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The Role of Information Communication Technologies in Innovation in Kenya's Micro, Small and Medium Establishments

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Abstract

The interface between information communication technologies (ICTs) and innovation remains largely under-researched. Attempting to bridge this knowledge gap, this cross-sectional study of Kenya's micro, small and medium establishments examines the role of ICTs in innovation. The study applies Probit estimators to a comprehensive data set of 24,164 micro, small and medium establishments. Generally, the study reveals that the sectors having the highest incidence of innovation are electricity, gas, steam and air conditioning; ICT; education and real estate. Although the minority of establishments generated some innovations, product innovation was the most common type. Generally, information and communication technologies are found to stimulate innovation activity. The specific findings include: (1) Mobile phones and mobile money are positively and significantly correlated with product and marketing innovation but are insignificantly correlated with process innovation; (2) Fixed phones are negatively and significantly correlated with product and process innovation; (3) There is a positive and significant relationship between the propensity of innovation and websites, computers, tablets and video cameras; (4) The ownership of radios is positively and significantly correlated with marketing innovation propensity but insignificantly correlated with an enterprise's propensity for product and process innovation while ownership of television sets does not affect product, process or marketing innovation; (5) The effect of age and size on the propensity of innovation is concave: older and larger establishments tend to innovate more than relatively younger and smaller ones, but the relationships get reversed after a certain threshold; (6) The predicted probability of product, process and marketing innovation increases with increases in Research and Development (R&D), training, credit and foreign trade. These findings suggest that micro, small and medium establishments should be encouraged to integrate ICTs in their day-to-day operations.

Abbreviations and Acronyms

EPC	Export Promotion Council
ERS-WEC	Economic Recovery Strategy for Wealth and Employment Creation
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
ICTs	Information Communication Technologies
IPRs	Intellectual Property Rights
KARLO	Kenya Agricultural and Livestock Research Organization
KARI	Kenya Agricultural Research Institute
KEFRI	Kenya Forestry Research Institute
KEMRI	Kenya Medical Research Institute
KENIA	Kenya National Innovation Agency
KEPROBA	Kenya Export Promotion and Branding Agency
KETRI	Kenya Trypanosomiasis Research Institute
KIRDI	Kenya Industrial Research and Development Institute
KMFRI	Kenya Marine and Fisheries Research Institute
KNBS	Kenya National Bureau of Statistics
MSEA	Micro and Small Enterprises Authority
MSEs	Micro and Small Enterprises
MSMEs	Micro, Small and Medium Enterprises
NACOSTI	National Commission for Science, Technology and Innovation
NCST	National Council for Science and Technology
NRF	National Research Fund
R&D	Research and Development
STI	Science, Technology and Innovation
STISA	Science, Technology and Innovation Strategy for Africa
SDGs	Sustainable Development Goals

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1. Introduction

At national, regional and global levels, science, technology and innovation have been acknowledged as enablers of wealth creation, social welfare and international competitiveness. Goal 9 of the Sustainable Development Goals (SDGs) on industry, innovation and infrastructure seeks to spur industrial technology capability and infrastructure by increasing research and development spending, and increasing the number of research and development workers. The African Union's Science, Technology and Innovation Strategy for Africa (STISA-2024) articulates that "competitiveness and economic transformation requires sustained investment in new technologies and continuous innovation". Through the Vision 2010, "Kenya intends to become a knowledge-led economy wherein the creation, adaptation and use of knowledge will be among the most critical factors for rapid economic growth" (Government of Kenya, 2007).

Recent statistics on innovation in Africa indicate that Kenya is a top performer. The Global Competitiveness Report ranked Kenya as the fourth most innovative country in Sub-Saharan Africa behind Seychelles, South Africa and Mauritius, and the 78th most innovative country in the World with a score of 36 out of 100 (World Economic Form, 2019). The score is computed from scores of ten innovation activities. Firms with innovation activity, according to the 2014 African Innovation Outlook which sampled 117 firms with 10 employees and above are estimated at 74 per cent.

Despite this good performance, there is low level of R&D conducted by private sector firms (private sector accounts for only 8.7% of the country's Gross Expenditure on R&D - GERD). In Kenya, the government is the main source of R&D funding and about 20 per cent of R&D funds are spent on basic research (NEPAD Planning and Innovation Agency - NPCA, 2014). The Kenya Innovation Survey Report (KNBS and MHEST, 2012) indicates that innovative activities in Kenya's business sector are constrained by high innovation costs, challenges in accessing finance, unsupportive business environment, weak linkages to knowledge-based institutions, and high costs and weak linkages for commercialization. Additionally, most innovations do not proceed to the commercialization stage (NPCA, 2014).

Like many developing countries, Kenya's policy focus on micro, small and medium enterprises (MSMEs) is motivated by many reasons. These enterprises are an important source of income and employment. In 2016, MSMEs, which are defined as enterprises employing between 1 and 99 employees, accounted for 93.7 per cent of Kenya's total working population, and 31.4 per cent of gross value added in 2015 (KNBS, 2016). Arising from these statistics, an issue of concern is the low share of the sector in value addition relative to the large share in employment. Studies

reveal that enterprise level innovation contributes to the growth (Audretsch et al., 2014). MSMEs act as seedbeds for entrepreneurship and drivers of competition and innovation (House, 1984). Kenya's development blueprint considers these enterprises as seedbeds for Kenya's industrial development (Government of Kenya, 2007). They facilitate growth and development in rural areas and complement industrial transformation in large enterprises (Moyi, 2005; 2006). Whereas government policy expects MSMEs to play important roles in economic and industrial transformation, these enterprises suffer from restricted levels of technology, inappropriate technology and inadequate institutional technological capacity (Government of Kenya, 1992; 2005, KNBS 2016). They apply techniques that are insufficiently productive, which cannot produce goods that can enable them break into more dynamic markets (Moyi, 2005). MSMEs are known for high mortality. Liedholm (2001) found that 50 per cent of MSEs in Kenya closed within the first three years of operation while KNBS (2016) found that most establishments die within the first 3.8 years of operation.

The MSME survey (KNBS, 2016) further reveals that growth of MSMEs in Kenya is conditioned on access to infrastructure, including information and communication technology (ICT). According to the data, MSMEs that were licensed and registered as private companies had better access to computer services. Kenya continues to spearhead the deployment of digital technologies, particularly mobile phones, for inclusion of marginalized groups. For instance, the country outperformed many developing countries in Africa and elsewhere in digital inclusion in 2014 (World Bank, 2015). In that year, 58.4 per cent of all adults in Kenya held mobile money accounts compared to 11.5 per cent in Sub-Saharan Africa and 10.0 per cent in low-income countries. A joint survey by the Kenya National Bureau of Statistics, and the Communications Authority of Kenya found that 85.7 per cent of enterprises owned mobile phones, out of which 77.3 per cent used the phones to receive orders, 71.7 per cent to place orders and 73.3 per cent used mobile money accounts to make and receive payments (KNBS and CAK, 2016). A similar finding is established from the 2016 MSME survey, which reveals that 78.6 per cent of MSME owners used mobile phones (KNBS, 2016). Additionally, 92 per cent of enterprises used computers while 84.2 per cent had internet access within the business premise. Most of the businesses used internet for sending and receiving e-mails and obtaining information about goods and services. However, only 39 per cent used the internet to undertake e-commerce and 26.5 per cent sold their products online. A larger proportion of enterprises (71.1%) bought or sold goods and services via mobile phone (KNBS and CAK, 2016). In 2018, mobile penetration surpassed the 100 per cent mark, which was attributed to the fact that a number of mobile phone users have more than one SIM card (Communication Authority of Kenya, 2018). These statistics demonstrate the increasing importance

of ICTs in MSMEs and their potential role in improving the performance of these enterprises.

1.1 Statement of the Problem

There has been minimal analysis of the role of ICTs on innovation in Kenya. The only recent evidence on Kenya shows that education of a production worker, physical capital, firm age and size, and access to finance are important predictors of the propensity to innovate (Njiraini et al., 2018). In the study, mobile money did not play any role in influencing innovation. Some of the shortfalls of this study relate to the fact that the study used data from five (5) regions: Central, Mombasa, Nairobi, Kisumu and Nakuru. Similarly, the study analyzes only one ICT application: mobile money. The current study attempts to fill these gaps by using a more comprehensive data sets covering the entire country with information on mobile phones, mobile money, fixed phones, websites, tablets, computers, video camera, radio and television.

Apart from Kenya, many studies that have been undertaken in other countries to determine the drivers of innovation have identified various factors, including firm age, size, research and development (R&D), finance, competition and access to networks. However, only a few studies analyzed the role of ICT on firm innovation. Yet, ICT is an enabler of wealth creation, social welfare and international competitiveness. Few studies considered ICT particularly computer-based technologies and applications, including personal computers, e-mail, website, e-commerce and information technology R&D. However, such studies were focused on developed countries and failed new forms of ICTs such as mobile phones, mobile money and the internet (Higón, 2012). Although past research has focused more on factors such as age, size, research and development, finance, competition and networks, and less on ICT-related factors as indicated above, this can be justified by the fact that the role of ICT in firm innovation was not evident until recently. In the last few decades, there has been dramatic global market growth in ICT, and the telecommunications industry is undergoing rapid technological change. Consequently, there has been an emerging interest in how ICTs influence innovation in firms (Hempell and Zwick, 2008; Koellinger, 2008; Dibrel et al., 2008; Higón, 2012). There is also an increasing interest in deploying mobile phone-based technologies for inclusive development in Africa (Aker and Mbiti, 2010). Despite this, studies on the effect of ICTs on innovation in developing countries are scarce. As such, the purpose of the current study is to extend knowledge on the determinants of innovation by providing evidence on the role of ICTs in innovation in Kenya.

1.2 Objectives of the Study

The study examines the predictors of innovation in Kenya but lays emphasis on the role of information and communication technology (ICT). The specific objectives of the study are as follows:

(a) To analyse the incidence of innovation in MSMEs in Kenya.

(b) To examine the role of ICTs on innovation in Kenya's MSMEs.

1.3 Structure of the Paper

The paper is structured as follows. Innovation policies and laws are reviewed in section 2 while the conceptual framework is presented in Section 3. Relevant studies are reviewed in section 4. Methods and data are described in section 5. Study findings are presented and discussed in section 6 while policy and research implications are presented in section 7.

2. Policy, Legal and Institutional Framework

Innovation has been in Kenya's policy agenda for decades. The 1974-1979 Development Plan recognizes science and technology as an important pillar in the country's social economic development. Kenya's explicit science, technology and innovation (STI) policy is traceable to the 1970-74 National Development Plan, which called for the establishment of the National Council for Science and Technology (NCST). The subsequent Development Plan (1974-78) required the Council to be given the mandate to "ensure the application of results of scientific activities to the development of agriculture, industry and social welfare in the country". In 1979, the Science and Technology Act (Cap 250) was enacted. This Act established five research institutes, namely: Kenya Agricultural Research Institute, Kenya Medical Research Institute, Kenya Trypanosomiasis Research Institute, Kenya Forestry Research Institute and Kenya Industrial Research and Development Institute. The Act also established the National Council for Science and Technology (NCST), whose mandate was to determine national scientific and technological priorities and advice the government on national science and technology policy. It was in view of this mandate that the Sessional Paper No. 5 of 1982 on Science and Technology for Development (Government of Kenya, 1982) was formulated. This policy highlighted the weak research capacity in industry and gave recognition to Micro and Small Enterprises (MSEs) as the cornerstones of innovation and technology development in the country. It proposed a National Research Fund that would receive exchequer funding to the tune of 1 per cent of GDP. The fund was established 30 years later following the enactment of the Science, Technology and Innovation Act No. 28 of 2013, which established the National Research Fund (NRF) that should receive exchequer funding amounting to 2 per cent of GDP.

The policy documents also acknowledged the role of training in supporting indigenous enterprises. The interventions at the time combined training with business extension services. This was the case with the 1974-1978 and 1984-1988 Development Plans, which proposed the Small Business Promotion Centres Programme, Business Management Training Programme and industrial extension services. The Kenya Industrial Estate (KIE) was established in 1967 with the mandate to support MSEs largely through worksites, access to credit and business development services. On its part, Sessional Paper No. 2 of 1996 placed emphasis on research, extension services and technology transfer. The sessional paper further called for the development of a comprehensive policy framework for industrial technology development and acquisition of technology through mechanisms such as Foreign Direct Investment (FDI), purchasing or leasing, training and accessing patents. The role of indigenous enterprises in

promoting technological and industrial development was an overarching theme in government policy interventions, often referred to as "Kenyanization policies". To overcome the low participation of the private sector in R&D, the 1997-2001 Development Plan proposed R&D expenditure as a tax-deductible item, zero rating importation of R&D equipment and consumables, and special work permit exemptions for R&D personnel. The implementation of these remains unclear given the relevant provision in the Income Tax Act (Cap 470), which requires tax deductibles to consist of expenditure on scientific research and sums paid to approved scientific research associations, universities, colleges or any other approved research institutions. The private sector seems to be omitted from the institutions considered.

The Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth (Government of Kenya, 1986) was aimed at ushering in market-oriented reforms in line with the Structural Adjustment Programmes (SAPs) that were advocated by the International Monetary Fund and the World Bank. Given this policy thrust, the role of government became mainly facilitative as opposed to interventionist. In the new role, the government anticipated heightened import competition and sought to cushion the local industry by making provision for preferential tendering in favour of MSEs, encouraging formation of cooperatives (to offer information and support to MSEs), develop simple goods and production techniques (to replace imports) and disseminate information on new products and production techniques.

Sessional Paper No. 2 of 1992 on Small Enterprises and Jua Kali Development in Kenya (Government of Kenya, 1992) was the first comprehensive policy framework for MSEs. This policy prioritized the need to modify and adapt foreign technologies by re-orienting the Kenya Industrial Research and Development Institute (KIRDI) to enhance its capacity to undertake this role. The Third Medium Term Plan re-emphasizes the importance of transforming KIRDI into a "world class research institution". Other preferences of the 1992 policy include building a machine tool industry in the private sector, creating local markets for MSEs through preferential public procurement, and identifying technology research needs of MSEs through collaborative research. These policy interventions were re-stated in the 2005 Sessional Paper, which called for a reservation of at least 25 per cent of government procurement in favour of MSEs and encouraged sub-contracting arrangements between large and medium firms and MSEs.

The Sessional Paper No. 2 of 1996 on Industrial Transformation to the Year 2020 (Government of Kenya, 1996) identified technology extension services and technology development grant system as being pivotal in linking R&D institutions with *jua kali* enterprises. Budgetary support to institutions that support *jua kali*

technologies was also the main highlight of the Eighth National Development Plan 1997-2001 on Rapid Industrialization for Sustainable Development (Government of Kenya, 1997).

The Economic Recovery Strategy for Wealth and Employment Creation (Government of Kenya, 2003) singled out business incubation as a way of buttressing linkages in the sector. Sessional Paper No. 1 of 2005 on Policy Framework for Education, Training and Research (Government of Kenya, 2005a) recognized the important role of human resource development in technology acquisition and transfer. Sessional Paper No. 2 of 2005 on Development of Micro and Small Enterprises for Employment Creation for Poverty Reduction (Government of Kenya, 2005b) was more elaborate on technology in MSEs. Generally, it highlights four main intervention areas. First, adapting and adopting new technology by development of skills and technological capacity. Second, enhancing infrastructure and technical support including incubators, business development and financial services. Third, information management and dissemination, including markets, marketing and linkages and, lastly, improving the policy and regulatory environment. ICT was singled out in the policy among the mechanisms that can enhance marketing of MSE products and activities in international markets. The policy interventions are aimed at addressing the challenges in the sector, which were reported as unfavourable regulatory and policy environment, limited access to markets and market information, limited access to financial services, inadequate access to skills and technology, limited access to infrastructure, and information and limited inter-firm linkages.

The Kenya Vision 2030 (Government of Kenya, 2007) identifies science, technology and innovation among the six foundation of the country's socio-economic development. It identifies knowledge-driven economic growth as part of the country's technology vision. It singles out four elements as being instrumental in the exploitation of knowledge. The first element is an economic and institutional regime that recognizes incentives creation and uses of existing knowledge. The second one is human capacity and competence that is capable of creating, disseminating and utilizing knowledge efficiently. The Kenya Vision 2030 consequently proposes the strengthening of SMEs through improvements in productivity and innovation. The third element is an innovative information and communication infrastructure that can store, process and communicate knowledge. Finally, an innovation ecosystem with knowledge generators including research institutions, think tanks, universities, private enterprises and the community. One of the strategies identified in the Kenya Vision for promoting science, technology and innovation includes intensification of innovation in priority sectors. This includes coordination of research activities by various institutions; use and protection of local technological knowledge through

intellectual property rights (IPR) developed by industries, and for the protection of indigenous knowledge.

Following the Kenya Vision 2030, the government made significant changes to the country's innovation system. This included enactment of the Science, Technology and Innovation Act No. 28 of 2013, which repealed the Science and Technology Act (250) of 1979. The STI Act (2013) established key institutions aimed at facilitating knowledge creation and innovation. These include the Kenya National Innovation Agency (KENIA), the National Research Fund (NRF) and National Commission for Science, Technology and Innovation (NACOSTI). The Act also re-establishes the six (6) existing research institutions established by the 1979 Science and Technology Act (Cap 250). These include the Kenya Agricultural Research Institute (KARI), Kenya Forestry Research Institute (KEFRI), Kenya Industrial Research and Development Institute (KIRDI), Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Medical and Fisheries Research Institute (KEMRI) and Kenya Trypanosomiasis Research Institute (KETRI).

Following the enactment of the Kenya Agricultural and Livestock Research (KALR) Act No. 17 of 2013, the Kenya Agricultural Research Institute (KARI) has been transformed to Kenya Agricultural and Livestock Research Organization (KARLO) by merging KARI, Kenya Sugar Research Foundation (KESREF), Tea Research Foundation (TRF) and Coffee Research Foundation (CRF).

The National Research Fund was established in November 2014, while KENIA became functional in 2015. KENIA has a wide range of functions including developing and maintaining a database on innovation; increasing awareness of intellectual property rights among innovators; and administering a National Innovation Recognition Award where outstanding innovations in Kenya are recognized and receive cash awards. Other than KENIA, NACOSTI and the research institutions mentioned earlier, other institutions that support technology development and innovation include the Kenya Industrial Property Institute (KIPI) and Kenya Copyright Board; and Micro and Small Authority (MSEA) established under the Micro and Small Enterprise Act No. 55 of 2012.

The Kenya Vision 2030 has identified ICT as an enabler of Kenya's social economic transformation (Government of Kenya, 2007) while the 2016 ICT National Policy identifies innovation as one of enablers of investment and ease of doing business (Government of Kenya, 2016). The government, informed by ICT policy, has invested heavily in ICT-related technologies and infrastructure. This has led to improvements in access and speed of internet services and enhanced mobile phone penetration. The ICT policy prescribes the adoption of e-government and e-services particularly by the government to enhance service delivery. This has seen

the adoption of e-procurement, e-tax, Integrated Financial Management System - IFMIS, among others. The ICT policy also calls for the adoption of e-education system and e-learning, development of e-commerce and m-commerce; promotion of a secure digital transaction payment systems and promotion of digital financial inclusion, largely through mobile money services.

The Sessional Paper No. 9 of 2012 on the National Industrialization Policy Framework for Kenya (2012-2030) calls for the strengthening of industrial research, development and innovation aimed at improving production and quality of products. This was to be achieved through facilitation and mobilization of resources for R&D, effective intellectual property rights (IPR) system, strengthened linkages between institutes of higher learning, R&D institutions and the department of State responsible for industrialization and appropriate technology transfer mechanisms.

Other recent developments that have a positive effect on innovation in Kenya include the enactment of the Movable Property Security Rights Act 2017, which provides for the use of intellectual property rights as collateral for credit facilities. To address the protection of indigenous knowledge envisioned in the Kenya Vision 2030, the National Policy on Traditional Knowledge, Genetic Resources and Traditional Cultural Expressions (2009) was approved. The policy's goal is to enhance the preservation, protection and promotion of sustainable use of traditional knowledge while still accelerating technological development. In 2016, the Protection of Traditional Knowledge and Cultural Expressions Act (No. 33 of 2016) was enacted to protect and promote traditional knowledge in line with Article 11 of the Constitution of Kenya.

The Government adopted Kenya's Industrial Transformation Programme in July 2015, aimed at promoting the country's industrial development. The Programme prioritizes three key strategies. The first is the launch of sector-specific flagships in agro-processing, textiles, leather, construction, oil and gas, mining and IT-related services. The second is the development of SMEs through skills and capability development, access to credit and the promotion of sub-contracting between large and small enterprises; and the third is creation of an enabling environment to accelerate industrial development through technical, infrastructural support, market access and access to high quality inputs. The programme also recognizes the importance of investor-friendly policies that address unfair business practises while enforcing local content requirements.

Kenya's "Big Four" agenda targets the creation of 1,000 additional manufacturing small and medium enterprises (SMEs) with access to affordable capital, skills and markets. The Agenda identifies sectors similar to those presented in Kenya's Industrial Transformation Programme, including textile and apparel, leather,

agro-processing, blue economy, construction materials, oil, mining and gas, iron and steel and ICT. The "Big Four" agenda also acknowledges the role of innovative technologies in achieving affordable housing and enhancing food security.

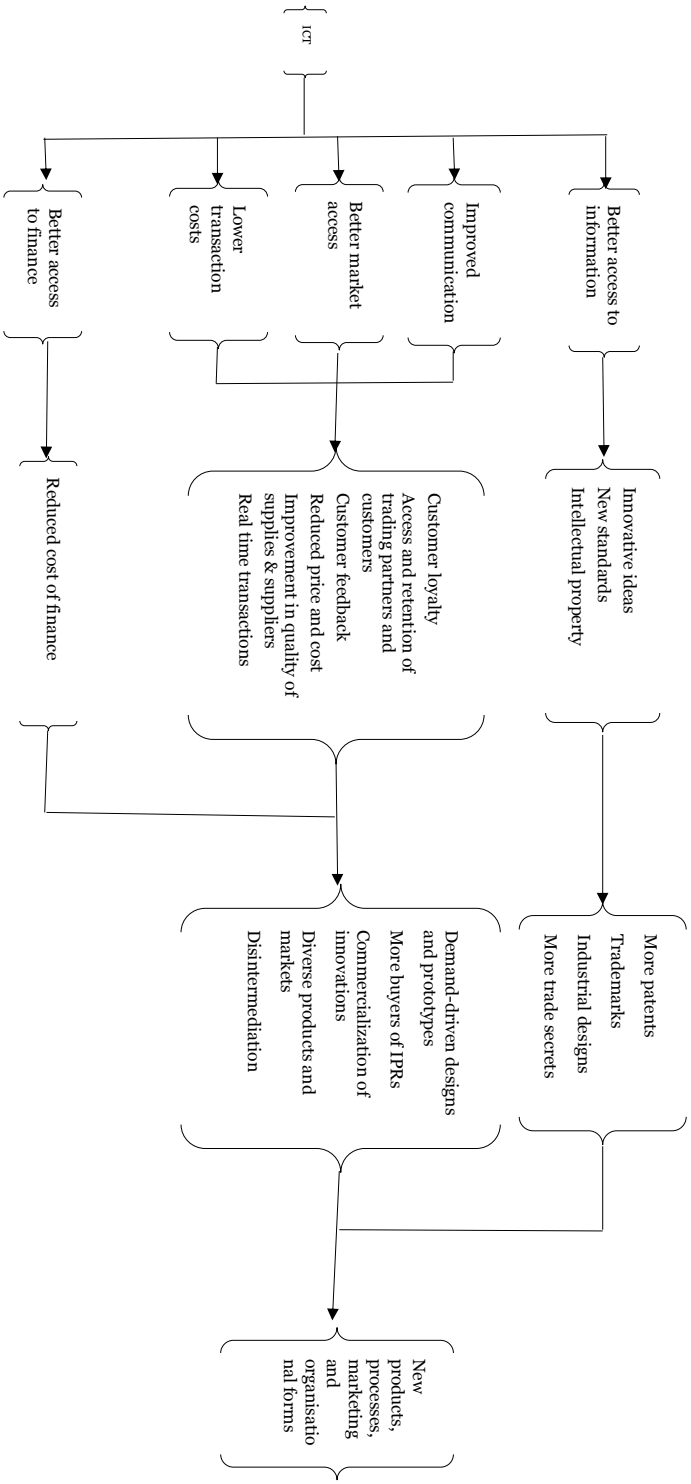
Past policy intentions suffered four main weaknesses. First, the definition of innovation has not been clearly demonstrated. The sources of innovations are also not well documented, with government policies biased towards government agencies that undertake research but overlooking the role of the private sector, including MSMEs. Policy consequently fails to recognize the different types of innovation (product, process, marketing and organizational) and the different interventions that each one of them requires. Second, they also failed to appreciate the patterns of innovation in the country. According to the African Innovation Outlook (2010), half (51.6%) of research output undertaken in Kenya (over the period 2005-2009) was concentrated in the public agricultural (including veterinary) and medical institutions indicated earlier, which are largely donor-funded. Third, there have been lags in implementation of the stated policy partly due to weak linkages across stakeholders. This is presented in the Third Medium Term Plan as among the challenges affecting MSMEs. Delays in implementation are also manifest in delays in introducing interventions such as R&D fund, in re-orienting STI institutions such as KIRDI, in introducing relevant policies including incubation policy and sub-contracting policies. Lastly, are the institutional gaps some of which were later addressed by STI Act and MSE Act, and low government commitment, Moreover, institutions involved in STI lack necessary infrastructure and financial resources to undertake R&D effectively. It is likely that lack of a national innovation policy may be a further contributory factor to the current policy challenges.

3. Conceptual Framework

The conceptual framework presented in Figure 1 is based on the transaction cost theory (Cordella, 2006; Boateng, 2011) and distance theory (Weber et al., 2012). The transaction cost theory predicts adverse selection and moral hazard problems in markets with unequal access to information (Dornberger et al., 2008; Cordella, 2006). Adverse selection happens before a business contract when the presence of unequal information makes the parties to the transaction make wrong decisions regarding the choice of products, partners and customers. Moral risk occurs when unequal information makes it probable that one of the agents in a business transaction will be opportunistic after signing the contract. The most common moral risk is to cheat on quality and quantity (Okello, 2011). Usually, one agent incurs losses occasioned by such behaviour by their counterpart. The distance theory is based on the idea that the physical separation of two agents acts a barrier to transact because they will incur transport costs (Weber et al., 2012).

Using these theories, five channels through which ICTs influence innovation can be identified. The channels are through access to information, improved communication, better market access, lower transaction costs, and better access to finance. The first channel is through better access to information. Access to information is especially more important to MSMEs because they face problems in terms of availability, asymmetry and uncertainty of information (Jagun et al., 2008). This implies that implementing ICTs has the potential to improve the performance of these enterprises. But better outcomes will only materialise if MSMEs not only use the ICTs but also integrate them in their day-to-day activities (Dornberger et al., 2008). For example, mobile applications (apps) have been used to provide users with useful and relevant information (Qiang et al., 2011). ICT interventions in this area include providing market prices in input, intermediate and product markets via mobile phone. In technology markets, access to information by MSMEs helps them know new technologies, new market standards including intellectual property rights. For techno-preneurs, this new knowledge generates innovative ideas, which lead to higher chances of patenting, developing trademarks and industrial designs and trade secrets. Eventually, these patents, trademarks, industrial designs and trade secrets end up as new products, new processes, marketing designs and organizational forms.

The second channel is through improved communication. Information asymmetry and monitoring costs tend to go up as the distance between any two transacting parties increases (Weber et al., 2012). Mobile banking has been shown to overcome the tyranny of distance (King, 2012). In developing countries, communication barriers are more critical in rural areas. For example, MSME operators are required to travel to urban areas to enable them access technology and innovation


ICT
Better access to information
Improved communication
Better market access
Lower transaction costs
Better access to finance
Innovative ideas
New standards
Intellectual property
Customer loyalty
Access and retention of trading partners and customers
Customer feedback
Reduced price and cost
Improvement in quality of supplies & suppliers
Real time transactions
Reduced cost of finance
More patents
Trademarks
Industrial designs
More trade secrets
Demand-driven designs and prototypes
More buyers of IPRs
Commercialization of innovations
Diverse products and markets
Disintermediation
New products, processes, marketing and organisational forms

fairs. Through smart phones, television, and video conferencing, such operators have an opportunity to obtain the necessary information without the need to incur transport costs. There is also a digital divide between technology source markets in developed countries and MSMEs located in developing countries. ICTs remove the distance barriers between the producers of technology (mainly located in developed countries) and the consumers of technology (mainly located in developing countries) mainly through transport substitution (Bhavnani et al., 2008), which happens because they enhance information flows between sellers and buyers allowing for efficient trading of information without travelling. This has the effect of deepening technology markets, which have been very thin in many developing countries.

The third channel is through better market access. ICTs provide data and information directly to the users. By doing so, they allow "middlemen" to be eliminated from the market (Bhavnani et al., 2008). This enhances market efficiency by enabling users to access arbitrage market opportunities that they would otherwise have missed out on (Bhavnani et al., 2008). The fourth channel is the reduction of transaction costs. Transaction costs include information-search costs, negotiation costs and enforcement costs (Cordella, 2006). The fifth channel is better access to finance due to the use of ATMs, agent banking, mobile-banking, mobile money, and mobile credit. For example, the use of mobile money has become very popular because mobile phones are cheaper to deploy, are owned by more people, provide instant and convenient service and can deliver personalized information to users. By 2015, seven (7) out of every ten (10) adults in Kenya were mobile money users (Financial Sector Deepening Kenya, 2016). About 71.7 per cent of MSMEs use their business phones to place orders while 77.3 per cent use them to receive orders (KNBS and CAK, 2016). Data from Central Bank of Kenya shows that the number of mobile money transactions rose from 5.5 million in 2007 to 1.114 billion in 2015, representing an annual growth rate of 54.3 per cent.

With improved communication, better market access, lower transaction costs and better access to finance, technology markets gain through reduced prices, improvements in quality of supplies and suppliers, real time transactions and retention of trade partners and customers. As a result, designs and prototypes will be demand-driven, demand for IPRs will rise and opportunities for commercialization of innovation will increase. The outcomes of all these activities will include new product designs, new processes, new markets and organizational forms.

4. Literature Review

4.1 Theoretical Literature

There are a number of theoretical perspectives on the drivers of innovation, namely global engagement hypothesis, information spillover hypothesis, market structure hypothesis, resource-based view, relational theory and transaction cost theory (Lederman, 2010; Deng et al., 2012, Weber et al., 2012). The market structure theory (or industrial organization perspective) identifies firm size as a key predictor of innovation. It argues that innovation activity can be stimulated through competition, which threatens market entry. According to industrial organization theory and the Schumpeterian conjecture, large firms have a higher propensity to innovate due to the greater scale of production and capacity, coupled with extensive infrastructure in marketing, finance and R&D (Bhattacharya and Bloch, 2004). Firms that have the capacity to leverage on technology to destroy their competitors become larger over time due to economies of scale.

The resource-based theory argues that unique resources possessed by a firm can be a source of competitiveness. These resources necessarily confer not only competitive differential to the firm but also customer value that is profitable (Griffith and Yalcinkaya, 2010). These resources are heterogenous, idiosyncratically distributed and they tend to be scarce, valuable, imperfectly tradeable and hard to imitate. They can be tangible (financial, legal, physical) or intangible (human, technological, organizational, relational and informational).

The global engagement thesis and the relational view posit that exposure to external knowledge and resources enhances a firm's capacity to innovate. Exposure to external knowledge and resources occur when firms participate in foreign markets through imports of intermediate goods, technology agreements and foreign direct investment (Lederman, 2010). Firms can also establish networks through technology licensing, knowledge sharing networks and collaborative arrangements (Deng and Sinkovics, 2012). According to Cohen and Levinthal (1990), the ability of a firm to identify, evaluate, assimilate and commercialize new and external information is a function of the firm's absorptive capacity. Persons with opportunities to interact with others are said to augment a firm's capacity of making novel associations and linkages. This relates to influence by "externally generated technical opportunities" (Cohen and Levinthal, 1989).

The information spillover hypothesis argues that firms can learn from aggregate accumulated knowledge even if they did not contribute to the invention leading to such knowledge (Lederman, 2010). Therefore, firms that have access to more commercial knowledge and information will possess a higher propensity to innovate than firms with restricted access to such information. Firms with many

years of experience, firms that conduct training and those with prior linkages and relationships with buyers and suppliers are more likely to be innovative. Firms in this case experience externally generated technical and innovation opportunities (Cohen and Levinthal, 1990). The cumulative nature of innovation is based on a firm's absorptive capacity, continued investments and ability to access technological opportunities. Age is usually included in regression models to capture learning-by-doing effects presented by Arrow (1962) and life-cycle effects. According to the learning hypothesis, larger firms are more innovative than smaller firms because the latter learn their efficiency and costs over time (Kranisqi, 2007). According to the life cycle hypothesis, more new knowledge is generated in the early stages of the industrial life cycle than in the later stages (Tavassoli, 2015). This is explained by younger firms' uncertainty about the product and the market, which drive them to seek new knowledge and deploy innovation as a strategy to overcome various risks. Younger firms are therefore more innovate relative to older firms. Age squared is included to capture non-linearities in the relationship between firm age and the propensity to innovate.

Since innovation is an information-intensive activity, transaction cost and distance theories identify information asymmetry as one of the key constraints to the functioning of technology markets (Weber et al., 2012). ICT is known to reduce transaction costs, to lower information asymmetry and to enhance innovative efficiency by diminishing the distance between producers and consumers of the innovations (Aker and Mbiti, 2010; Weber et al., 2012). By enabling information to flow fast, cheaply and accurately, ICT can reduce the chances of entrepreneurs making wrong decisions. It also reduces the risks incurred by firms, thereby presenting enterprises with opportunity to invest more in technology and innovation. According to Cohen and Levinthal (1990), firms that have low investment in absorptive capacity may be 'locked-out' of technological developments. This is particularly evident in ICT where technological developments are fast often building on older technology. In conclusion, therefore, "each new generation of technology builds on that which came before, once off the technological escalator it's difficult to get back on" (Reich, 1987, p.64).

4.2 Empirical Literature

Numerous studies have examined firm-level predictors of innovation. Most of these studies were cross-sectional and used the discrete choice framework. These include Abdu and Jibir (2017), Mahendra et al. (2015), Seenaiah and Rath (2018), Lederman (2010), De Mel et al. (2009), De Jong and Vermeulen (2006) and many others. Different proxies of innovation and types of innovation were analysed. While Song and Oh (2015) and Freel (2005) analysed product and product

innovation, others used multivariate models expanding the type of innovation to include marketing and organizational innovation (Abdu and Jibir, 2017; Lenz-Cesar and Heshmati, 2012). Apart from predominantly adopting 0/1 dummies as a proxy for innovation, other studies used either patent registration (Mahendra et al., 2015) or innovation capacity (Silva et al., 2014).

The most commonly identified drivers of innovation include firm age (Abdu and Jibir, 2017; Freel, 2005; Ruiz-Jimenez et al., 2016; Liu and Qiu, 2016), size (Kamasak, 2015; Deng et al., 2012; Song and Oh, 2015; Bhattacharya and Bloch, 2004), research and development (Lenz-Cesar and Heshmati, 2012; Lederman, 2010; Garcia-Villaverde et al., 2017), education and training (Abdu and Jibir, 2017; Seenaiah and Rath, 2018; De Jong and Vermeulen, 2006; Tavassoli, 2015; Freel, 2005), access to credit (Seenaiah and Rath, 2018; De Mel et al., 2009), exposure to foreign markets (Liu and Qiu, 2016; Tavassoli, 2015; Bhattacharya and Bloch, 2004) and competition (Abdu and Jibir, 2017; De Mel et al., 2009; Song and Oh, 2015; Bhattacharya and Bloch, 2004). Others include share of foreign ownership (Seenaiah and Rath, 2018), regulations (Lederman, 2010), profitability (Lenz-Cesar and Heshmati, 2012), partnerships and collaborations (Deng and Sinkovics, 2012), capital intensity (Song and Oh, 2015), and capital structure (Tavassoli, 2015).

Firm size is usually included in innovation regressions to test the industrial organization and Schumpeterian theories of innovation. Firm size increases a firm's propensity to innovate because large firms enjoy economies of scale by spreading fixed costs over a large sales volume (Van Dijk et al., 1997). This was established in Nigeria, Indonesia, Korea, Sri Lanka, Sweden and USA (Abdu and Jibir, 2017; Mahendra et al., 2015; Lenz-Cesar and Heshmati, 2012; De Mel et al., 2009; Deng and Sinkovics, 2012; Song and Oh, 2015; Tavassoli 2015; Acs and Audretsch 1988; Bhattacharya and Bloch, 2004). However, some studies failed to detect any effect of firm size on the likelihood that a firm will innovate (Kamasak, 2015; Deng and Sinkovics, 2012; De Jong and Vermeulen, 2006). When both size and size squared are included in the same regression, it is possible to test the threshold hypothesis: the idea that the effect of size is positive but is reversed after a certain point. Both Bhattacharya and Bloch (2004), Pamukcu (2003) and Lederman (2010) tested the existence of such thresholds and established that the innovation activity of firms increased significantly with firm size but at a decreasing rate.

Although learning models and life cycle models postulate a positive correlation between firm age and the propensity to innovate (Kranisqi, 2007; Tavassoli, 2015), empirical evidence is mixed. While some studies have found a negative and significant effect of age on the propensity to innovate (Abdu and Jibir, 2017; Seenaiah and Rath, 2018), others find a positive correlation (Mahendra et al., 2015)

and yet others do not establish any significant relationship (Deng and Sinkovics, 2012; Kamasak, 2015; De Jong and Vermeulen, 2006; Freel, 2005; Ruiz-Jimenez et al., 2016). Liu and Qiu (2016) found that the relationship between age and the propensity to innovate increases but at a decreasing rate. A study by Njiriani et al. (2018) in Kenya reveals that MSEs that are already undertaking innovation had higher levels of innovation intensity. This is representative of the learning models whereby MSEs that benefit from innovation are more likely to value and consequently invest more towards innovation. Such investments include use of information and communication technology.

Resource advantage theory postulates that human capital stimulates innovation activity. Human capital is usually captured in empirical work by including measures of education, training and skills. Tavassoli (2015), Van Dijk et al. (1997) and Acs and Audretsch (1988) find that firms with skilled labour have a higher chance to innovate than others. Similarly, firms that provided training are found to be more innovative (Abdu and Jibir, 2017; Seenaiah and Rath, 2018). De Jong and Vermeulen (2006) and Jose Madeira Silva et al. (2014) do not find any role for training and education programs in innovation. When innovation is broken down into product and process innovation, Hempell and Zwick (2008) find that skilled employees contribute to product innovation but youthful employees (given as the share of employees under 30 years of age) stimulate innovation activity. This is complemented in the study by Higón (2011), which reveals that managers aged over 46 years contribute negatively to process innovation. Freel (2005) finds that training enhances process innovation but slows product innovation while Njirani et al. (2018) present a positive relationship between innovative MSMEs and skilled production level workers

As established in Schumpter's creative destruction theory, innovation or new knowledge comes about from R&D. Empirical studies have confirmed this conjecture (Seenaiah and Rath, 2018; Abdu and Jibir, 2017; Song and Oh, 2015; Lenz-Cesar and Heshmati, 2012; Deng and Sinkovics, 2012; Bhattacharya and Bloch, 2004; Morikawa, 2004). Further industry-based comparative studies associate certain sectors of operation with greater innovation. The manufacturing sector has been found to be more innovative compared to services and other sectors (Abdu and Jibir, 2017 and De Mel et al., 2009). According to Cohen and Levinthal (1990), firms in manufacturing sector are in a position to recognise and exploit new information rendering them more innovative. Exporting firms, which are more likely to be manufacturing businesses, were found to have a higher innovative propensity (Tavassoli, 2015). This is further evidenced in Kenya, where Njirani et al (2018) establish that innovative MSEs had a higher proportion of export sales compared to non-innovative MSEs.

Firms in high-technology sectors were found to have better frameworks geared for innovation (Lenz-Cesar and Heshmati, 2012). This is further established by Kamasak (2015), who found a positive relationship between innovation performance and technological capabilities in firms in Turkey and Gómez and Vargas (2016) who report that firms in high-technology sectors in Spain were more likely to generate product innovations.

Evidence shows that firms with industry partnerships have a higher chance of innovating compared to those without cross-sector linkages (Deng and Sinkovics, 2010; De Jong and Vermeulen, 2006). In Korea, companies belonging to foreign groups of enterprises were less likely to undertake corporate innovation while those that belonged to domestic corporate groups were more likely to innovate (Lenz-Cesar and Heshmati, 2012). This reveals that the nature of institutional set-ups plays a role in either expanding or contracting firm-level innovation.

The business environment within which enterprises operate also influences the innovation process. Firms that have access to financial markets are more likely to engage in product innovation activity, while those that identified access to finance as a challenge were most likely to participate in process innovation (Higón, 2011). In Indonesia, firms that cited access to finance as a major obstacle were less likely to initiate product innovation activity (Mahendra et al., 2015). Firms that operated in competitive sectors were less likely to innovate (Deng and Sinkovics, 2012; De Mel et al., 2009). Acs and Audretsch (1988) establish that a lower level of market concentration is associated with increased innovation activity.

The role of ICT in innovation has been analysed by Hempell and Zwick (2008), Koellinger (2008), Dibrel et al. (2008) and Higón (2012). Hempel and Zwick (2008) study of Germany firm-level data establishes a significantly positive correlation between ICT investments and product innovation, but finds no influence on process innovation. In fact, it is firms that invest in non-ICT that are most likely to invest in process innovation. Koellinger (2008) using data from 7,302 European firms find that internet-based technologies complement innovation. Higón (2012) examines the role of the following ICT devices and applications in the innovation process: personal computer, e-mail, website, e-commerce and R&D IT. The usage of personal computers, websites and R&D IT are significantly and positively correlated with innovation. However, e-commerce serves no function in the innovation process, while e-mails negatively affect both product and process innovation. Dibrel et al. (2008) used firm-level US data to establish an indirect role for innovation in firm performance, which is complemented by IT.

4.3 Summary

At the theoretical level, the resource-based theory, information spillover hypothesis, industrial organization theory, learning models, global engagement thesis and transaction cost theory have identified the predictors of innovation.

The established identified determinants of firm level innovation as evidenced by the studies reviewed are the age and size of the enterprise, internal investment in R&D, access to finance, foreign trade, markets and competition. Although these analyses are extensive, there are several gaps in the literature. Firstly, there are few studies on African countries, including Kenya. Secondly, there are limited studies on the role of ICTs on firm innovation.

5. Methodology and Data

5.1 Data

The data used in this study was retrieved from the Micro Small and Medium Enterprises (MSMEs) baseline survey conducted between mid-February and early March 2016 by the Kenya National Bureau of Statistics (KNBS). It was the first comprehensive survey of micro small and medium enterprises in the country. The final sample size was 24,164 establishments. The unit of observation was the establishment, which is defined as an economic unit that produces and/or sells products and operates from a single physical location (KNBS, 2016). If a business, enterprise or firm has several such locations, each is termed a separate establishment.

5.2 Empirical Model

Most studies examining the determinants of innovation applied either logit or probit estimators (Abdu and Jibir, 2017; Mahendra et al., 2015; Seenaiah and Rath, 2018; Lederman, 2010; De Mel et al., 2009; De Jong and Vermeulen, 2006; and many others) but a few used OLS, Tobit and Poisson (Deng and Sinkovics, 2012; Acs and Audretsch, 1988; Liu and Qiu, 2016). These different approaches can be attributed to the way innovation was captured. Due to its complexity, there is not yet consensus in the literature on how to best measure innovation at firm level (Bhattacharya and Bloch, 2004). The most common approach has been to use dummy (0/1) variables, suggesting the use of maximum likelihood approaches within a binary choice framework. Ideally, logit or probit yield similar results in terms of marginal effects derived using the two methods. Both the cumulative standard logistic distribution, adopted by the logit, and the cumulative standard normal distribution, adopted by the probit, are symmetric and bell-shaped. Similarly, the difference between the predicted probabilities from probit and logit models are also minimal (Cameron and Trivedi, 2005). However, the two methods differ because unlike the standard normal distribution, logistic distribution has a closed-form solution. Given the foregoing features of the two models, this study adopts the probit model.

In this study, the dependent variable, y_i, is innovation (product, process and marketing) that was captured as a dummy variable that takes the value 1 if the respondent indicated that the establishment had either introduced a new or significantly improved product, process or marketing technique between 2013 and 2015, and 0 otherwise. In this set-up, the establishment is faced with a discrete

choice problem of deciding whether to innovate or not, which cannot be observed. This choice can be captured theoretically via a continuous latent variable that we call y_i^*. Given y_i and y_i^*, the modelling strategy for innovation choice begins with modelling y^* that cannot be observed and then moving on to model y_i which can be observed. This procedure starts by modelling y_i^* as specified in (1)

$$y_i^* = x_i \beta + \varepsilon_i \qquad \text{where } i=1.....n \qquad (1)$$

ε_i is white noise. If we assume that $y_i=1$ if $y_i^*>0$ and $y_i=0$ if $y^*_i \leq 0$. This implies that the conditional probability that an establishment chooses y_i will be:

$$Pr(y_i=1 \mid x_i) = Pr(\varepsilon_i > -x_i \beta \mid x_i) \qquad (2)$$

To estimate (2), an assumption has to be made on how the error term, ε_i ,is distributed. Assuming that ε_i is normally distributed, (2) can be re-written to yield the probit model.

Where Φ(.) and Φ(.) are, respectively, the probability distribution (pdf) and the cumulative distribution function (cdf) for the standard normal distribution. On the basis of (3), the estimated probit model can be written as:

$$Pr(Innov_i=1 \mid ICT, Controls) = \Phi(\alpha_0 + ICT_i' \alpha_1 + Controls_i' \alpha_2 + \varepsilon_i) \qquad (4)$$

$Innov_i$ is the dependent variable, which is represented by three types of innovation: process, product and marketing. $Innov_{ci}$ represents process innovation which takes a value of 1 if the respondent indicated that they had either introduced a new process or significantly improved the process between 2013 and 2015. $Innov_{di}$ represents product innovation, which takes a value of 1 if the respondent indicated that the establishment either introduced a new product or significantly improved its product between 2013 and 2015. $Innov_{ki}$ represents marketing innovation, which takes a value of 1 if the respondent indicated that the establishment either

$$\Pr(y_i = 1|x_i) = \Pr(\varepsilon_i > -x_i\beta|x_i) = 1 - \int_{-\infty}^{-x_i\beta} \phi(\varepsilon)d\varepsilon = 1 - \Phi(-x_i\beta) = \Phi(x_i\beta) \qquad (3)$$

introduced a new marketing technique or significantly improved their marketing strategy during the 2013-2015 period.

IT_i is a matrix containing ICT applications (mobile phones, mobile money, radio, television, personal computer, fixed phone, website, tablet, digital video camera). The matrix labelled $Controls_i$ includes traditional determinants of innovation (size, size squared, age, age squared, R&D, training, credit, foreign trade, competition, ISIC sector, County). All the variables used in the regressions are described and listed in Table 1.

Table 1: List of variables used in regressions

Dependent variables			
		Mean	S.D.
Product innovation	Dummy variable, 1= the respondent indicated that they had either introduced a new product or significantly improved the product between 2013 and 2015; 0=otherwise	0.12	0.32
Process innovation	Dummy variable, 1= the respondent indicated that they had either introduced a new process or significantly improved the process between 2013 and 2015; 0=otherwise	0.05	0.22
Marketing innovation	Dummy variable, 1= the respondent indicated that they had either introduced a new marketing technique or significantly improved the technique between 2013 and 2015; 0=otherwise	0.07	0.26
Independent variables			
Age	Age of establishment in years	8.56	8.47
Size	Number of employees	8.84	70
Training	Dummy variable, 1=establishment offered training to employees; 0=otherwise	0.16	0.37
R&D	Dummy variable; 1= Establishment spends money on innovations, 0 = otherwise	0.06	0.23
Credit	Dummy variable; 1 = applied for and received a loan in the last 3 years	0.27	0.44
Foreign trade	Dummy variable; 1= establishment exports its products and imports inputs	0.03	0.16
Competition	Dummy variable; 1 = market competition and lack of market are major obstacles to operations	0.24	0.43
Mobile phone	Dummy variable; 1 = establishment has a dedicated phone for business, 0 = otherwise	0.51	0.50
Mobile money	Dummy variable; 1=establishment uses mobile-money, 0=otherwise	0.50	0.50
Computer	Dummy variable; 1=establishment owns a computer, 0=otherwise	0.25	0.43
Telephone	Dummy variable; 1=establishment owns a fixed telephone, 0=otherwise	0.08	0.28
Website	Dummy variable; 1=establishment owns a website, 0=otherwise	0.11	0.31
Tablet	Dummy variable; 1=establishment owns a tablet, 0=otherwise	0.04	0.19
Video camera	Dummy variable; 1=establishment owns digital video camera, 0=otherwise	0.05	0.22

Radio	Dummy variable; 1=establishment owns a radio, 0=otherwise	0.27	0.44
TV	Dummy variable; 1=establishment owns a television set, 0=otherwise	0.20	0.40

6. Results and Discussion

6.1 Incidence of Innovation

This section discusses the distribution of innovators among micro, small and medium establishments in Kenya. This is accomplished by generating cross-tabs between the types of innovation against key attributes such as formality status, ownership structure, gender, size, age, sector, training status, mobile money and ICT status. The results are presented in Appendix 1.

The results indicate that a minority of establishments undertake innovations. Generally, the incidence of product, process and marketing innovation among Kenyan MSMEs is 9.0, 3.7 and 5.3 per cent, respectively. About 11.6 per cent of the establishments have undertaken any combination of the three types of innovation. Product innovation is the most common while process innovation is the least common among these establishments. Unfortunately, these levels of incidence fall much below levels that have been reported by previous studies in other countries. In Sri Lanka, 26 per cent of firms with no employees and 40 per cent of firms with one to nine employees engaged in some form of innovation (De Mel et al., 2009). Results from a World Bank Enterprise Survey for 2,676 Nigerian manufacturing establishments revealed that that the incidence of product, process, organization and marketing innovation were, respectively, 49.8, 49.7, 39.7 and 52.4 per cent, respectively (Abdu and Jibir, 2017).

Generally, the incidence of innovation varies with the size of the establishment. Small and medium establishments engage more in innovative activities than micro establishments. About 500 out of 2,251 (or 22.2%) small establishments, 68 out of 330 (or 20.6%) medium establishments undertook innovation compared to 2,215 out of 21,475 (10.3%) micro establishments. Analysis of the incidence of product innovation does not produce any different results. Product innovation incidence is 8.1, 17.2 and 17.6 per cent among micro, small and medium establishments, respectively. Process innovation incidence is higher among small establishments (10%) compared to medium (7.9%) and micro (3%) establishments. The incidence of marketing innovation among small establishments (12.2%) also compares favourably with the levels existing among medium enterprises (12.7%). However, marketing innovation incidence among micro establishments is much lower (4%).

Learning-by-doing theories postulate that older firms are more innovative than younger firms. This seems to be confirmed in MSMEs in Kenya. Age differences are prevalent in the incidence of innovation, with newer firms recording generally less innovation compared to their young and mature counterparts. The overall innovation incidence among mature, young and new establishments is 13.4, 11.3 and 10.4 per cent, respectively. This pattern does not change with product and

process innovation. However, new and young establishments score equally in incidence of marketing innovation: 4.8 per cent and 4.7 per cent, respectively.

Incidence analysis also shows that staff training, growth, mobile money, ICT adoption, formality and sector are related to differences in innovation. Establishments that offer training to their employees tend to innovate more compared to establishments that do not offer professional development opportunities. Generally, about 29.6 per cent of the firms that offered training to their employees had been involved in innovation activities, whereas only 12 per cent of establishments that did not offer training to their employees had undertaken innovation. Innovation incidence among high-growth establishments is 19.8 per cent compared to 10.8 per cent among low-growth establishments. The use of mobile money is associated with a higher likelihood of innovation (22.7%) compared to non-use (12.5%). Similarly, the users of ICT applications have a higher chance of innovation (28.6%) compared to non-users (14.3%). Benefits associated with formality are also evident. Formal establishments are more likely to innovate (18.6%) compared to non-registered establishments (9.3%). The four sectors with the highest incidence of innovation include electricity, gas, steam and air conditioning (33.3%), ICT (27.7%), education (23.4%) and real estate (22.1%) while those with the lowest innovation incidence are human health and social work (7.1%) and water supply, sewerage and waste management.

6.2 Regression Results

Table 2 presents marginal effects extracted from probit regressions. Results for the Wald chi-square tests for joint significance of the coefficients are reported at the bottom of the table. The Wald chi-square and the associated p-values (<0.05) show that the null (H0 = all the coefficients associated with independent variables are simultaneously equal to zero) is rejected at conventional levels of significance. This implies that all the models are statistically significant compared to models with no predictors. In addition, all the explanatory variables have the expected signs with most of them returning statistically significant coefficients.

Table 2: Marginal effects from probit model on determinants of innovations

	Product	Process	Marketing
Mobile money	0.03***	0.00	0.02***
	(0.005)	(0.004)	(0.004)
Mobile phone	0.02***	0.01	0.02***
	(0.006)	(0.004)	(0.004)
Fixed phone	-0.02**	-0.01*	-0.01
	(0.009)	(0.007)	(0.007)
Website	0.03***	0.02***	0.04***
	(0.008)	(0.006)	(0.006)
Computer	0.03***	0.00	0.01*
	(0.007)	(0.005)	(0.005)
Tablet	0.02*	0.03***	0.00
	(0.012)	(0.008)	(0.009)
Video camera	0.04***	-0.00	0.02***
	(0.011)	(0.007)	(0.008)
Radio	0.01	0.01	0.02***
	(0.006)	(0.004)	(0.005)
TV	0.01	0.00	-0.00
	(0.007)	(0.005)	(0.005)
Log age	0.05***	0.03***	0.02***
	(0.009)	(0.007)	(0.007)
[Log age]^2	-0.01***	-0.01***	-0.01***
	(0.003)	(0.002)	(0.002)
Log size	0.02***	0.02***	0.03***
	(0.007)	(0.005)	(0.006)
[Log size]^2	-0.00**	-0.00	-0.00***
	(0.001)	(0.001)	(0.001)
R&D	0.14***	0.08***	0.09***
	(0.009)	(0.005)	(0.006)
Training	0.06***	0.03***	0.03***
	(0.006)	(0.005)	(0.005)
Credit	0.04***	0.02***	0.01***
	(0.005)	(0.004)	(0.004)
Foreign trade	0.03**	0.02**	0.01
	(0.014)	(0.009)	(0.010)

Competition	-0.01 (0.006)	0.01** (0.004)	0.00 (0.005)
No of obs.	14,295	13,750	14,269
Wald chi^2	1564	1099	1519
p-value	0.001	0.001	0.001
Pseudo R^2	0.178	0.202	0.235
Pseudo LL	-4298	-2352	-2848

All models accommodate sector and county fixed effects. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

The purpose of this study is to assess how ICTs influence innovation in micro, small and medium establishments in Kenya. The results presented in Table 2 show that all ICT applications, except fixed phones, are beneficial for innovation in Kenya's MSMEs. Holding other variables constant, establishments that make use of mobile phones in their business have a higher propensity to generate product and marketing innovations compared to non-users. Specifically, owning a mobile phone compared to not owning one increases the probability of product and marketing innovation by 0.02 ($p<0.01$) while it does not significantly affect process innovation. Usage of mobile money compared to non-usage increases the probability of product innovation by 0.03 ($p<0.01$) and marketing innovation by 0.02 ($p<0.01$). Considering product, process and marketing innovation, the results show that mobile money seems to play a bigger role in product innovation compared to marketing innovation. Although the correlations between ownership of mobile phones and use of mobile money, and product and marketing innovation, are strongly positive and robust, mobile phones and mobile money do not affect process innovation. Njiraini et al. (2018) find that mobile money use does not affect the decision to innovate in micro and small enterprises. The varying results between Njiraini et al. (2018) and the current study is due to the different time periods and the scope of the two studies. Njiraini et al. (2018) study covers 2010-2012 from five (5) regions: Central, Nyanza, Mombasa, Nairobi and Nakuru while the current study uses nation-wide data that was collected in 2015.

Establishments that own fixed telephones have 2 per centage points ($p<0.05$) lower chance of generating product innovation and 1 per centage points ($p<0.10$) lower chance of generating process innovation compared to those who do not fixed telephones. These results suggest that there is a negative correlation between fixed telephones and innovation propensity, which can be explained by the fact that the fixed phone is an outdated and, therefore, declining technology which is slowly

being dislodged from the market by the mobile phone. Probably, fixed phone technology has acted as a "technology escalator" for mobile phone technology (Reich, 1987).

Similarly, the predicted probabilities of product, process and marketing innovation are on average between 2 percentage points and 4 percentage points higher for website adopters than for non-adopters. This finding is corroborated by the finding by Higón (2012) that the adoption of websites is associated with a higher likelihood of innovation. This finding is consistent with prediction of the global engagement thesis and the relational view, which argue that external knowledge and resources enhance innovation in establishments. Websites tend to expose firms to external knowledge and resources, thereby exposing them to foreign markets and foreign direct investment.

On average, owning a personal computer compared to not owning one increases the product innovation propensity and marketing innovation propensity by 3 percentage points and 1 percentage points, respectively. This finding is consistent with Morikawa (2004) who found that innovation propensity of firms using computers was higher compared to those without computers. Higón (2012) found that the application of personal computers was positively and significantly correlated with both process and product innovation.

Video cameras are significantly and positively correlated with product and marketing innovation but not significantly correlated with process innovation. Tablets matter for product and process innovation but do not affect marketing innovation. Radios matter only for marketing innovation but do not affect product and process innovation. Owning a television set does not affect innovation.

These preceding results confirm the predictions of the transaction cost theory that the use of mobile money, mobile phones and other ICT applications reduce transaction costs, lower information asymmetry and diminish the distance between producers and consumers (Aker and Mbiti, 2010; Weber et al., 2012). As evidenced in theory, ICT improves access to communication and enhances market access, therefore enhancing opportunities to innovate. In addition, mobile money enables the entrepreneurs to overcome "frictions in financial markets" by being able to transact small financial transactions via mobile phone. However, it is surprising that mobile phones and mobile money do not affect process innovation.

Apart from the significant effect of ICT equipment and applications on the different types of innovation, the predicted probabilities of product, process and marketing innovations all tend to increase with growth in R&D, employee training, credit and foreign trade. There is convexity in the relationship between age and size, and these different types of innovation (product, process and

marketing). The non-linear size effect is supported by Lederman (2010), Song and Oh (2015), Bhattacharya and Bloch (2004) and Pamuken (2003). A large establishment is more likely to innovate than a small establishment but the relationship is reversed for firms with more than 13 employees. The relationship between enterprise age and innovation propensity is quadratic. The coefficient on age is positive and statistically significant. However, the sign of the coefficient on age-squared is negative and statistically significant. Thus, it follows that innovation is characterized by "learning-by-doing" at the establishment's early stages. However, the strategic conservatism of older establishments may explain the decline in innovations later in the life of the establishment (Rhee et al., 2010).

7. Conclusion and Policy Implications

Motivated by the scarcity of research on the intersection between innovation and ICTs in Sub-Saharan Africa, this study sought to analyse the incidence of innovation among MSMEs in Kenya. It has also examined the factors that influence innovation propensity across various sectors, particularly the role of mobile technologies. Incidence analysis shows that the unconditional probability of product, process and marketing innovation was 15, 6 and 9 per cent, respectively. Although the minority of establishments undertook innovation, product innovation remained the most common type of innovation in any sector. The sectors with the highest incidence of innovation included electricity, gas, steam and air conditioning (33.3%), ICT (27.7%), education (23.4%) and real estate (22.1%). The sectors with the highest innovation incidence (oil and gas, IT related sectors and real estate) have been prioritized in the Industrial Transformation Programme among the flagships to be launched, and in the "Big Four" agenda of the Government of Kenya .

Study findings show that establishments that own mobile phones for business, those that use mobile money and other forms of ICT in their operations have higher product, process and marketing propensity. In addition, the predicted probabilities of product, process and marketing innovations rise with the increase in R&D, training, credit and foreign trade. The effects of both establishment age and size are non-linear. The coefficients on age and size are positive and statistically significant whereas the coefficients on age squared and size squared are negative and statistically significant. This implies that older and larger establishments tend to innovate more than the relatively younger and smaller ones, but the relationships tend to get reversed after a certain threshold point, which this study establishes as SMEs (with more than 13 employees).

The findings of this study have wide implications for policy, which would be critical for the country in the development of a National Innovation Policy, and further research. Firstly, the evidence that ICTs stimulate innovation implies that MSMEs should be encouraged to integrate ICTs in their day-to-day operations. These strategies, which should be aimed at closing the digital divide, include the adoption of e-commerce systems, m-commerce systems, enterprise resource planning, online purchasing and sales, web presence for marketing purposes, knowledge management, supply chain management and computer-integrated manufacturing. Although promoting e-commerce and m-commerce have been identified as policy priorities in the 2016 National ICT Policy, there are gaps in the regulation of auxiliary services including courier systems, integration and security of digital payment platforms (including mobile money) and consumer protection provisions. ICT-based market solutions therefore present an important

opportunity for Kenya to achieve the manufacturing sector targets outlined in the "Big Four" agenda.

Secondly, the finding that mobile phones and mobile money have a positive and significant impact on product and marketing innovation implies that reforms aimed at lowering mobile-based transaction costs for firms play a critical role in promoting innovation. As such, policies that enhance both access to mobile technology and access to mobile finance should be prioritized. Smart phones, for instance, are beneficial to firms seeking to advance m-commerce and e-commerce, and enhancing access to information. Thirdly, the fact that mobile technology platforms are not significant drivers of process innovation is important to interrogate. Further research is therefore required to unravel the factors that account for the marginal effects of mobile money and mobile phones on process innovation.

Fourthly, given that MSMEs and the private sector in Kenya lack a culture of spending on R&D, the Government needs to provide more fiscal incentives for innovation. The National Research Fund established under the Science, Technology and Innovation Act of 2013 can be applied to encourage enterprises to undertake R&D activities. This calls for expansion of the mandate of the Fund to support Kenyan MSMEs. This is in view of the finding that establishments that undertake R&D have a higher product, process and marketing innovation propensity compared to those not spending on R&D.

Fifthly, the finding that training, credit and foreign trade stimulate innovation implies that policy should improve the business environment by removing friction in financial markets and external knowledge-sharing. Policy interventions aimed at promoting R&D and industrial skills and in attracting local and foreign investment as prioritized in Kenya's Industrial Transformation Programme need to be viewed from an innovation point of view. This would require the promotion of FDI and hence technology and skills transfer. There is need to develop policies, strategies and systems that ensure technology and skills transfer are prioritized in the implementation of the 2019 Kenya Investment Policy. Policy interventions to enhance MSME access to export markets should also be prioritized. Market access and limited market information has been a policy concern for the sector as presented in the 2005 Policy for Development of Micro and Small Enterprises. The policy further called the Government to facilitate marketing of MSE products in international markets through interventions such as publicity by the Kenya Export Promotion and Branding Agency (KEPROBA) and by leveraging on ICT. This is a critical policy intervention, which should still be pursued by the Government, specifically by the Micro and Small Enterprises Authority (MSEA) and KEPROBA.

Skills upgrading could further be enhanced through promotion of incubation and sub-contracting and strengthening of linkages between academia and industry, which calls for the development and implementation of policies to promote the same which are presented as policy reform priorities in the Third Medium Term Plan. E-learning platforms provide a further opportunity to MSMEs to enhance their skills without having to 'close shop' for classroom training. Relevant training curriculum targeting MSMEs should therefore adopt e-education and e-learning approaches.

Access to credit is a persistent challenge among MSMEs in Kenya. The 2016 MSME survey further reveals costs of credit and lack of adequate collateral as key constraints. The enactment of the Movable Property Security Rights Act 2017, which provides for the use of intellectual property rights as collateral for credit facilities is therefore good news for MSMEs. This, however, calls for dissemination of this law by bodies such as the Kenya National Innovation Agency, Kenya Industrial Property Institute and Micro and Small Enterprise Authority to enhance uptake of credit among MSMEs. It will also call for enhancing awareness on the role of intellectual property rights among innovative MSMEs.

Lastly, the finding that both enterprise age and size have non-linear effects implies that public policies are likely to have differentiated effects on innovation depending on the age and size of the establishment. The interventions required would be informed by the age and size of the firm. Therefore, further research should determine the thresholds in the different sectors so that interventions can be designed to benefit specific types of establishment and industries.

References

Acs, Z. J. and Audretsch, D. B. (1988), "Innovation in large and small firms: An empirical analysis". *The American Economic Review*, 678-690.

Abdu, M. and Jibir, A. (2017), "Determinants of firms innovation in Nigeria". Kasetsart Journal of Social Sciences.

Aker, J. C. and Mbiti, I. M. (2010), "Mobile phones and economic development in Africa". *The Journal of Economic Perspectives*, 24(3): 207-232.

AU–NEPAD (African Union–New Partnership for Africa's Development) (2010), African Innovation Outlook 2010, AU–NEPAD, Pretoria.

Audretsch, D., Coad, A. and Segara, A. (2014), "Firm growth and innovation". *Small Business Economics*, 43(4): 743-749.

Avermaete, T., Viaene, J., Morgan, E. J., Pitts, E., Crawford, N. and Mahon, D. (2004), "Determinants of product and process innovation in small food manufacturing firms". *Trends in Food Science and Technology*, 15(10): 474-483.

Beckinsale, M. and Ram, M. (2006), "Delivering ICT to ethnic minority businesses: An action-research approach". *Environment and Planning: Government and Policy*, 24(6): 847-867.

Bhavnani A, Won-Wai Chiu R, Janakiram S, Silarszky P. (2008). The role of mobile phones in sustainable rural poverty reduction. Washington, DC: World Bank Global Information and Communications Department.

Bhattacharya, M. and Bloch, H. (2004), "Determinants of innovation". *Small Business Economics*, 22(2): 155-162.

Boateng, R. (2011), Mobile phones and micro-trading activities–conceptualizing the link. info, 13(5), 48-62.

Communications Authority of Kenya (2018), First Quarter Sector Statistics Report for the Financial Year 2018/19 (July-September 2018).

Cordella, A. (2006), "Transaction costs and information systems: Does IT add up?". *Journal of Information Technology*, 21(3): 195-202.

Damanpour, F. (1996), "Organizational complexity and innovation: Developing and testing multiple contingency models". *Management Science*, 42(5): 693-716.

De Jong, J. P. and Vermeulen, P. A. (2006), "Determinants of product innovation in small firms: A comparison across industries". *International Small Business Journal*, 24(6): 587-609.

De Mel, S., McKenzie, D. J. and Woodruff, C. M. (2009), Innovative firms or innovative owners? Determinants of innovation in micro, small, and medium enterprises.

Deng, Z. and Sinkovics, R. R. (2012), "Determinants of international innovation performance in Chinese manufacturing firms: An integrated perspective". *Asian Business and Management*, 11(1): 31-55.

Dornberger, U. Bernal Vera L. E. and Norena A. S (2007), "The influence of new information and comunication technologies on transaction costs of micro, small and medium-sized enterprises". In Kurihara, Y. (ed), *Information technology and economic development*. IGI Global.

Egbetokun, A. A., Siyanbola, W. O., Sanni, M., Olamade, O. O., Adeniyi, A. A. and Irefin, I. A. (2008). "What drives innovation? Inferences from an industry-wide survey in Nigeria". *International Journal of Technology Management*, 45(1-2): 123-140.

Elche-Hotelano, D. (2011), "Sources of knowledge, investments and appropriability as determinants of innovation: An empirical study in service firms". Innovation, 13(2): 220-235.

Financial Sector Deepening Kenya (2016), 2016 FinAccess Household Survey. Nairobi: FSD Kenya.

Freel, M. S. (2005), "Patterns of innovation and skills in small firms". *Technovation*, 25(2): 123-134.

Gómez, J., Salazar, I. and Vargas, P. (2016), "Sources of information as determinants of product and process innovation". *PloS one*, 11(4): e0152743.

Government of Kenya (1964), 1964-1970 National Development Plan. Nairobi: Government Printer.

Government of Kenya (1970), 1970-1974 National Development Plan. Nairobi: Government Printer.

Government of Kenya (1974), 1974-1978 National Development Plan. Nairobi: Government Printer.

Government of Kenya (1982), Sessional Paper No. 5 of 1982 on Science and Technology for Development. Nairobi: Government Printer.

Government of Kenya (1984), 1984-1988 National Development Plan. Nairobi: Government Printer.

Government of Kenya (1986), Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth. Nairobi: Government Printer.

Government of Kenya (1992), Sessional Paper No. 2 of 1992 on Small Enterprise and Jua Kali Development in Kenya. Nairobi: Government Printer.

Government of Kenya (1994), 1994-1996 National Development Plan. Nairobi: Government Printer.

Government of Kenya (1996), Sessional Paper No. 2 of 1996 on Industrial Transformation in to the Year 2020. Nairobi: Government Printer.

Government of Kenya (1997), 1997-2001 National Development Plan. Nairobi: Government Printer.

Government of Kenya (2002), 2002-2008 National Development Plan. Nairobi: Government Printer.

Government of Kenya (2003), Economic Recovery Strategy for Wealth and Employment Creation 2003-2007. Nairobi: Ministry of Planning and National Development.

Government of Kenya (2005), Sessional Paper No. 1 of 2005 on Policy Framework for Education, Training and Research. Nairobi: Government Printer.

Government of Kenya (2005), Sessional Paper No. 2 of 2005 on Development of Micro and Small Enterprises for Wealth and Employment Creation and Poverty Reduction. Nairobi: Government Printer.

Government of Kenya (2007), Kenya Vision 2030. Nairobi: Ministry of Planning and National Development and the National Economic and Social Council (NESC), Office of the President.

Government of Kenya (2012), Sessional Paper No. 9 of 2012 on the National Industrialization Policy Framework of Kenya 2012-2030. Nairobi: Government Printer.

Griffith, D. A. and Yalcinkaya, G. (2010), "Resource-advantage theory: A foundation for new insights into global advertising research". *International Journal of Advertising*, 29(1): 15-36.

Hempell, T. and Zwick, T. (2008), "New technology, work organisation, and innovation". *Economics of Innovation and New Technology*, 17(4): 331-354.

Higón, D. A. (2012), "The impact of ICT on innovation activities: Evidence for UK SMEs". *International Small Business Journal,* 30(6): 684-699.

House, W. J. (1984), "Nairobi's informal sector: Dynamic entrepreneurs or surplus labor?". *Economic Development and Cultural Change*, 32(2): 277-302.

Jagun, A., Heeks, R. and Whalley, J. L. (2008), "The impact of mobile telephony on developing country micro-enterprises: A Nigerian case study". *Information Technology and International Development*, 4(4): 47-65.

Jose Madeira Silva, M., Simões, J., Sousa, G., Moreira, J. and Wagner Mainardes, E. (2014), "Determinants of innovation capacity: Empirical evidence from services firms". *Innovation*, 16(3): 404-416.

Kamasak, R. (2015), "Determinants of innovation performance: A resource-based study". *Procedia-Social and Behavioral Sciences*, 195: 1330-1337.

King, M. (2012), Is mobile banking breaking the tyranny of distance to bank infrastructure? Evidence from Kenya. The Institute for International Integration Studies Discussion Paper Series iiisdp412, IIIS.

KNBS and MHEST (2012), The Kenya Innovation Survey Report 2012. Nairobi: Kenya National Bureau of Statistics and Ministry of Higher Education Science and Technology.

KNBS (2016), Micro, Small and Medium Establishments Basic Report 2016. Nairobi: Kenya National Bureau of Statistics. Retrieved from https://www.knbs.or.ke/2016-micro-small-and-mediumenterprises-msme-survey-basic-report-2/.

KNBS and CAK (2016), Enterprise ICT Survey 2016. Kenya National Bureau of Statistics and Communications Authority of Kenya. Retrieved from http://www.ca.go.ke/images/downloads/RESEARCH/Enterprise%20ICT%20Survey%20Report%202016.pdf.

Koellinger, P. (2008), "The relationship between technology, innovation, and firm performance—Empirical evidence from e-business in Europe". *Research Policy*, 37(8): 1317-1328.

Lederman, D. (2010), "An international multilevel analysis of product innovation". *Journal of International Business Studies*, 41(4), 606-619.

Lenz-Cesar, F. and Heshmati, A. (2012), "An econometric approach to identify determinants of cooperation for innovation among firms". *Applied Economics Letters*, 19(3): 227-235.

Liedholm, C. (2001), Small firm dynamics: Evidence from Africa and Latin America, World Bank Institute. http://siteresources.worldbank.org/WBI/Resources/wbi37189.pdf.

Liu, Q. and Qiu, L. D. (2016), "Intermediate input imports and innovations: Evidence from Chinese firms' patent filings". *Journal of International Economics*, 103: 166-183.

NEPAD Planning and Coordinating Agency (NPCA)(2014), African Innovation Outlook 2014.

Njiraini P., Omolo J and Gachanja P (2018), "Innovation and micro and small enterprises growth performance: Evidence from Kenya". Journal of Business and Management 20 (10): 9-16.

Mahendra, E., Zuhdi, U. and Muyanto, R. (2015), "Determinants of firm innovation in Indonesia: The role of institutions and access to finance. *EFI,* 61(3), 149-179.

Ministry of Industrialization and Enterprise Development (2015), Kenya's Industrial Transformation Programme. Nairobi: Government of Kenya

Ministry of Information Communication and Technology (2016), National Information and Communication Technology (ICT) Policy. Nairobi: Government of Kenya

Morikawa, M. (2004). "Information technology and the performance of Japanese SMEs". *Small Business Economics*, 23(3), 171-177.

Moyi, E. and Njiraini, P. (2005), *Towards technology models for MSEs in Kenya: Common principles and best practices*. KIPPRA DP No. 51. Nairobi. Kenya Institute for Public Policy Research and Analysis.

Moyi, E., Otieno, G., Mumo, I. and Ronge, E. (2006). *Developing a marketing framework for micro and small enterprises in Kenya*. KIPPRA DP No. 60. Nairobi: Kenya Institute for Public Policy Research and Analysis.

Njiraini, P., Gachanja, P. and Omolo, J. (2018), "Factors influencing micro and small enterprise's decision to innovate in Kenya". *Journal of Global Entrepreneurship Research*, 8(1): 34.

Pamukcu, T. (2003), "Trade liberalization and innovation decisions of firms: Lessons from post-1980 Turkey". *World Development*, 31(8): 1443-1458.

Qiang, C. Z., Kuek, S. C., Dymond, A. and Esselaar, S., (2011), Mobile applications for agricultural and rural development. ICT Sector Unit, World Bank http://siteresources.worldbank.org/INFORMATIONANDCOMMUNICATIONANDTECHN OLOGIES/Resources/MobileApplications_for_ARD.pdf (Accessed: 08/12/2018).

Okello, J. J. (2011), "Use of information and communication tools and services by rural grain traders: The case of Kenyan maize traders". *International Journal of ICT Research and Development in Africa*, 2(2), 39-53.

Organization of American States (OAS) (2001), Bogota Manual: Standardization of technological innovation in Latin American and Caribbean countries, Organization of American States.

OECD (2005), Oslo manual: Guidelines for collecting and interpreting innovation data, Third Edition. Paris: OECD.

Reich, R. B. (1987), The rise of techno-nationalism. Atlantic, May: 63-69.

Ruiz-Jiménez, J. M., del Mar Fuentes-Fuentes, M. and Ruiz-Arroyo, M. (2016), "Knowledge combination capability and innovation: The effects of gender diversity on top management teams in technology-based firms". *Journal of Business Ethics*, 135(3): 503-515.

Seenaiah, K. and Rath, B. N. (2018), "Determinants of innovation in selected manufacturing firms in India: Role of R&D and exports". *Science, Technology and Society*, 23(1): 65-84.

Song, C. and Oh, W. (2015), "Determinants of innovation in energy intensive industry and implications for energy policy". *Energy Policy*, 81: 122-130.

Tavassoli, S. (2015), "Innovation determinants over industry life cycle". *Technological Forecasting and Social Change*, 91: 18-32.

Weber, D., Kulkarni, U. and Riggins, F. (2012), Breadth and depth: The impact of ICT adoption on outreach capabilities of microfinance institutions. (July 29, 2012). AMCIS 2012 Proceedings. Paper 2.

World Economic Forum - WEF (2019), *The Global Competitiveness Report 2019*. Geneva: World Economic Forum.

World Bank (2015), *The little data book on financial inclusion 2015*. Washington DC: World Bank.

Van Dijk, B., Den Hertog, R., Menkveld, B. and Thurik, R. (1997), "Some new evidence on the determinants of large-and small-firm innovation". *Small Business Economics*, 9(4), 335-343.

Appendix

Appendix 1: Incidence of innovation in MSMEs

		Product innovation	Process innovation	Marketing innovation	All
Size	N	%	%	%	%
Micro	21,475	8.1	3.0	4.4	10.3
Small	2,251	17.2	10.0	12.2	22.2
Medium	330	17.6	7.9	12.7	20.6
Total	24,056	9.1	3.7	5.3	11.6
Age					
New	9,866	8.1	3.0	4.8	10.4
Young	4,939	9.2	3.7	4.7	11.3
Mature	9,355	10.5	4.7	6.3	13.4
Total	**24,160**	**9.3**	**3.8**	**5.4**	**11.7**
Staff training?					
No	12,398	9.2	3.8	5.4	12.0
Yes	2,424	24.3	12.3	16.0	29.6
Total	**14,822**	**11.7**	**5.2**	**7.1**	**14.9**
Growth					
Low growth	20,762	8.5	3.3	4.7	10.8
High growth	2,832	15.8	8.2	10.8	19.8
Total	**23,594**	**9.4**	**3.9**	**5.4**	**11.9**
Paybill?					
No	7,665	9.5	3.6	5.0	12.5
Yes	3,223	18.5	8.1	13.3	22.7
Total	**10,888**	**12.2**	**4.9**	**7.4**	**15.5**
ICT index					
Low	950	12.0	4.4	6.3	14.3
High	2,346	22.3	10.2	16.2	28.6
Total	**3,296**	**19.3**	**8.6**	**13.3**	**24.5**
Registered?					
Yes	6,269	14.8	7.0	9.6	18.6
No	17,895	7.3	2.7	3.9	9.3
Total	**24,164**	**9.3**	**3.8**	**5.4**	**11.7**
Sector					

A	64	6.3	9.4	4.7	9.4
B	39	2.6	10.3	0.0	10.3
C	2939	8.1	7.7	4.6	11.8
D	9	11.1	33.3	33.3	33.3
E	66	7.6	4.5	0.0	7.6
F	226	13.7	6.6	6.6	16.4
G	12482	8.2	1.8	4.6	10.0
H	304	12.5	8.2	10.2	18.8
I	2553	9.2	4.3	6.6	12.2
J	177	23.7	13.6	12.4	27.7
K	1126	12.6	3.8	8.2	14.7
L	77	15.6	10.4	16.9	22.1
M	199	14.6	9.0	7.5	19.6
N	370	13.8	5.9	7.8	16.8
O	1137	13.9	6.3	6.3	16.7
P	384	19.8	8.9	12.5	23.4
Q	326	5.2	2.8	3.1	7.1
R	1448	9.8	5.5	4.2	12.6
Total	23926	9.4	3.9	5.4	11.8

Micro = 0 – 9 employees; Small=10-49 employees; medium=50-99 employees. New refers to an establishment whose age is below 5 years of age, young between 5 and 8 years of age and mature above 8 years of age. A=Agriculture, forestry and fishing, B=Mining and quarrying; C=Manufacturing; D=Electricity, gas, steam, air conditioning; E=Water supply, sewerage, waste management; F=Construction; G= Wholesale and retail trade, repairs of motor-vehicles and motorcycles; H=transportation and storage; I=Accommodation and food service; J=Information and communication; K=Finance and insurance; L=Real estate; M=Professional, scientific and technical; N=Administrative and support services; O=Public administration and defence; P=Education;Q=Human health and

social work; R=Arts, entertainment and recreation

Appendix 2: Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Age	1.00														
2.	Age2	0.89*	1.00													
3.	Size	0.07*	0.08*	1.00												
4.	Size2	0.03*	0.03*	0.91*	1.00											
5.	Training	0.06*	0.06*	0.07*	0.02*	1.00										
6.	Growth	-0.06*	-0.02*	0.58*	0.39*	0.09*	1.00									
7.	Website	0.08*	0.09*	0.10*	0.00	0.30*	0.11*	1.00								
8.	Mobile phone	0.03*	0.04*	0.04*	0.01	0.16*	0.06*	0.19*	1.00							
9.	Fixed phone	0.11*	0.11*	0.08*	0.00	0.20*	0.10*	0.37*	0.17*	1.00						
10.	Computer	0.08*	0.08*	0.11*	0.02*	0.32*	0.13*	0.51*	0.23*	0.32*	1.00					
11.	Tablet	0.03*	0.03*	0.08*	0.00	0.17*	0.10*	0.26*	0.10*	0.20*	0.28*	1.00				
12.	Video cam	0.05*	0.06*	0.08*	0.00	0.18*	0.10*	0.32*	0.12*	0.26*	0.34*	0.35*	1.00			
13.	Radio	0.01	0.00	0.02*	0.01	-0.01	0.02*	0.02*	0.03*	0.02*	0.05*	0.08*	0.09*	1.00		
14.	TV	0.03*	0.03*	0.05*	-0.00	0.07*	0.06*	0.16*	0.09*	0.13*	0.19*	0.16*	0.20*	0.36*	1.00	
15.	Mobile money	0.06*	0.07*	0.11*	0.02	0.20*	0.11*	0.32*	0.16*	0.22*	0.32*	0.13*	0.16*	0.07*	0.21*	1.00

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