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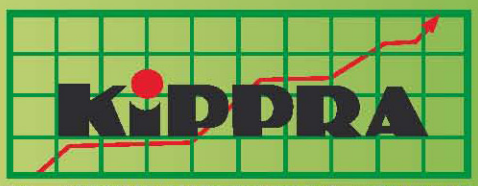

The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

Foreign Direct Investment, Spillover Effects and Innovation: Experience from the Kenyan Enterprise Sector

Nandwa Mukolwe Erick

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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

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Foreign Direct Investment, Spillover Effects and Innovation: Experience from the Kenyan Enterprise Sector

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Kenya Institute for Public Policy
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Bishops Garden Towers, Bishops Road
PO Box 56445-00200 Nairobi, Kenya
tel: +254 20 2719933/4; fax: +254 20 2719951
email: admin@kippra.or.ke
website: http://www.kippra.org

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Abstract

Globally, the role of Foreign Direct Investment (FDI) in promoting innovation in the host economies has not been certain. Various studies have established that the impact varies across countries depending on economical, technological and institutional arrangement. Therefore, this study seeks to establish whether spillovers effects from FDI inflows influence innovation among Kenyan enterprises. Using the World Bank Enterprise Survey data of 2013 and the Crepon, Duguet and Mairesse (CDM) model of 1998 in the empirical analysis, the study findings provide evidence that FDIs influence process and market innovation among Kenyan enterprises through forward spillovers and horizontal slipover effects, but there is no evidences of backward spillovers. The study further establishes that innovation expenditure from foreign firms, exporting activities, sourcing international quality certification and use of ICT positively influence product, process and market innovation in Kenya. Besides, other FDI-related variables including sources of funding, cooperation in innovation, protection and market competition were found to influence innovation decisions while investment in R&D, employee training, marketing, equipment acquisition, informal competition, cooperation in innovation, exporting, protection and financial access aspects influence the intensity of expenditure on innovation decisions. The study recommends that there is need for investment in creating an enabling environment that promotes continued FDI inflows, continuous learning and capability enhancement and addressing barriers to innovation, including access to finance, informal competitors and custom and trade obstacles. Besides, there is need for a systemic innovation policy with modalities supporting coordination, linkages and interactive learning among all the stakeholders.

Abbreviations and Acronyms

BSFDI	Backward Spillovers from Foreign Direct Investment
CBET	Competence-Based Education and Training
CDM	Crepon, Duguet and Mairesse
EAC	East African Community
EMS	Equipment, machinery and software's
EPZA	Export Processing Zones Authority
FDI	Foreign Direct Investment
FSFDI	Forward Spillovers from Foreign Direct Investment
HSFDI	Horizontal Spillovers from Foreign Direct Investment
ICT	Information Communications and Technology
ILTECH	Internationally Licensed Technology
IRQC	Internationally Recognized Quality Certification
KIP	Kenya Industrial Policy
KIPPRA	Kenya Institute for Public Policy Research and Analysis
MSEs	Medium and Small Enterprises
MTP	Medium-Term Plan
NIP	National Investment Policies
OECD	Organization for Economic Cooperation and Development
R&D	Research and Development
SEZs	Special Economic Zones
ST&I	Science, Technology and Innovation
TVET	Technical and Vocational Education Training
UNCTAD	United Nations Conference on Trade and Development
WIPO	World Intellectual Property Organization

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1. Introduction

1.1 Background Information

Foreign direct investment (FDI) has been extensively captured in literature as a driver for increased productivity in the host economies. Globally FDI is known to promote fiscal capital formation, transfer technology and knowledge, generate employment and human capital, stimulate productivity, augment output and promote foreign trade through spillover effects (Smallbone, 2007). The spillover effects, defined as an increase in the productivity of domestic firms due to the presence of foreign firms in the domestic economy, have been linked to having a huge potential for driving innovation[1] and improving competitiveness among the indigenous entrepreneurs (OECD, 2008). Spillovers from FDI occur either directly through ownership and control of their affiliates firms or indirectly through technology diffusion, transfer of skills, labour mobility, increased competition and market access, therefore enhancing the innovative capabilities and performance of domestic firms (Gorg and Greenaway, 2004).

Spillover effects notwithstanding, the nature and extent to which a host economy benefits from FDI inflows depends on the local firm's ability to identify, assimilate and exploit knowledge from the environment (Cohen and Levinthal, 1989). Similarly, the government's role in creating an economic, institutional and technological conducive environment in the recipient economy, and narrow technology gap between foreign and local firms is vital (Nyamwange, 2009). Given that most developing countries, especially in Sub-Saharan Africa have been characterized by limited ability to harness the benefits associated with FDI inflow, the need to enhance innovation capabilities in these countries, including Kenya, has continuously stood out as matter of policy concern.

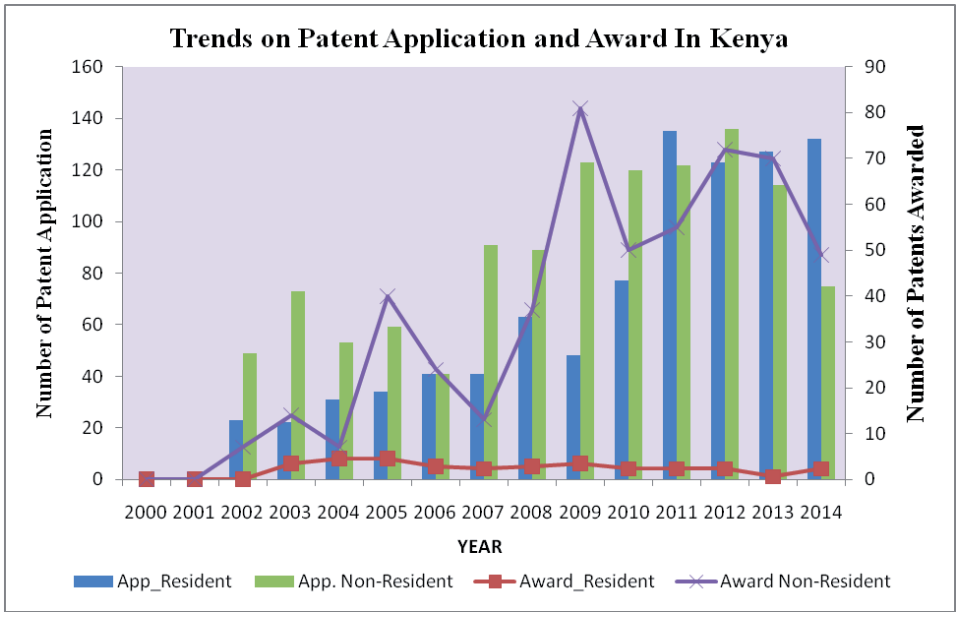
1.2 Innovation in the Kenyan Context

A closer look at the innovation performance in Kenya reveals that the capacity of Kenyan enterprises to develop new products or add value on produced goods is limited (Government of Kenya, 2013). This is confirmed by the global innovation index rankings of which Kenya has continuously performed poorly. For instance, Kenya was ranked at 85 out of the 145 countries considered globally, which was a slight improvement from the 2011 ranking of position 89 (Cornell University, INSEAD, and WIPO, 2014; 2011). Further, the World Bank Enterprise Survey of

[1] The latest (third) edition of the Oslo Manual defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD, 2010)

2013 for Kenya involving 549 innovating firms also indicated that among these firms, only 18 (3.3%) applied for patents[2] for products, 19 (3.3%) applied for service patents and 24 (4.4%) applied for copyright. Besides, several studies (Government of Kenya, 2006 and Gitonga and Kieyah, 2011) and national statistics provide evidence that the level of awareness of intellectual property[3] rights in Kenya is low especially among the domestic entrepreneurs, with the number of patents application remaining relatively low. Figure 1 shows that since 2000, though the numbers of patent applications have been increasing, the number awarded especially among the local applicants is worryingly low compared to their foreign counterparts. It is also worth noting that the number of annual patents application both local and foreign hardly surpassed the 140 mark.

Figure 1: Trend on patent application and award in Kenya



Data Source: WIPO Statistical Database (2015)

This huge difference is linked to knowledge gap among the local applicants who probably fail meeting technical patenting requirements. From the trend, it is apparent that there is room for local entrepreneurs to learn best practices from their foreign counterparts; this does not seem to be happening. Besides, the figure indicates a significant increase in the number of applications among the domestic

[2] A patent is an exclusive right granted for an invention – a product or process that provides a new way of doing something, or that offers a new technical solution to a problem (http://www.wipo.int/edocs/pubdocs/en/intproperty/450/wipo_pub_450.pdf).

[3] Intellectual property (IP) refers to creations of the mind: inventions; literary and artistic works; and symbols, names and images used in commerce. IP is divided into industrial property and copyrights; Industrial property includes patents for inventions, trademarks, industrial designs and geographical indications (http://www.wipo.int/edocs/pubdocs/en/intproperty/450/wipo_pub_450).

entrepreneurs especially from 2010 surpassing their foreign counterparts. The increase may have been as a result of consolidation and implementation of the Kenya's national IP legislative framework comprising of the copyright, trade mark, industrial property and anti-counterfeiting laws.

Collectively, the dismal innovation performance in Kenya has been linked to unfavourable policy and regulatory environment characterized by inadequate business skills and technical know-how, lack of supportive infrastructure, limited access to finance, lack of information and markets and weak linkages among business enterprises (Government of Kenya, 2006; KIPPRA, 2013). In addition, skills gap occasioned by weak linkages between the private sector and TVET curricula has also created a mismatch between the supply and demand for skills in the economy (AfDB, 2014). Collectively, these have limited the ability of Kenyan firms to create or adopt technology, thus leading to low innovation uptake.

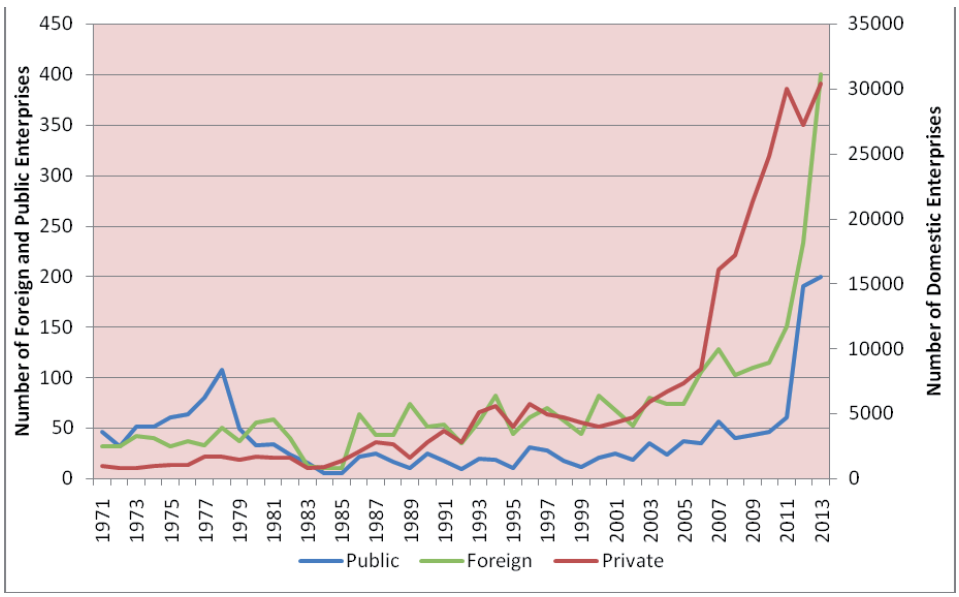
1.3 Policy Reform, FDI Inflows and Growth of Business Enterprises in Kenya

Like any other developing country, Kenya has been implementing policy and regulatory reforms with an aim of not only attracting FDI inflows but also enhancing innovation and the productivity of domestic enterprises. The reforms included the development of Sessional Paper No. 2 of 1997 on Industrial Transformation to the Year 2020 and Sessional Paper No. 2 of 2005 on the Development of Medium and Small Enterprises (MSEs) for Employment and Wealth Creation. The two identified business enterprises as among the avenues for the country's industrialization, employment creation, income generation and poverty reduction, and overall economic growth.

In addition, through the Kenyan Vision 2030, the Government recognized the role of science, technology and innovation (ST&I) in a modern economy and the central role it plays in wealth creation, social welfare and international competitiveness (Government of Kenya, 2007). The Vision paved way for enactment of the Science, Technology and Innovation Act of 2013 that provided for the National Commission of Science, Technology and Innovation, the Kenya National Innovation Agency and the National Research Fund. However, the Act is yet to be fully implemented. Further, targeted efforts included formulation of policies such as the Kenya National Industrial Policy Framework that identified the role of FDI Inflow as an alternative strategy that could significantly contribute to technology transfer. Other supportive legislations include the enactment of the Investment Promotion; Technical and Vocational Education Training (TVET), and Export Processing Zone (EPZ) Acts as well as creation of the respective authorities/institutions.

The reforms, coupled with the major recent discoveries in minerals, oil and gas in the last decade led to a significant increase in FDI inflow in both aggregate amount and the number of foreign firms. Statistics indicate that FDI inflow in Kenya and the number of foreign firms increased from US$ 18.8 million in 1991 to US$ 944.3 million in 2013 and 53 in 1991 to 400 in 2013, respectively. Of the foreign firms, 60 per cent are spread across the manufacturing sector, 30 per cent across the service and 10 per cent in the retail sector. Similarly, in the same period, the number of domestic enterprises also increased from 179,714 to 742,176 (World Bank, 2014; Government of Kenya, 2007; 2013). This recent upsurge has captured policy makers' attention to pursue the need of developing a local content policy in view of supporting growth among domestic firms. Figure 2 shows the trend in number of domestic private, public and foreign business enterprises in Kenya from 1971 to 2013.

Figure 2: Trend showing growth public, private and foreign firms in Kenya

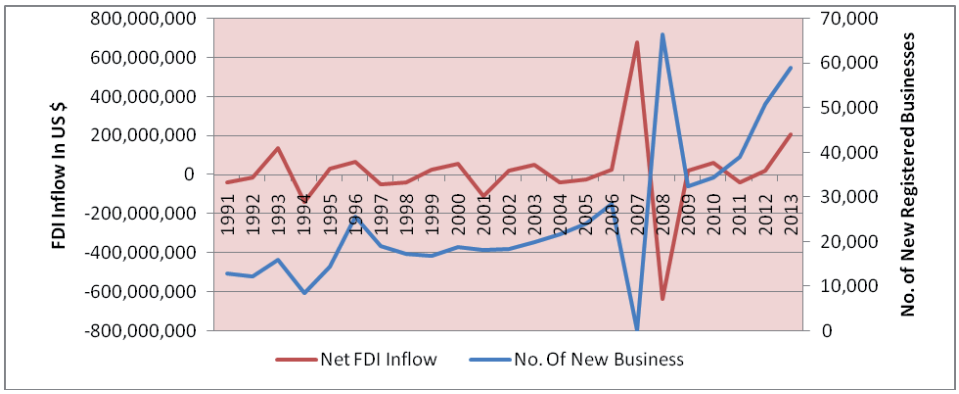


Data Source: World Bank Database and KNBS (Various), Statistical Abstracts

Similarly, Figure 3 below shows the relationship between FDI inflow and formation of business enterprises. From the figure, the rate of formation of new enterprises and FDI inflow exhibit a pattern of interdependence. The trend depicts moderate changes from 1990 to 2006, with a sharp rise observed on both FDI and the number of business between 2007 and 2009. These significant increases have been attributed to major policy reforms in 2005 and discoveries in the mining sector.

The decline is associated to the effects of post-election violence, and removal of dormant firms at the Registrar of Companies.

Figure 3: Trend showing net new business formation and aggregate FDI inflow in Kenya



Data Source: World Bank Database and KNBS (Various), Statistcal Abstracts

Other factors held constant, this trend of interrelationship suggests a possibility of positive externalities accruing to domestic firms from FDI inflows. This is consistent with the growing consensus in the existing literature that spillover effects from FDI do not only provide extra funding for investment and demonstrate new technologies to domestic firms but also offer technological assistance and training to local suppliers and customers, therefore transferring the technical and business know-how (Dunning, 1992; Smallbone, 2007).

Besides innovation and FDI inflows, the question as to whether FDI inflows and its spillover effects translate to innovation in Kenya is yet to be fully explored. Inasmuch as World Bank (2014) and Oluyomi and Oyebani (2013) assess innovation characteristics among Kenyan firms using product and process innovation, vertical and horizontal linkages and spillover aspects were not explored. Other studies including Gachino (2006) and Managi and Bwalya (2010) examined the spillover effects of FDI on productivity using horizontal, vertical, regional technology, intra-industry and inter-industry productivity using total factor productivity to measure the absorptive capacities of the domestic firms and not process, product or market innovation aspects. Unlike the earlier studies, this paper attempts to examine how spillovers from FDI influence product, process and market innovation among Kenyan enterprises taking into consideration the horizontal and vertical linkages for both the manufacturing and services sectors.

1.4 Problem Statement

The Kenya Vision 2030 recognizes the role of Science, Technology and Innovation (ST&I) in transforming Kenya into a knowledge-led economy by creation, adaptation and use of knowledge (Government of Kenya, 2007). Consistent with the Kenya Vision 2030, the Kenya National Industrial Policy Framework identifies FDI Inflow as one of the strategies that could significantly contribute to technology transfer and spur the country to higher growth path. Implementation of these policies has seen an increase in FDI both in aggregate amounts and in the number of enterprises from US$ 21.2 million in 2005 to US$ 944.3 million in 2014 and 73 to 400, respectively. Similarly, in the same period, the number of domestic business enterprises holding a huge potential for promoting industrialization also increased from 406,950 to 742,176 (KNBS Statistical Abstracts, 2008 and 2014).

However, despite these remarkable achievements, there has been a disproportionate change in the overall industrial productivity. For instance, in the last two decades, the industrial sector's share of monetary GDP stagnated at about 15-16%. Similarly, the contribution of the manufacturing sector to GDP, whose 60% is made of SMEs, also stagnated at 10% in the same period (KNBS, 2015; KNBS, 2010). The stagnation has been associated with low innovation uptake and weak systems supporting linkages and interactive learning. The situation is further exacerbated with the continued fragmentation of policy and institutional framework for coordination and supporting innovation (World Bank, 2014). Collectively, these factors have not only constrained the expansion and growth of the enterprise sector but also limited the caacity of Kenyan firms to harness the benefits associated with FDI inflows.

Given that the Kenya enterprise sector, dominated with MSEs, contributes over 25 per cent to GDP and employs over 42 per cent of the working population (KIPPRA, 2013), limited growth of existing enterprises implies continued unemployment, poverty among majority of Kenyans and further stagnation in productivity therefore curtailing the achievement of the Kenya Vision 2030 as goals as earlier envisaged.

1.5 Research Questions

The study endeavours to answer the following research questions:

1. What characterizes innovation investment among Kenyan enterprises.
2. What factors determine innovation investment decisions among the Kenyan enterprises.

3. What factors drives the intensity of expenditure on innovative investment decisions among the Kenyan firms?
4. Which among spillover effects associated with FDI influence innovation in Kenya?

1.6 Objectives of the Study

The overall objective of this study is to establish the effects of Foreign Direct Investment inflows on promoting innovation among Kenyan enterprises.

The specific objectives are to:

1. Examine the innovation characteristics of the Kenyan enterprises sector.
2. Identify factors that determine the firms decision to invest on innovation.
3. Establish the factors which determine the firm's investment intensity on innovations.
4. Establish whether spillover effects from FDI influence innovation among Kenyan enterprises.

1.7 Significance of the Study

Unlike most of the studies involving FDI relating it to overall GDP growth, foreign exchange, capital stocks and human capital skills, this study assesses how spillover effects from the FDI inflow influence innovation among Kenyan enterprises. This endeavour is consistent with the Kenyan Vision 2030 objective that seeks to transform the industrial sector to a more diversified and competitive through promoting science, technology and innovation (STI). The study is also vital at this point when the focus among policy makers has shifted not only towards growing the Small and medium Enterprises but also to promoting the concept of local content. Insights from this study will enhance the policy makers understanding on what promotes innovation in Kenya, how well can FDI spillovers be harnessed for the much-needed industrial transformation and help identify the existing gaps and opportunities for policy reforms. Recommendations from this study will inform implementation of the various investment policy frameworks including developing Special Economic Zones (SEZs), Industrial Zones and SME Parks meant to both attract FDI and enhance the Kenyan industrial growth.

2. Literature Review

2.1 Theoretical Literature

2.1.1 The Neoclassical Theories

The neoclassical theories stemmed from Schumpeterian (1934) endogenous growth models that explored the concept of technological change and productivity growth. The theory was further developed by Solow (1956) and Swan (1956) both whom contributed to the growth of the concept of technological progress and labour productivity growth. These neoclassical economists pioneered by Solow (1956) held to the fact that long-term economic growth was a function of production technology, capital accumulation, population growth and technological progress and ignored the concept of diminishing returns on capital. They further assumed that the rate of technological progress was being determined by scientific and not economic forces, implying that economists can take the long-run growth rate as given exogenously from outside the economic system. The neoclassical approach was criticized for these assumptions by scholars including Nelson and Winter (1982), Romer (1986) and Grossman and Helpman (1991) that led to the development of the new Growth Theory.

2.1.2 Endogenous (New) Growth Theory

The endogenous growth model was an extension of the basic neo-classical growth model. This model came into play in the 1980s through Nelson and Winter (1982) work that elaborated a formal model of economic development reflecting evolutionary or neo-Schumpeterian theoretical approach. In the theory, Nelson and Winter postulated that the evolutionary processes are characterized by a sequence of innovation and imitation of which they also associated to role of learning and investment in human capital. Romer (1986) and Lucas (1988) further improved the theory by capturing the idea of limitless growth, since returns on investment in a wide range of capital goods, including human capital, do not necessarily diminish as the economy develops. The new growth theory emphasizes that economic growth stems from the increasing returns associated with new knowledge. It underscores that the ability to grow the economy from positive externalities arises from increasing knowledge rather than labour or capital, which in turn creates opportunities for nearly boundless growth. The theory further advocated for provision of incentives for knowledge creation through activities such as research and development, the education system, entrepreneurship, innovation, macroeconomic expectations and openness that can be individually pursued at a country level (Cortright, 2001). By emphasizing that economic growth results

from increasing returns associated with new knowledge, the New Growth theory diverged from neoclassical economic theory that offered very limited sets of policy advice to states seeking to influence their economic destiny. The theory provided a basis upon which policy makers in developing economies such as Kenya can use investment policies to help harness benefits associated with FDI inflows.

2.1.3 Schumpeterian Innovation Dynamics

To answer the question on what kind of market structure promotes rapid technological progress, Schumpeter (1911) viewed small entrepreneurial ventures as seedbeds of technological discovery. Later, he advanced the hypothesis that large firms with market power accelerate the rate of innovation (Schumpeter; 1942). Schumpeter postulated that rapid technological progress is as a result of the market power which in itself was endogenous in nature. However, he argued that entry of new large firms with a considerable degree of market power may dominate an industry through creative destruction,[4] which he referred to as a cost that must be paid in relation to innovation. With these perspectives, Schumpeter not only linked technological progress to innovation emanating from small entrepreneurial ventures but also accommodated the new growth theory upon which the study is hinged. Schumpeter's assertions served as an eye opener to most of the policy makers because it gave them a wider policy perspective for enhancing innovation though adjustments of market structures and promoting openness.

2.1.4 Agglomeration Theories

According to the agglomeration theories, innovative activities are considered to be geo-spatially concentrated (Gerald and William, 2014). These theories have been extensively used in explaining the spillover effects from FDI inflows in host countries. The theories provided mechanisms of assessing FDI spillover effects on innovation from sharing of input and resources, matching of the local labour markets and knowledge transfers through codified or written documents.

2.1.4 Demand pull and supply push theories

Literature also captures demand and supply theories in explaining FDI spillover effects and innovations. Supply-side theories are based on the fact that spillovers arise from foreign affiliates carrying out joint contacts on technology-intense activities such as ICT and "codifying" technology in the form of operating manuals

4 Creative destruction refers to the incessant product and process innovation mechanism by which new production units replace outdated ones (Schumpeter, 1942)

and handbooks and the like that allow easier and quicker transfers of technology from one firm to another. The demand side theories postulates that firms in the host country can opt to undertake reverse engineering efforts, hire personnel away from foreign affiliates, pay licensing and management fees to the multinationals and "patent around" intellectual property restrictions for using foreign technology, thus promoting innovation (Blomstrom and Kokko, 1998).

2.1.5 Spillover effects and transmission mechanisms

The existing literature acknowledges and distinguishes different transmission channels through which spillovers occur thus influencing innovation. First, with the presence of multinationals in a given industry, local firms can observe and imitate the technologically advanced production methods of foreign-owned affiliate through "demonstration effects" (Wang and Blomstrom, 1992). Secondly, spillover effects arise as result of labour mobility with local firms benefiting from transfer of knowledge and technology by attracting high skilled employees from multinationals: horizontal spillovers (Fosfuri et al., 2001). Through labour mobility, imitation, reverse engineering, personal contact and industrial espionage aspects happen thus influencing innovation. Fourthly, the entrance of foreign firms may increase competition and thereby force local firms to be more productive and innovative, "the competition effect" because of exports (Aitken and Harrison, 1997).

Studies have also established that technology and knowledge from FDI may spills over to domestic firms through association, interactions, collaborating and linkages in doing business resulting to both forward and backward spillovers. Blomstrom and Kokko (1998) and Dunning (1992) demonstrated that backward spillovers may arise from input supplies through which local suppliers get technical assistance, employee training and research and development (R&D) activities from foreign affiliates, thus contributing to transfer of knowledge and technology and resulting to the backward spillover effects. Through backward inter-firm linkages, the extent of local buying are assessed and mostly used to indicate whether or not local content requirements are met by foreign multinationals (Girma et al., 2006; Masso et al., 2010). Forward linkages occur through FDI opening up new output markets for local enterprises (Dunning, 1992; René and Roy, 2010) from which interactive learning occurs and best practices are borrowed

2.2 Empirical Literature

Empirically, there are various studies linking FDI spillover effects and innovation. These studies have attempted assessing how FDI influences innovation input in terms of decision to undertake an innovative venture, expenditure on the innovative venture, innovation output through a knowledge production function and the overall productivity and growth among enterprises.

Masso et al. (2010) used the CDM model on three different waves of cross-section data from Estonian firms covering 1998-2000, 2002-2004 and 2004-2006 to study foreign direct investment and innovation. From the study, they established that the presence of public funding, formal protection (trademarks or copyright) and exposure to international competition positively influenced innovation decisions among Estonian firms. On the innovation intensity (expenditure on cooperation on innovation, formal protection and international competition), Masso reported positive and significant results on public funding, international competition, cooperation in innovation and formal protection at various waves. The findings also indicated that lack of finance, information about new technology and markets negatively affected innovation intensity. Further, on linkages and spillover effects, backward FDI spillover negatively influenced process innovation and not product innovation while forward FDI spillovers positively influenced both product and process innovations. The study also established that predicted values of innovation intensity, formal protection, information sources, competitors, customers, suppliers positively influence product and process innovation while the size of the labour force negatively influences both product and process innovation.

Lehtoranta (2010) using the CDM model studied innovation and growth performance among Finnish firms. In this study, Lehtoranta measured innovation by expenditure on R&D activities. The findings indicated that the probability of a firm engaging in innovation activity is positively related to the firm size, export share, past domestic patenting, share of educated labour force and the sector to which the firms belong. On innovation expenditure per employee; export share, collaboration in innovation, R&D activities, public funding and sector variables also positively influenced innovation expenditure among the Finnish firms. However, on the innovation output equation the study used innovation sales per employee and used product and process innovation among other variables as explanatory variables. The findings post mixed results. Collaboration with competitors and suppliers positively correlated with innovation output in one period while collaboration with suppliers negatively correlated in another period.

Griffith et al. (2006) using the CDM model and firm level panel data studied the innovation and productivity across four European countries (USA, France, Germany, Spain and UK). On the decision to engage in innovation measured by expenditure on R&D, the study established that international competition, protection, funding, size and location of the firm positively influenced the decision to innovate in all the four countries. On innovation intensity, the study revealed that international competition, cooperation in innovation and national and external sources of funding variables positively influenced innovation intensity in one case and negatively in other cases. Formal protection and local funding sources had either positive or negative signs but both were statistically insignificant across all the four countries. Further, firm size and linkages with customer and suppliers positively influenced both product and process innovation. The study found out that predicted variable positively influenced process and not product innovation.

Damijan et al. (2008) using panel data for ten countries studied the impact of firms' heterogeneity on spillover effects from FDI. The study constructed horizontal and backward linkage variables and reported mixed results: First, the results indicated that positive horizontal spillovers were equally distributed across size classes of firms, while negative horizontal spillovers seemed more likely to accrue to smaller firms. Second, positive horizontal spillovers were more likely to be present in medium or high productivity firms with higher absorptive capacities, while negative horizontal spillovers were more likely to affect low to medium productivity firms. Third, vertical spillovers were less frequent than horizontal spillovers from FDI. The report also revealed that smaller and more productive firms were more likely to benefit from positive vertical spillovers while larger and less productive firms were more likely to suffer from negative vertical spillovers.

OECD (2009) report explored the non-technical and mixed models of innovation across 30 OECD member countries drawn from Europe, Asia and Australia using a CDM model. On the decision to innovate, the results indicated that large firms and operating in international markets were likely to be more innovative except in Brazil and Canada where operating in international market decreases the likelihood to innovate. The study also posted mixed result on knowledge, cost of funding and market competition measured by decreased demand. On market competition, all the countries included in the study posted positive and significant coefficients except for Netherlands and Italy which posted negative results. Similarly, firm size variable also posted mixed results with countries such as UK, Norway, Newzealand, Brazil, and Australia showing a negative relationship while other countries yielded positive and significant coefficients.

Johansson et al. (2008) using Heckman (two-step) approach carried out a panel data analysis on the innovation intensity using R&D expenditure per employee for Denmark,

Finland, Norway and Sweden. The study also posted mixed results with findings revealing that bigger firms spend more on innovation per employee in Denmark but less in the other three countries. Similarly, despite access to international markets increasing innovation expenditure per employee in Denmark, Norway and Sweden, the study reported decreasing expenditure per employee in Finland.

Managi and Bwalya (2010) studied the foreign direct investment and technology spillovers in Sub-Saharan Africa, using firm-level data from Kenya Tanzania and Zimbabwe. Using System Generalized Methods of Moment (GMM), they established that the coefficient on horizontal spillover variable was positive and significant in Kenya and Zimbabwe and negative and insignificant for Tanzania. On vertical linkage, Kenya and Zimbabwe also posted positive and significant coefficients. On forward (or regional) spillovers, the results indicated a positive and significant relationship for Kenya and Tanzania while negative and insignificant coefficients for Zimbabwe.

Abazi-Alili (2014) used two-step Probit estimation techniques to establish innovation activities and firm performance in fourteen Central Eastern and South-Eastern European economies. He established that size, R&D activities, both foreign domestic ownership, competitive pressure in the market and proportion of skilled workers positively influence innovation decisions in transition economies while age and export intensity do not. On innovation intensity measured as labour productivity per employee, the age and sector variable were found to positively influence the innovation intensity.

World Bank (2014) study on understanding firm-level innovation and productivity in Kenya used CDM model to study innovation tendencies among the Kenyan firms. The findings revealed that decreased market demand, market share of the firm and perceived government-related obstacles positively influenced innovation investment decisions. On the contrary, access to finance obstacles reduce the likelihood to innovate among Kenyan firms while trade cost, ownership, size and age variables did not influence innovation decisions. The report revealed that innovation expenditure in Kenya was explained by access to external market, competition, lack of finance, government-related obstacles, ownership and size variables.

Oluyumi and Oyebanji (2013) used the Kenyan manufacturing firm as one of the cases in studying whether FDI foster inclusive innovation and technology development in Africa. They employed a logistic model to test the hypothesis on the inter-relationship between firm characteristics and the product or process innovation activities. The findings revealed that firms with international quality certifications, those whose principal customers were large firms, and those using ICT were more likely to do process innovation than their counterparts. Age, technology level, exporting activity, usage of technology licensed from a foreign company and location had either positive or negative but insignificant coefficients.

2.3 Overview of the Literature

Having assumed that that the rate of technological progress was determined by scientific forces outside the economic systems and not by the interaction of economic forces in market system, neoclassical theories were extensively criticized in the literature. Therefore, the new growth theories emphasizing that economic growth results from the increasing returns associated with new knowledge have in recent times been adopted. Similarly, various methodologies including simple Probit, Logit, Heckman (two-step) and Generalized Methods of Moment have empirically been used in various studies involving FDI and innovation. However, independently, they do not exhaustively assess the concept innovation starting from where innovative decisions are made, respective expenditure and innovation output while capturing firm level characteristics, obstacles to investment and linkages and interactive learning aspects. These gaps lead to development of CDM and OECD models.

Whereas CDM and OECD models have managed accommodating all the new developments and informing new studies on the subject in developed economies, the same is yet to be replicated in developing countries especially in Africa, including Kenya. Given that the empirical studies on the topic have been yielding unique results and policy recommendations depending on the economic, institutional and technological condition of the recipient economy, various researchers have recommended country specific studies on the subject. It is upon this that the study adopts the new growth theory and the CDM model in exploring how benefits from FDI can be harnessed to promote innovation in Kenya.

3. Methodology

3.1 Conceptual Framework

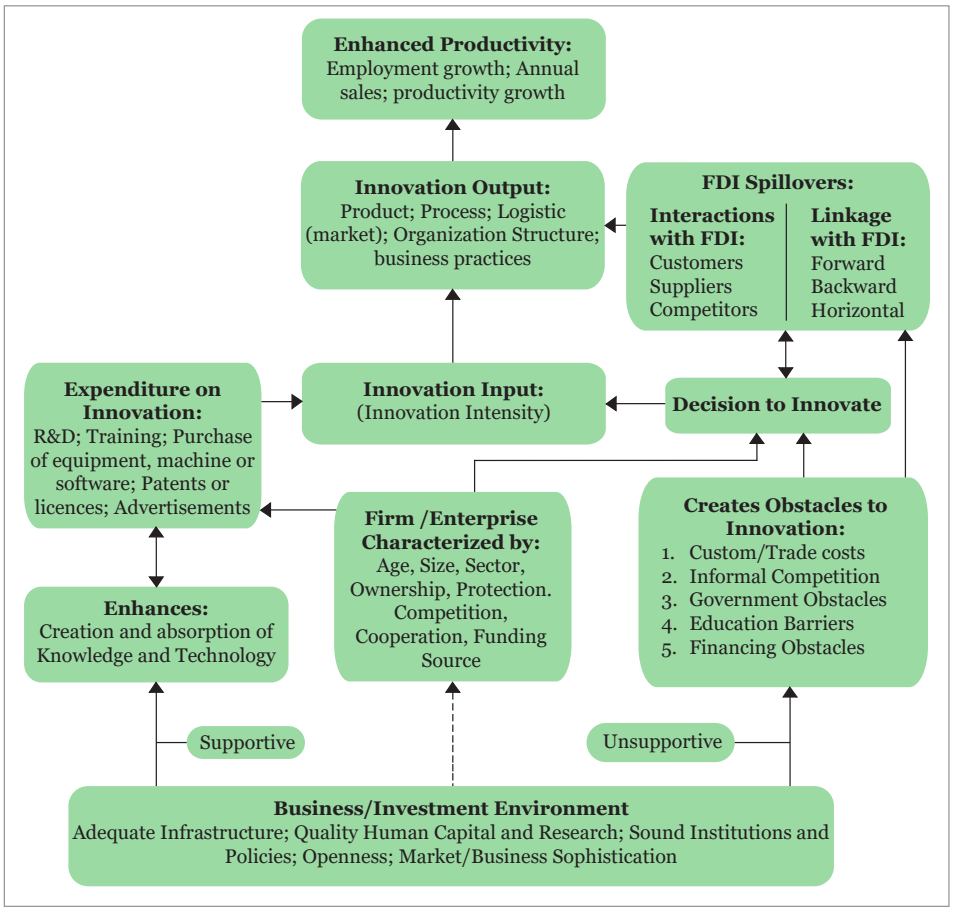
Innovation, defined as implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD, 2010) is a firm level phenomenon. However, innovation entails a process that starts with undertaking innovative decisions, spending on the decisions made and then realizing output from the innovative venture undertaken manifested through employment growth, annual sales or productivity growth.

Further, for a firm to innovate, a number of factors both internal and external play different roles at different stages in the innovation process. Internally, the absorptive capacity, defined as the firm's ability to identify, assimilate and exploit knowledge from the environment (Cohen and Levinthal, 1989) is critical. This is driven by firm level characteristics such as age, sector, location, size, ownership structure, funding sources, competition and the quality of the labour force of a given firm. The firm level characteristics define the firms capability for either creating or adopting new knowledge and technology by undertaking innovative ventures including research and development (R&D), acquiring modern technology such as ICT and undertaking interactive learning with suppliers and customers.

Externally, a conducive investment environment characterized with adequate infrastructure, quality human capital and research, sound institutions and policies, market and business sophistication play a role in creating and sharing new knowledge and technology (Cornell University, INSEAD, and WIPO, 2015). On the other hand, unsupportive business environment characterized with limited access to finance, informal competition, custom and trade costs, unfriendly tax regimes by the government and limited skills emanating from poor education systems are associated with increasing cost of investment and create obstacles that impede innovation.

In addition to the conducive environment, existing literature has established that FDI plays a critical role in supporting innovation through linkages and associations between foreign and domestic firms. Positive externalities including backward, forward and horizontal spillovers occur when foreign firms source inputs from local firms, when domestic firms access external markets (exports) and when skilled employees with knowledge and technical know-how move from foreign affiliate firms to domestic firms, respectively. The conceptual framework in Figure 4 does not only capture the linkages and interaction of these factors but also acts as a pointer to the anticipated model for this study.

Figure 4: Conceptual framework



Source: Authors self-conceptualization

3.2 Analytical Framework

The analytical framework of this study is based on the New Growth Theory (Endogenous Growth Model). The model is a reflection of the evolutionary theoretical approach that captured the outcomes of externalities arising from specific investments including R&D, investment in capital goods and human capital (Wang & Mu, 2012; Romer, 1986). These authors collectively associated economic growth to the role of innovation and imitation that is embedded in continuous learning and investment in human capital.

Empirically, Romer (1986) modeled the first Schumpeterian endogenous growth model incorporating a theory of technological change into growth. Lucas further improved upon this in the year 1998. The model took the form:

$$y_{tj} = Z_t \bullet F(C_{tj}, L_{tj}) \qquad (1)$$

Here Z_t denotes aggregate labour-augmenting technological progress; F is firm's production function; y is firm's output, and C and L are the factors of production (i.e. capital and labour).

From equation (1), technology progress influences output. This was supported by previous studies including Wang and Mu (2012) who acknowledged that spillovers from FDI have an impact on technology level, therefore connecting spillovers effects with productivity. The model created room for further modeling and capturing vital variables theoretically used in explaining innovation and the absorptive capacity in a given economy. According to the literature, the variables included the FDI inflows, import, R&D, capital and labour all of which influence firm productivity and growth.

By extension, Romer (1986) extended the spillover effect to firm level using a Cobb-Douglas Production function. This further revealed the connection between technological spillovers and production in details as follows.

$$Y = A \bullet C^{\alpha} \bullet L^{\beta} \qquad (2)$$

From Romers' formulation, Wang and Mu (2012) explain that as C (capital) increases with increasing FDI, import, R&D and other related variables, production also increases. These authors argue that with the existence of spillovers, technology level will change and in turn positively affect the quality of labour. According to the equation, technological shift represented by parameter A is affected by a number of factors including and not limited to the quality of capital used, therefore pointing out that technological spillovers can influence labour productivity.

3.3 Empirical Model Specification

To establish whether FDI inflows explain innovation among the Kenyan enterprises, a version of the Crepon, Duguet and Mairesse (CDM) model of 1998 is adopted. In the CDM model, it is assumed that firms use enhanced Cobb-Douglas technology with constant returns to scale and also use knowledge inputs in addition to labour and capital inputs (Lehtoranta, 2010). The model consists of three iterative steps with four equations. In the first step (a two-step innovation decision procedure) is referred to as Heckman equation model. The second step estimates the innovation outputs (a knowledge production function) while the third step assesses whether innovation output influences or promotes productivity (Heckman, 1998; Crépon et al., 1998).

The first step, Heckman selection equation arises from the fact that factors explaining the decision to undertake an innovative venture are correlated with the costs on the innovative venture undertaken (innovative intensity). The intensity to innovate is embodied in the decision to innovate, which is the selective criterion of the firms included in this study. Therefore, the firm's latent (unobserved) propensity to innovate denoted by g_i^* takes the form:

$$g_i^* = \beta_0 \chi_{0i} + \varepsilon_{0i} \qquad (3)$$

Where g_i^* take binary values (1, 0); 1 if an innovative venture is undertaken and 0 otherwise. The innovative ventures undertaken in this case include R&D; employee training; purchase of equipment, machinery, software (EMS); purchase of patents and external consultancies. χ_{0i} is a vector of variables that explain this innovation effort including firm age, funding Source, access to foreign market, competition, protection (patents, copyrights and licenses) and cooperation in innovation; β_o is the associated coefficient vector and ε_{oi} is the error term.

The second equation under the Heckman selection model (the innovation intensity) function models the size of the innovative effort *i* (i.e. the aggregated expenditure on the innovate venture). This is based on whether the firm engaged in innovative activities or not as outlined in equation 3. The equation takes the form:

$$r_i = \begin{cases} r_i^* = \beta_1 \chi_{1i} + \varepsilon_{1i} & f \quad g_i = 1 \\ 0 & f \quad g_i = 0 \end{cases} \qquad (4)$$

Here, χ_{1i} is a vector of three categories of variables i.e. obstacles encountered from institutional and regulatory environment, innovative ventures undertaken and firm level characteristics. The obstacles include custom and trade costs, telecommunication challenges, government-related (business licensing and permits), financing obstacles and education barriers. Firm level characteristics in this case are size, age, competition, access to export market and cooperation in innovation while the innovative ventures include R&D, purchase of EMS and patents, training and marketing. ε_{1i} is the error term.

The second step and the third equation of the CDM model (the knowledge or innovation production function) relates the potentially unobserved knowledge (innovation output) to the innovation input and other variables associated to FDI spillovers (Masso et al., 2010). The model takes the form:

$$t_i = LN \left\{ \frac{p_j}{1 - p_j} \right\} = \alpha_k r_i^* + \beta_2 X_{2i} + \varepsilon_j \qquad (5)$$

The dependant variable t_i is the innovation output, where $t_i = LN \left\{ \frac{p_j}{1 - p_j} \right\}$ is the

conditional probability linking innovation output with the innovation input; σ's are the multiple regression coefficient and ε_j the error term. In this study, t_i is a categorical variable encompassing introduction of a new product, a new process or market and takes binary form (0, 1), with 1 representing either introduction of a new significant product (or process or new market); 0 otherwise. Various studies have used this approach to explain knowledge or innovation output function (see World Bank, 2014; Oluyomi and Oyebani, 2013; Masso et al., 2010).

The innovation output (t_i) is explained by three sets of independent variable: first are the predicted values (r_i*) from equation 4 as one of the explanatory variables. The second category of variables relating to spillover effects emanates from linkages from FDI; that is, capturing the horizontal (labour mobility) and vertical (forward and backward) linkage and the interactions or association at the input or product market through customers, suppliers and competitors. This inclusion captures Dunning (1992) assertions that the spillover effects may occur through a diffusion of new technology caused by worker mobility between foreign-owned and domestic companies; demonstration effects; or increased incentives to adopt state-of-the art technology as a result of the increased competition in the product markets.

From the literature, the horizontal spillovers (HSFDI) computed as the share of total employment (output) accounted for by the foreign owned enterprises in an industry *j* at time *t*, meaning that the more dominant presence of foreign-owned affiliates in a sector the more likely the spillover benefits to domestic firms within that sector (Masso et al., 2010; René and Roy, 2010).

$$HSFDI_{ijt} = (\sum_{k \neq j} Y_{kjt} \bullet For_{ijt})(\sum Y_{kjt}) \quad \text{..... (6)}$$

In this study, Y_{kjt} is the total output in firm *j* of subsector *k* while Y_{kjt}*For_{ijt} is the output from foreign affiliated firms. The variable is not only meant to measures labour mobility among firms but also capture imitation, reverse engineering, personal contact and industrial espionage, which influence innovation (René & Van, 2010).

Backward spillovers from FDI (*BSFDI*) capture the extent of potential spillovers to domestic supplier firms from foreign-owned clients. The backward spillovers ($BSFDI_{jt}$) to sector *j* (domestic firms) in period *t* are measured by the proportion of inputs or intermediary goods in sector *j's* output supplied to foreign-owned firms in downstream industries. In this study, α_{kj} is the percentage of inputs supplied locally to foreign-owned firms (downstream sectors):

$$BSFDI_{jt} = \sum_{k \neq j} \alpha_{kj} \bullet HSFDI_{kj} \quad (7)$$

It is through the analysis of backward inter-firm linkages that the extent of local buying is used to indicate whether or not local content requirements are met by foreign multinationals in the host economy (see Girma et al., 2006; Masso et al., 2010).

Similarly, technology can be transferred through domestic firms sourcing intermediary goods (input) from foreign multinationals or markets (i.e. forward linkage) with foreign affiliated firms referred to as upstream firms. In this case, forward spillover indicator (FSFDI) measures the share of intermediary goods that are sourced by sector *j* (Kenyan enterprises) from upstream sectors *k* (foreign firms) either directly imported or purchased from foreign-owned affiliates in Kenya.

$$FSFDI_{jt} = \sum_{k \neq j} \beta_{kj} \bullet HSFDI_{kt} \qquad (8)$$

Here, β_{kj} is the percentage of inputs imported either directly or indirectly by Kenyan firms. With this variable, openness, market and business sophistication aspects and the soundness of the related policy aspects are measured (René and Roy, 2010).

The third step and the fourth equation in the CDM model, which is beyond the scope of this study, is the production or performance equation, where innovation output from equation 5 is now used as dependant variable (Crépon et al., 1998; Lööf et al., 2003) and takes the form:

$$y_i = \alpha_T t_i + \beta_3 \chi_{3i} + \varepsilon_{3i} \qquad (9)$$

Where y_i is the log of productivity (change in sales per employee or value added by employee; and χ_{3i} is a vector of standard control variables in the productivity analysis.

3.4 Endogeneity, Selection Bias and Correction

The usual problems associated with studies on FDI and spillover effects are endogeneity and selection biases. Endogeneity arises from the fact that some of the explanatory variables in the model can be simultaneously determined as dependent variables. The sample selection bias occurs where the dependent variable is observed only for a restricted non-random sample, which can happen when the model only includes innovating firms (Lehtoranta, 2010; Damijan et al., 2008). To correct this, the study used the CDM framework that structurally models the innovation investment decision and the innovation process. The CDM model corrects the endogeneity problems by simultaneously determining some

of the explanatory variables in the model as dependent variables in three steps. Selection bias is handled in the model by including the non-innovative firms in the total sample in a selection equation for estimating a non-selection hazard. Further, the CDM model allows for estimating knowledge production function using predicted innovation expenditure from Heckman (Heckman et al., 1998).

3.5 Data Source

To achieve the objectives of this study, cross-section data from the 2013 World Bank Enterprise Survey for Kenya is used. The dataset consists of data and information on formal firms from both manufacturing sector and service sector but excluding firms in agricultural sector and extractive industry, and Government-owned entities. The sub-sectors represented include construction, retail and wholesale services, hotels and restaurants, transport, storage, and communications, and computer and related activities. The dataset also categorized firms into private domestic and foreign firms. Information captured in the dataset and vital for this study included the year of firms' establishment, size, sector, sales, input source, market for the output, innovative ventures undertaken, technology used, labour relations, sources of finance and obstacles to innovation to innovation. Other additional information that the survey provided and was useful was on whether the enterprise engaged in an innovative activity in the last three years, whether the firm introduced new or significant product or service, process of logistic methods of delivery, engaging in training, carried out R&D, and use of ICT and internationally licensed technology. From the dataset, the study considered 534 enterprises from both manufacturing and service sectors for analysis of which 60 enterprises foreign-owned or associated (the criteria being that if more than two percent shares owned by foreigners).

3.6 Description of Measurement Variables

A summary description and measurement of the variables included in this study are as captured in Table 1.

Table 1: Table showing variables, descriptions and measurement

Variable Name	Description	Measurement
Dependent Variables		
Decision to innovate (g_i*)	Captures if a firm undertook at least one of the innovative ventures including R&D; Employee training; Purchase EMS or patents/license/ copyright and seeking external consultancies in the last three years	Dummy (1 if undertook at least one innovation venture, 0 otherwise)
Innovation intensity (r_i)	Sum of expenditure on all the innovative ventures undertaken per worker (innovation input)	$Log(\frac{\sum Innovation\ expenditure}{Total\ No.\ of\ Employees})$
Innovation output (t_i)	Meant to measure innovation by introducing new significant product, process or new market	Binary variables (1 if new significant product, process or logistic introduced, 0 otherwise)
Firm level Characteristics		
Firm size	Measured by the number of employees	*Log (Employees)*
Ownership	2% owned by foreigners represent FDI investment	Dummy (1 FDI invested, 0 otherwise)
Age	For how long has the firm been in existence? 2013 being the base year	Age = (2013-year the firms was set up)
Funding	Captures the sources of funding spent on innovation. Either internal or external sources	Dummy (1 if funding is from external source, 0 otherwise)
Internationally Licensed Technology (ILTECH)	Does the firm use Internationally Licensed Technology?	Dummy (1 if yes, 0 otherwise)
International Recognized Quality Certification (IRQS)	Has the firm acquired international quality certification status?	Dummy (1 if yes, 0 otherwise)
Cooperation in innovation	Captures if the innovative output was developed in cooperation with external institution/organization/firm	Dummy (1 if there was cooperation in innovation, 0 otherwise)
International experience	Captures whether the firm has ever exported or imported output or input respectively	Dummy (1 if exported or imported input or output, 0 otherwise)
Innovative Investment ventures		
Purchased license/ patents	Adopted new technology through new licenses and permits in the last 3 years	Dummy (1 if adopted internationally licensed technology, 0 otherwise)

Employee training	Offered Formal training to employees in the last 3 years	Dummy (1 if offered formal training to employees, 0 otherwise)
Investment in new technology (EMS)	Proxies used are if a firm purchased equipment, machinery or software (EMS) in the last 3 years	Dummy (1 if acquired equipment, machine or software, 0 otherwise)
Research and development (R&D)	Undertaking R&D activities either internally or external collaborations	Dummy (1 if carried Out R&D activity, 0 otherwise)
Marketing and advertising	Indicate if a firm used the services of a marketing firm or advertising firm?	Dummy (1 if marketed or advertised product or services, 0 otherwise)
Obstacles to Innovation		
Trade costs obstacles	Are transport and customs and trade regimes an obstacle?	Dummy (1 if obstacle ranges from moderate to severe, 0 otherwise)
Government related obstacles	Are business licensing and permits obstacles?	Dummy (1 if obstacle ranges from moderate to severe, 0 otherwise)
Education obstacle	Is inadequately educated labour force an obstacle?	Dummy (1 if obstacle ranges from moderate to severe, 0 otherwise)
Financing obstacles	Is access to finance an obstacle?	Dummy (1 if obstacle ranges from moderate to severe, 0 otherwise)
Informal competition	Is the firm exposed to informal competition?	Dummy (1 if obstacle ranges from moderate to severe, 0 Otherwise)
FDI Linkage Related Variables		
Horizontal spillover	Captures the labour mobility associated with local firms acquiring personnel from foreign firms	$HSFDI_{ijt} = (\sum_{k \neq j} Y_{kjt} \bullet For_{ijt}) / (\sum Y_{kjt})$
Backward linkage	FDI linkage through foreign firms using raw material input or supplies from domestic firms	$BSFDI_{jt} = \sum_{k \neq j} \alpha_{kj} \bullet HSFDI_{kt}$
Forward linkage	FDI linkage through domestic firms using material input or supplies of foreign origin	$FSFDI_{jt} = \sum_{k \neq j} \beta_{kj} \bullet HSFDI_{kt}$
FDI Association/Interaction and Learning Related Variables		
Export sales (foreign customers)	Proportion of firms export meant to measures the indirect impact of FDI on innovativeness	% share of output exported to foreign market
Foreign input suppliers	Measured by a proxy of importing input/raw materials or intermediate good	% raw materials of foreign origin
Competition	Competition in the product market both local and external proxied by decrease in demand	Dummy (1 if output demand decreased in the period, 0 otherwise)

4. Results and Discussions

This section presents descriptive statistics of the Kenyan enterprise sector, the empirical results from econometric analysis and detailed discussions on the implications of the results.

4.1 Innovation Investment Characteristics of the Kenyan Enterprise Sector

4.1.1 Innovation investment tendencies among the Kenyan enterprises

Table 2 captures the summary on the innovation characteristics of the sample of the Kenyan firms included in this study. From the table, the enterprises are spread across manufacturing, service and retail sector with 274, 144, and 116 firms each, respectively. The statistics indicate that only the manufacturing sector uses imported input and internationally licensed technology while internationally recognized quality certification is sought across all sectors. In total, 534 firms of which 60 are foreign affiliated were considered for analysis.

Table 2: Summary statistics on the Kenyan enterprise sector

	(1)		(2)			(3)				TOTAL
	OWNERSHIP		INOVATIVATION			LINKAGE/ASSOCIATION				
Sector	F_ Firms	D_ Firms	Product	Market	Process	Have_ IRQC	USE_ ILTECH	Market_ Compe-tition	Internet Use	FIRMS
Manufacturing	**38**	**236**	**75**	**60**	**77**	**106**	**65**	**122**	**137**	**274**
Not Exporting Output	**11**	**127**	**38**	**28**	**36**	**40**	**20**	**61**	**68**	**138**
Not Importing Input	7	73	21	17	21	19	10	36	39	80
Importing Input	4	54	17	11	15	21	10	25	29	58
Exporting Output	**27**	**109**	**37**	**32**	**41**	**66**	**45**	**61**	**69**	**136**
Not Importing Input	3	43	14	11	18	16	12	19	20	46
Importing Input	24	66	23	21	23	50	33	42	49	90
Other Services	**18**	**126**	**39**	**29**	**34**	**43**	**0**	**54**	**65**	**144**
Not Exporting Output	**8**	**86**	**24**	**19**	**22**	**19**	**0**	**31**	**46**	**94**
Not Importing Input	8	86	24	19	22	19	0	31	46	94
Exporting Output	**10**	**40**	**15**	**10**	**12**	**24**	**0**	**23**	**19**	**50**
Not Importing Input	10	40	15	10	12	24	0	23	19	50

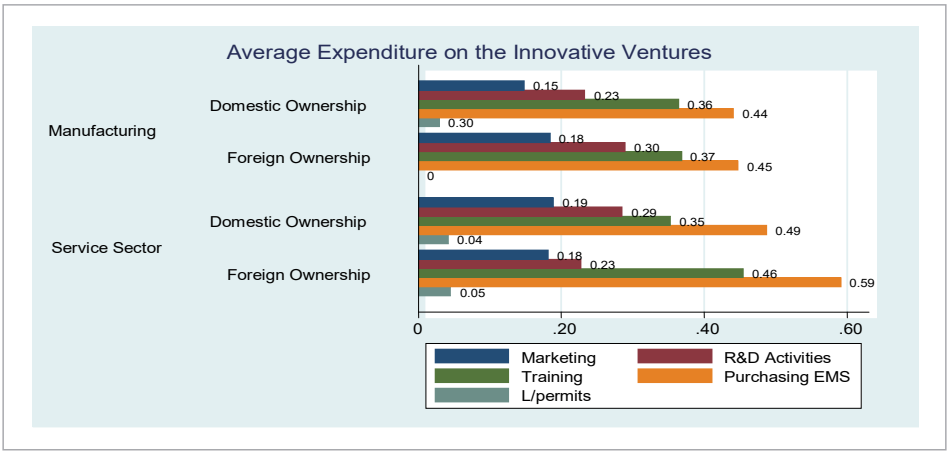
Retail	**4**	**112**	**35**	**32**	**33**	**17**	**0**	**50**	**59**	**116**
Not Exporting Output	**1**	**96**	**27**	**25**	**27**	**10**	**0**	**40**	**51**	**97**
Not Importing Input	1	96	27	25	27	10	0	40	51	97
Exporting Output	**3**	**16**	**8**	**7**	**6**	**7**	**0**	**10**	**8**	**19**
Not Importing Input	3	16	8	7	6	7	0	10	8	19
Grand Total	**60**	**474**	**149**	**121**	**144**	**166**	**65**	**226**	**261**	**534**

Data source: World Bank Database, 2013

4.1.2 Innovation input characteristics

Figure 5 shows how Kenyan firms spend on innovation per sector and ownership structure

Figure 5: Innovative input characteristics across sector and ownership structure



Data source: World Bank (2013) Database

From the Figure, expenditure on EMS dominates the innovative ventures in Kenya followed by undertaking formal training then R&D activities, marketing and spending on acquiring licenses and permits respectively. Foreign firms have a higher tendency to purchase EMS and offer formal training to employees as compared to domestic firms in both manufacturing and services sectors. This implies that promoting foreign investment in Kenya will supply not only the required capital for investment in innovation but also come with the foreign technology from which positive externalities are likely to accrue to domestic firms (see Nadideand İbrahim, 2014). Further, foreign manufacturing firms included in

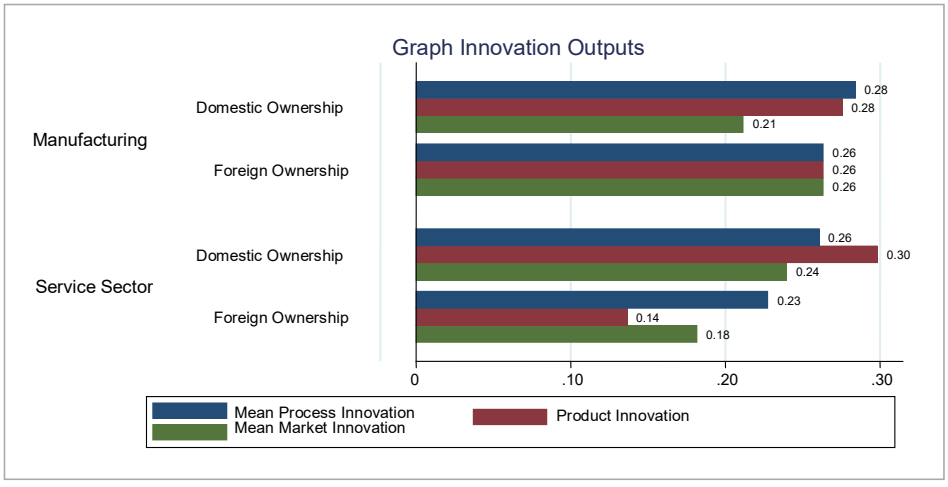
the study have 0 per cent application of patents/licensing; however, this does not mean no innovations are done within the country but rather innovations may be done in Kenya and protected from the headquarter of the foreign firm using the international patent. This phenomenon may have a negative effect on innovation especially basing on Bernstein (1988) work that demonstrated that relatively limited performance of R&D in host countries by foreign affiliates deprives host countries of the productivity spillovers.

Besides, innovation is a firm level phenomenon that enhances creation or adoption of skills and technology from the environment. Innovative ventures include and not limited to investment in R&D activities, engaging in formal training, purchasing equipment or machinery or software (EMS), acquiring copyrights or licenses or permits and marketing of the output.

4.1.3 Innovation output characteristics

Similarly, Figure 6 captures innovation output characteristics in relation to sector and ownership. From the bar graph, domestic firms dominate innovation in the service sector with approximately 30 per cent of Kenyans firms doing Product innovation as compared to the 14 per cent foreign firms. In contrast, foreign firm appear to be performing relatively better than the domestic manufacturing sector with 26 per cent of foreign firms doing market innovation as compared to 21 per cent of the domestic firms. This offers an opportunity for domestic manufacturing firms to learn, imitate or borrow best marketing practices from their foreign counterparts.

Figure 6: Innovation output characteristics across sector and ownership structure

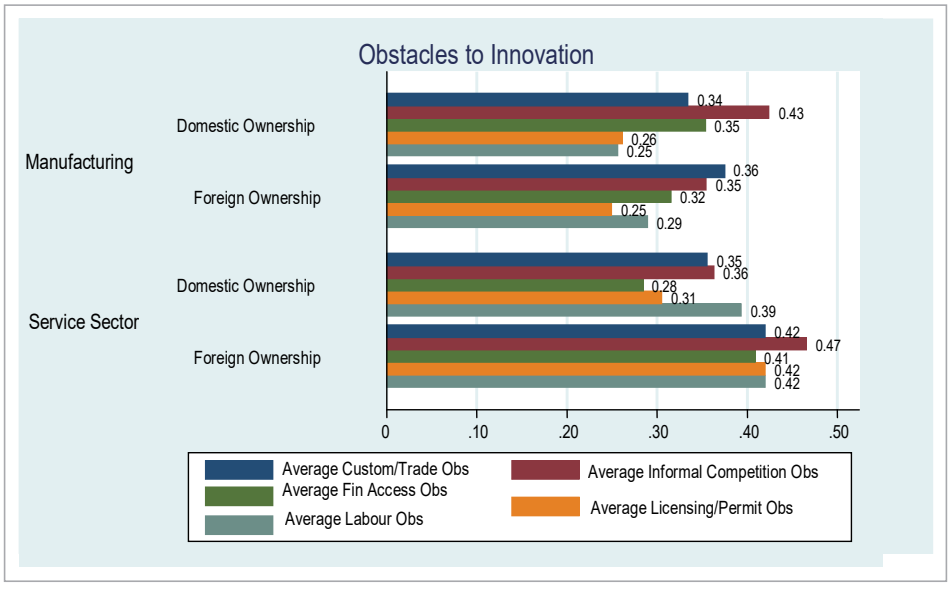


Data source: World Bank (2013) Database

4.1.4 Environment investment obstacles and innovation in Kenya

The Kenyan investment environment is also characterized by obstacles ranging from labour regulations, financial access, customs and trade, government and taxation-related, and informal competition emanating from the weak legislative, regulatory or institutional framework. Figure 7 shows how the effect of these obstacles, especially associated with innovation, vary with sector and ownership structure. From the bar graph, foreign firms in the services sector are the most affected with these obstacles, with informal competition dominating with approximately 47% while other obstacles surpassing the 40% mark. This coincides with what observed in Figure 5 in the preceding section that foreign firms lag behind in innovation in the sector. To promote foreign investments in this sector, there is need for appropriate policy interventions to help address these challenges. Customs and trade obstacles, informal competition and financial access obstacles dominate across the sector and ownership structure. Labour and licencing/permit obstacles are less dominant factors to innovation.

Figure 7: Innovation input obstacles across sector and ownership structure in Kenya

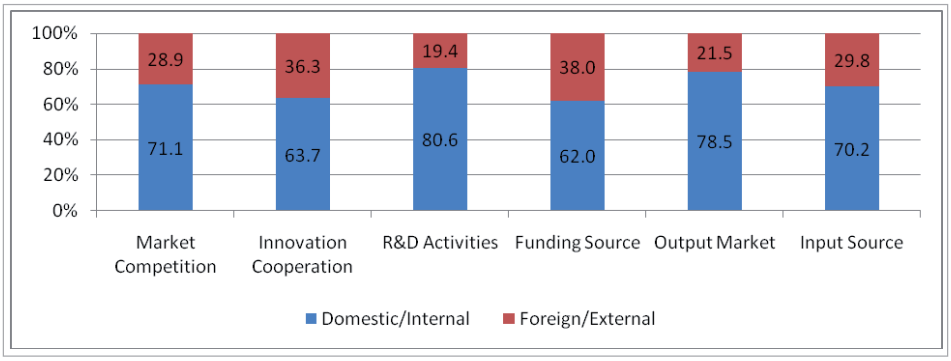


Data source: World Bank (2013) Database

4.1.5 Association, linkages and innovation characteristics among Kenyan firms

In line with the theories supporting harnessing positive externalities, linkages and interactive learning with external business environment among enterprises is vital. In the Kenyan context, a Figure 8 shows how limited Kenyan firms interact with the external environment. For instance, only 38 per cent of Kenyan firms access external funding sources, 36.3 per cent undertake cooperation in innovations and 19.4 carry out joint R&D activities. In essence, this is a disincentive as far as harnessing the benefits associated with the spillover from FDI is concerned. With such performance, chances of expanding and growing the enterprise sector to their full potential and achieving international competitiveness are slim. This therefore calls for alternative policy interventions to facilitate and support linkages.

Figure 8: Firm level characteristics in terms of internal and external linkages



Data source: World Bank (2013) Database

4.2 Empirical Results from Econometric Analysis

As much as the descriptive statistics give hints on the expected outcome to the questions addressed in this paper, they do not tell the whole story. The interactions of these factors in the real business environments may distort the presumed direct relationship. In an actual economic system, specific firm level characteristics and forces may influence innovative behaviour differently. To ascertain the actual interrelationship and the economic significance, regression analysis that offers an opportunity of controlling for these factors was done. This section therefore captures the results from econometrics analysis and the respective policy relevance.

Annex Table A1 captures the descriptive statistics of variables included in the analysis.

4.2.1 Results from innovation input equation-The Heckman Model

Following the empirical model specification equations (3) and (4), the first step and two equation (Heckman) results of the CDM model are as captured in Table 3 below. According to Heckman (1979) assumptions for selectivity, the model is applicability if first, the standard error of the selection and the outcome equations are correlated; second, the mills ratio (or the lambda) introduced solves the selectivity bias by making the two equations independent; and finally the covariates included in the model must also be appropriate.

Table 3: Results for the Heckman regression model

Heckman selection model (Regression model with sample selection) Log likelihood = -728.9548			Number of obs = 534 Censored obs = 242 Uncensored obs = 292 Wald $chi^2(16)$ = 239.68 Prob > chi^2 = 0.0000	
Log (Innovation Intensity)	**Coef.**	**Std. Err.**	**z**	**P>|z|**
Log _Firm Size	-0.7721***	0.0984	-7.85	0.000
Log_Firm Age	-0.1663	0.1630	-1.02	0.308
Importing_Input	0.1569	0.1327	1.18	0.237
Competition (Decreased demand)	0.1351	0.1236	1.09	0.274
Innovation_cooperation	-0.5636***	0.1704	-3.31	0.001
Exporting _Output	-0.2944**	0.1281	-2.30	0.022
Did _Purchase Equip. Mach. S/ware	0.9240***	0.1245	7.42	0.000
Did _Formal Training	0.4292***	0.1107	3.88	0.000
Did _R&D	0.4932***	0.1201	4.11	0.000
Did _Product Marketing	0.3558***	0.1286	2.77	0.006
Did _Protection (CLP)	0.1892	0.2577	0.73	0.463
Log _protection (CLP) Obstacles	-0.0058	0.2263	-0.03	0.915
Log _Labour _Obstacles	0.0300	0.2330	0.13	0.757
Log _Financial Access Obstacles	-0.4059*	0.2187	-1.86	0.076
Log _Informal competition Obstacle	0.4140*	0.2380	1.74	0.083
Log _Custom and Trade _Obstacle	0.4974**	0.2248	2.20	0.024
_cons	5.4537***	0.2863	19.05	0.000
Decision to Innovate	**Coef.**	**Std. Err.**	**z**	**P>|z|**
Internal Innovation Funding	0.3484***	0.1231	2.83	0.005
External Innovation Funding	0.3285***	0.1038	3.17	0.002
Innovation _Cooperation	0.5262***	0.1690	3.11	0.002
International Experience	0.0945	0.1122	0.84	0.400
Protection (CLP)	0.3016***	0.1346	2.24	0.025
Competition	-0.1811*	0.1133	-1.60	0.110
Log_Firm_Age	-0.1071	0.1495	-0.72	0.474
Informal Competition	0.1949**	0.1036	1.88	0.060
_cons	0.3784***	0.2176	-1.72	0.086
/athrho	-0.9439***	0.2299	-3.99	0.000
/lnsigma	0.0876	0.0811	1.02	0.280
rho	-0.7370	0.1050		
sigma	1.0916	0.0885		
lambda	0.7721	0.0984		
LR test of independent equations	(rho = 0): chi^2 (1) = 7.83		Prob > chi^2 = 0.0051	

Note: (***), (**) and (*) imply statistical significance at 1%, 5% and 10% respectively.

From the results, rho tested by athrho coefficient measuring the correlation between the error term is 0.9242 and is statistically significant at 1% (i.e. P>|z|=0.000). The LR wald test for independence coefficient was 7.83 and significant at 1 % (i.e. $\chi 2$=0.0051) implying that selection biases were corrected. Finally, the overall Wald test coefficient being 239.68 and significance at $\chi 2$=0.000 imply that the covariates used in the regression model are appropriate and the results are reliable for interpretation.

4.2.2 Decision to innovate

Equation (3) sought to identify the factors driving innovation decisions among Kenyan firms. From table 3, the selection equation results indicate that both internal and external sources of funding, cooperation in innovation, licensing and protection (copyright, permits and licensing) market and informal competition significantly affect innovation decisions while firm age and having international experience do not. Since all the variables entered the model as dummies, it implies that a unit change in any of these variables changes the likelihood of Kenyan firms engaging in innovation by the magnitude of the respective coefficient. For instance, as chances of informal competition increase from zero to one, the probability of Kenyan firms making innovation decisions increases by 19 per cent. The same interpretation applies to the other variables. These findings are consistent with those of Juan et al., (2010) and Grifith et al., (2006). Market competition measures by decreased demand in both domestic and external market is negative, implying a unit change in market competition reduces the likelihood of Kenyan firms making innovation decisions by 18 per cent. The sign reflects what one may expect since decreased demand implies a drop in the sales and thus depriving a firm an additional income that in one way influence innovation decisions. The study by OECD (2009) for UK, Norway, New Zealand, Brazil and Australia also reported similar findings. Firm age does not affect innovation decision; similar results were also posted by abazi-Alili (2014) and World Bank (2014) reports for in transiting economies and Kenya, respectively.

4.2.3 Innovation intensity

Equation (4) aimed at establishing the factors driving the expenditure on innovative decisions undertaken. The results (see table 3) indicate firm level characteristics including cooperation in innovation, firm size and exporting output; innovative ventures including carrying out R&D activities, formal training, purchasing EMS and marketing output; and financial access, custom and trade and informal competition obstacles either positively or negatively influence

expenditure per employee among Kenyan firms. Importing input, age, market competition, protection and labour and protection obstacles do not. However, since some variables are dummies, some continuous and some appear both in the selection equation and output equations, their respective interpretations differ. For instance, size being a continuous variable implies that an infinitesimal change in the size of the firm reduces the likelihood of its expenditure per employee on innovation by 0.77 units. In the case of exporting output, a dummy variable, as a firm's tendency to export increases from zero to one, the likelihood of a firm spending on innovation reduces by 29 per cent. In addition, since cooperation in innovation appear in both equations, the coefficient is adjusted and then semi-logarithmic coefficients generated (Halvasorsen and Palmquist, 1980). On performing the adjustment, cooperation in innovation reduces the probability of expenditure on innovation by 0.31 units as captured in Table 4 below.

Table 4: Semi logarithmic adjusted coefficient for innovation cooperation

Variable	Obs	Mean	Std. Err.	[95% Conf. Interval]
Innovation Cooperation	534	-0.309513	0.0016718	-0.3127972 -0.3062289

The results on firm characteristic are similar to what Johansen et al. (2008) study reported for Sweden, Finland and Norway; those on direct innovative ventures are consistent with Geroski, et al., (1996) and Grifith et al., (2006) findings while the result on access to finance obstacles is consistent with Masso et al., (2010) finding for Estonia.

These findings are of economic significance since pursuing policies promoting openness, linkages and cooperation and even supporting growth of Kenyan firms saves the firm from extra spending on innovation per employee: the savings that can be reinvested elsewhere within the firm. Similarly, customs and trade and informal competition obstacles increase the likelihood of Kenyan firms spending on innovation, implying that faced with these challenges, Kenyan firms tend to counter by investing more on innovation to survive in the market.

4.3 Results from Innovation Output Equations

4.3.1 FDI spillover effects and innovation output

To assess whether spillover effects associated with FDI inflow enhance innovation among the Kenyan enterprises, the model (5) (knowledge production function) was estimated basing on the product, process and market innovation concepts emanating from the OECD (2010) definition. Horizontal, backward and forward

linkage variables were constructed using models (6), (7) and (8) respectively. To appreciate the heterogeneity among Kenyan firms in terms of the ownership structure, sector, linkages with external market and level of technology known to influence innovation, three specifications of innovation output equation were estimated, allowing introduction of the control variables at different levels and assessing their effects on innovation. This approach has been used in various studies involving CDM model (Masso et al., 2010 and Damijan et, al., 2008). The first estimation utilized the three FDI linkage variables and pooled predicted values from innovation intensity as explanatory variables. The second step segregated innovation intensity variable by ownership (foreign and domestic), the three FDI linkage variables and introduced use of internationally recognized technology as well as having international quality certification while the third step included all the control variables considered in the study. The respective results from the three specifications estimated are as captured in Tables 5, 6, and 7 below.

Table 5: Results on the first step innovation output Probit model

	(1)		(2)		(3)	
	Process Innovation		Product Innovation		Market Innovation	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
Innovation Intensity (Predicted)	0.6330***	(0.000)	0.4772***	(0.000)	0.5209***	(0.000)
Forward Spillovers (FSFDI)	8.5371***	(0.011)	1.1889	(0.665)	5.3373*	(0.069)
Backward Spillovers (BSFDI)	-0.9183	(0.721)	-0.1015	(0.720)	-0.7857	(0.693)
Horizontal Spillovers (HSFDI)	1.2410*	(0.098)	0.2777	(0.711)	0.5658	(0.453)
_cons	-3.7607***	(0.000)	-2.9120***	(0.000)	-3.3186***	(0.000)
Number of observations	534		534		534	
LR chi2 (4)	98.27		59.80		64.56	
Prob >chi^2	0.0000		0.0000		0.0000	
Pseudo R^2	0.1579		0.0946		0.1130	
Log likelihood	-262.1446		-286.2466		-253.4775	

Note: (***), (**) and (*) imply statistical significance at 1%, 5% and 10%, respectively

In the first specification, the results (Table 5) indicate that firms undertaking innovative ventures are most likely to achieve product, process and market innovation since the pooled variable on innovation intensity is positively and statistically significant at 1 per cent. For Probit models, the interpretation of the coefficients is based on the marginal effects as presented in Annex Table 2. From the marginal effects, forward spillovers are seen increase the probability of Kenyan firms engaging in process and market innovation by 2.37 and 1.42 units respectively, but not product innovation. Similarly, horizontal spillovers increase the likelihood of process innovation by 0.34 units but not product or markets innovation. There is no evidence that backward spillovers occur among the Kenyan firms, for the variable was negative and statistically insignificant. This may be attributed to both low levels of association, linkages and interactive learning with foreign firms due to limited knowledge and technical know-how. This was also evident in the descriptive analysis where there were minimum linkages with external environment in terms of sourcing input. The results are consistent with Masso et al. (2010), Damijan et al. (2008) and Managi and Bwalya (2010) findings.

On segregating innovating intensity according to firm ownership and introducing the first batch of control variables, foreign and domestic firms' innovation intensities are positive and significant across process, product and market innovation. However, unlike the preceding estimation, forward FDI spillover effect is now only significant in process innovation. The sign changes for product innovation and the coefficient of market innovation becomes insignificant while the horizontal spillovers variable becomes insignificant. Damijan et al. (2008) and Masso et al. (2010) observed changes of similar kind in their respective studies. The results also indicate that firms having internationally recognized quality certification are more likely to realize product innovation and not market or process innovation while having internationally licensed technology does not significantly affect innovation among Kenyan firms. Oluyumi and Oyebanji, (2012) also reported findings of similar kind.

The results for the second specification are as presented in Table 6. The respective results capturing the marginal effects of each variable are as captured in Annex Table 3.

Table 6: Results for the second step innovation output Probit model

	(1)		(2)		(3)	
	Process Innovation		Product Innovation		Market Innovation	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
F _Innovation Int.	0.6486***	(0.000)	0.4794***	(0.000)	0.5789***	(0.000)
D_Innovation Int.	0.6443***	(0.000)	0.5146***	(0.000)	0.5317***	(0.000)
Forward Spillovers (FSFDI)	8.0109**	(0.020)	-0.2780	(0.924)	4.8621	(0.114)
Backward Spillovers (BSFDI)	-0.1007	(0.713)	-0.9877	(0.644)	-0.1094	(0.728)
Horizontal Spillovers (HSFDI)	1.1307	(0.159)	0.2559	(0.759)	0.1668	(0.840)
Have _IRQC	0.1176	(0.408)	0.2975*	(0.029)	0.1261	(0.382)
USE _ILTECH	0.0954	(0.671)	0.2341	(0.264)	0.0962	(0.673)
_cons	-3.8611***	(0.000)	-3.165***	(0.000)	-3.446***	(0.000)
Number of observations	534		534		534	
LR chi^2 (7)	99.35		66.99		67.11	
Prob >chi^2	0.0000		0.0000		0.0000	
Pseudo R^2	0.1596		0.1060		0.1174	
Log likelihood	-261.6079		-282.6489		-252.2038	

Note: (***), (**) and (*) imply statistical significance at 1%, 5% and 10% respectively. IRQC and ILTECH represent internationally recognized quality certification and internationally licensed technology, respectively

In the third specification, introducing the last batch of control variables including export sales, imported input, firm size and competition the signs on the horizontal spillover become negative while the coefficient of internationally recognized quality certification on product innovation now becomes insignificant. The foreign and domestic firms' innovation intensities, firm size, percentage share of exports and use of ICT proxied by internet use in innovation positively influence innovation across product, process and market. Similar kind of results were also posted by Masso et al. (2010), Griffiths et al. (2000) and Oluyumi and Oyebanji, 2013). However, from the findings, percentage foreign input and reported market competition does not influence innovation among the Kenyan firms.

The results for the third specification are as presented in Table 7. Similarly, the respective marginal effects for these variables upon which interpretation of the magnitude of the effect of unit change on any of the independent variable on the dependent variable may be based is as captured in Annex Table A4.

Table 7: Results for the third step of the innovation output Probit model

	(1)		(2)		(3)	
	Process Innovation		Product Innovation		Market Innovation	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
F _Innovation Intensity	0.7058***	0.000	0.6019***	0.000	0.6429***	0.000
D _Innovation Intensity	0.7032***	0.000	0.6315***	0.000	0.5916***	0.000
Have _IRQC	-0.0190	0.899	0.0979	0.502	-0.0531	0.733
USE_ILTECH	-0.0907	0.708	0.0699	0.762	-0.1071	0.674
Forward Spillovers (FSFDI)	0.7822	0.350	-0.2888	0.760	-0.3214	0.726
Backward Spillovers(BSFD)	-0.1118	0.709	-0.1114	0.659	-0.1250	0.717
Horizontal Spillovers (HSFDI)	6.0839*	0.074	-1.9338	0.514	3.0677	0.312
Export Sales (%)	0.0043**	0.021	0.0047***	0.010	0.0051***	0.008
Foreign Input (%)	0.0019	0.411	0.0002	0.946	0.0015	0.508
Log _Employees (Firm Size)	0.3268**	0.020	0.5113***	0.000	0.3782***	0.009
Competition	0.1090	0.402	-0.2119*	0.098	-0.1874	0.168
Internet_Use_Innovation	0.3777***	0.007	0.3911***	0.004	0.5634***	0.000
_cons	-4.8831***	0.000	-4.5912***	0.000	-4.5422***	0.000
Number of observations	534		534		534	
LR chi2 (12)	123.58		107.40		106.77	
Prob >chi²	0.0000		0.0000		0.0000	
Pseudo R²	0.1985		0.1699		0.1863	
Log likelihood	-249.4904		-262.4436		-232.3721	

Note: (***), (**) and (*) imply statistical significance at 1%, 5% and 10% respectively. IRQC and ILTECH represent internationally recognized quality certification and internationally licensed technology, respectively

In overall, the three specified knowledge production equations provide evidence that there exists positive externalities through forward and horizontal spillovers among Kenyan firms. In economic perspective, occurrence of positive horizontal spillovers implies labour mobility among Kenyan firms. In policy terms, this is an incentive for promoting industrial growth. The more policy interventions encouraging the presence of foreign-owned affiliates in any sector the more likely the spillover benefits to domestic firms within that sector (Juan et. al., 2010; René and Roy, 2010). Similarly, forward spillovers variable being positive and significant provide a better assessment of openness, market and business sophistication of the related policy aspects (René & Roy, 2010). The findings imply that cultivating an enabling business environment that promotes openness and business sophistication encourages FDI and therefore an incentive for innovation. These, coupled with other factors promoting innovation established in this paper

provide an incentive for charting the way forward on various investment policy frameworks in Kenya including those geared to developing the special economic zones (SEZs), industrial zones and SME parks meant to promote industrial growth as envisaged in the Kenya Vision 2030.

Besides, backward inter-firm linkages variable that assesses the extent of local buying or whether local content requirements are met by foreign multinationals in the host economy or not (see Girma et al., 2006; Juan et al., 2010) was statistically insignificant. In this context, the result is not strange in three perspectives. First, the World Bank Enterprise Survey excludes agricultural and extractive (i.e. mining and oil exploration) firms which, in the Kenyan context, does not only hold a huge potential in promoting local suppliers in the value chain but have also been a major incentive accounting for the recent upsurge of foreign investment following the recent discoveries of minerals, oil and gases. Second, from the dataset considered for the study, the proportion of input reported to be sourced locally by foreign firms may possibly have not been robust enough to give significant results. Third, this may also be inferred to imply minimal level of cooperation, association and linkages among Kenyan firms with the external or export market in terms research, inputs, funding and output market.

5. Summary, Conclusion and Recommendations

5.1 Summary

The paper sought to establish effects spillovers from Foreign Direct Investment inflows on innovation among Kenyan enterprises using the New Growth Theory approach. The study utilized the Crepon, Duguet and Mairesse (CDM) model in the analysis. Preliminary analysis indicates that domestic firms dominate innovation in the services sector while foreign firms perform relatively well in the manufacturing sector; spend more on innovation and are the most affected by innovation investment obstacles. Statistics also indicate minimal level of cooperation and association among Kenyan firms with the external or export market in terms of research, inputs, funding and output market. Further, besides empirical analysis establishing what influences decisions to innovate and intensity of expenditures on innovation decisions, the findings provided evidence that spillover effects from FDI influence innovation among Kenyan firms.

5.2 Conclusion

The insights from the paper are not only vital in enhancing understanding of what influences innovation in Kenya but also provide a platform for policy recommendation towards promoting innovation and harnessing the benefits from FDI inflows. In addition, the paper provided an incentive for charting the way forward on various investment policy frameworks in Kenya, including those geared to developing the special economic zones (SEZs), industrial zones and SME parks meant to promote industrial growth as envisaged in the Kenya Vision 2030. Pursuing appropriate policies aimed at expanding the Kenyan enterprise sector that will guarantee creation of wealth, improved social welfare and achieving international competitiveness is necessary in addressing stagnation in productivity, unemployment and poverty challenges as experienced in the Kenyan economy thereby setting the economy to the desired growth path towards achieving the Kenya Vision 2030.

5.3 Recommendations

To effectively harness the benefits associated with FDI, the innovative capacities of Kenyan firms can also be enhanced by promoting linkages and interactive learning especially from the foreign firms. This can be through formulating of an innovation policy in Kenya. The policy envisaged should not only promote FDI inflows but also promote openness that will enhance import and export trade. Besides, the policy can also establish a communication system and platforms for

sharing information in innovation among the actors by supporting modalities for availing of publications and codified standards. Further, establishing mechanisms to promote inter-firm employee movement such as availing apparatus supporting imitation are vital.

There is need for enhanced training and capacity building among Kenyan firms. This can be through encouraging on-the-job training for employees. Further, alternative strategies including increased funding, and implementation of skills exchange programmes such as internship and apprenticeship are necessary. The intervention can be extended to offering duty free importation of capital goods such as ICT equipment and other scientific apparatus that enhance innovative capacities among Kenyan investors.

Besides, there is need for continued improvement of the investment climate by addressing challenges obstructing innovation including issues on access to finance, activities of informal competitors and trade and custom regulations proved to affect innovation in Kenya. This can be achieved by removing rigidity in the market to assist formal enterprises, especially the tax systems, through proper legislative interventions, regulatory and institutional adjustments.

There is need for a coherent economic incentive to support innovation in Kenya. Though the enactment of Science, Technology and Innovation Act of 2013 that provided for National Research Fund was a move to the right direction, it is yet to be implemented. To meet the current innovation requirements, there is need to review the 2 per cent GDP budget allocation. Further, in accordance to the provisions in the Industrial Property Act 2001, there is need to effectively utilize the waiver on patent application fee in relation to innovations serving public interests.

5.4 Limitation and Areas for Further Research

Due to the elimination of agro-based enterprises and firms in the extractives sectors in the World Bank Survey of 2013, the data set used was not robust enough to yield significant results on backward spillovers as was earlier envisaged by the paper. To fully explore this, there is need for more sound and comparative empirical studies supported with compressive data to inform future policy direction on local content development for Kenya. Data from different time periods (waves) can also be used in studies of similar kind to establish the impact of the various government policy interventions on enhancing innovation and industrial productivity in Kenya.

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Annex

Table A1: Descriptive statistics of the variables included in the empirical analysis

Variable	Obs.	Mean	Std. Dev.	Min	Max
Age (Years of existence since initial formation)	534	22.6311	18.0886	1	107
Size (Number of Employees)	534	65.6124	168.0669	0	2000
USE_ILTECH (Inter. Licensed technology)	534	0.12172	0.327272	0	1
Have _IRQC (Inter. Recognized Quality Cert.)	534	0.31086	0.46328	0	1
Protection (Copyright/Licensing/permit)	534	0.19101	0.393467	0	1
ICT Use for Innovation (Internet)	534	0.48876	0.500342	0	1
Competition (Decreased Demand)	534	0.42322	0.494533	0	1
Labour_Obstacle	534	0.32678	0.34747	0	1
License/Permit _Obstacles	534	0.28699	0.301908	0	1
Financial Access _Obstacles	534	0.32257	0.297348	0	1
Informal Competition _Obstacles	534	0.39419	0.306349	0	1
Custom/Trade _Obstacles	534	0.35066	0.325301	0	1
Innovation Cooperation	534	0.14045	0.347778	0	1
Decision to innovate	534	0.38577	0.487233	0	1
Process Innovation	534	0.26966	0.444201	0	1
Market Innovation	534	0.22659	0.419019	0	1
Product Innovation	534	0.27903	0.448941	0	1
Log(Innovation Intensity/Expenditure)	534	2.52413	2.475311	0	8.301
External Innovation Funding	534	0.47004	0.499569	0	1
Internal Innovation Funding	534	0.76404	0.424992	0	1
Informal Competition	534	0.55431	0.497508	0	1
International Experience	534	0.47753	0.499963	0	1
Importing R/Material or Input	534	0.27715	0.448013	0	1
Exporting Output	534	0.3839	0.486789	0	1
Did_(Copyright/Licensing/permit)	534	0.03371	0.180645	0	1
Did_ EMS (Purchase Equip., Mach. or S/ware	534	0.46816	0.499453	0	1
Did_ Formal Training	534	0.3633	0.4814	0	1
Did_ R&D Activities	534	0.2603	0.43921	0	1
Did_ Product Marketing	534	0.17041	0.376347	0	1
FSFDI_ Forward Linkage	534	0.00421	0.034553	0	0.6
BSFDI _Backward Linkage	534	0.00145	0.019479	0	0.4
HSFDI _Horizontal Linkage	534	0.01472	0.095877	0	1
Innovation Intensity (Predicted values)	534	4.784093	0.916162	2.7243	7.0506
Foreign Innovation Intensity	534	0.513043	1.477973	0	6.9944
Domestic Innovation Intensity	534	4.271051	1.745174	0	7.0506

Data source: World Bank (2013) Database

Table A2: Marginal effects results on the first step innovation output Probit model

	(1)		(2)		(3)	
	Process Innovation		Product Innovation		Market Innovation	
Delta Method	dydx Coef.	P>|z|	dydx Coef.	P>|z|	dydx Coef.	P>|z|
D _Innovation Intensity	0.1755***	0.000	0.1450***	0.000	0.1392***	0.000
HSFDI	0.3440*	0.096	0.0844	0.711	0.1512	0.453
BSFDI	-0.2541	0.721	-0.3084	0.720	-0.2100	0.693
FSFDI	2.3666***	0.009	0.3613	0.665	1.4266*	0.067

Note: (***), (**) and (*) imply statistically significance at 1%, 5% and 10% respectively

Table A3: Marginal effects results on the second step innovation output Probit model

	(1)		(2)		(3)	
	Process Innovation		Product Innovation		Market Innovation	
Delta Method	dydx Coef.	P>|z|	dydx Coef.	P>|z|	dydx Coef.	P>|z|
F _Innovation Intensity	0.1794***	0.000	0.1437***	0.000	0.1539***	0.000
D _Innovation Intensity	0.1782***	0.000	0.1542***	0.000	0.1413***	0.000
HSFDI	0.3127	0.157	0.0767	0.759	0.0443	0.840
BSFDI	-0.2785	0.712	-0.2960	0.644	-0.2920	0.728
FSFDI	2.2426**	0.018	-0.0833	0.924	1.2925	0.112
Have _IRQC	0.0325	0.407	0.0892**	0.027	0.0335	0.381
USE_ILTECH	0.0264	0.671	0.0702	0.260	0.0256	0.673

Note: (***), (**) and (*) imply statistically significance at 1%, 5% and 10% respectively

Table A4: Marginal effects results on the third step innovation output Probit model

	(1)		(2)		(3)	
	Process Innovation		Product Innovation		Market Innovation	
Delta Method	dydx Coef.	P>|z|	dydx Coef.	P>|z|	dydx Coef.	P>|z|
F _Innovation Intensity	0.1848***	0.000	0.1666***	0.000	0.1565***	0.000
D _Innovation Intensity	0.1841***	0.000	0.1748***	0.000	0.1440***	0.000
Have _IRQC	-0.0050	0.899	0.0271	0.502	-0.0129	0.732
USE_ILTECH	-0.0238	0.708	0.0193	0.762	-0.0261	0.674
HSFDI	0.2048	0.349	-0.0799	0.760	-0.0782	0.726
BSFDI	-0.2927	0.717	-0.3086	0.659	-0.3040	0.717
FSFDI	1.5929*	0.072	-0.5353	0.514	0.7466	0.311
Export Sales (%)	0.0011**	0.020	0.0013***	0.009	0.0013***	0.007

Foreign Input (%)	0.0005	0.410	0.0000	0.946	0.0004	0.508
Log _Employees (Size)	0.0856**	0.018	0.1415***	0.000	0.0921***	0.008
Competition	0.0285	0.401	-0.0586*	0.096	-0.0456	0.166
Internet_Use_Innov	0.0989***	0.006	0.1083***	0.003	0.1371***	0.000

Note: (***), (**) and (*) imply statistically significance at 1%, 5% and 10% respectively

Algorithm for semialogarithm adjustment of coefficients

predict select_xb, xbs

gen delta=mills*(mills+select_xb)

gen b_innovation_coorperation=[loginn_intens1]_b[innovation_coorperation] - ([decision_to_ innovate]_b[innovation_coorperation]*e(rho)*e(sigma)*delta)

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Kenya Institute for Public Policy Research and Analysis
Bishops Garden Towers, Bishops Road
PO Box 56445, Nairobi, Kenya
tel: +254 20 2719933/4, 2714714/5, 2721654, 2721110
fax: +254 20 2719951
email: admin@kippra.or.ke
website: http://www.kippra.org