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External knowledge modes and firm-level innovation performance: Empirical evidence from sub-Saharan Africa

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ABSTRACT

This paper examines the significance of external knowledge sources as impacting factors on innovation by incorporating a variety of external sourcing strategies, the firm's internal competencies and the industry attributes, into a unique analytical framework in predicting the innovative capabilities of firms in developing countries. The World Bank Enterprise and Innovation follow-up dataset for manufacturing, service and retail firms in 11 countries in sub-Saharan Africa is utilised to assess the degree to which firms utilize external sources of information (customers, competitors, consultants, new employees and workshops) in the implementation of product, process, marketing and organizational innovation. Sectoral and country-specific estimations are performed with IV binary treatment and Tobit models, respectively. The findings demonstrate that, although internal sources are essential, external sources of information are also necessary to attain the desired level of innovativeness. These findings confirm the open innovation literature in that firms that open their innovation process and utilise distinct knowledge sources have a superior capability to introduce innovations. The paper provides significant contributions to the literature. The paper uncovers three sources of external knowledge linking indirect players in the market that are not common in the literature (consultant, new employees and workshop). The study shows that the baggage of knowledge inherent in these three sources is indeed essential to the innovative capabilities of the firms. Second, the results also reveal that the essentiality of external sources of knowledge differs conditional on the type of innovation considered (product, process, marketing or organisational), dependent variable operationalisation, sectoral, methodical configurations, and country specifics. Third, the study contributes to the understanding of how firms in emerging economies develop competencies for innovativeness through the interplay of knowledge from both direct and indirect market players. The findings offer essential insights on how management could invest in the distinct, useful and preferred external sources to best foster a compelling introduction of any innovation. The study further provides robust and novel evidence of the role of new consultants, employees and workshops on firms' propensity to innovate.

Introduction

Innovation is broadly recognised as a driver of economic growth (Galindo & Méndez-Picazo, 2013; Pece, Simona, & Salisteanu, 2015; Rosenberg, 2004; Verspagen, 2009). A crucial contributing factor to the implementation and success of innovations at the firm-level is the internal competencies and unique firms' attributes (Lawson & Samson, 2001). According to the Oslo Manual, innovation activities are all scientific, technological, organisational, financial and commercial steps, including investment in new knowledge, which lead to, or are planned to lead to, the implementation of innovations (OECD, 2005). However, while firms' internal knowledge is considered essential to the innovation propensity, exploring the external environment to harness external knowledge to complement in-house capabilities is deemed substantially significant. Scholarly studies indicate that the utilisation of external knowledge sources is essential to a firm's ability to innovate (Chesbrough, Vanhaverbeke, & West, 2006; Lazzarotti & Manzini, 2009). According to these scholars, the successful implementation of innovation is associated with the utilisation of diverse knowledge sources, which offer different learning prospects that a firm can take advantage of regarding innovation. Also, other studies underscore the effect of internal capabilities and resources on a firm's ability to

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innovate (Becheikh, Landry, & Amara, 2006; Freel, 2003). Yet, some studies demonstrate that the attainment of internal and external knowledge may be paired activities in the firm's innovation strategy (Doloreux & Shearmur, 2013; Vega-Jurado, Gutiérrez-Gracia, & Fernández-de-Lucio, 2009). Some researchers argue that innovation activities depend on external factors and might occur due to some external factors such as demand from the market, competitors actions, and government legislation (Caruana, Ewing, & Ramaseshan, 2002; Corrocher & Zirulia, 2010; Tao, Garnsey, Probert, & Ridgman, 2010; Tripsas, 2008; Yalabik & Fairchild, 2011). Furthermore, other authors assert that there is a positive relationship between R&D activities and the utilisation of external knowledge source. The authors reiterate further that with an increase in R&D intensity and product novelty, external knowledge is revealed to complement such successful innovative ventures (Bercovitz & Feldman, 2007; Hottenrott & Lopes-Bento, 2014). The external knowledge sources from universities and research organisations tend to be positively linked with the product and process innovation (Vivas & Barge-Gil, 2015). The diversity of external knowledge source likely to enhance innovation and could enable the firms to improve innovation abilities (Ferreras-Méndez, Fernández-Mesa, & Alegre, 2016). The variety of knowledge sources is found to be positively associated with the introduction of innovation (see, Amara & Landry, 2005; Nieto and Santamaría, 2007).

In innovation literature, the importance of external knowledge has been discussed widely (Freeman, 1995; Lundvall, 1992; Malerba, 2004; Nelson, 1993). Involving market-based information, such as knowledge from suppliers and customers may facilitate the market requirement, particularly for the innovative goods and services. The interaction with customers might be an essential source of knowledge for the implementation of open service innovation model (Chesbrough, 2011). Also, previous literature indicates that interaction with lead user may provide benefit to the companies to improve their innovative efforts (Hagedoorn, 1993; Von Hippel, 1976). Some studies argue that knowledge sources from customers and competitors have a positive impact on innovation (Lee, Wang, & Lin, 2010; Lefebvre, De Steur, & Gellynck, 2015; Leiponen, 2005a) and that knowledge sources that emanate from the customers are also considered essential for innovation (Mina, Bascavusoglu-Moreau, & Hughes, 2014; Rodriguez, Doloreux, & Shearmur, 2017). Further, the first most recent study by Abdul Basit and Medase (2019)) show that knowledge from customers in the private and public sector relates significantly positive with the propensity to innovate in German firms.

Hence, the resource-based theory of the firm proposes that to be innovative, the firms need complementary resources and further, the selection of partners relies on the firms required types of resources (Fritsch & Lukas, 2001; Miotti & Sachwald, 2003; Tether, 2002). In literature, the two main categories are identified as the market/value chain and research/ instructional. With the perspective of market category, further two types of sources are identified; clients and suppliers. Further, the first work of Von Hippel (1976) reveals that the source of knowledge from lead clients reduces the risks which might occur with the introduction of innovation in the market. In addition, the innovation literature provides two main explanations about this (Laursen, 2011): first, usually clients get more benefit from the innovation; second clients also provide sticky knowledge to the companies. Sticky knowledge is generally explained as tacit knowledge, which means that such knowledge could be delivered often with face-to-face communications. Also, the suppliers could provide valuable information for the adoption of technology (Leiponen, 2005a; Tether, 2002) and suppliers also support in technical problems solution for the new product development (Tsai & Hsieh, 2009). For large innovation project, the competitors could also play an important role, as competitors usually contain complementary resources that might reduce the cost. In contrast, Miotti and Sachwald (2003) highlight that cooperation with competitors might be risky in two cases: in the first case, it might be risky if the anticipated research results seem to be generic character and in the second case when the strong common interest is found.

In general, a firm cannot rely only on internal knowledge for the development of any innovation process. Hence, for the internal innovation efforts, firms mostly seek external knowledge sources as well as external partners. This current study investigates the relationship between diverse external knowledge sources and innovation within the purview of firms in sub-Saharan Africa. Although many researchers provide the insights on knowledge sources and innovation, however most studies focus the external knowledge sources effects on innovation in the manufacturing sector (Amara & Landry, 2005; Nieto & Santamaría, 2007; Zeng, Xie, & Tam, 2010). Hence, the present study examines different strategies with regards to the usefulness of knowledge that affects the propensity for innovation in the manufacturing and service sectors, respectively. However, there have been relatively no studies regarding external sources of knowledge that emanate from the *new employees* and *workshops* in shaping the managerial learning process of the firms and its impact on the ability to introduce different types of innovation, i.e. product, process, marketing and organisational innovation. Also, the knowledge source from the consultants and its effect is limited to product innovation in previous studies, for instance, Tether and Tajar (2008) and Ardito and Petruzzelli (2017) and for product and process innovation (Gómez, Salazar, & Vargas, 2016). Thus, the present study contributes to the literature and considers the knowledge source from the consultant and its impact on the product, process, marketing and organisational innovation. The findings not only support a superior insight into the diversity of knowledge designs for innovation implementation but also indicate the potential benefits of some external knowledge sources as essential ingredients for the managerial learning process. The study recognises innovation strategies using firm-level information. Within the context of this study, an innovation strategy is defined as choices made by a firm regarding external sourcing of information and knowledge (Laursen & Salter, 2006). These three sources of external knowledge (such as *consultants*, *new employees* and *workshops)* are fundamentally relevant for firms in sub-Saharan Africa owing to the inability of most of the firms to compete internationally and the limitedness of tangible resources in supporting their innovative capabilities. However, scholars have maintained that the dearth of primary capabilities to exploit enhanced technologies remains the reason most developing countries lag with regards to the ability to introduce innovation (Lugones et al., 2006; Salazar & Holbrook, 2004). Specifically, for countries in Africa, the deficiency of resources and the incapability to grasp external knowledge constitute the innovation impediments (Lall & Pietrobelli, 2002). This study fills this research gap. Previous research indicates that the use of external knowledge or firms learning capability generally contingent upon firm own internal ability or the firm own knowledge skills as well as on investment in internal R&D activities (Cohen & Levinthal, 1990; Teece, 2000). As a matter of importance, the paper incorporates some fundamental variables in the estimation that perhaps support the firms' ability to gain from external sources of knowledge.

The use of external knowledge sources and its association with innovation is well documented in the literature. The research reveals that interaction with the customers and suppliers may facilitate innovation activities (Von Hippel, 1986). In a competitive economic environment, external knowledge sources are the crucial factors for effective innovation activity. Previous research confirms that firms that use the diverse knowledge sources are more capable of producing innovation (Grant, 1996; Levitt & March, 1988; Gómez et al., 2016; Svetina & Prodan, 2008). Furthermore,

some other scholars reveal that external knowledge source plays an important role for innovation and particularly when firms engage in internal R&D activities; it enables the firms to absorb and utilise the specific knowledge source efficiently for the innovation process (Arora & Gambardella, 1994; Cohen & Levinthal, 1990). Moreover, researchers stress that external sources of information are positively linked with new product development, such as product innovation (Tsai, 2009: Belderbos, Carree, & Lokshin, 2004). The external knowledge may grant access to the firms for innovation activity through the learning process, for instance, firms may get benefit from external knowledge sources to gather useful information for those innovation producing abilities which the firms might not possess before (West & Bogers, 2014). Additionally, another study confirms that firms that leverage on an external source of information, as well as well-prepared firms, may get advantage and perform better with the different level of radical innovation and introduce successful innovations (Chiang & Hung, 2010). In contrast, some studies provide a separate argument that knowledge sources from the customers show an adverse effect on innovation output in Swedish manufacturing (Lööf & Heshmati, 2002) and knowledge sources from customer shows an insignificant impact on product innovation in French manufacturing firms (Monjon & Waelbroeck, 2003). Also, another study provides evidence that collaboration with the customer has an insignificant negative impact on productivity growth, and further customer collaboration shows insignificant implications for new product sales (Belderbos et al., 2004).

In innovation literature, researchers have acknowledged different methods of external sources of information for instance information from R&D collaboration Brockhoff (1992); Shan, Walker, and Kogut (1994) and technology acquisition (Granstrand & Sjölander, 1990) and information transfer from informal networks such as customers, competitors, institutions and consultants (Laursen & Salter, 2006). Further, Hagedoorn and Hesen (2007) stress that firm use different external knowledge sources according to their internal requirement or external environment. Some scholars confirm that respective source of information has a drawback to the firm and each source of knowledge also provides a different advantage to the firms (Kang & Kang, 2009; Lin & Wu, 2010). This could be explained in a way that each knowledge source influences differently on firm performance according to the firms' capability. Thus, the companies need to know the suitable policy for external knowledge sources utilisation, and it is crucial to recognise the different modes of external knowledge sources and their impact on innovation output. However, notable scholars examine the external knowledge sources and their impact on firm performance but did not pay attention to how the various types of external knowledge sources affect firms in the manufacturing and service sectors. For example, the existing studies examine the knowledge source from customers and its impact on product innovation (e.g. Tsai, 2009; Fitjar & Rodríguez-Pose, 2013; Ardito & Petruzzelli, 2017) and on radical or incremental innovation Laursen and Salter (2006), and knowledge sources from universities and the government research organizations effects on product innovation (Tödtling, Lehner, & Kaufmann, 2009) and knowledge sources from customer, competitors and their effect on innovation types (i.e product, process, marketing and organizational innovation; see, Abdul Basit & Medase, 2019) and the external knowledge sources from customers, suppliers, universities and their effects on innovation activities (Mina et al., 2014). As a matter of importance, the existing research does not pay attention to the knowledge sources from the *new employees* and *workshops* and their influence on all four types of innovations identified above. In other words, various modes of knowledge sources influence innovation performance differently. Although these sources are not direct participants in the market, they offer indirect relevant information to firms. In order to develop an efficient strategy for external knowledge source, it is necessary to recognise the different knowledge sources and their suitability on innovation performance. Thus, this study analyses the five different external sources of knowledge, including the source of knowledge from the *competitors, customers*, *new employees*, *consultants* and *workshops on innovation performance*. The question then is; how do direct and indirect market players of external knowledge sources relate to firm-level innovativeness?

Moreover, a few studies have examined the role of external knowledge sources in innovation in sub-Saharan Africa (see, for instance, Adeyeye, Egbetokun, Sanni, Siyanbola, & Aremu, 2014; Adeyeye, Egbetokun, Opele, Oluwatope, & Sanni, 2018; Egbetokun et al., 2009; A. Egbetokun (2015); A.A. Egbetokun, 2015). However, the relationship between external sources of knowledge that emanate from those that are indirectly involved in the market process such as *consultants*, *new employees* and *workshops* has less been documented. To a large extent, scholars have documented the relationship between sources of knowledge from *customers* and *competitors* and innovation in developed economies as compared to developing countries, especially firms in sub-Saharan Africa. This study makes a few substantial contributions to the literature. First, the findings of the study reveal the relevance of knowledge players that are not directly involved in the market process to innovation performance. Second, it shows the essentiality of the diverse knowledge sources about the types of innovation preferably introduced by the firms. Most studies have mainly linked the external knowledge sources impact to product innovation (e.g. Tsai, 2009; Fitjar & Rodríguez-Pose, 2013; Tödtling et al., 2009; Ardito & Petruzzelli, 2017) and on radical or incremental innovation (Laursen & Salter, 2006) and on perceived number of product innovations (Kang & Kang, 2009). Hence, the present study uses five distinctive external sources of knowledge (i.e. from the competitors, customers, new employees, consultants and workshops) and relates their impact on all four types of innovations. It offers a clear understanding of the external knowledge source that is more important for different innovation types, which are ignored in the previous literature. Owing to the cost that might be associated with the ability of firms to acquire external knowledge, and the resource constraint of most firms in sub-Saharan Africa, this study offers firms the latitude to the choice of external knowledge. The study also reveals that model specifications could influence the direction of specific external knowledge mechanisms on innovation.

Furthermore, Egbetokun, Atta-Ankomah, Oluseye, and Lorenz (2016) and Adeyeye et al. (2018) document that one of the constraints to innovative success among firms in sub-Saharan Africa is the inability to explore suitably the resources from the external environment, and the inadequacy of economic of infrastructure (Adeyeye et al., 2018). Also, the African Innovation Outlook II (AUNEPAD, 2014) highlights that the most significant external sources of information to firms' innovative capacity is market-based: customers, suppliers and competitors. Firms in all the countries, apart from Kenya, make small utilisation of information from universities or government and private research laboratories. The weak links between firms and these knowledge and research institutes is certainly an essential limitation to innovation in African countries, especially in the case of science-based sectors (Egbetokun et al., 2016). For countries that are considered in this analysis, it is shown that Kenya level of external knowledge sources for innovation relates in this order: 88% from suppliers, 89.7% from competitors, 80.3% from customers, 53% from consultants, 10.3% from conferences or workshops. In the case of Nigeria, it follows in this order: 39.3% from suppliers; 51.7% from customers, 30% from competitors, 14.6% from consultants, and 11.5% from conferences. Similarly, Tanzania usage of external sources of information follows this order: 32.1% from suppliers, 66.7% from customers, 27.4% from competitors, and 16.7% from consultants 16.7% from conferences. Uganda

case relates thus: 26.1% from suppliers, 49% from customers, 23% from competitors, 12.2% from consultants 16.4% from conferences. Zambia utilises external information in this intensity: 5.7% from suppliers, 10.9% from customers, 3.3% from competitors, 0% from consultants 0% from conferences (African Innovation Outlook II (AU-NEPAD, 2014).

With the above review on the intensity of external sources of information used by firms in sub-Saharan Africa, this article provides empirical support on the impact of the external knowledge sourcing approaches espoused by firms, on the development of different innovation types, and evaluates to what degree this effect is shaped by the firm's internal technological competencies. Also, the article investigates the effects of these activities relative to the sectors in which the firms belong, considering two sectoral classifications: manufacturing and service; and country-specific differences. The actual importance of external knowledge sources as the contributing factor to innovation is adopted by incorporating a variety of external sourcing strategies, the firm's internal competencies and the industry characteristics, into a different analytical framework.

The analysis utilises firm-level data from the World Bank Enterprise and Innovation Follow-up surveys involving 11 countries in sub-Saharan Africa. The findings demonstrate that, although internal sources are essential, external sources of information are also necessary to attain the desired level of innovativeness. The paper has three principal contributions to the literature. First, the paper uncovers three sources of external knowledge linking indirect players in the market that are not common in the literature (*consultant, new employees and workshop*). It shows that the baggage of knowledge inherent in these three sources is indeed essential to the innovative capabilities of the firms. Second, the results also reveal that the essentiality of external sources of knowledge differs conditional on the type of innovation considered (product, process, marketing or organisational), dependent variable operationalisation, sectoral, methodical configurations, and country specifics. Third, the study contributes to the understanding of how firms in emerging economies develop competencies for innovativeness through the interplay of knowledge from both direct and indirect market players. The findings offer essential insights on how management could invest in the distinct, useful and preferred external sources to best foster a compelling implementation of any innovation

The paper is designed in the following format: Section 2 reviews the arguments of existing literature, both conceptual and empirical on the relationships between external knowledge sources and innovation. The working hypotheses are then formulated. The next session describes the dataset and the characteristics of the respective estimation variables. The section that follows documents the empirical findings and their interpretations. The conclusion presents a summary of the results, discusses their implications for theory and managerial practice, and recommends possibilities for future research.

Literature and hypotheses

In the era of open innovation, external knowledge and technology play a significant role in firm innovation performance. Chesbrough (2003) claims that knowledge generated inside the firms might be used to the firms' boundary and its essentiality to absorb the external knowledge capabilities as suggested by earlier studies (Cohen & Levinthal, 1990; Leonard-barton, 1995; Powell, Koput, & Smith-Doerr, 1996). The previous literature reveals that knowledge and capabilities might be beneficial through networks (Ahuja, 2000; Granovetter, 1973; Hansen, 1999; Sparrowe, Liden, Wayne, & Kraimer, 2001). Hence, network can be considered a significant pathway where firms can explore external knowledge. In innovation literature, researchers have acknowledged different methods of external sources of information for instance information from formal networks such as R&D collaboration (Brockhoff, 1992; Shan et al., 1994) and technology acquisition (Granstrand & Sjölander, 1990) and information transfer from informal networks such as customers, competitors, institutions and consultants (Laursen & Salter, 2006).

Moreover, the effect of using external knowledge sources on innovation performance varies on the type of knowledge sources used by firms for innovation. Hagedoorn and Hesen (2007) stress that firms use different external knowledge sources according to their internal requirement or external environment. Further, some scholars confirm that respective source of information has a drawback to the firm and each source of knowledge also provides a different advantage to the firms (Kang & Kang, 2009; Lin & Wu, 2010). In other words, various modes of knowledge sources influence innovation performance differently. Also, innovation literature highlights the effect of various external knowledge sources such as suppliers, competitors, lead users and universities (Laursen & Salter, 2006; Von Hippel). Gambardella and Giarratana (2006) argue that with the use of external knowledge sources, its relevance to firms' internal R&D capabilities is somewhat enhanced. Further, Cohen and Levinthal (1990) indicate that those firms that invest more in the internal R&D are more capable of absorbing and recognising external knowledge.

Further, scholars confirm the argument suggested by Cohen and Levinthal (1990) and find that internal and external knowledge complementary relationship exists (see Refs. Cassiman & Veugelers, 2006; Lokshin, Belderbos, & Carree, 2008). The open innovation provides the pathways for external knowledge flows, and the firms may benifit from such external information (Rigby & Zook, 2002). Those firms that employ the external source of information may enhance their knowledge base, and based on external information, firms can integrate the diversity of ideas for the development of new product and process. Additionally, such firms that use the external knowledge source might be in a better position to face different challenges, for instance, short product life cycles or increase of risks in R&D and costs (Berchicci, 2013; Chesbrough, 2003; Keupp & Gassmann, 2009; Rigby & Zook, 2002). On the other hand, some studies provide evidence that excessive external knowledge beyond its absorptive capacity might bring negative impact on firm innovation performance. In this context, the researcher suggests that too much dependency on external information becomes disadvantageous and might be harmful to the firms (see Refs. Laursen & Salter, 2006; Katila & Ahuja, 2002). The plausible explanation could be that intensive reliance/usage of external knowledge sources might create additional costs and which should be taken into consideration. Furthermore, extreme dependence on external knowledge sources might affect the firm internal knowledge stock building and may also enhance the monitoring as well as coordination costs for the external knowledge sources (Berchicci, 2013; Leiponen & Helfat, 2010).

Nonetheless, prior literature and practitioners identified that valuable information might reside outside of the firms (Cohen & Levinthal, 1990) and further integrating as well as accessing such external information might be critical to the firm's innovation performance (Rosenkopf & Almeida, 2003). For the most important novel innovation development often requires the new ideas/ information outside of the firms; for instance, innovation such as bone cement to treat spinal fractures and drug-eluting stents discovered with the combination of various external knowledge (Fleming, 2001; Rosenkopf & Nerkar, 2001). A considerable literature document how firms deal with both internal and external sources of new knowledge for innovation development (Arora & Gambardella, 1990; Bercovitz & Feldman, 2007; Cassiman & Veugelers, 2006;

Chesbrough, 2003; Grant, 1996; Karim & Mitchell, 2004; Phene, Fladmoe-Lindquist, & Marsh, 2006; Sampson, 2007). Due to the constraint for the internal advancement of new knowledge stock (Christensen & Bower, 1996; Levitt & March, 1988; Nelson & Winter, 1982; Thompson, 1965) and employing as wells as accessing the external information is the most important for the firms (Cohen & Levinthal, 1994; Laursen & Salter, 2006; Rosenkopf & Almeida, 2003). Also, previous literature highlights that harnessing external knowledge from other firms and universities might be helpful for the firm's innovation performance. For instance, Cohen, Nelson, and Walsh (2002) indicate that customers are considered as paramount for the source of information, which suggest the new ideas for new projects and even suggest more than the firm's manufacturing operations. In other words, product users contain certain knowledge that is different from the researcher's knowledge, which is developed inside the firms. Because the users get expertise with the product functioning in first-hand and observe the limitations of a specific product, such experiences may expose the problems which the industrial people do not realise and might suggest the solutions or improvement for the specific product which could be beneficial for other users.

Therefore, knowledge is often closely linked with the person who develops specific knowledge, so it is often considered as tacit knowledge. It is commonly believed that tacit knowledge transfer needs interactions. A firm cannot rely only on internal knowledge for the development of the innovation process. Hence, for the internal innovation efforts, firms mostly seek external knowledge sources as well as external partners, so in this way, external knowledge becomes quite essential for the firms. In this vein, a study by Chesbrough (2003) sheds lights on the importance of open innovation and explains that in the market, external sources of knowledge and external networks need to be complemented with the internal knowledge in order to create the additional benefits. Fig. 1 summarises the conceptual model for the analysis.

This study highlights the flow of literature on the role of heterogeneous sources of external knowledge in innovation. In the original theorisation of innovation, innovation is described as a methodical and open process (Chesborough, 2006; Lundvall, 2007). Hence, innovation stems from the utilisation of external knowledge sources and the firm's collaborations with external allies (Kline and Rosenberg, 1986; Lundvall, 2007). Several studies have examined the use of external sources of knowledge and its influence on innovation (Nieto and Santamaria, 2007; Tödtling et al., 2009; Tomlinson, 2010; Von Hippel, 1988). These researches demonstrate that customers and suppliers are the primary sources of innovation for firms that handle their strategy in a market and technology-focused approach.

We contend in this study that another common area for external knowledge acquisition for the firms could be from the indirect market players such as *consultants*, *new employees* and *workshops.* Competitors can also add to innovation by presenting complementary resources at the level of R&D and technology (Miotti & Sachwald, 2003). Universities and public research groups can be exploited to obtain knowledge from transfer technologies related to research activities (Becheikh et al., 2006). This sort of knowledge may be disseminated directly by the corporations or supplied indirectly via publications and conferences or workshops, an essential area for the focus of this article. Further universal sources of innovation, such as websites, trade fairs, and business associations, can be employed to tackle problems or discover common fields of interest to stimulate the sharing of ideas and information (Becheikh et al., 2006). Similarly, Vega-Jurado et al. (2009) show that a strategy directed towards the acquisition of external knowledge could not alone promote ideas and supply the resources required for innovation.

Moreover, scholars identify that various types of innovation are linked with the diversity of external knowledge sources (Freel, 2003; Tödtling et al., 2009; Varis & Littunen, 2010). For example, Tödtling et al. (2009) highlight that for incremental innovation; firms seek external knowledge or cooperate with the providers of business services. On the other hand, for radical innovation, firms seek external knowledge from universities and research organisations. Also, some studies encourage the idea for knowledge sharing and point out that the sharing of knowledge with others does not decrease the external knowledge resources for innovation (Antikainen, Mäkipää, & Ahonen, 2010; Egbetokun & Siyanbola, 2011). Firms may get benefit with the recombination of internal knowledge and information received from the customers, competitors, suppliers, consultants and such knowledge combination could generate new ideas which enable the companies to develop the new products (Lee et al., 2010; Lefebvre et al., 2015; Tether & Tajar, 2008). Therefore, in the product market, competitors and customers are recognised as a critical element for product development. Likewise, sources from competitors and customers are paramount, and in case of negligence of these sources, it might bring instant reaction on the firms' sale. Further, Lukas and Ferrell (2000) confirm that customers contribute to a large extent to the development of innovation novelty. Thus, firms must pay attention to the external information that might be transformed into the development of innovation activities (Köhler, Sofka, & Grimpe, 2012). Essentially, there is still a need to provide a clear understanding of which types of external knowledge source or more refined indicators of external knowledge sources that are more beneficial to the introduction of any forms of innovation. By so doing, types of external knowledge sources such as knowledge from *new employees* and *workshops and its effect on innovation types become a significant lacuna that exists in the extant literature* that this study fills. However, scholars assert that existing literature is scant on these external sources of knowledge (Chen, Chen, & Vanhaverbeke, 2011; Lefebvre et al., 2015; Nieto & Santamaría, 2007) and that makes them pertinent to this present study.

Scholars reiterate that in order to establish a competitive advantage, firms must explore knowledge from diverse allies. If firms depend only on their internal sources of knowledge, they are likely to lose valuable prospects that a variety of players could offer them (Chesbrough, 2003). Consequently, innovation activities offer a collaborative procedure that underpins the relationships between firms and the various market players (Yam, Lo, Tang, & Lau, 2011), because interaction with several sources of knowledge can suggest further resources that are essential for innovation (Romijn & Albaladejo, 2002). Prior scholars offer claims that support the positive connection between distinct sources of knowledge and innovation performance about countries in sub-Saharan Africa (e.g. Egbetokun & Siyanbola, 2011; Adeyeye et al., 2014; A. Egbetokun, 2015, 2015b; Adeyeye et al., 2018). Undeniably, it is contended that the capacity of firms to understand knowledge acquired via their networks is essential to successful innovation (Cohen & Levinthal, 1990). Some scholars have examined various knowledge sources that could influence the innovation activities of firms (e.g. Amara & Landry, 2005; Leiponen & Helfat, 2011; Herstad, Aslesen, & Ebersberger, 2014). The underlying principle that connects diverse sources of knowledge and innovation performance is because access to a greater diversity of sources of knowledge offers firms with more suitable information concerning opportunities for development (Burt, 1992). The ensuing arguments encapsulate those debates. Market-related sources of knowledge, such as customers and suppliers, are deemed essential instruments through which firms enhance their innovation activities (Amara & Landry, 2005). Customers are essential allies that can offer beneficial information (e.g. competition, new technology, and customer needs).

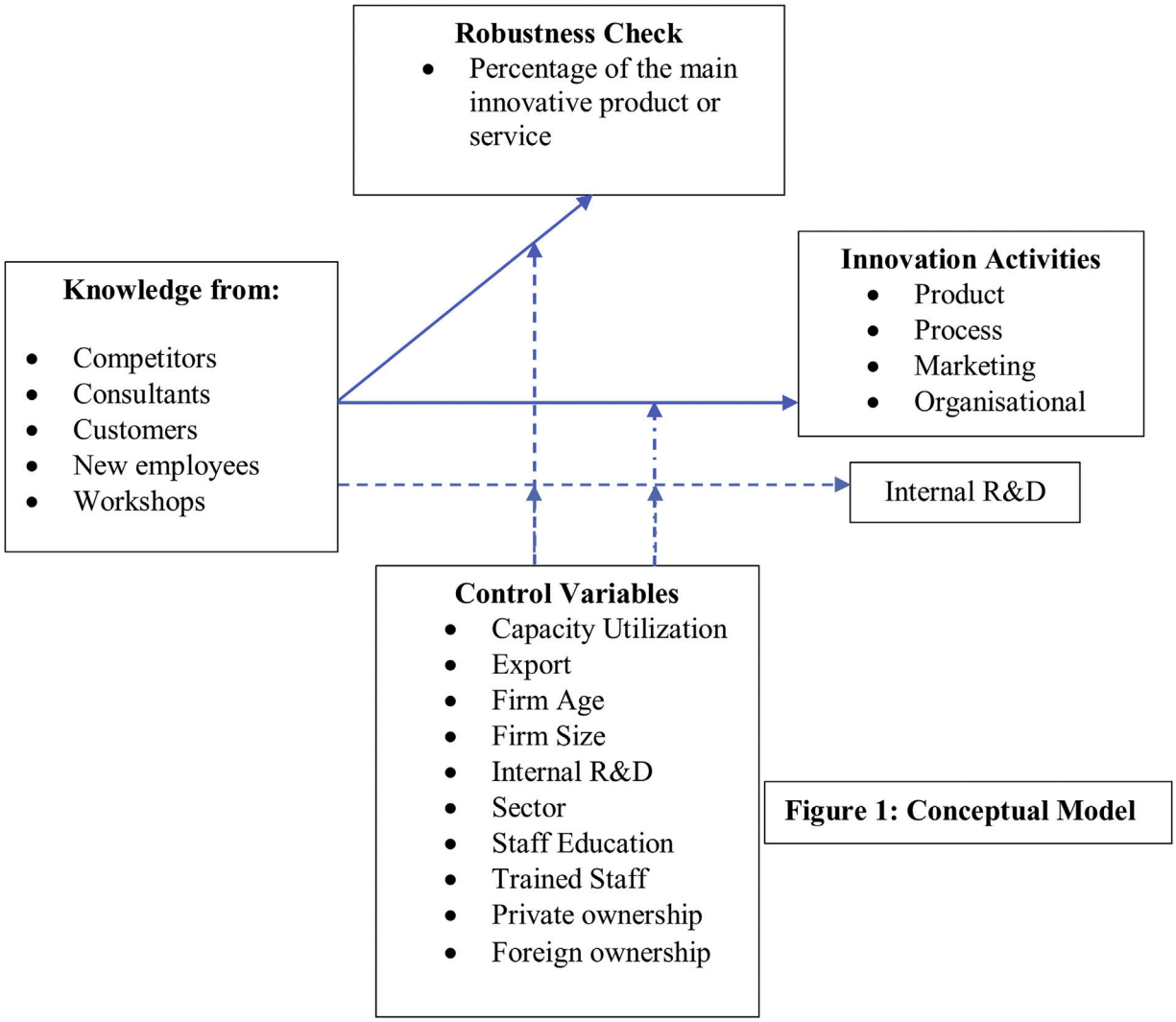

Figure 1: Conceptual Model

Fig. 1. Conceptual model.

Suppliers are also sources of information that provide information sharing created by their customers and suppliers. Prior researchers corroborate the essential role of suppliers for the advancement of innovation activities (Bruce, Leverick, Littler, & Wilson, 1995; Teubal, Yinnon, & Zuscovitch, 1991). Also, the knowledge gained from competitors supports firms to enhance their position by investigative scaling and position benefit building (Day & Wensle, 1988; Dickson, 1992; Gómez et al., 2016). Therefore, Lawson and Samson (2001) contend that a firm with enhanced competitor information can utilise this knowledge to its gain by employing its powers counter to a rival's weakness and adopt competitors' strengths using reproduction and improvement. Information for innovative activities can also be offered from representatives that are not directly linked to the market, as *consultants*, *new employees*, *universities*, *governmental bodies*, as well as *conferences*, *workshops*, *trade fairs* and *exhibitions*. Tether and Tajar (2008) maintain that *consultants* have an imperative role for innovation in firms because they can act as sources of external concepts. This is confirmed in the study of Gómez et al. (2016) for process innovation.

Additionally, Hargadon and Sutton (1997) claim that *consultants* do not generate profoundly novel technologies but transmit ideas from one framework to another, and such advances to improved innovation. Conferences, trade fairs, exhibitions, and workshop are deemed useful platforms for new products or the promotion of services. Thus, partaking in these activities help knowledge formation and collaborative learning (Maskell et al., 2006; Bathelt & Schuldt, 2008), which improve innovation. In general, diverse sources of information are positively associated with different innovation activities. Therefore, this study tests in a similar analytical framework whether information sources from (a) customers; (b) competitors; (c) consultants; (d) new employees (f) and workshops are positively associated with a firm's propensity to innovate among firms in sub-Saharan Africa. Based on these arguments, the following working hypotheses are formulated:

H1. Sources of knowledge from the direct market players (customers and competitors) support firms' propensity to innovate.

H2. Sources of knowledge that emanate from the indirect market players (consultants, new employees and workshops) are a positive reinforcer for firms' innovativeness.

Data and variables

We use the World Bank Enterprise Survey (WBES) and Innovation Follow-up Survey (IFS) to test our hypotheses. Since both datasets consist of the same firms, we merge first, then for each country using firms' specific identifier and later append the out-

Table 1
Sample by country and sector.

Country	Manufacturing	Retail	Services	Total
DR Congo	243	136	150	529
Ghana	377	115	228	720
Kenya	414	166	201	781
Malawi	176	144	203	523
Namibia	170	188	222	580
Nigeria	1,147	549	979	2675
South Sudan	90	390	258	738
Sudan	103	139	420	662
Tanzania	441	121	251	813
Uganda	382	165	215	762
Zambia	368	123	229	720
Total	3911	2236	3356	9503

come of the merger for eleven SSA countries considered in our analysis. The two datasets are firm-level and cover the following periods for each country: DR Congo (2013), Ghana (2013), Kenya (2013), Malawi (2014), Namibia (2014), Nigeria (2014), South Sudan (2014), Sudan (2014), Tanzania (2013), Uganda (2013), and Zambia (2013)[1]. The content of WBES data ranges from institutions-related variables like political stability, corruption to business characteristics and performance indicators.

The World Bank since 1990 has been consistent in collecting firm-level survey data to allow for country-specific analysis. As the world becomes interconnected and interdependent, the World Bank in 2005 started conducting a firm-level survey to allow for comparative analysis across countries. On the other hand, the World Bank realises the role of firms in jointly stimulating the economy, hence the collection of innovation dataset. IFS was pioneered in 2011 to garner data on innovation and innovation-related activities specific to firms' internal operations. The economy comprises manufacturing, retail, and services. The firm-level WBES was a representative sample of firms in the formal non-agricultural sector. The WBES is stratified based on the sector of activity, firm size and geographical locations of the sampled firms, respectively. Business owners and top echelon managers were both the WBES and IFS respondents. We show the number of firms in each country, constituting manufacturing, retail, and services in Table 1 (www.enterprisesurvey.org).

Independent variables

Since firms obtain innovative ideas from a distinct array of sources, the paper utilises five dummy variables that characterise various types of knowledge sources available to management for a firm's innovativeness. The explanatory variables are **competitors, consultants, customers, new employees and workshops**. The five variables take value 1 if the manager(s) learn about management practices from competitors; consultants; suppliers or customers; new employees; workshops and 0 otherwise.

Dependent variables

This paper investigates the relationship between distinct types of innovation and external knowledge sources. The survey asks participating firms if firms introduced new or significantly improved goods and services in previous years for *product innovation*. For *marketing innovation*, the survey asks respondents if the firm introduced new or significantly improved marketing methods in the past years. *Organisational innovation* measures new or significantly improved organisational structures introduced in previous years. Furthermore, the survey asks respondents if firms introduced any innovative methods of manufacturing products or offering services, which represents *process innovation*. Also, the innovation types we consider in our study comply with the Community Innovation Survey (CIS) and the Oslo Manual, where firms document if in the past years they introduce any new or significantly improved forms of innovation. The four innovation types are represented by dummy variables which take '1' if the firm has introduced or significantly improved on any of these innovation types and '0' otherwise.

Internal R&D

Firms' R&D effort is essential for innovative outcomes (Gómez et al., 2016). Also, R&D activities have a positive relationship with the growth of the firm (Bogliacino, Piva, & Vivarelli, 2012; Coad, Segarra, & Teruel, 2013; Hall & Heffernan, 1985). The survey asks top managers in the establishments if they do internal R&D. It takes "1" if firms conduct internal R&D and "0" otherwise. Notable scholars have documented that internal R&D supports the absorptive capacity of firms making complementarity effects more realistic (Brouwer & Kleinknecht, 1996; Cassiman & Veugelers, 2006; Cohen & Levinthal, 1989; Egbetokun & Savin, 2014).

Formal training

Training refers to courses structured to help individuals develop skills that might be useful in their jobs (Blundell, Dearden, Meghir, & Sianesi, 1999). Leiponen (2005b) empirically reveals the importance of skill to innovation performance. This variable is unique to the economic of knowledge of the focal firm. The WBES asks respondents if the establishment provided formal training for employees' skill empowerment. We code this as a dummy variable, which takes "1" if the establishment did provide formal training to staff and "0" otherwise. We argue that firm dynamism regarding growth according to the Schumpeterian view is contingent on investment in R&D and more prominently skills acquisitions. Aside from managerial experience and workers' qualification, especial training (Smith et al., 2005) offered to staff by the establishment to stimulate innovation performance is a prerequisite for the firm's performance. According to *the Frascati Manual (2002)* and reviewed by Smith et al. (2005), education and training are not considered as one of the knowledge inputs contributing to R&D measurement. It further allows us to argue that training and creativity are also distinctive knowledge-based entities.

Staff education

The Staff level used may not be a suitable measure of innovation knowledge-related variable, but due to the paucity of data on staff qualification, we have decided to use high school as a measure of staff's educational attainment. Aghion and Akcigit (2015) suggest that various levels of educational attainments for a leapfrogging economy that wants to catch-up with technologically advanced economies are crucial. The survey asks respondents for the percentage of full-time workers who completed high school.

Control variables

The innovative process is likely to be influenced by both the general and specific firm characteristics (Cassiman & Veugelers, 2006; Catozzella & Vivarelli, 2014; Schmiedeberg, 2008a). The assumptions involving the effect of control variables on innovative activities are established on Lojpur, Pejic-Bach, and Pekovic

[1] Since the study considers both WBES and IFS, we then select countries that have these characteristics. Our exclusion of other countries in the sub-region is based on non-availability of Innovation-Follow-up Surveys as we have in the 11 countries used in the study.

(2015)). The study includes sector dummies, firm *size*, and *firm age* as general firm characteristics.

Firm size

We use full-time permanent employees representing workers employed in the last three years by the firms. It is a measure of the natural logarithm of full-time permanent employees. Several studies use this measure, e.g., Bogliacino et al. (2012) and Bogliacino, 2014); Cantner, Gerstlberger, and Roy (2014)); Barasa, Knoben, Vermeulen, Kimuyu, and Kinyanjui (2017)); Abdul Basit, Kuhn, and Ahmed (2018)). We use this measure as we argue that most innovative firms' present and past employment figures provide researchers with the possibility of measuring firms' performance regarding innovations, and as a good measure of control.

Firm age

Several scholars have argued the role of age to firm performance (Huergo & Jaumandreu, 2004; Huynh & Petrunia, 2010; Jong & Vermeulen, 2006; Coad, Segarra and Teruel, 2016; Yildiz, Bozkurt, Kalkan, & Ayci, 2013). It is either to generate innovation (Anderson & Eshima, 2013) or to enhance performance in general. However, there is mixed empirical evidence of the contribution of a firm age to innovation performance. Regarding this study, the age of firms could determine the ability to allocate time for employees to be creative in the workplace. We measure the variable by subtracting the year firms began operation from the year-waves of the survey after which we express the outcome in natural logarithm.

Export

Exporting firms are more efficient than non-exporting firms (Clerides, Lach, & Tybout, 1998). A few scholars have also documented the relevance of exporting capabilities to the performance of the firms (Ganotakis & Love, 2011 and 2012); Filatotchev et al., 2009). The WBES reports the percentage of sales accounting for direct exports. This measurement is retained in this analysis, as documented in the WBES.

Ownership

The study controls for both private and foreign ownership because it could impact the ability of the firms to explore external sources of knowledge. Ownership heterogeneity has been considered essential components of firm-level innovativeness (Wright, 2017). Dachs and Peters (2014) provide evidence of the role of both foreign and domestic ownership on the likelihood of innovative-active firm contributing to employment growth. Also, foreign ownership has been evidenced to impact firm-level employment growth (Lipsey, Sjöholm, & Sun, 2013). These variables are measured as a percentage owned by private domestic firms and foreign domestic firms, respectively. The measurements are retained as reported in the WBES.

Capacity utilization

Capacity utilisation has been considered an essential element in the success of the firms and their production efficiency (Mazaheri & Mazumdar, 2005; Ngui & Muniu, 2012). It is also documented that manufacturing firms in SSA on average use 50% of their capacity (Mazaheri & Mazumdar, 2005). Expanding their capacity and increasing their capacity utilisation is considered essential to production (Fevolden, 2015). Capacity relies upon the resources, such as buildings, machinery and labour firms have available. Capacity utilisation is the degree to which that capacity is being utilised. When the firm is making full utilisation of all its resources, it means the firm is operating at maximum capacity or 100% capacity utilisation. It is an essential piece of information in the process of lowering waste in the production process and stimulating innovativeness (Fevolden & Grønning, 2010).

Sector dummies

In the ES, there are three sector classifications: manufacturing, retail, and services firms. Sector specificity also plays an essential role in innovation performance, being mindful of endogeneity and sector-specific differences in innovation output (Brouwer & Kleinknecht, 1996). Considering the importance of the three sectors, and as argued by O'Sullivan et al. (2005) that sectoral differences in the innovative activity do have prominent implications for the allocation of resources. We generate three sector dummies: manufacturing, services, and retail, respectively, where retail serves as the base category in the estimations.

Econometric approach

Econometrics model

For the hypotheses to be examined, the instrumental binary treatment model (ivtreatreg) is employed. This is because of the binary nature of some of the instruments and endogenous variables. For the robustness checks and sectoral estimations, a Tobit model is utilised due to the nature of the dependent variable. The IV binary treatment model is beneficial to estimate binary treatment models with the heterogeneous response to treatment both for detectable and imperceptible selection. However, the utilisation of a binary treatment model in the study relies on the work of Cerulli (2011). The binary treatment model with *heterogeneous* treatment to response suffices in dealing with the possible endogeneity concerns that may evolve. Eqs. (1, 2 and 3) represent the econometric functional forms for the primary estimation, while Eqs. (4) corresponds to the estimation equation.

$$y = \mu_0 + \alpha w + x\beta_0 + w(x - \mu_x)\beta + e_0 + w(e_1 - e_0)\ IV\ model\ where$$
$$e_1 \neq e_0\ (both\ observable\ and\ unobservable\ heterogeneity) \quad (1)$$

The analysis is performed with a Heckman's sample selection model (Heckman, 1979) using a binary treatment model that also espouses the postulation of normality. The conventional form of the selection model adopted presupposes that there is an underlying regression relationship:

$$y_i = x_i\beta + u_{1i} \quad (2)$$

where the dependent variable for observation i is observed when:

$$z_i\gamma + u_{2i} > 0 \quad (3)$$

where $u_1 \sim N(0, \sigma)$, $u_2 \sim N(0, 1)$ and $corr(u_1, u_2) = \rho$. As a rule of thumb, sample selection can be safely ignored when $\rho = 0$.

Eq. (1) below represents the estimation model.

$$Innovation(product, process, marketing\ \&\ Organisational) = \beta_0$$
$$+ \beta_1(Knowledge\ sources: Competitors, Consultants, Customers,$$
$$New\ Employees, Workshops) + \beta_2(Firm\ Size) + \beta_3(Firm\ Age)$$
$$+ \beta_4(Trained\ Staff) + \beta_5(Staff\ Education)) + \beta_6(Internal\ R\&D)$$
$$+ \beta_7(Export) + \beta_8(Capacity\ Utilization) + \beta_9(Private\ Ownership)$$
$$+ \beta_{10}(Public\ Ownership) + \beta_{11}(Sector\ Dummies) + \varepsilon \quad (4)$$

Innovation is the dependent variable, which depicts the four innovation types launched by the focal firms. The error term is captured by ε.

Table 2
Descriptive statistics of estimation variables.

Variables	Mean	S.D.	Min	Max
% of innovative prod & service	7.32	18.91	0	100
Product innovation	0.54	0.5	0	1
Process innovation	0.47	0.5	0	1
Marketing innovation	0.5	0.5	0	1
Organizational innovation	0.39	0.49	0	1
Trained staff	0.28	0.45	0	1
Staff education	53.22	38.3	0	100
Customers	0.09	0.29	0	1
Workshops	0.09	0.29	0	1
New Employees	0.06	0.25	0	1
Competitors	0.09	0.28	0	1
Consultants	0.08	0.27	0	1
Internal R&D	0.11	0.31	0	1
Firm size	2.2	1.41	0	9.1
Firm age	2.57	1.43	0	7.61
%Export	4.4	15.68	0	100
Capacity utilisation	22	35.91	0	100
Manufacturing	0.41	0.49	0	1
Retail	0.24	0.42	0	1
Services	0.35	0.48	0	1
Patent	0.04	0.2	0	1
Labour regulation	0.36	0.48	0	1
Political instability	0.19	0.4	0	1
Foreign ownership	9.79	27.74	0	100
Private ownership	73.26	42.08	0	100

Table 3
Relationships between external knowledge sources and innovation.

Variables	(1) ProdInno	(2) ProcInno	(3) MarkInno	(4) OrgaInno	(5) Tobit
Firm size	0.084***	0.080***	0.094***	0.077***	−1.998***
	(0.011)	(0.011)	(0.012)	(0.011)	(0.637)
Firm age	−0.000	0.007	0.003	0.012**	−5.491***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.657)
Staff education	0.001***	0.001***	0.001***	0.001***	0.038*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.022)
Customers	−0.048	0.003	−0.036	−0.019	18.912***
	(0.034)	(0.035)	(0.039)	(0.033)	(3.562)
Workshops	0.114***	0.094***	0.115***	0.148***	13.008***
	(0.034)	(0.034)	(0.038)	(0.033)	(3.560)
New employees	0.067*	0.086**	0.102**	0.045	17.153***
	(0.036)	(0.037)	(0.041)	(0.035)	(3.683)
Competitors	−0.014	−0.032	−0.013	0.011	1.049
	(0.033)	(0.034)	(0.038)	(0.032)	(3.605)
Consultants	0.047	0.065*	0.077*	0.073**	−6.962*
	(0.036)	(0.037)	(0.041)	(0.035)	(3.628)
Internal R&D	0.192***	0.211***	0.247***	0.189***	46.493***
	(0.029)	(0.029)	(0.032)	(0.028)	(2.288)
Export	0.003***	0.002***	0.003***	0.002***	−0.158***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.057)
Capacity utilisation	0.002***	0.001***	0.001***	0.001***	0.050
	(0.000)	(0.000)	(0.000)	(0.000)	(0.034)
Private ownership	0.000	0.000**	−0.000	0.000	0.145***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.027)
Foreign ownership	0.001**	0.000	0.000	0.001**	0.213***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.036)
	(0.018)	(0.019)	(0.021)	(0.018)	(2.165)
Trained staff	−0.731***	−0.760***	−1.012***	−0.657***	4.323**
	(0.190)	(0.191)	(0.203)	(0.184)	(1.835)
Lambda	0.545***	0.585***	0.725***	0.532***	
	(0.113)	(0.113)	(0.120)	(0.109)	
Sigma	0.623	0.638	0.713	0.604	55.969***
					(1.049)
rho/R-Squared	0.875	0.916	1.000	0.880	0.037
Constant	0.400***	0.282***	0.421***	0.236***	−53.127***
	(0.026)	(0.027)	(0.030)	(0.025)	(3.647)
Wald chi2 (31)	932.42	974.54	880.02	959.56	1021.42
Prob > chi2	0.000	0.000	0.000	0.000	0.000
Observations	9,503	9,503	9,503	9,503	9,503

Note: the estimation control for sector dummies. Model 5 is Tobit estimation for the robustness checks with the percentage of the main innovative products and services as a dependent variable. 7,534 are left-censored observations at the percentage of the main innovative product and service <= 0 and 1,969 uncensored observations. Standard errors in parentheses.

* p < 0.1.
** p < 0.05.
*** p < 0.01.

Results

Table 2reports the descriptive statistics, including the mean and standard deviation. The correlation matrix is reported in Table A4. Also, two other estimations are performed using the Tobit and OLS models with the percentage of the main innovative products and services as a dependent variable. The estimations are clustered at the level of country and industry, respectively. Table A1 reports separate estimations for the manufacturing and services firms. Also, in Table A2, a logit and instrumental variable regressions are performed to ascertain the relationship that exists between external knowledge sources and internal R&D. In this analysis, internal R&D serves as a dependent variable. In the same Table A2, the marginal effects of both estimations are performed. Further, Table A3 documents the results of the relationship between external sources of knowledge and innovation for each country.

With the sectoral distribution, 41% belong to manufacturing, 24% retail, and 35% services. On average, 7.3% is related to the firms' main innovative products and services. The 54% of the firms implement product innovation, 47% process innovation, 50% marketing innovation, and 39% organisational innovation. Relatively, firms in sub-Saharan Africa engage in the introduction of innovation. Trained staff represent 28% and 53.22% for employees with a high school certificate; a measure the analysis uses as a human capital variable.

Importantly, attention is shifted to the different sources of external knowledge considered in the analysis. Regarding the external sources of information available to top managers to improve management practices and foster compelling innovation, 9% of each of the firms obtain information from the *customers*, *competitors* and *workshop*, respectively. This means 27% of the firms have a combined source of external information from these three channels. From *new employees* to the firms, 6% is observed and 8% from *consultants*. Relatively 11% of the firms conduct internal R&D. On average, 22% represent the capacity utilisation of the establishments. Percentage of sale from direct export stands at 4.4%. The shares of private domestic ownership and foreign domestic ownership are 73.3% and 9.8%, respectively. The following variables: *patent*, *labour regulation* and *political instability* serve as the instruments for the estimation in Table 3 where we employ an instrumental variable treatment model with a heterogeneous treatment to response using the Heckman two-stage model (i.e. *heckit option*). The instruments uphold the basic assumptions underlying the use of valid and reliable instruments in the instrumental variable framework. 5% of the firms report having applied for a patent. 36% of the establishments report that labour regulation remains an obstacle to their operation, and 19% consider political instability as a major obstacle.

In this article, three different estimations highlight the importance of diverse external knowledge sources on firm-level innovation. The first estimation uses the instrumental variable binary treatment model of which findings are documented in Models 1–4 in Table 3. Also, Model 5 in Table 3, a robustness estimation is performed to ascertain the stability of the results using a Tobit model where the dependent variable is left-censored. The other estimations involve sectoral, external knowledge sources relationship with internal R&D, and individual country analysis.

Considering Models 1–4 in Table 3, we employ three valid instruments which include *patents*, the degree to which *labour regulation* is a major obstacle to firms' operation and the degree to which *political instability* is a major impediment to the operation of

the firms. These three instruments are exogenous. In this case, the instruments should correlate with the sources of external knowledge and not innovation performance. The instruments conform perfectly to the exclusion constraints of the instrumental variable binary treatment model. The F-statistics of the instruments are also confirmed to be higher than 10, implying that the three instruments employed are not weak (Bascle, 2008).

The findings of Model 1 in Table 3 show that external sources of information from *worksh*ops ($b = 0.11$, $p < 0.01$) and *new employee*s ($b = 0.07$, $p < 0.1$) are positively correlated to product innovation. In Model 2, sources of information from workshops ($b = 0.09$, $p < 0.01$), new employees ($b = 0.09$, $p < 0.05$) and consultants ($b = 0.07$, $p < 0.1$) are correlated with process innovation. Similarly, Model 3 accounts for the correlation between marketing innovation and external sources of information. The correlations relate in this order. *Workshop* ($b = 0.12$, $p < 0.01$), *new employees* ($b = 0.10$, $p < 0.05$), and *consutants* ($b = 0.08$, $p < 0.1$). In Model 4, we observe support of a signficant and positive correlation between external sources of inormation from *workshopthe* ($b = 0.15$, $p < 0.01$) and *consultants* ($b = 0.07$, $p < 0.05$) to correlate with the introduction of organisational innovation.

With regards to some core variables that are contributory to the firms' ability to exploit and utilise external knowledge, it is observed that some predict a positive and significant return to innovation. The size of the firms is viewed to relate significantly and positively to the ability to innovate in Models 1–4. Age is only observed to be positive and significant for organisational innovation. The level of education measured by the percentage of the workforce with a high school certificate is positive and significant across the spectrum of the regression. Similarly, internal R&D, export, and capacity utilisation relate significantly and positively to the four innovation types considered. A weak correlation is observed for both private (*process innovation*) and foreign ownership (*product & organisational*) and innovation. Correlation between trained staff and innovation is observed to be significant and negative in Models 1–4.

Sectoral & country results

Furthermore, as mentioned in the preceding paragraphs, we also assume variations regarding the role of the external knowledge sources in sector-related estimation. The estimation is examined with a Tobit model (considering that the dependent variable is censored to the left) and OLS model, respectively, using the same explanatory and control variables as obtained in Table 3. The sectoral findings involving manufacturing and service firms reveal interesting results that are different from the instrumental variable estimations. The interpretations of the Tobit estimation is considered and not OLS. We observe the sources of information from the *customers, new employees* and *workshop* to relate significantly and positively with the dependent variable in both the manufacturing and service sector (Model 3 & 4) in Table A1. Source of information from the *competitor* is only observed to be positive and significant with the dependent variable in the service sector.

Consequently, country differences are also assumed in the study owing to institutional and structural differences. Although the institutional configuration in sub-Saharan Africa is observed to be the same with less divergence, some countries still exhibit relatively improved institutions than others. In Table A3, the estimation is performed with the percentage of the main innovative products and services as a dependent variable. For Ghana, results emerge for four different sources of external knowledge which are: *workshop* ($b = 9.71$, $p < 0.01$), *new employees* ($b = 13.40$, $p < 0.01$), *competitors* ($b = -19.02$, $p < 0.01$), and *consultant* ($b = 28.31$, $p < 0.01$). In the case of Nigeria, only two sources, *customers* and *new employees* signficantly correlate with the dependent variable. It is interesting to point out that countries with better institutions tend to fare well with regards to the relationships between the knowledge sources and innovation. With the country-specific results, private and foreign ownership relate significantly positive to the dependent variable for Ghana and South Sudan. Internal R&D is signficantly and positively consisent in all the models reinforcing the relevance of firms' knowledge capabilities to the introduction of innovation. To a large extent, some of the results that emerge from the findings are in line with earlier studies while others do not. For instance, taking into account the results in Table 3, we do not observe the traditional sources of knowledge from customers and competitors to relate with the four innovation types. However, using the percentage of the main innovative products and services as a dependent variable, the sources of knowledge from competitors and customers are found to relate positively and signficantly with the dependent variable (see, Tables A1 and A3). It further reveals that while sectoral differences play a role in the relationship between external sources and innovation, methodical approaches and dependent variable operationalisation are also confirmed to influence the direction of the relationship. The relationship between external knowledge sources as this study reveals is confirmed to be more significant when the dependent variable is a tangible output or a count as compared to when the dependent variable is a binary.

Robustness checks

We examine the robustness of our results by using the percentage of the main innovative products and services as a dependent variable. Since the dependent variable is censored, a Tobit model estimator is utilised. Also, because there is more than one observation for some firms, potentially generating serial correlation of the error term, clustered robust standard errors are employed. The cluster standard errors are adjusted at the level of country and industry, respectively. The results are reported in Model 5, Table 3. The estimation shows that our findings are robust to using a percentage of the main innovative products and services as a dependent variable. The coefficients of the independent variables, specifically, new employees and workshop retain their signs and significance. It is observed that external knowledge source from customers is now significant and positive while the external knowledge source from consultant returns a negative and significant effect, with no significant effect observed for competitors. Internal R&D consistently retains its sign and significance while we observe significant and positive coefficients for private and foreign ownership.

Discussions and conclusion

In this paper, we have studied the essentiality of diverse sources of external information in the introduction of product, process, marketing and organisational innovation. The findings point to a few conclusions. First, considering the main estimation where an instrumental variable treatment regression is performed, the results reveal that three of the sources considered (consultants, new employees and workshops) play a substantial role in producing innovation. A somewhat surprising outcome based on the inconsequential role of the traditional external sources of information that is, competitors and customers.

Nonetheless, we are not quick to downplay the role of these sources of knowledge despite the observed results. However, we play in the methodical application as one of the drivers of the results. An issue also identified by Garriga, von Krogh, & Spaeth, 2013. The interesting thing about the observed results is that the players that relate indirectly with the market are contributory to the propensity to innovate; a novelty this study documents. The most surprising observation is the consistently significant effect

of new employees and workshops as a source of external information in support of the innovative capabilities of the focal firms. Secondly, in order to check the stability of the results, we utilise a Tobit approach with the percentage of the main innovative products and services as a dependent variable. The results that emerge relate significantly with sources of information from the customers, new employees and workshop as essential candidates in supporting firm-level innovativeness. These findings corroborate prior studies that find that innovations are introduced by utilising knowledge from a varied set of external sources of information (see, for example, Amara & Landry, 2005) and not only from the firms' in-house capabilities.

Regarding the link between external knowledge search approach and innovation performance; the assessment accounts for a positive effect on innovation performance of the respective external knowledge strategy. The findings regarding customers are mainly in line with preceding studies indicating that investment in external sources could promote innovation performance (Chiang & Hung, 2010; Garriga et al., 2013; Katila & Ahuja, 2002; Katila, 2002; Laursen & Salter, 2006). Also, our study only aligns with some findings of Tether and Tajar (2008) and Gómez et al. (2016) in that consultant as an external knowledge source does not support the implementation of product innovation. There is a confirmation of a positive and significant effect of consultant on process innovation (Gómez et al., 2016). Interestingly, we find consultants to relate positively significant with the process, marketing and organisational innovation. Knowledge from the competitor does not relate with any of the innovation types with the instrumental variable binary treatment estimation, but when we consider the Tobit estimation, where the percentage of the main innovative products and service serves as a dependent variable, competitor relates positively significant with the variable ($b = 6.274$, $p < 0.01$).

This current study broadens the theoretical and empirical bases of the external knowledge search and innovation performance relationship, offering further evidence of the positive link across distinct innovation types. The paper has three principal contributions to the literature. First, the paper uncovers three sources of external knowledge that constitute the three indirect market players that are not common in the literature (*consultant, new employees and workshop*). It shows that the baggage of knowledge inherent in these three sources is indeed essential to the innovative capabilities of the firms. Second, the results also reveal that the essentiality of external sources of knowledge differs conditional on the type of innovation introduced (product, process, marketing or organisational), dependent variable operationalisation, sectoral, methodical configurations, and country specifics. Third, the study contributes to the understanding of how firms in emerging economies develop competencies for innovativeness through the interplay of knowledge from both direct and indirect market players. The findings offer essential insights on how management could invest in the distinct, useful and preferred external sources, notably, *consultant*, *new employees*, and *workshop*, to best foster a compelling implementation of innovation.

Relative to H1, where it is hypothesised that external knowledge sources from customers and competitors are useful candidates in supporting the propensity to which firms can innovate, the analyses do not support these hypotheses when we consider the instrumental variable estimation in Table 3. No significant return to innovation is observed for the two market sources of external knowledge. It is surprising, though, because studies have documented that customers and competitors are fundamental to the innovative capabilities of the focal firms. Indeed, the institutional and structural difference might be at play here. It is noteworthy that the contributions of the external sources of knowledge from n*ew employees,* w*orkshops* and *consultants* (except for product innovation) are observed to be consistently significant across the entire innovative activities of the firms with the estimation that involves the instrumental binary treatment model that allows us to cope with any endogeneity issues. To a large extent, H2 is supported. The findings add to existing literature and debate on the diverse external knowledge available for top managers to explore in supporting their managerial decision regarding innovation optimisation. This paper reveals the overarching importance of *new employees* as a source of external knowledge in supporting innovation performance at the focal firms. Overall, our results suggest that external knowledge search decisions align with crucial decisions in the firm's innovation strategy, such as the type of innovation the firm develops. About internal knowledge build-up, this result highlights the idea underlying the open innovation approach that a firm's innovation process is based on internal development and the synergetic effect of external knowledge sources (Cassiman & Veugelers, 2006; Chesbrough, 2006).

To enable a more precise insight of these findings, it might be fascinating to emphasise not only on the extent of the knowledge search and how firms search, but also on what sorts of external sources are utilised, and what distinctive impact they make to innovation performance. For example, in an analysis of the influence of *consultants, new employees and workshops* as external knowledge sources for innovation, Tether and Tajar (2008) uncovered that these professional knowledge sources have more capabilities to develop ready-to-market innovations than other sources such as universities, and, in turn, a more significant impact on innovation performance. The analysis of the effect of specific external knowledge sources on innovation performance would offer interesting insights about their relative significance in specific circumstances. In situations where there are lots of alternatives to gain access to vital external knowledge, firms have more significant inducements to carry out a broad search. Also, the cost of doing exploration activities with many external sources could be compensated by the gains obtained from accessing significant external knowledge. In situations of creative accumulation, typified by constant investments in R&D, firms on average relish steady technological benefits and ever-increasing benefits to knowledge formation (Malerba, 2002). Such perspectives promote firms to open their innovation process to enhance their prospects of accessing relevant external knowledge for the introduction of innovations. However, knowledge build-up entails a high and continuous effort to create new beneficial knowledge that can only be gained when firms are involved in continuing and long-enduring connections.

Additionally, we have shown that the effect of each source differs depending on the type of innovation pursued by the respective firms. In introducing product innovations, firms primarily depend on new employees, workshop and firms' internal competencies. Information from the consultants is not observed to support firms' ability to introduce product innovation. In both the instrumental variable binary treatment and Tobit model, there is no support for the role of competitors. In introducing process innovations, new employees, consultant and workshop with firms' internal sources are observed to be increasingly relevant. This divergence is also observed for results on marketing and organisational innovation, respectively.

Practical implications

These findings have implications for our understanding of how innovation is produced and studied. They recommend the need to distinctly consider what form of external knowledge best fits the desired innovation at the focal firms. This complements other evidence that demonstrates that the effect of many factors could be at play in the ability of the firms to introduce a successful innovation. For example, internal sources are considered essential for the four innovations studied in this analysis. Note also that sectoral

divergence with regards to the suitability of external knowledge is observed in our findings (see, Table A1). Our results confirm the importance of external sources of information, but they also highlight the relevance of internal sources, with regards to all the innovation types introduced by the firms. An open innovation approach lets firms not only to obtain higher innovation performance but also to capture value (Chesbrough, 2003).

Regarding policy recommendations, the findings from this analysis recommend that policies that encourage the links between firms and market and scientific sources of information must be stimulated since they positively affect innovation optimisation. These policies should consider that a diverse blend of sources of information is valuable to successful innovation introduction. Nevertheless, they should also consider the diverse nature and influence of the sources of information on the different innovation to attain the anticipated result. Interestingly, as a matter of interest, a separate estimation is performed accounting for the direct effect of these external knowledge sources on internal R&D (See, Table A2). The results are indeed compelling in that; all the knowledge sources are found to relate positively and significantly to the internal knowledge build-up of the focal firms.

Limitations and directions for future research

Like most scientific investigation, this study has some limitations that raise additional avenues for research. First, the lack of panel data limits inferring a strong relationship in the analysis. Although an instrumental variable framework has been used to observe the relationship between external knowledge and innovation performance, the approach allows us to cope with possible endogeneity concerns. While the approach dispels this fear, it would indeed be worthwhile to use a panel data in replicating the study to ascertain the stability of the results and perhaps possible generalisation could be inferred.

Second, while the proposed theoretical framework shows a deeper understanding of innovation performance, investigating how integrating activities of the firms in acquiring external knowledge for the introduction of these innovative activities remain the focus of this study. Specifically, we are interested in the relationship between indirect and direct market players and innovation in the framework of open innovation. Considering that countries could differ in many respects including institutional, geographic, economic and cultural divergence, an interesting area that connects the institutional quality of the respective countries and its relationship with external knowledge sources is worth examining. Also, a possible avenue for future study could be the link between external knowledge sources, ownership and innovation. Ownership is only included as a control variable, so, future studies could also explore how the blend of ownership with external knowledge sources could predict the propensity to which firm innovate.

Finally, our study only considers the effect of external knowledge sources on innovation in the final phase of the introduction of innovation. Nevertheless, investigating how these external elements are incorporated in the initial stages of the innovation process may offer a profound understanding of innovation introduction and commercialisation in the context of developing countries in Africa.

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Appendix A. Supplementary data

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