capacity, proxied by continuous in-house R&D seems to be of more relevance. Also of interest is the significance of BEXTERN2 for marketing innovation. The positive coefficient actually suggests increasing returns to portfolio size staring from as few as 2 external knowledge sources.

5.3. Interaction between formal and informal approaches to networking

Due to data limitations, the econometric analysis concerning the possible interaction hypothesised between collaboration (formal) and external knowledge sourcing (informal) activities of the firms is limited to alternate model specifications (Models 2 in all regressions). The idea was to check the significance of the coefficient of the interaction term when included in the model. Our expectation is that this interaction will be of a complementary nature indicated by positive interaction coefficients.

Considering overall innovation performance, significant interaction effects are not observed. For the manufacturing and service sub-samples, the trend is contrasting. A positive and weakly significant interaction effect appears for service firms only when the decision to network is considered (column 7 in Table 3). An interaction between collaboration and external knowledge sourcing in manufacturing only appears when breadth is considered (column 5 in Table 4), in which situation there is no interaction effect for the service sub-sample. This goes further in support of the earlier argument that breadth of networking seems to matter much less for service than for manufacturing firms.

When considering the different innovation types, positive interaction between formal and informal effects were only found for product innovation (column 3 in Table 5). The same goes for the manufacturing sub-sample (column 3 in Table 6a). In contrast, interaction effects are observed for all innovation types in the service sector except organisational innovation (Table 6b). However, these effects do not appear when the breadth of networking is taken

into account. The foregoing results, taken together, suggest only weak and non-robust support for the third hypothesis. Nonetheless, it should be noted that the positive coefficients are consistent with what was hypothesised.

What these results suggest is noteworthy and is worth exploring in greater detail. When firms make use of both formal and informal networking strategies, there seems to be a non-redundant 'cross-pollination' of knowledge that takes place. This cross-pollination tends to substitute for the direct importance of informal knowledge flows, particularly in the service sector. Thus, in services, when combined with formal collaborations, the use of external knowledge sources is only as useful as it supplements existing collaborative activities.

6. Conclusions and Implications

This paper addressed questions concerning the relationship between networking - in terms of collaboration and use of external sources of knowledge – and innovativeness of firms. The first question relates to the importance of the size of a firm's portfolio of network partners. The second explores the relationship between networking strategies and different innovation types. The third relates to the possibility of interaction effects arising from simultaneous use of both formal and informal networking strategies by firms. These issues were explored using a unique dataset within the context of the manufacturing and service sectors in Nigeria.

The results partially support the hypothesis of a positive relationship between firms' innovativeness and the number of both formal and informal network partners. The results are much more robust for informal networking while not particularly clear for formal collaboration. The relationship between networking and innovativeness was also found to be partly positive and not uniform for the four innovation types considered here. For product and process innovations, the use of external knowledge is relatively more important than having formal collaboration with external actors. This relationship is less clear for marketing and organisational innovation. Significant interaction effect between formal and informal approaches to networking was found, mostly among service firms. This suggests that when firms make use of both formal and informal networking strategies, there seems to be a non-redundant 'cross-pollination' of knowledge that tends to substitute for the direct importance of informal knowledge flows, especially in services. In general, the results point towards a difference in innovation and collaboration behaviour between service and manufacturing firms. Also, different innovation types are shown to be affected differently by different

approaches to networking. In this regard, product and process are more similar and both contrast to marketing and organisational innovation.

This study has some connotations for policy making. Despite the interest and commitment that government has in supporting university-industry interaction as a key driver of industrial innovation, the results herein show that the innovation activities of firms are still fashioned more by their relationships with their customers and suppliers. In comparison to these sources of innovation, universities and research institutes are of much less relevance. In a sense, it could then be put forth that placing emphasis on university-industry interaction as a stimulant to innovation seems a *misplaced priority* - trying to stimulate relationships which may have a faint impact on firm-level innovative performance. Consequently, increased attention needs to be paid to diversification of knowledge sources rather than emphasising a particular knowledge source. This is not to argue that universities are not useful for innovation. The point being made is that in a latecomer setting like Nigeria, where innovation takes place much less radically than in advanced settings, firms will benefit more from a broad base of knowledge than from any single knowledge source. This is even truer when the relatively low quality of the universities is taken into account. For firms, the major implication relates to the need to be more open in their innovation efforts and to adopt a portfolio approach to networking. This has been a main conclusion from several previous studies and this study also confirms the relevance of this for developing country firms. I extend this thesis by noting that firms are not likely to reap the full benefits of either their collaborative or external knowledge sourcing activities unless they combine both strategies. This is even more so for service firms.

This paper is a modest step forward in understanding the relationships between networking and innovativeness in the developing country context. To aid comparison and validation of findings, more country studies of this nature are desirable. The relationship between collaboration and external knowledge sourcing is itself an interesting issue that begs more understanding. For instance, it would be useful to know what types of firms use what sources of information and when. There is also the need for analyses aimed at determining the types of actors that a firm should include in its portfolio of external knowledge sources and collaborators, as well as whether formal or informal collaborations are to be preferred. This, indeed, is a major question that firm-level managers would want to find answers to, in the light of the importance of breadth that this paper has thrown up. Finally, the role of absorptive capacity has not been properly explored in this paper due to data limitations. This, indeed, is worth further study.

Three important limitations should be considered in interpreting the results of this study. First, the analyses did not include a variable on firm age despite its recognised importance in directly or indirectly affecting firm-level innovativeness. This is because the variable is not included in the survey that provided the data for this paper. Although an attempt was made to obtain this information from secondary sources, this did not prove very successful. Secondly, the results are based on a relatively small sample of firms. In particular, the small sample did not allow controlling for sector-specific effect, a shortcoming that could have had some effects on the results. Larger samples might yield markedly diverse results, confirming some of the ones presented herein while possibly confounding others. Thirdly, the sample included a fair share of micro-sized firms and some firms that would otherwise be classified as belonging to the informal sector. This being the first time that such comprehensive data as used in this paper is available in Nigeria, one could safely say that these problems are somewhat inevitable. It is hoped that subsequently, more data will be available to overcome these challenges.

References

Albaladejo, M (2003). Industrial Realities in Nigeria: From Bad to Worse. QEH Working Paper Series –Working Paper Number 101. Queen Elizabeth House, Oxford University, Oxford (available at http://www.qeh.ox.ac.uk/pdf/qehwp/qehwps101.pdf, accessed November 17, 2006).

Amara, N. and Landry, R. (2005). Sources of information as determinants of novelty of innovation in manufacturing firms: evidence from the 1999 statistics Canada innovation survey. Research Policy 25(3), pp. 245-259.

Aralica, Z., Račić, D., Radić, D. (2005). Innovation Propensity in Croatian Enterprises: Results of the Community Innovation Survey (available online at http://iweb.cerge-ei.cz/pdf/gdn/RRCIV_104_paper_01.pdf, retrieved December 28, 2007).

Belderbos, R., Carree, M. and Lokshin, B.. (2004), 'Cooperative R&D and firm performance', Research Policy 33(10), 1477-92.

Biggs, T, Shah, M and Strivastava, P. (1995). „Technological Capabilities and Learning in Africa Enterprises" World Bank Technical Paper No.288 Washington, D.C.

Birchall, D.W., Chanaron, J.J., Soderquist, K., (1996). Managing innovation in SMEs: a comparison of companies in the UK, France and Portugal. International Journal of Technology Management 12 (3), 291–305.

Bönte, W. and Keilbach, M. (2005). Concubinage or marriage? Informal and formal cooperations for innovation. International Journal of Industrial Organization Volume 23, Issues 3-4, April 2005, Pages 279-302

Bureau of Public Enterprises (BPE), (2007). Industry and Manufacturing Background. http://www.bpeng.org/en/companies/Industry+and+Manufacturing/industry_policy.htm; accessed July, 2007

Cassiman, B. and Veugelers, R. (2006). In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. Management Science, January 2006; 52: 68 - 82.

Central Bank of Nigeria (CBN) (2004). Real Sector Statistics In: Nigeria: Major Economic, Financial And Banking Indicators. Nnanna, O.J., Odoko, F.O., Okafor, C.M., Essien, S. N., Akinboyo, O. L. and Zayyad, T. T. (eds.). CBN Research Department

Central Bank of Nigeria (CBN) (2006). Central Bank of Nigeria Statistical Bulletin, December, 2006. CBN, Abuja.

Chesbrough, H. W. (2003a). Open Innovation: The New Imperative for Creating and Profiting from Technology. Oxford University Press, Oxford.

Chesbrough H. (2003b). Open Innovation. Harvard University Press: Cambridge, MA.

Chesbrough H. (2003c). The era of open innovation. Sloan Management Review Summer: 35–41.

Cohen, W. (2005), 'Empirical Studies of Innovative Activity'. In: Stoneman, P. (ed.), Economics of Innovation and Technological Change Handbook. Oxford: Blackwell Publishers Ltd. pp. 182-264.

Cohen, W. and Levinthal, D., (1989). Innovation and learning: The two faces of R&D. *The Economic Journal*, 99(397): 569-96.

Cohen, W. and Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1): 128-52.

Cohen, W. and Levinthal, D. (1994). Fortune favours the prepared firm. Management Science, Vol. 40, No. 2, pp. 227-251.

Cohen, W. and F. Malerba, (2001). 'Is the tendency to variation a chief cause of progress?' Industrial and Corporate Change, 10: 587-608.

de Man, A., Duysters, G.M., (2005). Collaboration and innovation: a review of the effects of mergers, acquisitions and alliances on innovation. Technovation 25, 1377–1387.

Drejer, I., Holst Jørgensen, B., (2005). The dynamic creation of knowledge: analysing public-private collaborations. Technovation 25(2), 83–94.

Duysters, G. and Lokshin, B. (2011). Determinants of alliance portfolio complexity and its effect on innovative performance of companies. Journal of Product Innovation Management 28(4), pp. 570-585.

Duysters, G. and W. Vanhaverbeke, 1996, Strategic interactions in DRAM and RISC technology: a network approach, Scandinavian Journal of Management, 12(4), pp. 437-61.

Edquist, C. (2005). 'Systems of Innovation: Perspectives and Challenges,' in J. Fagerberg, D. Mowery and R. Nelson' (eds), The Oxford Handbook of Innovation. Oxford University Press: Oxford.

Egbetokun A. A, Siyanbola, W.O. and Adeniyi, A.A. (2010). Learning to Innovate in Nigeria's Cable and Wire Manufacturing Sub-sector: inferences from a firm-level case study. Int. J. Learning and Intellectual Capital, **7**(1), pp.

Faems, D., B. Van Looy, and K. Debackere, (2005), 'Inter-organizational collaboration and innovation: towards a portfolio approach', Journal of Product Innovation Management, 22: 238-50.

Freeman, C., (1991). Networks of innovators: a synthesis of research issues. Research Policy 20(5), 499–514.

Freitas, I., Clausen, T., Fontana, R. and Verspagen, B. (2011). "Formal and informal external linkages and firms' innovative strategies. A cross-country comparison," Journal of Evolutionary Economics, 21(1), pages 91-119.

Frenz, M. and letto-Gillies, G. (2009). The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey. Research Policy 38 (7), pp. 1125–1135

Garcia-Torres, M. A. and Hollanders, H. (2009). The Diffusion of Informal Knowledge and Innovation Performance: A sectoral approach. UNU-MERIT Working Paper Series #2009-013

Goedhuys, M. (2007a). Learning, product innovation, and firm heterogeneity in developing countries; Evidence from Tanzania. Industrial and Corporate Change **16** (2), pp. 269-292.

Goedhuys, M. (2007b). The impact of innovation activities on productivity and firm growth: evidence from Brazil. UNU-MERIT Working Paper #2007-02, UNU-MERIT, the Netherlands.

Hagedoorn, J., 1993. Understanding the rationale of strategic technology partnering: inter-organizational modes of cooperation and sectoral differences. Strategic Management Journal 14, 371–385.

Hagedoorn, J., 2002. Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. Research Policy 31, 477–492.

Hoffman, K., Parejo, M., Bessant, J., Perren, L. (1998). Small firms, R&D, technology and innovation in the UK: a literature review. Technovation 18 (1), 39–55.

Hoppe, H. and Ozdenoren, E. (2005). International Journal of Industrial Organization 23(5-6), pp. 483-503

Jaffe, A.B. (1989). "Real effect of academic research", American Economic Review 75, 957-970.

Jung, D. I., Chow, C. and Wu, A. (2003). The role of transformational leadership in enhancing organizational innovation: hypotheses and some preliminary findings, The Leadership Quarterly 14 (2003), pp. 525–544.

Katila, R, and G. Ahuja, 2002, 'Something old, something new: a longitudinal study of search behavior and new product introduction', Academy of Management Journal 45(6): 1183-94.

Katz R, Allen T. 1982. Investigating the not invented here (NIH) syndrome: a look at the performance, tenure, and communication patterns of 50 R&D projects. *R&D Management* **12**(1): 7–19.

Keizer, J.A., Dijkstra, L., Halman, J.I.M. (2002). Explaining innovative efforts of SMEs. An exploratory survey among SMEs in the mechanical and electrical engineering sector in the Netherlands. Technovation 22 (1),1–13.

Kirkels, Y. and Duysters, G. (2010). Brokerage in SME networks. Research Policy 39 (2010) 375–385.

Laursen, K. and A. Salter (2004). Searching high and low: what types of firms use universities as a source of innovation? Research Policy 33 (8) 1201–1215.

Laursen, K. and A. Salter (2006) Open for Innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms, Strategic Management Journal, 27(2), pp. 131-150.

Lee, S., Park, G., Yoon, B. and Park, J. (2010). Open innovation in SMEs—An intermediated network model. Research Policy 39 (2) 290–300.

Leiponen, A. and Helfat, C.E. (2010). 'Innovation objectives, knowledge sources and the benefits of breadth' Strategic Management Journal, 31(2), pp 224-236

Lundvall, B.-A. (1988) "Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation" in Giovanni D., Christopher F., Richard N., Gerald S. and Luc S., eds., Technical Change and Economic Theory, Pinter Publishers, UK, pp. 349-369.

Lundvall, B.-A. (ed.) (1992), National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning, Pinter Publishers, London.

Lundvall, Bengt-Ake, K.J. Joseph, Cristina Chaminade and Jan Vang (eds.)(2009). Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting. Edward Elgar, Cheltenham.

Malerba, Franco and Vonortas, Nicholas S. (eds.) (2009). Innovation Networks in Industries. Edward Elgar Publishing: Cheltenham

Manufacturers Association of Nigeria (MAN) (2007). MAN Members' Directory (http://www.manufacturersnigeria.org/) accessed July/August, 2007

Mytelka, L. (2000) 'Local systems of innovation in a globalized world economy', Industry and Innovation, June, Vol. 7, No. 1, pp.33–54.

National Bureau of Statistics (NBS) (2007). 2006 Annual Abstract of Statistics (accessed July, 2008 from www.nigerianstat.gov.ng/annual_report.htm)

Nelson, R. and Winter, S. (1982). An Evolutionary Theory of Economic Change. Harvard University Press.

Noteboom, B. (1994). Innovation and diffusion in small firms: Theory and evidence. Small Business Economics Volume 6, Number 5, pp. 327-347.

Noteboom B., Haverbeke W. V., Duysters G., Gilsling V. and van den Oord A. (2007) Optimal cognitive distance and absorptive capacity. Research Policy 36(7):1016–1034

Ocasio, W. 1997. Towards an attention-based view of the firm. *Strategic Management J.* 18 187–206.

O'Neill, J., Wilson, D., Purushothaman, R. and Stupnytska, A. (2005). Glodman Sachs Global Economics Research Paper 134. Available at: http://www2.goldmansachs.com/hkchina/insight/research/pdf/BRICs_3_12-1-05.pdf. [Accessed July 12, 2008)

Organisation for Economic Cooperation and Development (OECD) (2005). Proposed guidelines for collecting and interpreting technological innovation data: Oslo Manual, 3rd ed. OECD. Paris.

Oyebisi, T.O., Ilori, M.O. and Nassar, M.L (1996). Industry-academic relations: an assessment of the linkages between a university and some enterprises in Nigeria, Technovation, 16 (4) pp. 203-209.

Oyelaran-Oyeyinka, B. (2005) 'Inter-firm collaboration and competitive pressures: SME footwear clusters in Nigeria', Int. J. Technology and Globalisation, 1 (3/4), pp.343–360.

Oyelaran-Oyeyinka, B. (2006). Systems of innovation and underdevelopment: an institutional perspective. Science, Technology and Society, 11(2), pp. 239-269.

Perez Perez, M. and Sanchez, A. (2002). Lean production and technology networks in the Spanish automotive supplier industry. *Management International Review*, **42**(3), 261.

Pittaway, L., Robertson, M., Munir, K., Denyer, D. and Neely, A. (2004). Networking and innovation: a systematic review of the evidence. Int. J. Management Reviews **5/6**(3&4), pp137-168.

Powell, W.W., Koput, K.W., Smith-Doerr, L., 1996. Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. Administrative Science Quarterly 41 (1), 116–145.

Romijn, H. and Albaladejo, M. (2002). Determinants of innovation capability in small electronics and software firms in southeast England. Research Policy 31 (2002) 1053–1067.

Schmitz, H. (1982) Growth Constraints on Small-scale Manufacturing in Developing Countries: A Critical Review. World Development 10(6).

Schmitz, H. (1989). Flexible Specialization - A New Paradigm of Small-Scale Industrialization? IDS Discussion Paper, No. 261.

Schmitz, H. (1995). Collective Efficiency: Growth Path for Small-Scale Industry, Journal of Development Studies 31(4).

Souitaris, V., 2001. External communication determinants of innovation in the context of a newly industrialized country: a comparison of objectives and perceptual results from Greece. Technovation 21 (1), 25–34.

Tether B. S. (2002), 'Who Co-operates for Innovation, and Why? Research Policy, 31.6, 947 – 967.

Tomlinson, P. (2010). Co-operative ties and innovation: Some new evidence for UK manufacturing. Research Policy 39 (2010) 762–775.

United Nations Conference on Trade and Development (UNCTAD) (2006). UNCTAD Handbook of Statistics 2006. Geneva

UNCTAD (2007). The Least Developed Countries Report 2007: Knowledge, Technological Learning and Innovation for Development. UNCTAD, Geneva/New York.

United Nations University Institute for New Technologies (UNU-INTECH) (2004). Designing a Policy-Relevant Innovation Survey for NEPAD, mimeo: A Study prepared by UNU-INTECH, Maastricht, The Netherlands (available online: www.nepadst.org/doclibrary/pdfs/innopolicy_aug2004.pdf).

von Hippel E. (2005), Democratizing Innovation, MIT Press.

von Hippel, E. (1988). The Sources of Innovation. Oxford University Press, New York.

Wooldridge, J.M. (2002). Econometric analysis of cross section and panel data. The MIT Press

Table 3: Innovation and networking, overall scope of innovation

	Full sample		Manufacturing		Service	
	(1)	(2)	(1)	(2)	(1)	(2)
COLLAB	-0.162	-0.261	0.084	0.172	-0.185	-0.740
EXTERN	1.409***	1.323**	1.539***	-0.756	1.197**	1.586***
CONRAD	0.746**	1.261**	0.597*	5.291***	1.299*	1.401*
SIZE	0.100	0.100	0.059	0.0556	0.262	0.256
GROUP	0.269	0.273	0.419	0.446	0.250	0.222
TRAINING	0.824***	0.791***	0.529	0.504	1.490***	1.458***
LOCATION	0.144	0.138	0.140	0.099	0.413	0.421
EXPORT	0.034	0.047	-0.426	-0.414	0.939**	0.920**
SERVICE	0.562*	0.532*				
COLLAB*EXTERN		0.507		-0.173		1.699*
COLLAB*CONRAD		-0.314		-0.118		-1.199
EXTERN*CONRAD		-1.596		-14.09***		0.263
cut1_cons	-1.485**	-1.577**	-1.617**	-3.172***	-1.963	-1.897
cut2_cons	0.361	0.277	-0.101	-1.651**	1.373*	1.543*
cut3_cons	2.010***	1.935***	1.684***	0.145	2.760***	2.943***
cut4_cons	3.301***	3.231***	2.981***	1.451**	4.205***	4.388***
N	472	472	309	309	163	163
McFadden R-sq.	0.089	0.091	0.076	0.080	0.148	0.152
Log lik	-596.9	-595.5	-405.0	-403.2	-177.2	-176.3
Akaike's IC	1219.7	1222.9	834.0	836.5	378.3	380.6
chi-sq	116.5***	119.0***	73.75***	245.7***	51.30***	.

Dependent variable: SINNO; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Ordinal logistic regression, explaining relationship between innovative performance across Nigerian firms and the size of network portfolio

	Full sample		Manufacturing		Service	
	(1)	(2)	(1)	(2)	(1)	(2)
BCOLLAB	-0.036	-0.077	-0.011	-0.099	0.161	0.558
BEXTERN	0.190***	0.194***	0.169***	0.208***	0.203***	0.055
CONRAD	0.790**	1.166***	0.686*	1.224**	1.461*	1.458*
BCOLLAB2	-0.007	-0.006	0.016	-0.025	-0.104	0.018
BEXTERN2	-0.031**	-0.030**	-0.056***	-0.062***	0.024	0.039
SIZE	0.0712	0.083	0.061	0.109	0.174	0.179
GROUP	0.240	0.244	0.447	0.385	0.411	0.306
TRAINING	0.763***	0.715**	0.562	0.443	1.348**	1.328**
LOCATION	0.100	0.092	0.103	0.113	0.299	0.146
EXPORT	0.007	-0.018	-0.482	-0.562*	0.906*	0.849*
SERVICE	0.524*	0.532*				
BCOLLAB*BEXTERN		0.021		0.083*		-0.199
BCOLLAB*CONRAD		-0.115		-0.109		-0.375
BEXTERN*CONRAD		-0.131		-0.177		0.0327
cut1_cons	-2.263***	-2.234***	-2.589***	-2.440***	-2.233	-2.743*
cut2_cons	-0.426	-0.392	-1.079*	-0.924*	1.077	0.570
cut3_cons	1.207***	1.252***	0.696	0.880	2.474***	1.982**
cut4_cons	2.501***	2.555***	2.000***	2.214***	4.010***	3.570***
N	472	472	309	309	163	163
McFadden R-sq.	0.088	0.091	0.077	0.086	0.178	0.192
Log lik	-597.3	-595.3	-404.9	-400.8	-170.9	-168.1
Akaike's IC	1224.6	1226.5	837.8	835.5	369.7	370.1
chi-sq	115.6***	116.8***	67.94***	70.75***	65.29***	64.26***

Dependent variable: SINNO; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Innovation and networking, scope of different innovation types

	SPROD		SPROC		SMARK		SORG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
COLLAB	0.105	-5.004***	-0.012	-0.357	-0.302	-0.054	-0.085	0.221
EXTERN	1.091***	4.956***	1.515***	1.728***	0.217	-2.158***	0.384	-2.107***
CONRAD	1.227***	1.032**	1.190***	1.219***	0.146	4.775***	0.387	5.264***
SIZE	0.068	0.083	0.146	0.152	0.203*	0.196*	0.219**	0.214**
GROUP	0.352	0.323	0.101	0.085	0.215	0.230	0.051	0.080
TRAINING	0.646**	0.635**	0.762***	0.748***	0.451*	0.427	0.304	0.274
LOCATION	0.080	0.051	0.003	-0.005	-0.065	-0.065	-0.190	-0.219
EXPORT	0.157	0.134	0.129	0.134	-0.200	-0.174	-0.093	-0.074
SERVICE	-0.081	-0.062	-0.462	-0.457	0.592**	0.565*	1.265***	1.242***
COLLAB*EXTERN		15.57***		1.179		-0.772		-0.841
COLLAB*CONRAD		-0.742		0.062		0.038		-0.277
EXTERN*CONRAD		1.113		-0.195		-14.04***		-14.62***
cut1_cons	1.041*	3.612***	1.040*	1.009*	1.032*	-0.567	0.665	-1.014*
cut2_cons	2.333***	4.913***	1.967***	1.939***	2.010***	0.417	1.452***	-0.224
cut3_cons			2.871***	2.844***			2.700***	1.033*
N	472	472	472	472	472	472	472	472
McFadden R-sq.	0.0951	0.102	0.104	0.105	0.0267	0.0316	0.0454	0.0504
Log lik	-457.0	-453.6	-546.2	-545.7	-492.6	-490.1	-610.9	-607.6
Akaike's IC	935.9	935.2	1116.4	1121.3	1007.3	1008.3	1245.7	1245.2
chi-sq	75.16***	914.7***	96.46***	96.27***	25.16***	553.2***	54.66***	481.0***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6a: Innovation and networking, scope of different innovation types, manufacturing sub-sample

	SPROD		SPROC		SMARK		SORG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
COLLAB	0.289	-4.033***	-0.170	-0.300	-0.114	0.359	0.0827	0.646
EXTERN	1.221***	4.433***	1.828***	1.883***	0.368	-1.992***	0.348	-2.181***
CONRAD	0.926**	0.775**	0.965**	0.889**	-0.070	4.205***	0.280	4.782***
SIZE	-0.038	-0.0221	0.069	0.067	0.252*	0.243*	0.227*	0.221*
GROUP	0.240	0.204	-0.111	-0.134	0.297	0.342	0.082	0.137
TRAINING	0.782**	0.776**	0.861**	0.866**	-0.149	-0.166	-0.012	-0.029
LOCATION	0.266	0.246	0.244	0.273	-0.110	-0.136	-0.260	-0.298
EXPORT	0.174	0.159	0.416	0.442	-0.686*	-0.674*	-0.578*	-0.572*
COLLAB*EXTERN		13.17***		0.347		-1.508		-1.720
COLLAB*CONRAD		-0.020		0.514		-0.073		-0.182
EXTERN*CONRAD		0.444		-0.180		-12.82***		-13.43***
cut1_cons	0.948	3.112***	1.082*	1.112	0.848	-0.739	0.344	-1.351*
cut2_cons	1.947***	4.116***	1.967***	1.999**	1.852***	0.274	1.129*	-0.563
cut3_cons			2.797***	2.832***			2.377***	0.700
N	309	309	309	309	309	309	309	309
McFadden R-sq.	0.109	0.114	0.121	0.122	0.0194	0.0254	0.0148	0.0204
Log lik	-285.6	-284.1	-336.3	-336.0	-324.9	-322.9	-416.4	-414.0
Akaike's IC	591.3	594.2	694.6	697.9	669.7	671.8	854.9	856.1
chi-sq	63.36***	579.6***	73.12***	.	12.17	163.0***	11.31	182.0***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6b: Innovation and networking, scope of different innovation types, service sub-sample

	SPROD		SPROC		SMARK		SORG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
COLLAB	-0.039	-4.847***	0.297	-4.587***	-0.448	-4.966***	0.030	0.144
EXTERN	0.569	4.287***	0.751	4.341***	0.035	1.178*	0.570	-1.810***
CONRAD	1.550*	1.289	1.399**	1.216	1.043*	5.577***	1.006*	6.034***
SIZE	0.227	0.221	0.259	0.264	0.146	0.150	0.330*	0.322*
GROUP	0.534	0.500	0.388	0.372	0.369	0.364	0.213	0.201
TRAINING	0.483	0.477	0.648	0.628	1.761***	1.719***	0.954**	0.906*
LOCATION	-0.013	-0.001	-0.189	-0.180	0.241	0.280	0.096	0.087
EXPORT	0.270	0.232	0.007	0.006	0.584	0.618	0.828*	0.841*
COLLAB*EXTERN		14.10***		14.76***		13.61***		-0.298
COLLAB*CONRAD		-2.878*		-0.055		0.715		-0.297
EXTERN*CONRAD		3.460		0.731		-14.15***		-15.33***
cut1_cons	0.805	3.098***	0.992	3.341***	1.589*	2.399***	0.908	-0.694
cut2_cons	2.684***	5.011***	2.019**	4.372***	2.702***	3.517***	1.791*	0.197
cut3_cons			3.105***	5.463***			3.205***	1.618*
N	163	163	163	163	163	163	163	163
McFadden R-sq.	0.088	0.113	0.082	0.086	0.126	0.132	0.098	0.104
Log lik	-159.7	-155.4	-203.5	-202.6	-150.3	-149.2	-181.5	-180.3
Akaike's IC	339.5	336.8	428.9	433.3	320.7	324.4	385.1	388.7
chi-sq	24.88***	224.7***	29.69	262.5***	36.12***	665.8***	27.49***	562.5***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Ordinal logistic regression, explaining innovative performance by innovation type across Nigerian firms

	SPROD		SPROC		SMARK		SORG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
BCOLLAB	-0.002	-0.054	0.0373	0.034	-0.218	-0.226	-0.004	-0.039
BEXTERN	0.109**	0.133**	0.213***	0.220***	0.024	0.017	0.070	0.054
CONRAD	1.245***	1.285***	1.194***	1.156***	0.151	0.391	0.404	1.034**
BCOLLAB2	0.011	-0.006	-0.009	-0.018	0.050	0.062	-0.011	0.009
BEXTERN2	-0.027*	-0.0311**	-0.033**	-0.034**	-0.020	-0.018	-0.008	-0.003
SIZE	0.053	0.0593	0.108	0.107	0.213*	0.219*	0.208**	0.226**
GROUP	0.353	0.342	0.078	0.070	0.223	0.226	0.053	0.072
TRAINING	0.654**	0.642**	0.634**	0.638**	0.471*	0.442*	0.247	0.168
LOCATION	0.080	0.106	-0.040	-0.030	-0.052	-0.0826	-0.218	-0.276
EXPORT	0.151	0.157	0.084	0.090	-0.210	-0.230	-0.100	-0.134
SERVICE	-0.062	-0.068	-0.521*	-0.525*	0.634**	0.651**	1.235***	1.294***
BCOLLAB*BEXTERN		0.036		0.009		-0.001		0.003
BCOLLAB*CONRAD		-0.076		0.040		-0.091		-0.153
BEXTERN*CONRAD		0.011		0.011		-0.080		-0.217*
cut1_cons	0.329	0.385	0.138	0.149	0.871*	0.878*	0.479	0.504
cut2_cons	1.607***	1.667***	1.068**	1.077**	1.854***	1.864***	1.270***	1.305***
cut3_cons			1.985***	1.994***			2.520***	2.576***
N	472	472	472	472	472	472	472	472
McFadden R-sq.	0.089	0.091	0.106	0.107	0.030	0.031	0.047	0.054
Log lik	-460.0	-459.1	-544.7	-544.5	-491.2	-490.3	-609.9	-605.2
Akaike's IC	946.1	950.2	1117.3	1123.1	1008.4	1012.5	1247.8	1244.5
chi-sq	72.13***	74.75***	107.0***	105.9***	25.55**	28.57**	56.72***	63.99***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8a: Ordinal logistic regression, explaining innovative performance by innovation type across Nigerian manufacturing firms

	SPROD		SPROC		SMARK		SORG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
BCOLLAB	0.099	0.052	-0.062	-0.056	-0.236	-0.289	-0.001	-0.079
BEXTERN	0.127**	0.159**	0.244***	0.249***	-0.001	0.027	0.054	0.0585
CONRAD	0.973**	1.127**	0.992**	0.821*	-0.025	0.124	0.322	0.968*
BCOLLAB2	-0.005	-0.050	0.013	0.002	0.080	0.056	-0.001	-0.001
BEXTERN2	-0.031*	-0.036*	-0.038**	-0.038*	-0.052***	-0.060***	-0.018	-0.016
SIZE	-0.049	-0.040	0.029	0.010	0.296**	0.330**	0.228*	0.270**
GROUP	0.255	0.200	-0.180	-0.201	0.449	0.429	0.111	0.104
TRAINING	0.765**	0.726*	0.732**	0.767**	-0.047	-0.094	-0.027	-0.138
LOCATION	0.241	0.295	0.220	0.271	-0.096	-0.087	-0.285	-0.344
EXPORT	0.124	0.117	0.310	0.350	-0.747*	-0.803**	-0.572*	-0.639*
BCOLLAB*BEXTERN		0.060		0.0017		0.056		0.034
BCOLLAB*CONRAD		0.106		0.190		-0.147		-0.115
BEXTERN*CONRAD		-0.108		0.006		-0.013		-0.229
cut1_cons	0.145	0.200	0.024	-0.027	0.392	0.523	0.107	0.240
cut2_cons	1.132*	1.194**	0.895	0.844	1.440**	1.581**	0.894*	1.041*
cut3_cons			1.734***	1.686***			2.144***	2.310***
N	309	309	309	309	309	309	309	309
McFadden R-sq.	0.102	0.107	0.119	0.121	0.043	0.048	0.016	0.024
Log lik	-288.0	-286.4	-337.1	-336.4	-317.1	-315.3	-415.8	-412.7
Akaike's IC	600.1	602.7	700.3	704.8	658.1	660.6	857.6	857.4
chi-sq	61.14***	68.04***	79.51***	79.21***	23.32**	26.82**	12.21	17.47

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8a: Ordinal logistic regression, explaining innovative performance by innovation type across Nigerian service firms

	SPROD		SPROC		SMARK		SORG	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
BCOLLAB	0.004	0.008	0.383	0.386	-0.115	0.134	0.122	0.210
BEXTERN	0.048	0.048	0.146	0.140	0.031	-0.116	0.091	0.001
CONRAD	1.604**	1.082	1.436**	1.430*	0.988	2.482**	0.879	2.261**
BCOLLAB2	-0.021	0.055	-0.109	-0.095	0.020	0.069	-0.015	0.041
BEXTERN2	-0.008	-0.008	-0.008	-0.007	0.033	0.050*	0.011	0.019
SIZE	0.224	0.209	0.221	0.217	0.109	0.107	0.296	0.273
GROUP	0.531	0.548	0.491	0.495	0.468	0.434	0.294	0.248
TRAINING	0.502	0.521	0.488	0.482	1.640***	1.605***	0.847*	0.770*
LOCATION	-0.037	-0.048	-0.287	-0.296	0.226	0.153	0.119	0.0437
EXPORT	0.282	0.241	-0.021	-0.024	0.573	0.554	0.826*	0.823*
BCOLLAB*BEXTERN		-0.055		-0.010		-0.107		-0.054
BCOLLAB*CONRAD		-0.605		-0.109		0.040		-0.270
BEXTERN*CONRAD		0.394		0.009		-0.518**		-0.446*
cut1_cons	0.440	0.351	0.655	0.612	1.968**	1.571*	0.857	0.444
cut2_cons	2.314***	2.247**	1.717**	1.675*	3.107***	2.742***	1.754*	1.357
cut3_cons			2.825***	2.785***			3.203***	2.849***
N	163	163	163	163	163	163	163	163
McFadden R-sq.	0.087	0.103	0.094	0.095	0.138	0.157	0.107	0.123
Log lik	-160.0	-157.1	-200.8	-200.7	-148.3	-145.0	-179.7	-176.5
Akaike's IC	343.9	344.2	427.5	433.3	320.6	320.0	385.4	385.0
chi-sq	24.54**	21.43	34.40***	35.24***	42.82***	55.30***	31.54***	43.55***

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 1: Description of Variables

	Variables	Description
Dependent Variables		
1	SINNO	Ranges from zero to 4. Indicates the number of different innovation types that the firm performed.
2	SPROD	Ranges from zero to 2. Indicates the number of activities amounting to product innovation that the firm had carried out. Constructed as the sum of the responses on two questionnaire items.
3	SPROC	Ranges from zero to 3. Indicates the number of activities amounting to process innovation that the firm had carried out. Constructed as the sum of the responses on three questionnaire items.
4	SMARK	Ranges from zero to 2. Indicates the number of activities amounting to marketing innovation that the firm had carried out. Constructed as the sum of the responses on two questionnaire items.
5	SORG	Ranges from zero to 3. Indicates the number of activities amounting to product innovation that the firm had carried out. Constructed as the sum of the responses on three questionnaire items.
Regressors		
6	COLLAB	Binary measure of whether or not the firm engages in joint activity with any of 6 external actors.
7	EXTERN	Binary measure of whether or not the firm uses any of 9 listed external knowledge sources
8	BCOLLAB	Constructed as the number of actors a firm collaborates with
9	BEXTERN	Constructed as the number of external knowledge sources that a firm uses
Controls		
10	SIZE	Measured as the logarithm of the firm's employees in 2007
11	GROUP	Dummy variable indicating whether the firm belongs to a group
12	TRAINING	Dummy variable indicating the incidence of staff training programmes
13	CONRAD	Dummy variable indicating whether the firm performed in-house R&D continuously during the reference period
14	LOCATION	Dummy variable indicating whether the firm is located in Lagos
15	EXPORT	Dummy variable indicating whether the firm sold products in at least one export market
16	SERVICE	Dummy variable indicating whether the firm is from the service or the manufacturing sample.
17	SECTOR	Variable indicating the sector of firm's main activity (2-digit level because of limited sample size)

Appendix 2: Share of innovative firms

Variable	% Total (N=472)	% Manufacturing (n=309)	% Service (n=163)	Mean comparison[a]
All innovation	97	96	99	-1.93*
Product	71	68	77	-2.06*
Process	78	79	77	0.57
Marketing	61	58	67	-1.89*
Organisational	75	70	86	-3.90**

[a]H_0: % manufacturing = % service, *$p<0.05$; ** $p<0.01$

Appendix 3: Correlation Matrix

	COLLAB	EXTERN	BCOLLAB	BEXTERN	SIZE	GROUP	TRAINING	CONRAD	LOCATION	EXPORT
EXTERN	0.2083*									
BCOLLAB	0.8387*	0.2027*								
BEXTERN	0.2125*	0.6935*	0.3248*							
SIZE	0.0968	0.0348	0.1345*	0.1707*						
GROUP	0.1065	0.0324	0.1134	0.1016	0.2679*					
TRAINING	0.1892*	0.3203*	0.1857*	0.3919*	0.1616*	0.0718				
CONRAD	0.2588*	0.1787*	0.3264*	0.2440*	0.2365*	0.1346*	0.2505*			
LOCATION	0.0457	0.0720	-0.0272	0.1304*	-0.0097	0.0537	0.0927	0.0814		
EXPORT	0.1022	0.1055	0.1524*	0.2126*	0.2956*	0.1839*	0.1067	0.1447*	0.1290*	
SERVICE	-0.0115	0.0795	-0.0677	0.1530*	-0.2446*	-0.0157	0.0619	-0.0423	0.4815*	0.0755

*p<0.01; Condition number = 14.4, Average Variance Inflation Factor = 1.92