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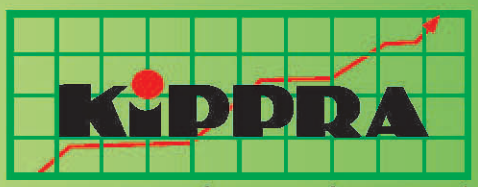

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Drivers of Firms' Innovation in Kenya

Anne Gitonga and Githinji Njenga

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Kenya Institute for Public Policy
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Abstract

Innovation is recognized in the Kenya Vision 2030 as an enabler of economic growth and development. The vision envisages a knowledge-driven economic growth with application of innovation to enhance efficiency and raise productivity in the economy. Though Kenya's performance in the Global Innovation Index has been steadily increasing in the last 5 years, it has remained lower than that of aspirator countries. It is, therefore, important to accelerate innovation in the country to achieve the vision of a globally competitive and prosperous upper middle-income country. Innovation plays a critical role in societal and economic development, particularly in enhancing firms' value addition activities and competitiveness. Therefore, identifying the drivers of firm level innovation, and types of innovation, is important in achieving the development goal of the country. This study thereby sets out to identify the drivers of innovation of firms in Kenya. The study estimated a probit model using data from the 2018 World Bank Kenya Enterprise Survey. The study established that firm size, female ownership, manager experience and R&D drive firm innovation in Kenya. Further, different factors influence the type of innovation undertaken by a firm. The sector of the firm, R&D and interactions (co-development) influence process innovation. In the case of product/service innovation, firm size, female ownership, manager experience, sector, R&D, and interactions (formal networks) are significant drivers. Proposed policy interventions to accelerate innovation include transforming the National Research Fund to fund R&D activities by MSMEs that focus on process innovation; review and enhancement of other fiscal incentives and research infrastructure provided by the government for innovation to scale uptake of R&D among Kenyan firms; and supporting MSMEs in external knowledge generating activities such as through exports. Government support to MSMEs in accessing export markets would, therefore, be important as it enhances the probability of MSMEs undertaking process innovation. Kenya's manufacturing sector is a priority sector, with the textile sector identified as among the strategic sectors to achieving this goal. The study establishes that this sector has a higher probability of participating in product innovation. Therefore, government's intent as indicated in MTP III of developing industrial clusters on textiles need to be accompanied with a mechanism to strengthen innovation interactions, especially business networks and associations among firms in Kenya.

Abbreviations and Acronyms

GII	Global Innovation Index
ICT	Information and Communication Technology
KIE	Kenya Industrial Estate
KIRDI	Kenya Industrial Research Development Institute
KNBS	Kenya National Bureau of Statistics
KeNIA	Kenya National Innovation Agency
MSE	Micro and Small Enterprise
MSEA	Micro and Small Enterprises Authority
MSMEs	Micro, Small and Medium Enterprises
OECD	Organization for Economic Co-operation and Development
R&D	Research and Development
ST&I	Science, Technology, and Innovation
SMEs	Small and Medium Enterprises
UNCTAD	United Nations Conference on Trade and Development
WIPO	World Intellectual Property Organization

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1. Introduction

1.1 Background of the Study

Innovation is a concept that has been studied for many years. Schumpeter (1942) and Drucker (1985) indicate that innovation aims at identifying and exploiting opportunities through the creation of something new that can be introduced to serve the market. Innovation allows firms to offer new products into the market, allowing businesses to maximize the market opportunity (Porter, 1998). Porter and Stern (2001) establish that innovation is associated with improved productivity, contributing to economic growth while potentially addressing social and human challenges. Indeed, studies reveal that innovation contributes to improved production, improved sales at the firm level and contributes to enhanced welfare through innovations in food production, provision of education, provision of healthcare and transport and mobility at the society level. Innovation is among the pillars for countries to establish competitive advantage. Similarly, Sustainable Development Goal 9 is about leveraging on innovation for dynamic and competitive economic development, employment generation and income generation. Kenya's Vision 2030 further establishes Science, Technology, and Innovation (ST&I) as among the enablers of growth.

The 2018 Oslo Manual defines innovation as "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD, 2018). This definition indicates that innovation is made available to users but does not state whether for commercial or social purposes. Innovation for the purpose of this study can be defined as a process undertaken often by social or economic agents that involves improvements for new or more efficient products, services, or processes to meet the needs of individuals, society, or commercial entity to address a market or societal need. Innovation typically occurs through a product or a process. This study acknowledges that there has been expansion over the years on the definition of innovation contributing to the emergence of organizational and marketing innovation. Market innovation is the introduction of new methods of marketing including design, packing and promotion of products while organization innovation refers to new forms and methods of organization of business companies (OECD, 2005). However, as noted in the 2018 Oslo Manual, there is a shift to focus on the two main types of innovation, product and process innovation to reduce ambiguity. Process innovation, defined as "any adopted improvement in technique with reduced average costs per unit of output" (Blaug, 1963: 13), presents great opportunities in enhancing price competitiveness of firms given the link between competitiveness and innovation. Process innovation

is a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use by the firm (OECD, 2018: 21). Product innovation is the introduction of new or improved goods and services.

Innovation occurs within an innovation system with relevant institutions and capabilities (Ames and Rosenberg, 1963; Abramovitz, 1986; Cohen and Levintal, 1990; Lundvall, 1992; and Lundvall et al., 2009). Top ranking countries in the Global Innovation Index (GII) have over the years invested in these innovation institutions and capabilities to innovate. The policies adopted by these countries focus on enhancing capabilities, thus promoting investment in enabling conditions such as infrastructure, research, and education. Republic of Korea, for instance, established several state agencies for research and training aimed at addressing technological capability challenges in the 1960s during the country's 'developing phase'. The private sector's capability was nurtured by limiting direct competition from multinational firms who were then restricted. Japan succeeded in developing technological capability using similar State-owned institutions through foreign equipment import to enhance technology transfer in the private sector (Park and Kim, 2020). Innovation policy has also played an important role in these two countries, which have well known products, particularly in electronics. The innovation policy adopted in Korea and Japan was not only aimed at generating knowledge from internal or external sources but also advancing the role of the government and strengthened knowledge generating institutions (Park and Kim, 2020). Israel has an explicit policy to promote the country's knowledge economy including investments in human capital (Getz and Goldberg, 2016). In Europe, Switzerland has been ranking top with respect to innovative performance attributable to the skilled labour market, business friendly R&D polices and well-developed knowledge infrastructure (Hotz-Hart, 2012); Indeed, in GII 2022, Switzerland, Republic of Korea, China and Japan were among the top 11 most innovative countries while Israel was ranked 16..

African countries have recognized innovation as an enabler of economic development with the adaption of the Science, Technology, and Innovation Strategy for Africa, 2024. Countries that lead in innovation in Africa include Mauritius, South Africa, and Kenya. To support the innovation efforts, South Africa initiated a10-year innovation plan in 2007, while Mauritius has the Science Technology Innovation Programme 2009 (Cele 2018; Government of Mauritius and ITC, 2017). National innovation systems in these and other developing countries are, however, under-developed with limited technology advancements, capacity limitations and weak innovation infrastructure and institutions. This makes most African countries lag in terms of innovation. Indeed, the 2019 GII report reveals that innovation is concentrated in very few African economies,

presenting a global innovation divide. In the developing countries, innovation is largely undertaken by micro and small enterprises (UNCTAD, 2019b). In Kenya, innovation, either in process or product/service is undertaken by one in every ten micro, small and medium enterprise (MSMEs); majority of whom are small enterprises who participate mostly in product/service innovation with very few in process innovation (KNBS, 2016).

Information and Communication Technology (ICT) has been established as increasing a firm's probability of undertaking innovation (Gitonga and Moyi, 2019). However, it would be important from a policy point of view to explore what other innovation infrastructural and interaction dynamics are driving process and product/service innovation in Kenya. Innovation interaction and infrastructure for purpose of this study refer to firm level networks and interactions that promote firm level innovation. The firm level networks and interactions include the use of business networks, firm level strategic alliances, co-development, and innovation infrastructure such as incubation services. Review of literature, however, reveals limited analysis of drivers of process innovation, particularly the role of innovation interactions. This is beneficial in informing national innovation policy.

1.2 Statement of the Problem

Innovation is a driver of economic growth and development. The Kenya Vision 2030 envisions a knowledge-driven economic growth with application of innovation to enhance efficiency across all sectors of the economy. Though Kenya's score of innovation in the Global Innovation Index has been steadily increasing in the last five years, it has remained lower than that of aspirator countries such as Malaysia, South Africa, and Thailand. It is, therefore, important to accelerate innovation in the country to achieve the vision of a globally competitive and prosperous upper middle-income country. Kenya's policy target is to achieve a rank of 85 in the Global Competitiveness Index (GCI) by 2022 from position 95 in 2019.

Firms undertake process and product/service innovation, which is necessary for the growth of a firm, since these innovations enhance competitiveness. Process innovation does so in terms of efficiency while product/service innovation does so through new or improved products/services. Therefore, it is important to understand the drivers of these types of innovation to accelerate firms' innovation in the country. There are, however, limited studies in Kenya informing the drivers of firm innovation, particularly internal factors, and external factors. Firms are heterogenous with different characteristics, and hence establishing which characteristics nurture innovation is of importance from a policy point of view.

Exploring on firm size in Kenya is critical given that most firms are MSMEs, which account for over 90 per cent of the private sector enterprises.

Almost half of the MSMEs (46%) in Kenya have female representation within the ownership structure. Women, however, face gender-specific limitations in business. It would be important to establish if these limitations also present constraints in introducing innovations within the enterprises. Further, firms operate in different sectors, and thus exploring how innovation undertaken by firms differs across these sectors is critical. Thus, establishing factors driving innovation in different sectors is critical in informing interventions necessary and especially for industrial priority sectors expected to drive economic growth. The role of external factors such as incubation and interactions in firm innovation has also not been adequately established in Kenya. These factors are critical in enhancing firms' capability to innovate.

This study, therefore, fills a knowledge gap and contributes to the literature on innovation by enhancing the understanding of drivers of the key forms of innovation undertaken by firms in Kenya. The study findings contribute to efforts to enhance productivity at the firm level, especially in the existing highly competitive environment. The findings on innovation interactions will further inform Kenya's policy agenda, including priority sectors to achieve the country's desired development goal and provide priorities that will inform the development and implementation of a comprehensive national innovation policy.

1.3 Objectives of the Study

The main objective of this study was to identify the drivers of firms' innovation in Kenya.

Specifically, the study aimed to:

(i) Determine the factors influencing innovation by firms.

(ii) Establish the differences in the factors influencing different types of innovation; that is process and product/service innovation.

(i) Establish the influence of firm size on innovation.

(ii) Establish the role of gender in firm innovation.

(iii) Identify the sectoral influence on firm innovation.

(iv) Establish the influence of innovation system infrastructure (incubations and interactions) on firm innovation.

2. Policy Review

Kenya has had explicit policies and legislations on Science Technology and Innovation (ST&I) which establish the innovation framework in the country. The first policy is the Sessional Paper No. 5 of 1982 on Science and Technology for Development, which identifies the key innovation players including government ministries, parastatal organizations, research institutions, the higher education sector, and professional bodies. The policy further identifies the private sector as critical in science policy making. The Sessional Paper No. 2 of 1997 on Industrial Transformation to the Year 2020 also provides clarity on the role of the government in encouraging a vigorous industrial private sector through appropriate policies that enhance access to funds, development of human capital and technological change. The recognition of the private sector in the policy framework is in line with innovation theories, which identify the private sector as key economic agent that undertakes innovation. This policy review, therefore, focuses on various interventions on key aspects geared towards enhancing private sector innovation in the country, including the priority sectors.

Research and Development (R&D): Weak R&D within the private sector is highlighted as a policy challenge starting from the Sessional Paper No. 5 of 1982. The Kenya Industrial Research Development Institute (KIRDI) and local universities are identified as key institutions in facilitating R&D and strengthening links to the private sector. The role of universities in R&D in the country has been increasing as evidenced from 41.9 million PPP$ (15% of gross expenditure on R&D (GERD) in Kenya) in 2007 to 254.6 million PPP$ (39% of GERD) in 2010 (AU-NEPAD, 2010). While universities are expected to be a source of innovation, most of them invest resources on publications as opposed to innovation (CUE, 2019).

Innovation infrastructure: The government recognizes the role of incubators in technology transfer as established in the 1982 Sessional Paper and Sessional Paper No. 2 of 2005 on Development of Micro and Small Enterprises for Wealth and Employment Creation for Poverty Reduction. The former recognizes the role of KIRDI in provision of innovation infrastructure. Though KIRDI has supported a number of MSEs through provision of incubation services and value addition technologies, it has inadequate capacity to effectively undertake this role due to resource limitations, leading to a shortage of modern technology. The third medium term plan on implementation of the Kenya Vision 2030 (MTP III), however, calls for the transformation of KIRDI into a world class research institution to support the acquisition and transfer of knowledge and technology. The 2005 Sessional Paper calls for strengthening of technology transfer mechanisms through incubators, thus enhancing business linkages between MSEs and large-scale enterprises. The Micro and Small Enterprises Authority (MSEA) established

by the Micro and Small Enterprises Act No. 55 of 2012 is mandated to facilitate technology development, acquisition, and transfer by MSEs through centres of excellence. Provision of innovation infrastructure such as incubation centres, common user facilities and centres of excellence are in fact priorities of Sessional Paper No. 05 of 2020 on Kenya Micro and Small Enterprises Policy. The Kenya National Innovation Agency (KeNIA), established in the Science, Technology and Innovation Act, No. 28 of 2013 is mandated to create synergies among incubation initiatives for diffusion of technology. The Government, as part of the Bottom-up Economic Transformation Agenda (BETA), continues to facilitate innovation and incubation hubs particularly targeting youth to strengthen capacity for youth talent and innovations development and MSMEs to enhance value addition. Despite policy intention for establishment of innovation infrastructure such as incubators, there are implementation weaknesses resulting in few government-supported incubators.

Facilitation of innovation and commercialization systems interactions and linkages

Sessional Paper No. 2 of 1992 on Small Enterprise and Jua Kali Development in Kenya, Kenya's first policy document for the sector, identified coordination weaknesses as among the challenges, and called for the establishment of an umbrella body to undertake coordination of the sector activities, which would include innovation interactions. This is replicated in Sessional Paper No. 2 of 2005 on Development of Micro and Small Enterprises for Wealth and Employment Creation for Poverty Reduction, which called for the establishment of MSEA to promote coordination of MSEs activities. This includes the coordination of MSE policies, programmes, and plans and the facilitation of innovation infrastructure. This coordination is, however, hampered by lack of an effective framework and resource constraints. The 1992 Sessional Paper further encouraged formation of MSME associations through the then District Development Committees. The association approach is thereby established in subsequent sector policies of 2005 and 2020. The 2005 Sessional Paper, for instance, established that MSE associations promote business linkages and networks while the 2020 Sessional Paper acknowledges that strong associations can enhance policy coordination.

The Kenya Vision 2030, in promoting innovation systems, prioritizes the establishment of an effective innovation system capable of creating and adapting knowledge and technology. This entails coordination efficiency. The first and the second medium-term plans on the implementation of the Kenya Vision 2030 (MTP I & MTP II), however, identifies ineffective coordination as among the ST&I challenges. KeNIA is mandated to alleviate this challenge by institutionalizing linkages within the innovation system.

The Sessional Paper No. 9 of 2012 on the National Industrialization Policy Framework for Kenya summarizes the role of the government in facilitating innovation through the development of policy framework to support commercialization of research findings; the strengthening of linkages between universities; the formulation of mechanisms to facilitate collaboration with the private sector specifically in research and through effective technology transfer mechanisms and adequate R&D resources. The country, however, lacks the framework to inform on the coordination or collaboration mechanisms and/or strengthen linkages within the innovation system. Further, implementation of the national innovation and commercialization policy under KeNIA is yet to be realized.

Innovation financing: The Sessional Paper No. 5 of 1982 on Science and Technology for Development was the first to note that research in the private sector is minimal and called for introduction of financial incentives and legislation to support it. Fifteen (15) years after, another policy document, Sessional Paper No. 2 of 1997 also identified access to credit as a major impediment for the private sector in undertaking innovation and noting that funding for private sector research is non-existent or unstructured. The issue of innovation financing was revisited after another 15 years through Sessional Paper No. 09 of 2012 on the National Industrialization Policy Framework for Kenya 2012-2030, which calls for the facilitation of resources for R&D. The Industrial Development Fund (IDF) proposed in the policy to provide funding for strategic industries and joint ventures is, however, yet to be established. The MSE Act No. 55 of 2012 also proposes the establishment of Micro and Small Enterprises Development Fund to finance research, development, innovation, and transfer of technology. Though the Fund is yet to be operationalized, progress has been made to this end, with the development of the Fund's draft Regulations.

In 2013, the government through enactment of the Science and Technology Act No. 28 of 2013, which repealed Cap 250 (which came into force in 1977), established the National Research Fund (NRF), aimed at "facilitating research for the advancement of science, technology and innovation". NRF is mandated to: award contracts, grants, scholarships or bursaries or any other award to individuals or institutions; offer financial support for the acquisition or establishment of research facilities; develop appropriate human resources and research capacity in the areas of science technology and innovation; finance research systems in all sectors and all levels of education; and fund the co-operation and sharing of research information and knowledge, including supporting conferences, workshops, seminars, meetings and other symposia. NRF, however, fails to provide sufficient incentives for motivating research by the private sector, since supporting R&D by the private sector is not an explicit mandate of the fund. This presents weaknesses

within the institutions established to facilitate R&D within the private sector. Further, there is low funding for innovation with little support from the private sector. While the ST&I Act, 2013 stipulates funding of ST&I activities to be 2 per cent of GDP, current Gross Expenditure on R&D (GERD) is 0.98 per cent (AUDA-NEPAD, 2019). Increase funding for R&D to 2 per cent of GDP in accordance with the Act is of priority in the Government's bottom-up economic agenda (BETA) further proposes to incentivise the private sector to contribute towards R&D.

Priority sectors: Kenya's manufacturing sector is of policy importance as indicated in the Kenya Vision 2030 and the National Industrialization Policy Framework for Kenya. Among the priorities of the industrialization policy framework is encouraging innovation to continually improve production in manufacturing. The industrialization policy identifies labour-intensive industrial sectors such as agro-processing, textile and apparel and leather and medium to high technology sectors; iron and steel; machine tools and spares, agro-machinery, pharmaceutical as the sectors to be prioritized.

Summary of policy review: There is weak innovation ecosystem in the country due to policy design gaps, coupled with the fact that Kenya does not have a single comprehensive innovation policy. As established in the Kenya Vision 2030, the contribution from the private sector, specifically small and medium size enterprises, can be strengthened by improving productivity and innovation, boosting ST&I in manufacturing and by increasing investments in R&D. Though the government has a role to play in facilitating the same, implementation has been inconsistent. Weak interlinkages within the Kenya innovation system continues to be a challenge. Despite the efforts of institutions such as MSEA and KeNIA, there are limited institutional linkages between players in the innovation ecosystem. The 2019 Kenya Investment Policy and MTP III reinforce the importance of linkages through institutionalization of incubation, sub-contracting, and creation of linkages between foreign affiliates and local small and medium enterprises (SMEs). The two policy documents subsequently call for the development of National Industrial Incubation and National Industrial Sub-contracting policies. The sub-contracting policy, for instance, which would provide the framework for interaction for firms in Kenya, is yet to be established or implemented. Technology transfer mechanisms are therefore still weak as evidenced by the limited technology licensing, franchising, or sub-contracting activities in Kenya, thus, presenting weaknesses in the country's innovation infrastructure.

Further, the institution that facilitates R&D financing, the National Research Fund (NRF), does not effectively facilitate R&D activities undertaken by the private sector. This poses a challenge in supporting MSEs, given that the MSEs' Fund is not yet in place.

The third medium-term plan (2018-2022) further calls for the development of a Science, Technology and Innovation Policy, and an Innovation Policy. These policies are yet to be actualized. Further, given one of the mandates of KeNIA is to implement a national innovation and commercialization policy, absence of innovation and/or commercialization policy will present implementation challenges. Lastly, the promotion of women in innovation is still weak despite the Sessional Paper No. 02 of 2019 on Gender and Development indicating that building of capacities of women's entrepreneurial skills is a policy priority.

3. Literature Review

3.1 Theoretical Literature

Literature reveals that innovation is undertaken intentionally by a profit-oriented firm and that it results in improvements in production (Romer, 1990). Schumpeter (1949) also argued that innovation is necessary for profit making. Several factors driving innovation in firms have been identified in several theories. The Schumpeterian theory pointed out the size of the firm as important in driving innovation, indicating that large firms have a higher incentive to undertake innovation. This is because large firms with huge resources are likely to invest in R&D, which results to innovation (Schumpeter, 1942). In the resource-based view of the firm theory, internal resources such as managerial skills of a firm determine innovation, since they have implications on R&D investment behaviour. These skills keep growing a firm's technological capability to protect its market position (Wernerfelt, 1984).

In the diffusion of innovation theory by Rogers (1962), human resources and networks are important particularly for the adoption of innovation. Further, the Teece Model by Teece (1986) establishes complementary assets as an additional factor that may inform firm level innovation. Complementary assets refer to the activities such as distribution channels and alliances, which firms undertake to benefit from an invention. Indeed, Dosi (1982) asserts that interactions with various actors leads to innovations. As established by Romer (1993: 345), discoveries undertaken at the firm level "are the product of a complicated set of market and non-market institutions that constitute what has been called a national innovation system". Such a system of innovation is constituted by the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge (Lundvall, 1992: 2). These interactions are beneficial in enhancing access to resources and contributing to innovation (Jarillo, 1989). Networks present opportunity to access new knowledge (Cohen and Levinthal, 1990). Further, networks and corporate alliances provide firms with organizational capital to innovate (Cirera and Custolito, 2019). These scholars thereby establish that innovation is a result of intentional knowledge generating activities with many interactions with various actors, undertaken by economic agents.

Cohen and Levinthal (1990) posit that the ability of a firm to identify, evaluate, assimilate, and commercialize information contributing to the firm's innovative performance is a function of the firm's level of prior related knowledge, also referred to as a firm's absorptive capacity. Absorptive capacity analyses the firm's ability to commercially apply new knowledge it has identified. A firm's knowledge

capital is informed by its absorptive capacity, and it is this absorptive capacity that contributes to an organizational unit's ability to develop new products. Certain firm characteristics, including firm age and size, inform the firm's ability to innovation (Acs and Audretsch, 1987). Further, for absorptive capacity to be established, investment in R&D is necessary. As indicated by Romer (1990), investments in R&D are intentional. Further, the capacity to absorb knowledge is achieved by increasing R&D intensity (Cohen and Levinthal, 1990). Tsai (2001) described absorptive capacity as a unit's R&D investment, which describes its capacity to learn. Further, literature reveals that firms that export are exposed to new technological knowledge, including processes and techniques (Grossman and Helpman, 1991). This market and technological knowledge inputs are not available with firms confined in domestic markets (Salomom and Shaver, 2005).

3.2 Empirical Literature

Firm level studies undertaken on the determinants of innovation at the firm level reveal that different factors entailing firm characteristics and external factors relating to firm's exposure and interactions influence innovation. In Kenya, such studies include Cirera (2015), who conducted a descriptive analysis using 2013 World Bank Enterprise Surveys; Njiraini et al. (2018) who uses the same dataset to analyse the link between innovation amongst MSEs and growth; and Gitonga and Moyi (2019) who use the KNBS 2016 MSME survey dataset to review the role of mobile technologies and other ICTs as enabler of innovation among Kenyan MSMEs. These three studies show that innovation is present among Kenyan enterprises, and that firm-level innovation rates are relatively high.

While Njiraini et al. (2018) reveal that Kenyan MSEs had higher levels of innovation intensity, Cirera (2015) established that 53 per cent of firms surveyed introduced either a product or process innovation. The innovation reported is largely incremental, with only 1.7 per cent of firms introducing radical innovations. However, possibly due to the nature of innovation undertaken, a small percentage of firms apply for intellectual property protection. For instance, 5.5 per cent of the enterprises sampled applied for a patent, 7.6 per cent a trademark, 6 per cent a utility model and 3.6 per cent for a copyright. Nonetheless, the firms that introduced product innovations experienced increased sales. Gitonga and Moyi (2019), establish that product innovation is the most common, accounting for 9 per cent of MSMEs with 5.3 per cent and 3.7 per cent of MSMEs participating in marketing and process innovation, respectively. However, 11.6 per cent of MSMEs undertook a combination of the three types of innovation; that is product, marketing, and process innovation.

Sector of the enterprise: In the studies reviewed, very few focussed on the role of the sector in innovation. Cirera (2015) finds that firms in the chemical sector

are the most innovative in Kenya. This is also established by Cohen and Levinthal (1990), who find that participating in manufacturing activities contributes to a firm's innovative capacity; given those with production experience can recognize and exploit new information. Indeed, Abdu and Jibir (2018) establish that retail and service firms are less likely to participate in product or process innovation compared to manufacturing firms. The study by Abdu and Jibir (2018) analysed innovation broadly among firms in Nigeria and established that firms in furniture and textiles sectors were more likely to be broadly innovative than other sectors. Gitonga and Moyi (2019) applied the probit model and established that firms operating in human health, social work and recreational sectors had a higher probability of participating in product innovation while manufacturing, wholesale and retail trade, repairs of motor vehicles, finance and insurance, and human health had a higher probability of participating in process innovation.

Size of the firm: The size of a firm has been established to have a significant contribution to innovation (Tsai, 2001; Oerlemans et al.,2005; Deng et al., 2012; Ayyagari et al., 2011; Abdu and Jibir, 2018; Njiraini et al., 2018; and Gitonga and Moyi, 2019). Tsai (2001) who focused on large firms established that innovation increased with size. Abdu and Jibir (2018) who studied micro, small, medium, and large enterprise in Nigeria, Oerlemans et al. (2005) who focused on small, medium, and large enterprises in South Africa and Deng et al. (2012) whose average firm size was relatively large manufacturing firms in China, came to a similar conclusion; there is a positive relationship between size and innovation. In Kenya, Njiraini et al. (2018) show that among MSEs, an additional employee is associated with an increased likelihood to innovate. Barasa et al. (2017) who accessed the relationship between regional institutions in Kenya, Uganda and Tanzania and innovation using merged data from World Bank Enterprise Surveys conducted in the three countries established a positive relationship between size, and innovation. Gitonga and Moyi (2019) study on MSMEs in Kenya also indicated similar results. Cirera (2015) finds that medium and large firms in Kenya are innovative. Size, therefore, is an important variable for analysis as it builds on Schumpeter (1942) theory, which reveals that larger firms have the resources and capacity to undertake innovation. Literature reveals, however, that this may not always hold depending on the type of innovation undertaken. In Ghana, for instance, small firms were established to be more innovative, particularly in product (Tetteh and Essegbey, 2014). Abdu and Jibir (2018) also established that when categorical variables were introduced to capture the different size stratum, micro, small and medium-size enterprises were more likely to be innovative in product and process than large-scale firms.

Age of the firm: The experience of a firm is critical in problem solving, since learning skills are enhanced incrementally (Cohen and Levinthal, 1990). Empirical evidence, however, shows varied results. Ayyagari et al. (2011) who focused on SMEs in developing countries and Barasa et al. (2017) and Njirani et al. (2018) who focused on MSEs in the East African region and Kenya, respectively, establish

that younger firms are more innovative. The latter study, however, establishes the relationship as non-linear, since the likelihood to innovate decreases as age of enterprise increases. The findings by Abdu and Jibir (2018) revealed that the probability of firms undertaking innovation in Nigeria decreased with age. However, Gitonga and Moyi (2019) using 2016 MSMEs Survey dataset by Kenya National Bureau of Statistics found that as firms' age increased, the probability of participating in innovation increased. Cirera (2015) find that firms that are innovative in Kenya are those with less than 10 years' experience and firms with between 30 and 34 years of experience. Deng et al. (2012), however, did not establish any significant relationship between age and innovation in Chinese firms.

Knowledge generating activities: Cirera (2015) presents the inputs of innovation as technology, equipment, and intangible assets such as human capital, scientific and creative capital, and organizational capital. Firms further invest in other knowledge generation or protection activities to enhance their innovative capital mainly through R&D. Investment in R&D is informed by theoretical literature as posited by Romer (1986, 1990). Though R&D is often considered as an input into innovation, in developing countries, however, R&D is undertaken by a small proportion of firms since it requires sufficient resources and capacity that firms may lack (Tetteh and Essegbey, 2014). This notwithstanding, empirical literature finds R&D to be robustly associated to innovation (Cirera and Maloney, 2017).

Mohnen et al. (2006) compared firms across seven European countries using a Tobit model. The dependant variable was innovation intensity, defined as share of the firm total sales due to improved or new products. The study found that firms undertaking R&D, particularly those in high technology sector, raise the share of innovation sales. The study by Deng et al. (2012), also using a Tobit model to establish the determinants of internal innovation performance show that R&D is insignificant; however, it is significant when an interaction term of R&D expenditure per head and export intensity is introduced. According to the study, it is in export-oriented firms that R&D expenditure has positive impact on the export performance of innovative products.

Abdu and Jibir (2018) also established that investments in R&D, training, size, participation in export, location, type, and sector contribute to the firm level innovation propensity among firms in Nigeria. The study further established that firms that undertake R&D were more likely to undertake process innovation by 32.2 percentage points while the likelihood to undertake product innovation was 27.9 percentage points. R&D is also a factor influencing innovation in Kenya, Tanzania, and Uganda (Barasa et al., 2017). Oerlemans et al. (2005), however, established that R&D was not a statistically significant determinant of innovation particularly among innovating firms in South Africa.

External trade: Gitonga and Moyi (2019) established that Kenyan MSMEs that participate in foreign trade are more likely to be innovative. In Ghana, firms that accessed new markets undertook innovation activities (Tetteh and Essegbey, 2014). The study by Oerlemans et al. (2005) uses a multivariate logistic regression model to assess the role played by technology and innovation management activities among innovative manufacturing firms in South Africa and establishes that innovative firms had a higher likelihood of exporting. Accessing export markets was also established to inform innovative output in China (Liu and Buck, 2007).

Human resources: Though limited, studies have also analysed the role of human resource capacity in firm level innovation. In Europe, Protogerou et al. (2017), using tobit regression models, explores the determinants of product innovation in young firms. The proxy of innovation used in the study was the degrees of radicalness or novelty of product innovation as either new to the firm, new to the market or no innovation. The study establishes that other than education level, factors that relate to human resource capacity are previous R&D experience and diversity in terms of expertise.

Studies in developing countries also establish human resource capacity as among the explanatory variables of firm level innovation. Barasa et al. (2017) establishes a positive and significant association between innovation, measured as product and service innovation, employee level of education and skilled labour in Kenya. Though Njiraini et al. (2018) found skilled employees to be statistically insignificant, the MSE manager's years of experience in a sector was, however, found to be significant but negative. While Ayyagari et al. (2007) established managerial education and experience, and education of employees to be associated with firm innovation, Abdu and Jibir (2018) establish formal training as a significant determinant of organizational innovation at the firm level in Nigeria. Ayyagari et al. (2007), whose study covered 47 developing countries, specifically establish that firms with managers between three and ten years of experience are more innovative than firms with inexperienced managers. The results, however, reveal mixed findings for both manager's experience and skills.

Gender of firm owner: In Sub-Saharan Africa, Barasa (2020) review on innovation in Tanzania established a positive association between female ownership and innovation. While female-owned enterprises were measured as a dummy variable capturing females with share capital holdings of not less than 51 per cent, innovation was defined as introduction of new products and processes. The study by Na and Shin (2019) conducted in over 6,000 firms from 30 emerging countries also had a similar finding that female ownership as a proportion is positively related to innovation measures. Among the variables of analysis in the study by Protogerou et al. (2017) is gender composition of founding team. The study establishes that female business owners are less likely to undertake activities such as innovation due to the perceived risk.

Innovation interactions: A country's institutional, micro-economic environment and common innovation infrastructure play an important role in influencing a firm's decision to innovate (Porter and Stern, 2001). A firm's ability to utilize such external resources contributes to its growth (Jarillo, 1989). These resources include networking practices, corporate alliances, and other technology transfer mechanisms such as incubation services and collaborative research. Studies on innovation interactions have, however, been more in developed countries.

Literature further reveals that common innovation infrastructure, such as incubation services, have a higher impact in developed countries compared to developing countries given the influence they have on indicators such as innovation, creativity, entrepreneurship digital growth, and education and skills, which are more common in developed countries (Al-Mubaraki and Busler, 2014). Marshall (1920) establishes that concentrations of firms contribute to knowledge and information spillovers and backward and forward linkages.

The firms with relationships and interactions are more likely to have absorptive capacity and consequently more likely to be innovative (Cohen and Levinthal, 1990). Interactions could be in form of simple licensing contracts or to complex joint development or collaborative manufacturing agreements (Mowery et al., 1996; Powell et al., 1996). The goal also varies from sharing risks, enhance market access, and pooling skills or other resources. Further, interactions can be established due to geographical proximity or institutional proximity. The latter refers to firms with similar institutional attributes (Tsouri, 2022). Interactions can also be in form of business networks through provision of timely knowledge and resources as established empirically in biotechnology industry (Powell et al 1996). Additional empirical studies on innovation interactions reveal that joint research ventures, joint R&D, firm level collaborations with suppliers, financiers, and other collaborative arrangements contribute to firm's performance (Mowery et al., 1996; Cohen and Levinthal, 1990; Lee et al., 2001; and Leiponen, 2005). These studies, however, do not establish the contribution to innovation. Mowery et al (1996), for instance, establish that participation in alliances contributes to an increase in a firm's ability to acquire technology-based capabilities. Lee et al (2001) examines the contribution of external networks such as strategic alliances, collaborations with universities or research institutions and financial networks on firm performance in 137 technological start-ups in Korea, which reveals that strategic alliances with financial networks predict the firm's performance. Leiponen (2005) establish that R&D collaborations among firms in Finland contribute to firm profitability. A study by Miguélez and Moreno (2015), however, find a positive association between innovation proxied as patents per capita, and networks which the study defined as the average number of co-inventions, in the study conducted in 27 European countries. Chan et al (2010) in a study conducted in a science park in South Africa establish that firms that network with others within the park benefit in terms of access to useful knowledge. Deng

et al. (2012), establishes three innovation interaction factors; collaboration with universities, original equipment manufacturers (OEM) partnership, and technological partnership have a positive and statistically significant association with the proportion of innovations exported. Though Tetteh and Essegbey (2014) established low levels of collaborations among firms in Ghana, 21 per cent of the processed innovations were a result of firm level collaborations with other firms.

Tsai (2001) in a study on two large multinational corporations to measure innovation and performance established that the interaction between networks and absorptive capacity significantly affects innovation and performance at the firm. Innovation was measured as number of new products introduced in the year divided by the target while performance was given as return on investment in the year divided by the target and R&D intensity proxied absorptive capacity. The inference, therefore, is that a firm must invest in absorptive capacity when expanding its networks.

3.3 Overview of Literature Review

The theoretical literature reveals that firms, as profit maximizing agents, play an important role in the provision of innovative products and services. According to the theories, the key drivers of the innovation process include R&D as established under Schumpeter's creative destruction and absorptive capacity as presented by Cohen and Levinthal (1990). The scholars also establish that exposure to new technological knowledge informs a firm's absorptive capacity. The literature further reveals that innovation requires resources and investment by a firm. Finally, Teece Model by Teece (1986) present that complementary assets also play a role in driving firm level innovation.

The empirical studies reviewed reveal that firms with absorptive capacity and capabilities, human and technological capacities and interactions, as articulated in theory, contribute to innovation both in developed and developing countries. There is, however, limited literature on the following: the contribution of innovation interactions such as being a member of a network, and incubation services on firm level innovation; the relationship between gender and innovation, and the sectors undertaking the different types of innovation.

A number of studies reviewed use a broad definition of innovation, thereby failing to disaggregate process and product innovation. Njiraini et al. (2018) and Abdu and Jibir (2018), for example, established an innovation score given as the sum of dummies for the four types of innovations: product, process, organization, and marketing innovation divided by four. Ayyagari et al. (2011) also defined innovation broadly by grouping different innovative activities, including new products, upgraded products, new technology, new plant, new joint venture, and new licensing agreement. Others such as Mohnen et al. (1992) and Deng et al.

(2012) developed a proxy of innovation as a proportion of output in terms of sales and export, respectively.

There is limited literature on process innovation, probably due to challenges in distinguishing between process and product innovation (Blaug, 1963). Studies that differentiated process and product innovation include Tetteh and Essegbey (2014) in Ghana, Abdu and Jibir (2018) in Nigeria and Gitonga and Moyi (2019) in Kenya. Tetteh and Essegbey (2014), for instance, establish that while product innovation is largely undertaken by small enterprises, process innovation occurs more in the services sector compared to manufacturing firms in Ghana. The study informed by descriptive analysis of 310 firms sampled from Association of Ghana Industries (AGI) established that though most process innovations were developed within the firm, 21 per cent of the innovations were developed through collaborations with other firms. The study by Abdu and Jibir (2018) did not establish major differences in the drivers of product or process innovation. However, both product and process innovation were established in firms that invested in R&D. The study by Gitonga and Moyi (2019) established the predictors to process innovation and those of product innovation to be similar. The key factor that was not associated with process innovation but was an explanatory factor for product innovation was use of mobile phones, websites, and computers. This reveals that the type of innovation undertaken by MSMEs in Kenya is informed by the firm's ICT intensity. This study, therefore, analyses the determinants of process and product/service innovation while acknowledging that both have different outcomes and thus different impacts on economic development. Product/service innovation theoretically enhances competitiveness while process innovation increases efficiency and productivity. Further, this study establishes the contribution of external factors, mainly the innovation interactions to firm's innovation.

4. Methodology

This section discusses the analytical framework, the empirical specification, measurement of variables, data sources, descriptive statistics, and estimation tests.

4.1 Analytical Framework

According to the literature on innovation, firms make a deliberate action to innovate. Solow (1957), for example, indicates that innovation is often undertaken intentionally by economic agents such as enterprises. Romer (1990) also asserts that innovation is undertaken intentionally by a profit-oriented firm. Therefore, a firm makes a choice to innovate or not to innovate. However, several factors drive firm innovation. Informed by the literature, these factors can be grouped into two: internal factors and external factors.

On internal factors, the Schumpeterian theory indicates that the size of the firm is crucial in driving innovation, given that large firms have a higher incentive to undertake innovation since they have huge resources (Schumpeter, 1942). Age of the firm is also critical in problem solving since learning skills are enhanced incrementally (Cohen and Levinthal, 1990). Further, in the diffusion of innovation theory by Rogers (1962), human resources are important in the adoption of innovation. According to the resource-based view of the firm theory, internal resources such as managerial skills of a firm determine innovation, since they determine R&D investment behaviour (Wernerfelt, 1984). Also, the ability of a firm to identify, evaluate, assimilate, and commercialize information contributing to the firm's innovative performance (absorptive capacity) is influenced by investment in R&D (Cohen and Levinthal, 1990: Tsai, 2001). Other internal factors driving innovation as established in the empirical literature are gender of firm owner and the sector of the firm. Thus, in this study, size of the firm, age of the firm, gender of firm owner proxied by female owner, human resources proxied by manager's experience and R&D were the internal factors identified as drivers of firm innovation.

According to the literature, external factors such as the innovation system infrastructure is also important. These include interactions that are necessary for innovation to occur (Teece, 1986; Romer, 1993; Lundvall, 1992). In the diffusion of innovation theory by Rogers (1962), networks are important particularly for the adoption of innovation. Thus, a firm's innovation benefit from these interactions since they enhance access to resources (Jarillo, 1989; Cohen and Levinthal, 1990; and Cirera and Custolito, 2019). These resources include networking practices, corporate alliances, and other technology transfer mechanisms such as

incubation services and collaborative research. In this study, incubation services and interactions (collaboration, alliances, networks) constituted the innovation system infrastructure. External trade has also been identified as an external factor driving innovation in firms. Firms that export are exposed to new technological knowledge, including processes and techniques (Grossman and Helpman, 1991). This study used exports to proxy for external trade.

4.2 Empirical Specification

In this study, three models were specified. To determine the factors influencing firm's innovation, we specified the following model:

Innovation = f(Age of the firm, firm size, female ownership, sector of firm, manager's experience

R&D, export, incubation, collaboration, alliances, networks (4.1)

In establishing the differences in the factors influencing difference types of innovation; that is product/service and process innovation, the following models were specified:

Process innovation = f(Age of the firm, firm size, female ownership, sector of firm, manager's experience

R&D, export, incubation, collaboration, alliances, networks) *(4.2)*

Product/service innovation = f(Age of the firm, firm size, female ownership, sector of firm, manager's experience

R&D, export, incubation, collaboration, alliances, networks) (4.3)

Since this study was concerned with the behaviour of firms given choices, a binary choice model was used in estimating the specified equations. This is because a firm has two alternatives; undertake innovation or not. According to Cameron and Trivedi (2006), the dependent variable y, in a binary choice model takes one of two values.

Let, $$y_i = \begin{cases} 1 \; with \; probablity \; p \\ 0 \; with \; probability \; 1-p \end{cases} \quad (4.4)$$

We get a regression model by parameterizing the probability to innovate, p to depend on a regressor vector X and a $K \; X \; 1$ parameter vector β. The commonly used models are of single index form with conditionality probability given by:

$p_i = Pr[y_i = 1 | x_i] = F(x_i' \beta)$ (4.5)

Where $F(x_i' \beta)$ is a specified function.

To ensure that $0 \leq p \geq 1$, it is natural to specify $F(x_i'\beta)$ to be accumulative distribution function (*cdf*).

The most common used binary models are the probit and logit models. If $F(x_i'\beta)$ has a standard normal *cdf*, we get a probit model. In a logit model, $F(x_i'\beta.)$ has a cdf of logistic distribution. Though the two models yield similar results, this study used the probit model because of its assumption of the normality of the error distribution, which makes it convenient to address specification problems (Wooldridge, 2016).

Therefore, a probit model was specified as follows:

To identify the drivers of innovation of firms in Kenya, we estimated, the probability that firm i chooses to undertake innovation as follows:

$$Pr[y_i=1|xi\ ]=x_i\beta+u \quad (4.6)$$

where (x_i) represents drivers of innovation as shown in equation (4.1)

To identify the drivers of process innovation of firms in Kenya, we estimated the probability that firm i chooses to undertake process innovation as follows:

$$Pr[y_i=1|x_i\ ]=x_i\beta+u \quad (4.7)$$

where (x_i) represents drivers of innovation as shown in equation (4.2)

To identify the drivers of product/service innovation of firms in Kenya, we estimated, the probability that firm *i* chooses to undertake product/service innovation as follows:

$$Pr[y_i=1|x_i\ ]=x_i\beta+u \quad (4.8)$$

where (x_i) represents drivers of innovation as shown in equation (4.3).

4.3 Data Type and Sources

This study utilized cross-section data set from the 2018 World Bank Kenya Enterprise Survey. The data assesses firms' various business environment factors in Kenya. While panel data from the several previous years surveys would have been more preferred, some variables of interest in this study were only available in the 2018 survey. Thus, cross-section data was found to be the most appropriate to achieve the main objective of identifying the drivers of firms' innovation in Kenya. Cross-section data is rich in firms' attributes and has been successful in explaining actions in firms.

The surveys' respondents were formal sector enterprises with five (5) and above employees covering the manufacturing and services sectors. Therefore, the micro

(with five and above employees), small, medium, and large enterprises were included in the survey. Micro enterprises with less than five employees were excluded in the survey. A total of 1,001 firms were covered: 455 manufacturing firms (food and beverages, textile, and garments, chemical, pharmaceutical and plastics and other manufacturing) and 546 firms in the services sector (retail, tourism, and other service sectors). The survey covered the following 10 counties: Nairobi, Kiambu, Nakuru, Mombasa, Kirinyaga, Kisumu, Uasin Gishu, Kilifi, Machakos, and Trans Nzoia. These counties account for most of the country's industrial firms. A range of business environment factors including access to finance, gender, corruption, infrastructure, innovation, competition, informality, and firm performance indicators were included in the survey. Other firm level variables such as age, size of the firm (given by number of employees), and sector were also covered in the survey. As established below, firm size, age and sector vary with the different types of innovation.

4.3.1 Variables' definition and measurement

There were three dependent variables in this study. To estimate the drivers of innovation, the dependent variable took the value of 1 if the firm introduced a new/improved product/service or introduced a new/improved process, and 0 otherwise. To estimate the drivers of product/service innovation of firm, the dependant variable took the value of 1 if a firm introduced new/improved products/services over the last three years, and 0 otherwise. Lastly, to estimate the drivers of process innovation of firm, the dependant variable took the value of 1 if a firm introduced a new/significantly improved process over the last three years, and 0 otherwise.

The independent variables used as identified in the literature and their measurement are detailed in Table 4.1 below.

Table 4.1: Independent variables and measurement

Variable	Measurement	Expected Sign
Firm level factors		
Age of firm	Number of years a firm has been in operations	(+,-)
Firm size	Number of permanent, full-time employees at the end of last fiscal year	(+,-)
Female ownership	Proportion of the firm owned by females	(-)
Sector	Categorial variable where 1 = Food, 2 = Textile and garments, 3 = Chemicals, pharmaceuticals and plastics, 4 = Other manufacturing, 5 = Retail, 6 = Other services	(-) retail and service, (+) textile manufacturing
Manager's experience	Number of working years for the top manager	(+,-)
R&D	Expenditure in Ksh on R&D in the last fiscal year	(+,-)
External factors		
Export	Dummy variable where 1 = if the firm exports and 0 = otherwise	(+,-)
Innovation system infrastructure		
Incubation	Dummy variable where 1 = use of incubation labs by the government, universities, or private sector and 0= otherwise	(+,-)
Interactions		
Collaboration	Dummy variable where 1 = Innovated through collaboration and co-development and 0 = otherwise	(+)
Alliances	Dummy variable where 1 = when introduced innovation from strategic alliance with other organization and 0 = otherwise	(+)
Networks	Dummy variable where 1= Member of formal/networks and 0 =otherwise	(+, -)

Authors' compilations

4.3.2 Descriptive statistics

Table 4.2 presents the descriptive statistics of the variables used in this study.

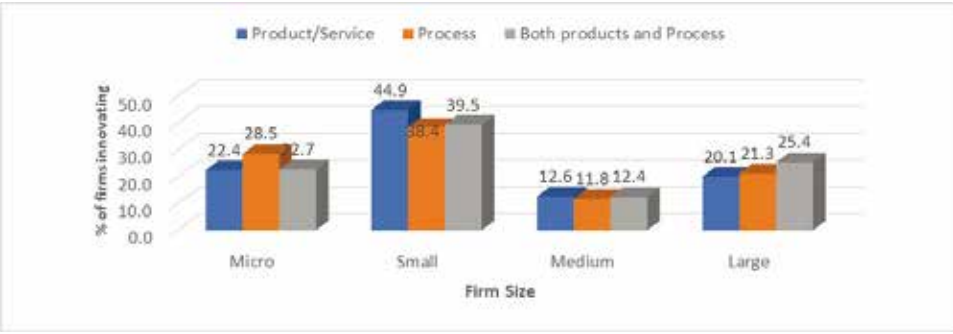
Table 4.2: Descriptive statistics

Variable	Observations	Mean	Std. Dev	Min	Max
Dependent variables					
Innovation (New/improved process or products/services)	1,001	0.54	0.48	0	1
Product/service innovation (New/improved products or services)	1,001	0.47	0.50	0	1
Process innovation (New/ improved process)	1,001	0.27	0.44	0	1
Independent variables					
Firm level factors					
Age of the firm	989	23.2	18.4	0	125
Firm size	1,001	73.96	252.92	1	6,000
Female ownership	1,001	21.06	31.59	0	100
Sector	1,001	4.07	1.78	1	6
Manager's work experience	986	16.35	11.42	1	65
R&D	1,001	280,813	45.6 million	0	1,000 million
External factors					
Export	1,001	0.16	0.36	0	1
Innovation system infrastructure					
Use of incubation labs	1,000	0.13	0.34	0	1
Interactions					
Collaboration and co-development	542	0.26	0.44	0	1
Strategic alliance	540	0.21	0.41	0	1
Networks	1001	0.38	0.49	0	4

Data source: World Bank (2019)

The statistics reveal that 54 per cent of firms undertook product/service or process innovation. Further, 27 per cent of firms sampled undertook process innovation and 47 per cent of firms undertook product/service innovation. While the average age of firms was 23.2 years, the average years of manager work experience was 16 years. Female ownership of firms averaged 21.1 per cent.

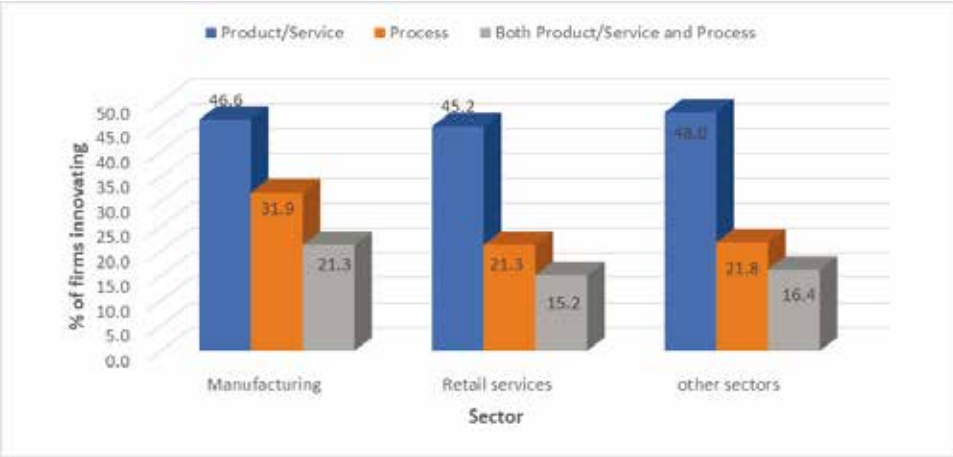
Figure 4.1: Firm size and innovation



Data Source: World Bank (2019)

The small firms (10-49 employees) were the majority who are innovating. As shown in Figure 4.1, 44.9, 38.4 and 39.5 per cent of firms who innovated in product/service, process and both product/service and process, respectively, were small firms. The other categories of firms reported to be innovating were micro (> 10 employees) and large (> 1000 employees) firms but to a lesser degree. The medium sized (50-99 employees) firms were the least in undertaking innovation. Micro firms often face resource challenges that limit their capacity to undertake innovation, while larger firms who may have the resources lack the flexibility to introduce innovation due to rigidities and inhouse bureaucracies.

Figure 4.2: Sector and innovation



Data source: World Bank (2019)

Most firms sampled were in the manufacturing sector. However, in terms of innovation, almost an equal proportion of firms in manufacturing (46.6%), retail services (45.2%) and other service sectors (48.0%) were innovating. Most innovation was in product/service. Innovation in processes was the second undertaken innovation by firms across all sectors (Figure 4.2). Innovation in both product/service and process was mostly within the manufacturing sector at 21.3 per cent compared to 15.2 per cent and 16.4 per cent in retail services and other service sectors, respectively. Most firms in the manufacturing sector undertook innovation compared to other sectors.

There was low uptake of R&D. Only 19 per cent of the firms reported to have undertaken R&D, spending an average of Ksh 280,813. The low uptake of R&D could be attributed to associated costs. Further, 13 per cent of the firms indicated to have used incubation services by the government, universities, or private sector. This could be attributed to limited awareness and access and a lack of policy guidance with respect to incubation services. Firms accessing foreign markets through exports were few at only 16 per cent. While 26 per cent of firms innovated through collaboration and co-development, 38 per cent were engaged in formal networks or associations.

Firms which undertook R&D innovated mostly in process and both product/service and process (Table 4.3). Such firms are likely to have sufficient resources to invest in both product/service and process innovation through R&D. Incubation was mostly used to innovate processes while collaboration and co-development was mainly used for both product/service and process innovation. Table 4.3

further reveals that there was at least product/service or process innovation among firms that undertook R&D, participated in incubations, or collaborated and co-developed.

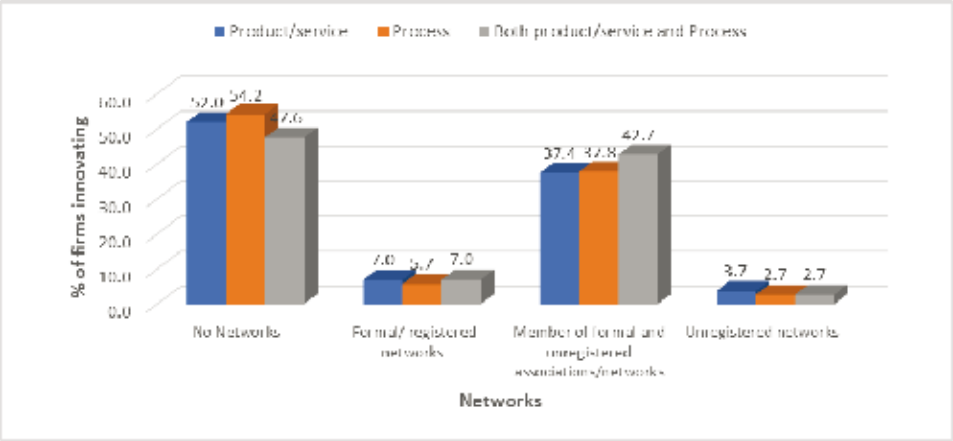
Table 4.3: R&D, incubation, and collaborations and co-development vs innovations (%)

Type of innovation	R&D		Incubation		Collaboration and co-development	
	Yes	No	Yes	No	Yes	No
Product/service	29.3	70.7	14.1	85.9	25.9	74.1
Process	37.2	62.8	18.6	81.4	34.7	65.3
Both product/service and Process	41.5	58.5	16.8	83.2	37.5	62.5

Data source: World Bank (2019)

On networks, about 43 per cent of firms belonged to either formal or unregistered associations/network. However, 79 per cent of these mainly had formal/networks. Firms with no networks innovated more compared to those with networks (Figure 4.3). While almost half of those firms without networks innovated, those firms with networks that innovated were below 50 per cent. For, example, while 52 per cent of firms without networks innovated in product/service, only 37.4 per cent of firms with formal and unregistered associations/networks innovated in product/service. In firms with formal/registered networks and those with unregistered networks, only 7 per cent and 3.7 per cent innovated in product/service, respectively.

Figure 4.3: Networks and innovation



Data Source: World Bank (2019)

4.4 Tests: Correlation Analysis and Endogeneity Test

Prior to the regression analysis, a correlation analysis was undertaken to test the strength of association of variables used in this study. The results showed a weak association among the explanatory variables (Annexes 1 and 2). However, since large firms have a higher likelihood of undertaking R&D, we suspected that these two variables, that is firm size, and R&D could be endogenous covariates. To test the endogeneity problem, the study fitted an extended probit regression (eprobit), which accommodates any combination of endogenous covariates. The test results revealed the correlation between the errors of product/service innovation and R&D equations to be -0.77 and statistically insignificant (see Table 4.4). Therefore, there was no endogeneity problem in the product/service innovation model and thus a normal probit model was estimated. The analysis, however, revealed endogeneity for the innovation and the process innovation models. An extended probit model was therefore estimated to address the endogeneity problem.

Table 4.4: Endogeneity test result using eprobit regression

Equation	Coefficient	Std Errors	Z
Corr (e.log R&D, e. innovation)	-0.482	0.221	0.030
Corr (e.log R&D, e. product/service innovation)	-0.779	0.419	-5.21
Corr (e.log R&D, e. process innovation)	0.0327	0.399	0.08

Data source: Authors' computation (2022)

5. Results and Discussion

5.1 Introduction

The study estimated 8 different models capturing firms' internal and external factors and effects, only excluding interactions, and finally both firms' internal and external factors and effects including interactions. However, in estimating the drivers of innovation of firms in Kenya, the outcome did not vary, and therefore there were no results. This study endeavoured to establish the contribution of external factors, mainly the innovation interactions to firms' innovation. The estimated results are discussed below.

5.2 Estimation Results

The estimated marginal effects on drivers of innovation are presented in Table 5.1. The study established that firm size, female ownership, manager experience and R&D were important drivers of firm innovation in Kenya. Further, different factors influenced the type of innovation undertaken by a firm. The manager's experience, sector of the firm, R&D, exports, and interactions (collaboration and co-development) influenced process innovation. In the case of product/service innovation, firm size, female ownership, manager's experience, sector, R&D, and interactions (formal networks) were significant drivers.

The influence of firm size on innovation

As established in Model 1 and Model 2, larger firms have a higher probability of innovation. The findings reveal that a unit increase in firm size would increase the likelihood of the firm undertaking innovation both by 3 per cent when only firm factors are considered and when external factors were included without interactions. The Schumpeterian theory indeed argue that larger firms have adequate resources to innovate. Empirical studies conducted in Kenya such as Ayyagari et al. (2012), Njiraini et al. (2018), Barasa et al. (2017) and Gitonga and Moyi (2019) also established a positive relationship between firm age and probability of participating in innovation. While firm size was important for innovation in general, it also mattered for product/service innovation but not process innovation. The probability to undertake product/service innovation increases by 4 per cent, with a unit increase in firm size with only firm factors and even when external factors were included without interactions (Models 6 and 7). However, the probability reduced to 3 per cent when interactions were included (Model 8).

The role of gender on firm innovation

Gender also mattered, however, with very low impact, whereby firms with a larger proportion of women as business owners had a 0.1 per cent probability to undertake firm innovation. The gender effect was, however, significant for product/service innovation and not for process innovation. The findings revealed that a firm with higher proportion of women in ownership structure has a 0.1 per cent probability of undertaking product/service innovation. Barasa (2020) and Na and Shin (2019) had a similar finding in Tanzania and emerging economies, respectively.

The sectoral influence on firm innovation

As indicated earlier, the firm's sector did not influence composite innovation. The same was established by Barasa et al. (2017), who also considered a composite innovation measure. However, when the innovation measure was disaggregated into process and product/service innovation, the study established that firms operating in other manufacturing (other than textile, garments, chemicals, pharmaceuticals, and plastic) lower the probability of undertaking process innovation by 12 per cent compared to food manufacturing firms. Firms in other services also have a lower probability of process innovation (Models 3 and 4). Firms operating in textile and garments, retail and other services sectors have a higher probability of undertaking product/service innovation compared to food manufacturing (models 6,7 and 8). Abdu and Jibir (2018) also identified manufacturing in textile as among the sectors that have a higher probability of participating in innovation. The study did not, however, undertake the analysis for process and/or product/service innovation. Innovation in the textile sector is necessary to cope with competition and dynamisms of the sector. Further, participating in manufacturing activities contributes to innovative capacity, given that those with production experience can recognize and exploit new information (Cohen and Levinthal, 1990).

The role of innovation system infrastructure (incubations and innovation interactions) on firm innovation

The study established that though access to incubation services had no effect on innovation, co-development and networks had an influence. While co-development mattered for process innovation, networks were important for product/service innovation. Firms that engage in collaboration and co-development with other firms have a 21 per cent likelihood of undertaking process innovation (Model 5). A unit increase in networks increases the probability that the firm will innovate a product/service by 5 per cent. The findings revealed, therefore, that networks

Table 5.1: Marginal effects on drivers of innovation

Variables	Innovation		Process Innovation			Product/service Innovation		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
	Firm level factors only	Firm level and external factors excluding interactions	Firm level factors only	Firm level and external factors excluding interactions	Firm level and external factors including interactions	Firm level factors only	Firm level and external factors excluding interactions	Firm level and external factors including interactions
Firm level factors								
Log of firm age	0.05 (0.11)	0.05 (0.10)	-0.01(0.09)	-0.007 (0.09)	-0.03 (0.15)	0.05 (0.10)	0.04 (0.10)	-0.02 (0.10)
Log of firm age squared	-0.01 (0.02)	-0.01 (0.02)	0.001 (0.02)	-0.002 (0.01)	-0.002(0.03)	-0.01 (0.02)	-0.012 (0.01)	-0.001(0.02)
Firm size	**0.03 **(0.01)**	**0.03***(0.01)**	0.01 (0.01)	0.01 (0.01)	-0.001 (0.02)	**0.04***(0.01)**	**0.04***(0.009)**	**0.03** (0.01)**
Female ownership	**0.001**(0.000)**	**0.001*(0.001)**	0.001(0.000)	0.00 (0.00)	0.001(0.001)	**0.001** (0.000)**	**0.001 (0.001)**	0.001(0.001)
Manager experience	**0.003**(0.002)**	**0.004** (0.002)**	0.002(0.001)	**0.003** (0.001)**	0.001(0.002)	**0.003 **(0.002)**	**0.003* (0.002)**	0.001(0.002)
Sector (reference=Food)								
Textile and Garments	0.05 (0.07)	0.061(0.07)	-0.03 (0.07)	-0.02 (0.06)	-0.06 (0.10)	**0.15** (0.08)**	**0.15* (0.08)**	**0.17** (0.08)**
Chemicals, pharmaceuticals, and plastics	0.07 (0.07)	0.08(0.06)	-0.01 (0.06)	0.005(0.05)	-0.02 (0.08)	0.15 (0.07)	0.15** (0.07)	**0.15** (0.07)**
Other manufacturing	-0.06 (0.05)	-0.03 (0.05)	**-0.12**(0.05)**	**-0.09** (0.04)**	**-0.13* * (0.08)**	0.06 (0.05)	**0.07 (0.05)**	**0.19** (0.06)**
Retail	0.03 (0.05)	0.05 (0.05)	-0.053 (0.050)	-0.03(0.05)	-0.11 (0.08)	**0.144** (0.06)**	**0.15** (0.06)**	**0.18** (0.07)**
Other service	0.02 (0.05)	0.3 (0.05)	**-0.08**(0.05)**	-0.60 (0.04)	**-0.17**(0.07)**	**0.13**(0.053**	**0.13** (0.05)**	**0.18**(0.06)**
Log of R&D	**0.03** (0.01)**	**0.03*(0.01)**	**0.02*** (0.003)**	**0.02*** (0.003)**	**0.01**(0.004)**	**0.02**(0.01)**	**0.02** (0.01)**	0.004 (0.01)
External factors								
Export	-		-	**0.08** (0.04)**	0.08(0.04)	-	0.04 (0.04)	0.01(0.04)
Innovation system infrastructure								
Use of incubation labs	-		-	0.05 (0.04)	0.05(0.04)	-	-0.02 (0.04)	-0.07 (0.05)
Interactions								
Collaboration and co-development	-		-		**0.21*** (0.06)**	-		-0.01 (0.05)
Strategic alliance	-		-		-0.05 (0.06)	-		-0.02 (0.05)
Networks	-		-		-0.01(0.05)	-		**0.05**(0.03)**
No. of obs.	948	947	948	947	503	948	947	503

Data source: Authors' computation (2022)

Note: Firm's age, and R&D variables were transformed into logs to rescale the values, minimize the variances, and mitigate against outliers.

contribute to product/service innovation, possibly through sharing of information and market opportunities. Tetteh and Essegbey (2014) in Ghana also established that innovation could be a result of firm level collaborations with other firms. Networks with other organizations, therefore, present opportunity for knowledge diffusion, technology and skills transfer among MSMEs in Kenya for product/ service innovation.

The role of R&D on firm innovation

R&D had a positive and statistically significant effect on innovation and the types of innovation. A firm which has investments in R&D has a 3 percentage point higher probability of innovation and 2 percentage point probability of undertaking process innovation when interactions were excluded. However, when interactions were included, the probability reduced to 1 per cent. Similar results were also revealed in the case of product/service innovation except that with inclusion of interactions, R&D was not a significant driver. Thus, as established by Barasa et al (2017), firm-level resources are essential for firm innovation in Kenya. Deng et al (2012) also establish that R&D is significant to international innovation performance only when external factors are excluded.

Other drivers of firm innovation

Manager's experience, though low, had an effect on innovation. Firms with managers having a higher number of years of experience have a 0.3 per cent or 0.4 per cent probability to undertake innovation (Model 1 and 2). Also, firms with managers having a higher number of years of experience have a 0.3 per cent probability to undertake process innovation or product/service innovation. Studies such as Barasa et al. (2017) and Ayyagari et al. (2007) found that firms with experienced managers have a higher likelihood of undertaking innovation compared to firms with inexperienced managers. Finally, firms engaged in external trade have an 8 per cent probability to undertake innovation, Similar results were found by Gitonga and Moyi (2019), Tetteh and Essegbey (2014), and Oerlemans et al. (2005).

6. Summary, Conclusion and Recommendations

6.1 Summary and Conclusion

This study set out to identify drivers of firms' innovation in Kenya. It established that innovation among firms in Kenya is influenced by firm size, female ownership, manager's experience and R&D. Further, the study established that drivers of process innovation differ from product/service innovation. Firms that undertake process innovation for instance have a higher likelihood to undertake R&D and co-development. In the case of product/service innovation, firm size, female ownership, manager's experience and R&D are significant drivers. In terms of sector, the study findings reveal a negative and statistically significant effect for firms operating in the manufacturing sector other than textile, garment, chemicals, pharmaceuticals and plastics and services sector (other than retail). This implies that firms operating in certain manufacturing and services sectors would have a lower likelihood of undertaking process innovation. This is not the case for product/service innovation, whereby firms in the services and retail sector have a higher likelihood in undertaking product/service innovation. Firms operating in textile and garments also have a higher probability of undertaking product/service innovation. On the role of innovation system infrastructure, interactions-co-development - matter for process innovation while formal association and/or network matter in the case of product/service innovation.

6.2 Recommendations

The study proposes the following interventions to accelerate innovation among firms in Kenya:

Firm size

Kenya's industrial base consists of micro, small, medium, and large sized enterprises. Micro enterprises, however, form the majority. This is acknowledged in Kenya's policies including Sessional Paper No. 5 of 2020 on Kenya Micro and Small Enterprises Policy. These firms often lack resources to innovate or to undertake knowledge-generating activities. From a policy point of view, therefore, the national innovation policy needs to consider interventions that support innovation in micro enterprises. Targeted policy solutions to micro size firms that meet their resource or capacity challenges are likely to accelerate innovation in Kenya.

Gender of firm owner

Continued policy interventions to promote women's access to education and access

to economic activities present opportunities in nurturing firm level innovation. In informing implementation of Sessional Paper No. 2 of 2019 on Gender and Development, enhanced initiatives to build capacities of women entrepreneurs and close the gender innovation gap is thereby of policy priority.

Sector of a firm

Kenya's manufacturing sector is a priority sector as recognized in the Kenya Vision 2030. The textile and apparel sector has been identified as among the strategic sectors to achieving these goals. The sector, as evidenced in this study, is among the manufacturing activities that have higher probability of undertaking product innovation and can, therefore, improve productivity of this manufacturing sub-sector. This presents an opportunity for the government to introduce sector-specific policy instruments to promote innovation and thus competitiveness for priority sectors such as textile and apparel.

Innovation interactions

Innovation interactions such as formal networks and collaborations and co-development agreements matter in promoting product/service innovation and process innovation, respectively. Process innovation benefits from co-development and collaborations while product/service innovation benefits from strategic formal networks.

Collaborations and co-development

Firms that co-develop have a higher probability to undertake process innovation. Thus, a review of policy incentives that promote co-development particularly between knowledge generators such as universities and industry is key. The incentives within institutions such as universities that generate knowledge may not be adequate to promote the commercialization of the knowledge. This calls for the development and implementation of a national innovation and commercialization policy as this is not yet instituted. This policy's goal, therefore, would be to introduce interventions and instrument to support collaborative innovation among MSMEs in Kenya and between MSMEs and academia.

Formal networks

Networks can be formed through membership to business associations or societies due to institutional proximities with other firms or network through geographical proximity. From a policy point of view, the promotion of business associations and networks offers additional benefits other than lobbying government, and pooling of resources as considered typically as to nurture product/service innovation. Sessional Paper No. 5 of 2020 on Kenya Micro and Small Enterprises Policy for Promoting Micro and Small Enterprises (MSEs) for Wealth and

Employment Creation encourages MSEs to join or form appropriate associations for the development of MSEs. This finding reiterates the importance of continued training and support from state and non-State agencies to MSE associations and networks to effectively serve the members, particularly in enabling them to facilitate innovation and technology diffusion. Industrial clusters as established in literature, enhances interactions and collaboration through skills and technology transfer. Policy also plays an important role in facilitating networks and collaborations, such as the sub-contracting policy and hasten development of industrial clusters proposed in MTP III. Of policy priority, therefore, is the operationalization of relevant policy instruments; the sub-contracting policy; the country's cluster development strategy and an industrial development master plan.

R&D uptake

The study revealed that there was low uptake of R&D among Kenyan firms. Therefore, there is need for review and enhance financial R&D support provided to MSEs. The National Research Fund established under the Science, Technology and Innovation Act of 2013 does not cater for MSMEs, as the emphasis is more on research by academia. Institutions such as KIRDI, which support R&D, can play a better role through strengthening and transforming into a world class research institution as envisioned in the Kenya Vision 2030. This would enable it to cater for multidisciplinary R&D and promote technology transfer among MSMEs around the country particularly in key innovative sectors such as textile and garments.

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Annex

Annex 1: Correction analysis - Innovation (combined)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Innovation	1.000												
(2) Log Firm Age	0.074	1.000											
(3) Log Firm Age Squared	0.075	0.983	1.000										
(4) Firm Size	0.125	0.347	0.345	1.000									
(5) Female Ownership	0.067	-0.080	-0.073	-0.148	1.000								
(6) Manager Experience	0.097	0.483	0.485	0.241	-0.054	1.000							
(7) Sector	-0.039	-0.182	-0.198	-0.159	0.004	-0.100	1.000						
(8) Log R&D	0.247	0.013	0.027	0.148	0.048	0.028	-0.071	1.000					
(9) Incubation	0.067	0.048	0.053	0.148	0.035	0.005	-0.146	0.119	1.000				
(10) Export	0.088	0.234	0.248	0.094	0.046	0.021	-0.244	0.190	0.053	1.000			
(11) Formal Network	0.075	0.151	0.155	0.262	-0.031	0.151	-0.011	0.125	0.063	0.054	1.000		
(12) Strategic Alliance	-	0.048	0.039	0.066	0.009	0.064	0.016	0.154	0.045	0.083	0.073	1.000	
(13) Collaborations and co-- Development	=-	0.077	0.079	0.077	0.020	0.072	0.047	0.207	0.050	0.075	0.111	0.591	1.000

Annex 2: Correlation analysis - Product/service innovation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Product Innovation	1.000												
(2) Log Firm Age	0.043	1.000											
(3) Log Firm Age Squared	0.042	0.983	1.000										
(4) Firm Size	0.148	0.347	0.345	1.000									
(5) Female Ownership	0.070	-0.080	-0.073	-0.148	1.000								
(6) Manager Experience	0.087	0.483	0.485	0.241	-0.054	1.000							
(7) Sector	0.034	-0.182	-0.198	-0.159	0.004	-0.100	1.000						
(8) Log R&D	0.236	0.013	0.027	0.148	0.048	0.028	-0.071	1.000					
(9) Incubation	0.022	0.048	0.053	0.148	0.035	0.005	-0.146	0.119	1.000				
(10) Export	0.048	0.234	0.248	0.094	0.046	0.021	-0.244	0.190	0.053	1.000			
(11) Formal Network	0.107	0.151	0.155	0.262	-0.031	0.151	-0.011	0.125	0.063	0.054	1.000		
(12) Strategic Alliance	-0.028	0.048	0.039	0.066	0.009	0.064	0.016	0.154	0.045	0.083	0.073	1.000	
(13) Co-Development	-0.019	0.077	0.079	0.077	0.020	0.072	0.047	0.207	0.050	0.075	0.111	0.591	1.000

Annex 3: Correlation analysis - Process innovation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Process Innovation	1.000												
(2) Log Firm Age	0.043	1.000											
(3) Log Firm Age Squared	0.048	0.983	1.000										
(4) Firm Size	0.092	0.347	0.345	1.000									
(5) Female Ownership	0.057	-0.080	-0.073	-0.148	1.000								
(6) Manager Experience	0.058	0.483	0.485	0.241	-0.054	1.000							
(7) Sector	-0.094	-0.182	-0.198	-0.159	0.004	-0.100	1.000						
(8) Log R&D	0.243	0.013	0.027	0.148	0.048	0.028	-0.071	1.000					
(9) Incubation	0.094	0.048	0.053	0.148	0.035	0.005	-0.146	0.119	1.000				
(10) Export	0.109	0.234	0.248	0.094	0.046	0.021	-0.244	0.190	0.053	1.000			
(11) Formal Network	0.065	0.151	0.155	0.262	-0.031	0.151	-0.011	0.125	0.063	0.054	1.000		
(12) Strategic Alliance	0.107	0.048	0.039	0.066	0.009	0.064	0.016	0.154	0.045	0.083	0.073	1.000	
(13) Co-Development	0.188	0.077	0.079	0.077	0.020	0.072	0.047	0.207	0.050	0.075	0.111	0.591	1.000

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