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Effect of Innovation on Employment Among Manufacturing Firms in Kenya

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

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Abstract

Statistics available at the Kenya National Bureau of Statistics provide evidence that Kenya is struggling with high unemployment rates, an occurrence that is likely to be aggravated by an expanding labor force as a result of the expanding national population. The country has also identified manufacturing as a key sector in driving economic growth and development and thus it ought to benefit the economy in addressing the unemployment problem. Moreover, the country has shown relentless efforts in scaling up its innovative activities. Nevertheless, previous empirical work lacks consensus on how innovation affects employment across various countries and sectors. Thus, this study sought to examine how employment responds to product and process innovations among manufacturing firms in Kenya. The study used balanced panel data covering 100 manufacturing firms in Kenya. This data was for two waves which are 2013 and 2018 extracted from the World Bank Enterprise Survey database. The paper decomposed innovation into product and process innovation. The paper estimated static labor demand function using Pooled Ordinary Least Squares. Particularly, from the pooled OLS, employment among firms with product innovation was found to be 31.3% higher compared to the firms with product innovation while it was 13.2% higher among firms with process innovation compared to those without. From the random effects model, employment among firms embracing product innovation was 27.4% higher compared to forms without product innovation while it was 9.1% higher among forms with process innovation compared to those without. The findings suggest the need for different stakeholders to put innovation especially product innovation among manufacturing firms on the forefront as this will aid in the fight against joblessness in Kenya.

Abbreviations and Acronyms

FDI	Foreign Direct Investment
FE	Fixed Effects
GDP	Gross Domestic Product
GII	Global Innovation Index
GMM-SYS	System GMM
GoK	Government of Kenya
H-T	Hausman Taylor
ILO	International Labor Organization
IV	Instrumental Variables
KNBS	Kenya National Bureau of Statistics
LSDVC	Least Square Dummy Variable Corrected
OLS	Ordinary Least Squares
R&D	Research and Development
RE	Random Effects
UK	United Kingdom
USA	United States of America
WIPO	World Intellectual Property Rights Organization

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1. Introduction

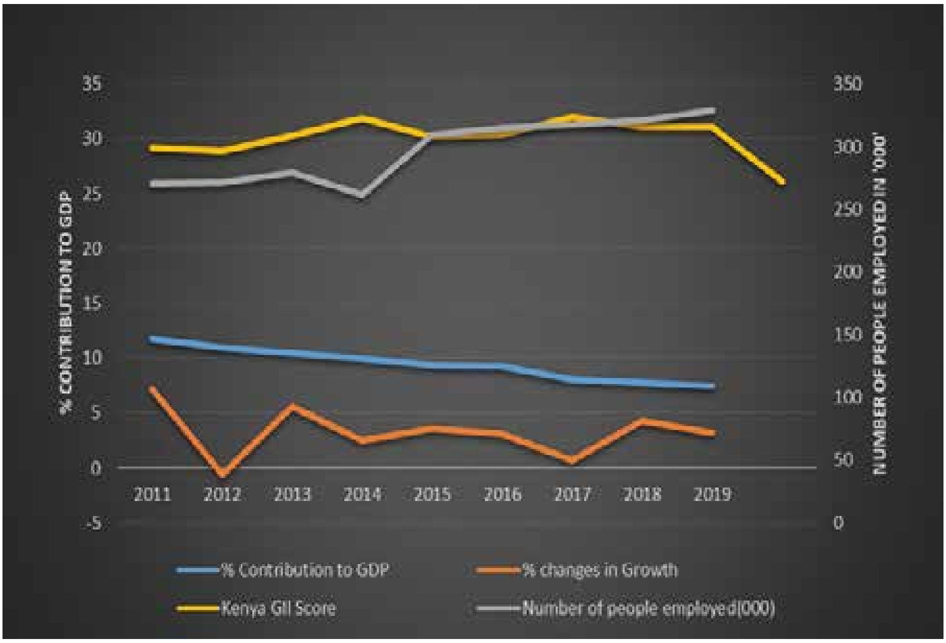
The concept of innovation is complex and multifaceted, and there is no generally accepted definition of innovation in science. Schumpeter, the founder of innovation theory on economics in 1982, regarded innovation as the economic impact of technological change, use of new combinations of existing productive forces to solve the problems of business (Kogabayer and Miziliuskas, 2017). Further, Afuah (1998) defined innovation as new knowledge incorporated in products, processes, and services by classifying innovations according to technological, market, and administrative/organizational characteristics. While the definition by Afuah (1998) combined the aspects of technology and market perspectives, the Schumpeter definition was based on sociological factors rather than economic factors; innovation was also treated as the only factor of change in the economy.

This paper, therefore, adopts a more comprehensive definition, which suggests that innovation consists of the generation of new ideas and its implementation into a new product, process or service, leading to the dynamic growth of the national economy and the increase of employment and to creation of pure profit for the innovative business enterprise (Kogabayer and Miziliuskas, 2017). This definition offers a holistic view of technological and administrative scenarios that feed into employment and growth of the economy, which are the subject of this paper. Process innovation relates to any new or significantly improved methods of manufacturing products or offering services; logistics, delivery, or distribution methods for inputs, products, or services; or supporting activities for processes. It affects unit costs and thus induces price reduction for firms' products. Product innovation refers to introduction of new or significantly improved products that result to product demand enhancement. This in turn will result in high output and thus employment growth through capacity expansion (Harisson et al., 2014; Okumu et al., 2019).

The manufacturing sector across the world drives economic development by enhancing export competitiveness and thus boosts employment opportunities of semi-skilled labour. It also promotes diversification and self-reliance, hence reducing dependency on imports. The sector is proclaimed as the biggest spender of applied research and innovation, with spillover effects to the rest of the economy (Roos, 2016). It stimulates the development of other economic activities and encourages improvement of social services through its linkage with other sectors such as trade, transport and communication, health, and agriculture. Manufacturing relates to industry and trade-based activities of fabrication, processing or preparation of products from raw materials and commodities. Ultimately, manufacturing needs to be innovative to respond to emerging issues and global trends. To this effect, rapid advances in innovation are vital for industrialization and sustainable development of a country as it drives entrepreneurship and creates opportunities especially for the youth.

As Kenya envisions to improve the contribution of manufacturing sector to GDP from 9.2 per cent in 2016 to 15.0 per cent by 2022, the sector performance has not been impressive, recording a marginal growth over the past one decade. The years 2012 and 2017 recorded the lowest growth of -0.6 and 0.7 per cent, respectively. The sector contribution to GDP has also been declining from 11.8 per cent in 2012 to 7.5 per cent in 2019. The number of people employed has remained steady over time, at least 300 million people since 2015. Figure 1. Shows trends in the manufacturing sector and innovation performance (GII Overall Score) for Kenya.

Figure 1: Trends in manufacturing sector and innovation performance in Kenya (2011-2020)



Data Source: KNBS (2016-2020), Economic Surveys; Global Innovation Index Reports (2011-2020)

Kenya's innovation performance score averaged 30.08 per cent over the last 10 years since 2011. In 2020, Kenya also performed well in market sophistication, business sophistication and knowledge and technology output pillars ranking at 57th, 68th and 70th out of 131 countries, respectively (WIPO, 2020). This has seen Kenya ranking 3rd among the 26 Sub-Saharan Africa countries in the 2020

GII. This innovation performance exhibited in the country necessitates the need for massive efforts by different players to push innovation advancement to even a higher trajectory to stimulate job creation through the idealistic, creative and energetic approaches.

Consequently, the general statistics also show that the country continues to grapple with high unemployment rates, recorded at 7.2 per cent in 2020Q3 compared to 5.2 per cent on 2019Q3, with youth being the most vulnerable, recording an annual employment rate of 7.27 per cent in 2020. Therefore, as the country transitions into a high technology and innovation hub, it is important to understand how innovation will shape structural changes in the labour market.

In addition, there is scanty empirical literature on the relationship between employment and innovation for developing countries, especially on the disaggregated front on process and product innovation (Okumu et al., 2019). Even as the developed and Latin American economies provide some consensus of positive association of product innovation on employment growth, the relationship between process innovation and employment growth is inconclusive. Further, the results cannot be generalized for countries such as Kenya given its entrepreneurial abilities. With this indeterminate nature of empirical results on the effect of innovation on employment and the growing labour force in the country, it is important to examine the impact of innovation on the employment levels in the manufacturing firms in Kenya. This will help in shaping policy dialogue and add to the existing body of literature. Particularly, this study endeavours to investigate the effect of innovation on employment among manufacturing firms in Kenya. It undertakes to estimate the effect of product and process innovation on employment among manufacturing firms.

The rest of the paper organized as follows: Section 2 provides a highlight of the global and regional stylized facts on innovation and development; Literature review, methodology and discussion of results are presented in sections 3, 4 and 5, respectively. Section 6 presents the conclusion and recommendations of the study.

2. Innovation and Development in the Manufacturing Sector

2.1 Global and Regional Facts

The increased globalization has necessitated the need to innovate to influence productivity through competitiveness and offer real time solutions. Notably, innovation is critical in economic development and social progress of any economy. It is essential in identifying barriers and new opportunities to improve chances to reacting and resolving eminent problems facing the world economies, including health and access to essential drugs, food security, climate change, unemployment, pollution, and sustainable energy sources (United Nations, 2013). Leveraging on technology and innovation, therefore, is essential for wealth creation globally (Government of Kenya, 2012).

As the world engrosses rapid and profound changes, creating more and better jobs has been identified as a priority in the global development agenda. Innovation, therefore, is considered as one of the economic drivers for investment, which in turn can stimulate employment opportunities. The world's population continues to grow, and so is the labour force. The world population is estimated at 7.7 billion people (UN 2020 estimate), and is projected to reach 9.7 billion by 2050. In 2019, the world working age population stood at 5.7 billion, with 57 per cent (equivalent to 3.3 billion people being in employment). The global unemployment rate increased to 6.4 per cent in 2020 from 5.4 per cent in 2019, equivalent to 188 million unemployed people worldwide (1LO, 2020).

About 77 per cent of the population in Africa is below the age of 35 years, with an average age of 19.7 years (World Economic Forum, 2020). This implies that the population and labour force in Africa is rapidly getting younger, and it is presumed to be creative; thus, it presents a unique opportunity to transform the continent if proactive measures are taken to reap the youthful population dividend. This exponential growth in population is likely to present challenges of exacerbating poverty, unemployment, inequality and creating pressure on economic infrastructure, especially if proper measures are not put in place.

According to World Bank estimates, the working age population in developing countries will increase by 2.1 per cent by 2050 and double in Sub-Saharan Africa from 600 million to 1.3 billion between 2020 and 2050 as a result of the rapid growth in youthful population experienced in the last two decades. Therefore, with technology and innovation being embraced as a key driver of economic transformation, policy makers hurdle with the question of whether innovation can unlock Africa's unemployed labour force (Okumu et al., 2019).

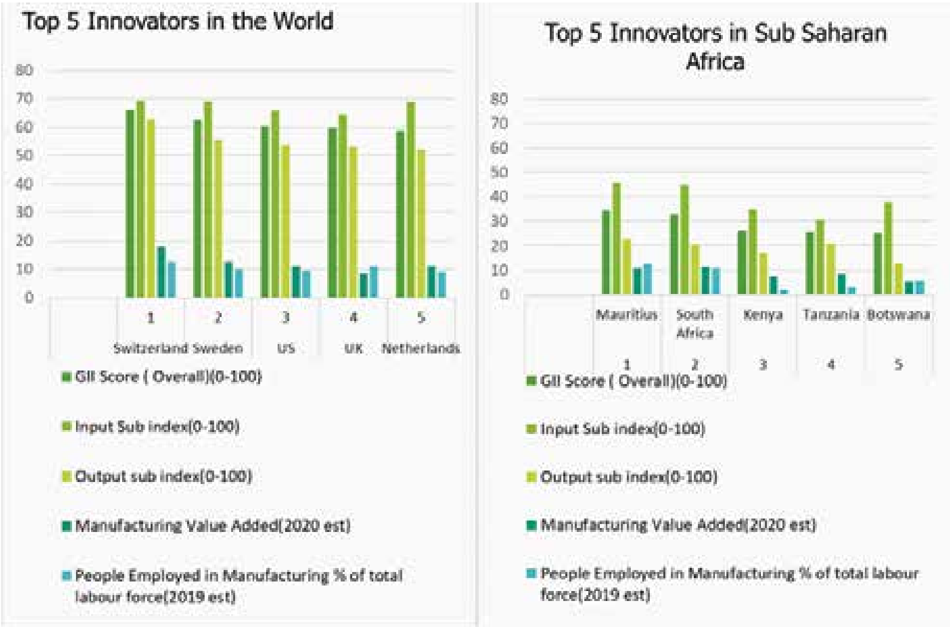
Statistics show that the world's most innovative economies such as Switzerland, which was ranked first in GII 2020 and top 5 in the last 6 years, have great performance in knowledge-intensive employment. The country is considered a world investment haven, majorly benefiting from the services and manufacturing sectors. The manufacturing sector has sustained high ranking for value added at 18.76 per cent of GDP in 2019 (World Bank, 2019), with increased production efficiency to stimulate employment opportunities. On average, the country has maintained a low unemployment rate of 4.76 per cent for the past 6 years, with the manufacturing sector accounting for about 13 per cent of jobs in 2019 (ILO, 2020).

A report by Mc Kinsley Global Institute on "Future works with bold digital transformation and skills development" suggests that Switzerland can reap from productivity boost, resulting from modern technologies. Job displacement is anticipated but the pace to create jobs could double to up to 800,000 new jobs driving real income growth, boosting consumption, and thus increasing demand for domestic employment. The manufacturing sector is poised to experience the most extensive displacement of activities of about 25 to 30 per cent of jobs displacement, almost twice the percentage of new jobs that might be created on average (McKinsey Global Institute, 2018).

Other top innovators include Sweden, US, UK and The Netherlands, which continue to enjoy resurgence in manufacturing output attributed to the strength of their economies, work force quality and good policy environments. The global manufacturing score card report of 2018 in which infrastructure and innovation forms part of the indicators, ranked UK, Switzerland and US with 78, 78 and 77 points out of 100, respectively. This performance was attributed to good policies, cost considerations, workforce investments and infrastructure (West and Lansang, 2018).

Figure 2 shows trends for the top five innovators employing about 10 per cent of their total labour force in the manufacturing sector. The countries also enjoy high value added as a percentage of GDP in the manufacturing sector compared to the highest of 26.18 per cent by China. The five best innovator countries in the world toped in the output sub-index in the order of their overall ranking. Regarding input sub-index, UK and The Netherlands missed out in the top five, ranking 6^{th} and 11^{th}, respectively. The input sub-index is composed of institutions, human capital and research, infrastructure, market and business sophistication indicators while the output sub-index constitutes creative outputs and knowledge and technology outputs.

Figure 2: Innovation and manufacturing trends for top five innovators in the world and in Sub-Saharan Africa



Data Sources: World Bank (2020), World Development Indicators 2020; ILO 2020; and WIPO (2020)

Figure 2 indicates that for Sub-Saharan Africa, the top five countries are doing well in the outputs scores with the highest and lowest being Mauritius and Tanzania at 45.77 and 30.41 per cent, respectively. The manufacturing sector for Kenya and Tanzania, however, employs a relatively small percentage of the labour force of less than 5 per cent compared to countries such as Mauritius, South Africa and Botswana that employ 12.65, 10.77 and 5.58 per cent, respectively.

Generally, Africa is labeled as being far from cutting edge technologies as its innovation is largely characterized by imitation, not to mention the costly and risky research and development (R&D) ventures (Naudé et al., 2011). Other bottlenecks include inadequate management capacity, insufficient trained human capital and technological capacity. These factors are heavily driven by high cost of doing business, intellectual property rights, and unresponsive economic and trade policies. Regarding policy framework, the region adopted a 10-year Science, Technology and Innovation (STI) strategic plan in 2014 to foster social and economic competitiveness through human capital development, innovation, value addition, industrialization and entrepreneurship. This strategy preceded the Consolidated Plan of Action (CPA) of 2006 that embedded strengthening of manufacturing capacity in one of its pillars. Significant achievements on capacity development, network of excellence, improved policy and building innovation mechanisms were recorded (African Union Commission, 2014).

Africa is championing change by embracing modern technology, connectivity, entrepreneurship, and contributing to innovative solutions. The continent has presented to the world some of the greatest innovations and ideas such as smart cities to tackle societal problems (World Economic Forum, 2020). Some countries such as Mauritius, South Africa and Kenya ranked top three in the GII 2020 in Sub-Saharan Africa with an overall rank of 52, 60 and 86, respectively. Out of the 25 out of performers identified in the GII report, 8 were from Sub-Saharan Africa, with Kenya among other countries such as India, Vietnam and Moldava holding a record of being innovative achievers for 10 consecutive years (WIPO, 2020). In addition, Kenya is ranked best in entrepreneurship. In the Forbes list of Africa's best 30 entrepreneurs below 30 years 2020, 7 Kenyans were ranked among the top young entrepreneurs.

At the country level, Kenya has embraced a raft of measures to support the uptake and utilization of science, technology and innovation. In terms of legislative and institutional framework, the government enacted the ST&I Act 2013, which established key institutions (NACOSTI, NRF and KENIA) to coordinate and support ST&I-related initiatives, projects, and programmes (Government of Kenya, 2013). It is also complemented by the ST&I Regulations of 2014 that uphold the standards of research in the country and secure public confidence. Some of the challenges that are to be addressed include infrastructural capacity, funding, and limited contribution of the private sector to research and technology development (Government of Kenya, 2014). The country, however, has no ST&I policy to guide the development of ST&I related initiatives.

2.2 Kenya Manufacturing Sector

Kenya aspires to be a newly industrialized middle-income country providing quality life to all its citizens by the year 2030. This vision can be achieved by embracing the role of transformative sectors such as manufacturing in developing skilled human resources that will support and prompt innovations in the priority areas (Government of Kenya, 2018). Manufacturing plays a critical role in economic growth and development through its contribution to national output, employment creation and poverty alleviation. As economies become industrialized, it is expected that employment and output will increase rapidly. Consequently, at advanced levels of development, the contribution of manufacturing will decline in favour of the services sector, resulting to structural to changes across various sectors (Santacreu and Zhu, 2018). In Kenya, the wholesale and retail sub-sector, which forms part of manufacturing activities, continue to shape the labour market, to a great extent accounting for 32 per cent of entry-level jobs held by the youth.

Statistics show performance of the Kenya manufacturing sector has not been impressive, characterized by a slow growth rate and static number of people employed over time (Figure 1). The underperformance of the manufacturing sector is attributed to inefficient production, which is driven by prohibitive cost of energy, reliance on obsolete technologies, limited access to credit, and counterfeiting products. Technological innovation, therefore, could benefit the manufacturing sector in enhancing efficient processing and value addition, quality products, plant equipment for energy generation as envisaged in the national research priorities for ST&I (Ministry of Energy, 2019). To revamp the manufacturing sector, the government is developing Special Economic Zones in Naivasha, Kisumu and Machakos to lower the cost of production through tax and other incentives such as land and green channel expatriates (Government of Kenya, 2013). The *Buy Kenya Build Kenya* (BKBK) initiative and the 40 per cent procurement directive by the President is also essential in promoting consumption of local products (Government of Kenya, 2017). Other initiatives to support innovation in the manufacturing sector include the establishment of Konza Technopolis that will provide a research and innovation ecosystem. This could stimulate job creation, thus help in addressing the problem of unemployment.

In general, the Kenyan economy has continued to exhibit high unemployment rates as the population and the labour force grows. The country recorded overall unemployment rates of 6.2 per cent, 4.7 per cent, 5.3 per cent and 4.9 per cent during the 2019Q1 to 2019Q4, respectively, as a percent of total labour force. In 2020Q1 to 2020Q3, the unemployment rates were 5.2 per cent, 10.4 per cent and 7.2 per cent, respectively (KNBS, 2019a; 2020a; 2020b). The relatively higher unemployment rates in 2020, especially in the second quarter compared to 2019 are majorly linked to the COVID-19 pandemic, which disoriented the job market and caused labour under-utilization among other socio-economic distresses. This shows the susceptible nature of the labour market in Kenya to external shocks. Statistics also show that Kenya's total labour force rose from 1.88 million is 2019Q3 to 1.90 million in 2020Q3 (KNBS, 2020b). The national population census of 2019, 2009, 1999 and 1989 show that the country's population has been increasing by at least 25 per cent from the time when one census is conducted until when another one is conducted a decade later. For example, the population growth rate was 34.11 per cent, 31.36 per cent and 26.26 per cent from 1989-1999, 1999-2009 and 2009-2019, respectively (KNBS, 2019b).

Notably, the unemployment challenges in Kenya are borne majorly by the youth, who account for about 29 per cent of the entire national population. In particular, the average annual unemployment rate for the Kenyan youth has been rising from 7.18 per cent in 2018 to 7.24 and 7.27 per cent in 2019 and 2020, respectively. In 2020Q3 age groups 20-24, 25-29 and 30-34 accounted for about 17.6 per cent, 10.7 per cent, and 6.6 per cent of the unemployment rate, respectively. The unemployment rates for corresponding groups in 2020Q2 were 22.8 per cent, 21.7 per cent, and 6.6 per cent, and 16.0 per cent, 7.9 per cent and 3.9 per cent for 2019Q3. The higher unemployment rates in 2020Q2 as earlier mentioned were majorly driven by labour under-utilization due to COVID-19 pandemic (KNBS, 2020b).

Literature on the causal effect of technology and innovation, particularly on development, points out controversy when assessing how employment responds to technological change. Ideally, this controversy revolves around the classical debate characterized by two opposing views. One of the views is the fear that labour-saving innovation breeds technological unemployment while the other one is anchored on compensation theory. This is an economic theory predicting indirect effects of innovation, which could counterbalance the reduction in employment due to the same innovation (Bogliacino, Piva and Vivarelli, 2014). Smolny (1998) showed that product innovation has a positive impact on employment among West Germany manufacturing firms. Similar results but for UK were found by Van Reenen (1997) and by Baffour et al (2020) among Ghanaian manufacturing and service firms. On the contrary, Zimmermann (1991) found a negative effect of technological progress on employment among German manufacturing industries. The finding by Klette and Førre (1998) is perhaps the most controversial in that it suggests absence of clear-cut positive relationship between R&D and net job creation. More so, Baffour et al (2020) failed to establish any significant relationship between process innovation and employment level.

Thus, as economies go through the trappings of globalization and the fourth industrial revolution, increased integration of innovations for SMART factories and technologies around automation, artificial intelligence and Internet of things continue to nurture and enhance country competitiveness. There is need to understand the labour structural changes brought about by the effect of innovation on the manufacturing sector, which has been earmarked as one of the key drivers of economic growth in the Kenya Vision 2030. Therefore, this study is crucial in revealing important information on the effect of process and product innovation on employment in manufacturing firms in Kenya.

3. Literature Review

3.1 Theoretical Literature

3.1.1 Schumpeter's Theory of Economic Development

Schumpeter, who was an early advocate for entrepreneurial profit, posits that in developing economies where innovations necessitate new business to wipe out old ones, a process he later called "creative destruction, booms and recessions in the business cycle are inescapable and removing them is only possible by thwarting the creation of new wealth through innovation. Schumpeter disregarded the classics way of perceiving capital accumulation as the leading driver of economic growth, but instead associated this growth majorly to the concept of entrepreneur-innovator who is considered a "hero of development" (Piętak, 2014). According to Schumpeter, economic development is propelled by the innovative and creative way of entrepreneurs (Piętak, 2014; Sweezy, 1943). Once an entrepreneur introduces an innovation, this economic agent enjoys great profits in the short-run, but these gains diminish over time as competitors ape such an invention (Schumpeter, 1934). The three main assumptions up on which Schumpeter's theory of economic growth is anchored are: private property, a competitive market and financial markets efficiency that could abet devising of new inventions. According to Piętak (2014), Schumpeter's theory is more applicable in countries that are democratic and economically developed.

3.1.2 Classical compensation theory

In the first half of the 19th century, economists put forth a theory (Marx later called it "compensation theory"), which dismissed the notion that labour labour-saving technology breed unemployment. According to this theory, a labour-saving innovation is proceeded by readjustments that create jobs to compensate for the lost ones (Vivarelli, 2007). For example, if an innovated machine displaces workers in an industry that uses the machine, this will translate to job creation in capital sectors involved in the production of the machine (Say, 1964). Assuming a competitive market, if an innovation helps to lower the unit cost of production, firms will adjust prices downwards and this will stimulate new demand, which in return will call for increased production and hence other employment opportunities (Stewart, 1966). In the absence of instantaneous competitive convergence, innovative entrepreneurs may gain extra profit during the lapse between which unit production cost has reduced and when prices follow the same downward trend. These extra gains can be reinvested in a new production venture that is job creating (Hicks, 1973).

Lost employment can also be compensated via increased income; i.e. a cost saving innovation implies increased income and hence consumption, which is an increasing function of income. Increased consumption can stimulate production and thus job creation (Pasinetti, 1983). Finally, an innovation may imply the creation of completely new products or significantly differentiating the existing ones. This will imply creation of new jobs without necessarily interfering with the existing ones (Vivarelli &and Pianta, 2000). Nevertheless, classical compensation theory, just like any theory has received criticism. For example, introduction of new machine does not necessarily imply adding to the stock of existing machines, but it might render old ones obsolete and thus scrape them out. This implies that there will be no labour compensation (Vivarelli, 2007).

3.2 Empirical Literature

This section is subdivided into two subsections. Herein, the paper first detours empirical works conducted beyond the African continent before discussing some studies within the continent.

3.2.1 Nexus between innovation and employment among non-African countries

Piva and Vivarelli (2005) applied GMM-SYS to an employment equation augmented for technology using a longitudinal dataset of 575 Italian manufacturing firms for the period 1992-1997, and found a significant although small positive relationship between innovation and employment. Smolny (1998) used micro-data for West Germany manufacturing firms from a panel covering 2,405 firms for the period 1980-1992 obtained from business survey, the innovation survey and the investment survey of the institute. The empirical results show that firms that innovate are more likely to exhibit employment growth than those that do not innovate.

In a study by Zimmermann (1991), the author relied on cross-sectional data covering 3,374 firms within 16 German industries for the year 1980 to illustrate that employment in Germany manufacturing industries is attributed to technological advances. In a related study, Peters (2004) sampled out 1,319 and 849 manufacturing and service firms, respectively, from the Community Innovation Surveys (CIS) data based on 2001 official innovation survey in the German manufacturing and service industries. Analytical results show a positive and significant impact of product innovation on employment. This impact in manufacturing firms tends to exceed that among service firms. Moreover, process innovation was noted to cause a reduction in employment during the period of analysis among manufacturing firms that solely conducted process innovations, but this was not the case among those that were marked by both process and product innovation. Process innovation had a positive impact on employment in the services sector

Bogliacino, Piva and Vivarelli (2014) subjected longitudinal data for 677 European firms from 1990-2008 to Least Squared Dummy Variable Corrected (LSDVC) estimation technique to show that the impact of R&D on employment is only positive among services and high-tech manufacturing firms. In another study, Meriküll (2010) relied on unbalanced panel data covering a sample of 2,783 firms obtained from Estonian CISs to show that at firm level, process innovation has positive statistically significant effect on employment. However, at industry level, the effect is much weaker. Although product and process innovations have positive and negative effects, respectively, on industry's job creation, their net effect on the industry's employment is insignificant. Using micro data from innovation surveys, Crespi, Tacsir and Pereira (2019) examine the impact of process and product innovation on employment growth and composition in Argentina, Chile, Costa Rica and Uruguay. Results from Instrumental Variables estimation provide evidence for growth of employment at firm level if new products are introduced. More so, there is lack of evidence that introduction of process innovations has a displacement effect.

In the paper by Damijan, Kostevc and Stare (2014) to investigate how employment responds to innovation, the authors use four waves of CIS data from 2004-2010 for 23 European countries. Their findings show that both product innovation and organizational and marketing innovation consistently affect employment growth positively in both manufacturing and service firms. On the contrary, process innovation was noted to cause labour displacement effects for manufacturing firms, but there was no evidence for negative effect in service firms. Zhu, Qiu and Liu (2021) used data extracted from China Firm Survey (2012) conducted by the World Bank to show that the effect of process innovation on employment is positive while that of product innovation is negative. The positive effect on job creation is associated with an increase in sales of old products while the negative one arises from increased productivity of new products.

Pawłowski and Yu (2017) used a panel dataset of 37 manufacturing industries for the period 2001-2010 to examine how environmental innovation would trigger employment in China. Random effect and fixed effect estimations were used appropriately to show that employment is an increasing function of environmental process innovation but a decreasing function of environmental product innovation. The findings further reveal that environmental innovation and employment exhibit heterogenous relationship across China's manufacturing industries. Environmental process innovation can significantly and positively trigger employment in dirty industries whereas similar but insignificant effect was noted in clean industries. Environmental product innovation was noted to freeze employment in manufacturing firms albeit insignificantly. Furthermore, the effect of environmental product innovation is negative in both clean and dirty industries, though this effect is only significant in the former.

In their evaluation of how Argentinean Support Programme for Organizational change affects employment and wages, Castillo, Maffioli, Rojo and Stucchi (2014) used unbalanced panel data set of firms in Argentina for the period 1996-2008. A combination of fixed effect and matching estimation were employed to show that both process and product have increasing effects to employment and wages, with the impact on employment being higher. Moreover, the effect of process innovation on wages was relatively less than that of product innovation. In the analysis of how employment and job quality are affected by technological innovation, Duhautois, Erhel, Guergoat-Larivière and Mofakhami (2020) use a matched data of French firms (CIS with administrative and fiscal data) fitted into difference-in-difference matching model to provide evidence that employment and certain aspects of job quality such as the number of permanent contracts and working hours increases with product innovation.

3.2.2 The nexus between innovation and employment among African countries

Baffour et al. (2020) studied innovation and employment in manufacturing and service firms in Ghana using a panel data of 421 firms. The study employed panel fixed effects and Hausman-Taylor estimation techniques to estimate a labour demand function, with employment levels as the endogenous variables while process innovation, product innovation, age of the firm, foreign direct investment (FDI) dummy, assets, union dummy and sector fixed effects were the regressors. The results revealed a significant positive impact of product innovation on employment, but not for process innovation.

Porath, Nabachwa, Agasha and Kijjambu (2021) used two-year panel data for 687 firms sampled from some selected SSA countries extracted from the World Bank Enterprise Survey to examine how employment is affected by innovation. The static labour demand equation estimated using FE, which is equivalent to first differencing when only two data waves are used, show that both process and product innovations are highly significant in driving employment. Medase and Wyrwich (2021) utilized the combined cross-sectional data of 1,359 observations extracted from Nigeria Innovation Survey, which was collected from 2005-2007 to 2008 to establish the relationship between innovation and employment growth within the manufacturing and service firms. The OLS and quartile regressions reveal a positive relationship between process innovation and employment growth among the manufacturing and services firms in Nigeria. Similarly, the relationship between product innovation and employment growth among manufacturing firms is also positive.

Okumu et al. (2019) estimated the effect of innovation on employment growth among manufacturing firms in Africa using pooled Ordinary Least Squares (OLS). Cross-sectional data collected in different years in different countries covering a sample of 64,000 firms from 27 African countries obtained from the World Bank Enterprise Survey dataset was used. The results indicated that employment growth is positively associated with both process and product innovation and, further, a weak business environment undermines the ability of innovation to induce employment growth. It was also revealed that the relationship between innovation and employment growth is conditioned on firm size and not firm age.

Elsewhere, Klette and Førre (1998) relied solely on descriptive analysis to examine how job creation relates directly with investment in innovation measured by R&D expenditure. Census data from 1982 to 1992 for firms employing more than 20 workers was used. One of the key findings was absence of a clear-cut positive relationship between R&D intensity of a firm and net job creation. It was also noted that both net job creation and job security were less among firms that were R&D intensive. Cirera and Sabetti (2019) used the World Bank Enterprise Survey data to show that there is a direct positive effect of innovation on employment quantity among developing countries in Africa and beyond.

In summary, while the literature on developed countries and Latin America may provide some consensus on the effect of product innovation on employment, there is lack of consensus on the relationship between process innovation and employment. Further, there are very few studies for African countries, and no studies in Kenya have examined the effect of innovation on employment.

4. Methodology

4. 1 Theoretical Framework

Evidence from a wide pool of literature shows that the relationship between innovation and employment can be estimated by fitting data in a labour equation with the main point of departure being model specification and estimation criteria. For example, Baffour et al. (2020) argue that the link between innovation and employment can be established by examining how innovation relates with employment quantity measured by the number of existing jobs. This paper, therefore, achieved its objectives by estimating a labour demand function. This function recognizes the influence of technology on marginal productivity of labour. According to Lachenmaier and Rottmann (2007) and Zimmermann (2009), the labour demand function can implicitly be expressed as:

$$L_{it}=f(T_{it},Q_{it},X_{it}\lambda_{it}) \quad (4.1)$$

Where L_{it} is labor demand, T_{it} is technological innovation, Q_{it} is the product quality while X_{it} and λ_{it} represent observable and non-observable variables, respectively. The subscripts i and t denote cross-sectional and time dimensions respectively.

4.2 Empirical Specification

Guided by the work of Baffour et al. (2020), this paper estimates the effect of innovation on employment at firm level by introducing other control variables for firm covariates, and by decomposing technology innovation into product and process innovation. In other related empirical studies, such as by Piva and Vivarelli (2005) and Van Reenen (1997), the authors specify both dynamic and stochastic labour equations, but they estimated the former equation with both innovation and employment lagged one period. The key independent variables (product and innovation) were based on whether an i^{th} firm innovated or not within three fiscal years that preceded the survey period while the dependent variable (employment) was strictly total labour quantity as at the end of each of the fiscal years that preceded the survey.

Based on this, the authors argue that the lagged effect of innovation on employment can sufficiently be captured by a static model without necessarily making a dynamic specification. This is because there is at least some time lag between when an innovation is made and when employment variable is recorded, giving time for employment to adjust to innovations if a causal relationship occurs. Estimation of the static model is also reinforced by an argument of Porath et al. (2021), in that with only two data waves and with long lags between these two waves, correlation is expected to be inconsequential. Moreover, this paper adopts a model specification that draws much from the specification presented by Baffour et al. (2020), but with some variability in how some variables were measured and the included variables. The static equation estimated is explicitly expressed as:

$$lnTotalfulabor_{it} = \beta_0 + \beta_1 ProdIn_{it} + \beta_2 ProcIn_{it} + \beta_3 lnwage_{it} + \beta_4 productivitygrowth_{it} + \beta_5 Salesgrowth_{it} + \beta_6 lnage_{it} + \beta_7 lnFDI\_Share_{it} + \beta_8 licencedtech_{it} + \beta_9 lnExpe_{it} + \beta_{10} FSize_{it} + (\varepsilon_i + v_{i,t}) \quad (4.2)$$

Where *lnlabour* is the natural log of total employment, while *Prodln* and *Procln* are process and product innovations respectively. *lnwage* and *lnage* are the natural logs of wage and age, respectively. *Productivitygrowth* is the growth in labor productivity whereas *salesgrowth* is the growth in total annual sales. *lnage* is the log of firm's age, *lnFDI-Share* is the log of the foreign direct investment as share of total ownership of a firm. *licencedtect* measures the presence of technology licensed from a foreign-owned company and is the natural log of years of experience of the top manager while *Fsize* captures firm size. β_1 to β_{10} are respective parameters that were estimated, while ε_i is the idiosyncratic individual and time-invariant firm's fixed effect while v_{it} is the usual error term. The subscripts *i* and *t* denote cross-sectional and time series dimensions, respectively. To enhance robustness of the results, region, sector and year dummies are also included during estimation to control for region, sector and time-specific fixed effects respectively.

4.3 Data Analysis

Data analysis employed both descriptive and inferential statistics. The commonly used panel data estimation techniques are fixed effect, random effect and Pooled Ordinary Least Square (POLS) estimations. However, if at least some of the covariates are time-invariant, FE approach, which relies on time demeaning, will eliminate all the time-invariant variables, making it impossible to estimate corresponding parameters. In the case of time invariant variables, Hausman-Taylor (H-T) method is preferred. The Hausman-Taylor (1998) estimation technique is an IV estimator that enables coefficients of time-invariant regressors to be estimated. With H-T estimator, IV estimators that are in between a FE and RE approach can be derived. The technique uses both the within and between transformation of the strictly exogenous variables as instruments, and all these instruments are derived from within the model with no external instruments. Based on this, the econometrics analysis strategy started with model selection that gave preference to POLS, whose results are presented alongside those of RE. The

RE results are meant to serve as a robustness check.

In the model specification, given that this paper treats innovation as a dummy variable, there was suspicion of innovation variables being time-invariant Nevertheless, attempts to run Hausman-Taylor estimation confirmed that none of the covariates fitted in the model was time-invariant and, as such, the use of H-T technique was nullified. Note also that FE, otherwise known as a "within estimator" yield consistent parameters in estimations involving panel data. FE allows time invariant error terms to freely correlate with regressors. This flexibility of the FE is what often makes it more preferred to RE, which relies on the assumption of no correlation between time invariant error term and the regressors. Despite having ruled out H-T method, implying that all the regressors were time variant, the authors were still skeptical to use FE, since a number of regressors in model were dummies and simply time demeaning them as it is in the case of FE might not give plausible findings.

After considering that the H-T and FE are less appropriate, the econometrics analysis proceeded to the estimation of equation 4.2 using POLS. Nevertheless, we run the RE estimates for the same equation and then conduct the Breusch-Pagan (B-P) test. This test helps to make a choice between POLS and RE. The B-P test establishes if the residuals are homoscedastic. Ideally, if the regressors are strictly exogenous and the time varying error terms are not correlated and homoscedastic, then both POLS and RE yield efficient estimates only if there is absence of unobserved effects. The B-P test results with Prob > chibar2 = 0.499 as shown in the appendix Table A4 suggests that the null could not be rejected. This served as evidence that residuals were homoscedastic and, as such, POLS was more appropriate compared to RE estimation. Nevertheless, for robustness checks, the study presented the results for both POLS and RE.

4.4 Definition of Variables and Data Sources

The definitions and measurements of variables as captured in equation 4.2 are as specified in Table 4.1.

Table 4.1: Definition of variables

Variables	**Measurement**
lntotalfulabour$_{it}$ = natural log of total employment	Natural log of the total number of permanent and temporary full-time employees at the end of the fiscal year before the survey
Prodln$_{it}$ = product innovation	Measured as dummy (0=No new/significant product/service was introduced and 1=New product/service was introduced) or significant change to existing one(s) took place
Procln$_{it}$ = process innovation	Measured as dummy (0=No new production process was introduced and 1=New or significant production process was introduced)
lnwage = natural log of wage	Wage is given by the total labor cost during the fiscal year before the survey divided by the sum of permanent and temporary full-time employees at the end of the same fiscal year
Productivitygrowth = growth in labor productivity	Computed by taking sales per hour per full-time employee during the fiscal year before the survey minus that during 3 fiscal years before the survey divided by the average of the two
Salesgrowth$_{it}$ = sales growth	The difference between total sales in the fiscal year before the interview and that at the end of 3 fiscal years before the survey divided by a firm's average sales during the same period
lnage = natural log of age of the firm since its first establishment	Natural log age of firms measured in numbers of years since the first establishment was set
lnFDI-Share$_{it}$ = natural log of the FDI share	Natural log of the firm's share measured as the percentage owned by private foreign individuals, companies and organizations
licencedtect$_{it}$ = Presence of imported/foreign technology	Dummy for use of technology licensed from a foreign-owned company (1=yes, 0=no)
lnExpe$_{it}$= natural log of experience	Log of experience where experience is the number of years of in the sector that top manager has
Fsize$_{it}$ = size of the firm	Firm size measured as a dummy (1=Small, 2=medium and 3=large).
Region$_{it}$ = region where the firm is located	Measured as a dummy (1=Mombasa, 2=Machakos, 3=Kirinyaga, 4=Kiambu, 5=Nakuru, 6=Kisumu, 7=Nairobi)
Sector$_{it}$ = sector to which a firm belongs	Measured as dummy (1=Food, 2=Textiles and Garments, 3=Chemical, pharmaceutical and plastic, 4=other manufacturing)
Year$_{it}$ = year of the survey	Year dummy (0=2013, 1=2018)

Source: Author

The World Bank Enterprise Survey data had three panel datasets of 2007 and 2013 only, the 2013 and 2018 only and the 2007, 2013 and 2018. After cleaning and constructing balanced panels for all the three data sets, it was noted that only 58 manufacturing firms (116 observations) were available for analysis using the 2007 and 2013 only dataset. For the 2007, 2013 and 2018 dataset, the resulting panel consisted of only 28 manufacturing firms (84 observations) while the 2013 and 2018 panel dataset gave rise to 200 observations on 100 manufacturing firms. Due to the relatively smaller sample size for 2007 and 2013 only and for the 2007, 2013 and 2018 datasets compared to the 2013 and 2018 panel, the study resorted to the use of the latter dataset. The 2007 and 2013 panel datasets were less preferred, also because the 2013 and 2018 dataset was more recent.

The original 2013 and 2018 data as extracted from the World Bank Enterprise Survey database comprised of 130 manufacturing firms, with 30 firms having been observed only once. Data cleaning started by construction of a balanced panel, which involved dropping 30 observations for firms that had not been observed for the two data collection waves. The data used was a balanced panel for 100 firms, each observed twice leading to a total of 200 observations. The 2013 data wave was collected from January 2013 to September 2014 while the 2018 one was collected from May 2018 to January 2019. The World Bank Enterprise Survey for Kenya stratifies firms into three categories, with all the firms surveyed having at least five employees. Precisely, firms with 5 to 19 employees were regarded as small firms while medium firms and large firms were those with 20 to 99 employees and those with over 100 employees, respectively.

From the constructed dataset, it was noted that some firms had switched from one size stratum to another. Generally, out of the 200 observations, 55 were for firms categorized as small, 91 for medium size while 54 were regarded as large firms. Furthermore, firms in the manufacturing industry used in this study were classified into four major sampling sectors. With the corresponding frequencies of observation in parenthesis, these sectors are food (74), textile and garments (22), chemical, pharmaceutical and plastic (33) and other manufacturing firms (71). As earlier noted, sector dummies were included to control for specific sector effects. These four sectors can be further categorized into 17 sectors as shown in appendix Table A2. In terms of geographical distribution, the firms were located in seven regions as summarized in appendix Table A3. The region dummies included were based on these regions. Evidence from the data indicates that some firms had relocated from one region to another between the two survey periods. Time dummies included were for 2013 and 2018 survey periods.

Although the paper relies on data extracted from the World Bank Enterprise Survey, most of the variables are not used in their original form. A series of data cleaning procedures, including recoding, log transformation and generation of some interaction variables was conducted. The dependent variable, which captures employment, was constructed by taking the number of permanent, full-time employees at the end of the fiscal year that preceded the year of the survey and summing it with the number of full-time temporary employees at the end of the same period before taking the natural logarithm of the outcome. Product and process innovations, which were the main independent variables of interest, were obtained by the yes/no responses to the questions of whether new products/services had been introduced over the three years before the year of the survey for product innovation while for process innovation it was whether a new or significantly improved process had been introduced or not during the same period.

Literature has also shown that there is a relationship between innovation and firm size, and hence the need to include this variable as a control regressor. Employment measured by the number of employees has been widely used as a proxy for firm size. Herein, the dependent variable is labour quantity, and this nullifies replicating it on the same equation as a regressor. Instead, firm size categorized into small, medium and large strata is used. In some studies, such as Baffour et al. (2020), value of assets has been used to proxy firm size. Lack of such data made it infeasible for this paper to embrace the same as an alternative to the number of employees.

There is a link between employment of a firm and its performance (Artz, Norman, Hatfield and Cardinal, 2010; Wang and Wang, 2012) Revenue, market shares, return on assets, value added productivity are among the indicators used to capture performance of firms. The available data could only permit the use of revenues (sales). With the assumption that employment is less likely to instantaneously respond to the volume of sales (revenue), the study instead uses growth in sales. A similar measure was also used by Artz et al. (2010). Computing growth in sales was done by getting the difference between total annual sales for the fiscal year just before the survey and that for three years before the survey period and then dividing this difference by the average of the two sales values. This measure makes it possible to trace how the total number of full time employees at the end of the fiscal year preceding the survey year had responded to changes in revenue from the end of three fiscal years prior to the year of survey through to the end of the fiscal year just before the survey.

Theory and empirical literature have provided substantial evidence that labour demand is a function of wages (Meer and West, 2016; Zavodny, 2000). Wage as used in this paper is computed by taking the total labour cost divided by the total number of full-time employees where the total labour cost includes wages, salaries and bonuses, among other labour costs incurred during the fiscal year just before the year of the survey.

A total number of employees was obtained by summing the total number of permanent full-time employees with the total number of full-time temporary employees, both measured as at the end of the fiscal year just before the survey. Computation of labour productivity growth started by computing productivity values, which was done by taking the total annual sales, divide it with the total number of full-time permanent employees to obtain annual value of sales per worker. The annual sales per worker was then divided by 52 to get the weekly sales per worker before further dividing the result by the average weekly number of hours each firm was operating. The resulting outcome measures sales per worker per hour, which was the measure of labour productivity. This was done separately for the fiscal year just before the survey and that for three years before the survey period. The difference between the two productivity values was obtained and then divided by their average.

Furthermore, the argument for inclusion of age of the firm is twofold. First, most of the empirical literature investigating how employment is affected by innovation have also used this variable (Medase and Wyrwich, 2021; Baffour et al., 2020). Second, there is literature showing that the age of the firm has effect on innovation. This effect is positive for some studies (Tripsas and Gavetti, 2000) but negative in others (Balasubramanian and Lee, 2008; Majumdar, 1997). Moreover, to obtain the log of FDI share as used in this study, the authors extracted the FDI (per cent owned by private foreign individuals, companies, or organizations) as available at the World Bank Enterprise Survey database, then divided this by 100 to obtain foreign ownership shares before taking the natural log of these shares. Measurement of other variables was as straightforward as explained in Table 4.1.

4.5 Descriptive Statistics

Table 4.2: Summary statistics

Variable		Overall (all firms)		Innovators (at least one form of innovation		Non-innovators (No innovation of any type)	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log of employment	overall	3.961	1.260	4.186	1.281	3.381	0.993
	between		1.205		1.232		1.008
	within		0.375		0.357		0.094
Product innovation	overall	0.613	0.489	0.841	0.367	0.000	0.000
	between		0.354		0.331		0.000
	within		0.337		0.195		0.000
Process innovation	overall	0.533	0.500	0.731	0.445	0.000	0.000
	between		0.304		0.334		0.000
	within		0.399		0.301		0.000
Log of wage	overall	11.961	1.481	11.92	1.355	12.051	1.785
	between		1.151		1.143		1.692
	within		0.933		0.7465		0.614
Productivity growth	overall	-0.036	0.185	-0.053	0.193	0.009	0.153
	between		0.139		0.167		0.154
	within		0.128		0.106		0.040
Sales growth	overall	0.022	0.771	-0.005	0.813	0.0930	0.654
	between		0.476		0.649		0.667
	within		.607		.538		.149

Log of firm age	overall	3.106	0.735	3.108	0.739	3.100	0.730
	between		0.669		0.690		0.743
	within		0.301		0.249		0.088
Log of FDI share	overall	0.055	0.161	0.060	0.164	0.042	0.154
	between		0.131		0.154		0.162
	within		0.094		0.071		0.000
Technology licensed by foreign firm	overall	0.2	0.401	0.248	0.434	0.074	0.264
	between		0.293		0.357		0.279
	within		0.275		0.264		0.000
Log of experience	overall	2.7959	0.799	2.853	0.745	2.696	0.848
	between		0.612		0.583		0.866
	within		0.517		0.448		0.134
Firm size	overall	1.995	0.740	2.090	0.726	1.759	0.725
	between		0.653		0.688		0.721
	within		0.351		0.289		0.168
Region	overall	4.815	2.336	5.137	2.232	4.019	2.399
	between		2.329		2.297		2.369
	within		0.251		0.000		0.000
Sector	overall	2.505	1.307	2.531	1.286	2.426	1.382
	between		1.195		1.251		1.330
	within		.538		0.441		0.495
Year	overall	.500	.501	.407	0.493	0.759	0.432
	between		0.000		0.308		0.369
	within		.5013		0.421		0.238

Source: Authors

From Table 4.2, based on the means of log of employment, it can be deduced that, on average, innovating manufacturing firms in Kenya employ more people than firms that do not take part in any form of innovations. Further, innovative firms pay, on average, low wage than what non-innovators pay. The log of FDI share indicates that, on average, firms that innovate have a higher share of foreign ownership than non-innovators. Relying on the mean of the log of age, on average innovative firms in the entire manufacturing sector are older than non-innovators. Similarly, the average log of experience suggests that firms that innovate have top managers who are more experienced than those that do not innovate. It is also suggested that innovative firms lag behind the non-innovating ones both in productivity growth and sales growth. All other remaining variables that are product and process innovations, technology licensed by foreign firms, firm size, region, sector, and year are categorical and dummies and as such we cannot draw meaningful inferences from their descriptive or summary statistics.

Before delving into econometrics analysis, by means of pairwise correlation, the paper provides an overview of the association between variables used and such results provided in Table 4.3.

Table 4.3: Pairwise correlation coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Log of employment	1.000										
2(Product innovation)	0.336	1.000									
(3) Process innovation	0.152	0.392	1.000								
(4) Log of wage	0.003	-0.105	-0.102	1.000							
(5) Productivity growth	-0.090	-0.142	-0.140	0.112	1.000						
(6) Sales growth	0.010	-0.063	-0.073	0.077	0.857	1.000					
(7) Log of firm age	0.176	0.020	-0.100	0.049	-0.118	-0.175	1.000				
(8) Log of FDI share	0.222	0.060	-0.071	0.043	0.036	0.056	0.0858	1.000			
(9) Foreign licensed technology	0.247	0.232	0.214	0.023	-0.029	-0.004	0.125	0.323	1.000		
(10) Log of Experience	0.001	0.028	0.116	0.113	0.056	0.046	0.321	-0.100	0.003	1.000	
(11) Firm size	0.741	0.271	0.107	0.198	-0.083	-0.051	0.103	0.121	0.155	0.067	1.000

Source: Authors

Table 4.3 shows that all the independent variables, except growth in productivity and year, are positively correlated with the log of total employment, which is the dependent variable. The magnitude of the pairwise correlation coefficients of less than 0.4 in absolute terms between nearly all the variables indicate weak association between the variables. Nevertheless, strong associations are seen between growth in sales and productivity and between employment and firm size. These strong associations are expected, since productivity and sales growth are interaction variables whose generation involved use of values of sales. In addition, classification of firms into either small, medium or large categories was based on the number of employees and hence the high correlation coefficient between log of employment and firm size was expected. Since correlation does not imply causality, econometric analysis was conducted to establish the causal effect and the results presented in Table 5.1.

5. Results and Discussion

5.1 Estimation Results

The results for the two estimation approaches are robust to heteroskedasticity and autocorrelation. Robust results for POLS were obtained by clustering the standard errors on years and individual firms. The results from POLS and RE estimation results are summarized in Table 5.1.

Table 5.1: Econometric results on determinants of employment

Variables	Pooled OLS	Random Effect
Product innovation	0.313** (0.119)	0.274** (0.122)
Process innovation	0.132 (0.132)	0.091 (0.146)
Log of wage	-0.084* (0.046)	-0.091** (0.045)
Productivity Growth	-1.565** (0.625)	-2.036*** (0.709)
Sales growth	0.486*** (0.172)	0.561*** (0.188)
Log of firm age	0.168* (0.097)	0.187 (0.116)
Log of FDI share	0.756* (0.402)	0.448 (0.448)
Foreign licensed Technology	0.196 (0.203)	0.0612 (0.172)
Log of Experience	-0.081 (0.109)	-.220** (0.112)
Firm size (Medium)	0.988*** (0.157)	0.652*** (.176)
Firm size (Large)	2.278*** (0.209)	1.497*** (0.236)
Constant	3.298*** (0.770)	4.099*** (0.722)
Rho = (fraction of variance due to u_i)		0.650
Prob > F	0.000	0.000
R-squared	0.675	within = 0.065
between = 0.676		

overall = 0.633		
No. of Observations	200	200
***significant at 1%, **significant at 5% *significant at 1%		

Note: Region, sector and time dummies included in the estimation to control for region, sector and year specific effects. Robust Standard errors in parenthesis. For POLS, standard errors are clustered at the level of year and firm.

The discussion of the results is majorly based on POLS, whose results are not far from the RE estimates, which is used for robustness check. With the prob>chi^2 of 0.000, it is concluded that the overall models for both POLS and RE are highly significant and, as such it is justified to make inferences based on their parameter estimates. Furthermore, Rho=0.650, corresponding for the RE estimations shows that 0.650 per cent of variations are explained by individual specific effects. The authors argue that including time dummies, sector dummies and region dummies in the estimated model reinforces the reliability of the results. Precisely, inclusion of these dummies helps to control for specific effects for years, sectors and regions and thus enhancing the robustness of the results. Moreover, the results remain robust even when the RE model is used instead of POLS, with the two estimation criteria resulting to the similar inference.

The analytical results from POLS, which is reinforced by those from RE, show that the influence of product innovation on employment among manufacturing firms in Kenya is positive and statistically significant. This effect can be explained using the classical compensation theory. The theory suggests that innovations may lead to job loss in one way and create more jobs in another way, such that the number of created jobs could offset that of lost ones and hence a positive effect of innovation on the net job creation. Alternatively, product innovation could lead to a new product or service being introduced to the market, thus stimulating an increase in demand for labour needed in production of such a product, especially if the new product is accompanied by expansion in the market share as measured by sales. The likelihood of increased labour demand being linked to product innovation through increased sales can, to some extent, be justified by the positive and significant effect of growth in sales on employment as reflected in Table 5.1.

In general, the findings on how employment responds to product innovation corroborate those by Peters (2004), Damijan, Kostevc and Stare (2014), Baffour et al. (2020), Medase and Wyrwich (2021), Okumu et al. (2019) and Porath, Nabachwa, Agasha and Kijjambu (2021). However, these findings contradict those of Zhu, Qiu and Liu (2021) and Pawłowski and Yu (2017), who established a negative and significant effect of product innovation on employment. The effect of process innovation on employment is positive, but statistically insignificant. This could be explained by the fact that innovative policies in manufacturing firms tend to focus more on product innovation at the expense of process innovation, which is affected majorly by weak technical efficiency (Cahn et al., 2019). The result supports Baffour et al. (2020), who also showed that process innovation has a positive but insignificant effect on employment. Furthermore, the results confirm those by Zhu, Qiu and Liu (2021), Pawłowski and Yu (2017), Medase and Wyrwich (2021), Okumu et al. (2019) and Porath, Nabachwa, Agasha and Kijjambu (2021) in terms of direction of influence, with the only point of departure being that for the just mentioned empirical works, the effect was significant unlike in the current paper where it is insignificant. However, our finding opposes those of Peters (2004) and Damijan, Kostevc and Stare (2014) who found a negative and statistically significant effect of process innovation on employment.

The authors also did a further robustness check by re-estimating equation 4.2 in three other different ways where a separate set of regressors measuring innovation was used in each case. In the first scenario, the authors dropped process innovation from the original equation while in the second scenario, it is product innovation that was left out. In the third and last case, both product and process innovation variables were eliminated from the estimation and instead replaced by a variable called "bothinno", which was coded as "1" if a firm took part in both product and process innovations and "0" otherwise. The POLS results for these three subsidiary estimations are captured by appendix Tables A5, A6 and A7, respectively. The results displayed in Table 5.1 provides evidence that if the labour demand equation specified in this paper is estimated with exclusion of process innovation, the effect of product innovation on employment is still positive and even highly significant than in the original case. Similarly, Table A6 reveals that the effect of process innovation on employment is still positive and insignificant even after excluding product innovation from the original estimation. Lastly, from Table A7, it can be deduced that firms simultaneously taking part in both product and process innovations tend to employ more workers than those involved solely in product or process innovation or in neither of the two. From the three subsidiary estimates, the authors argue that although process innovation has insignificant effect on employment, it augments the positive effect of product innovation on employment if the two forms of innovations are introduced concurrently.

Based on estimation results presented in Table 5.1, which are further reinforced by those in Tables A5, A6 and A7, this paper is also considered informative in contributing to existing literature on how employment responds to non-innovation regressors, which are growth in sales, age of the firm, foreign direct investment, presence of foreign licensed technology, years of experience of top managers and size of the firm. The paper establishes that employment is a decreasing function of wages. This finding supports a number of studies such as Meer and West (2016), Zavodny (2000) and Piva and Vivarelli (2005). Similarly, the results show that employment responds negatively to growth in labour productivity as measured by total sales per hour per full-time permanent employee. The results also suggest that employment among manufacturing firms in Kenya increases in responses to growth in sales. This finding confirms those by Piva and Vivarelli (2005) and Cirera and Sabetti (2019).

The results in Table 5.1 further show that age of a firm has a positive effect on employment. This effect was only significant at 10 per cent level of significance. Similar but highly significant findings were obtained by Baffour et al. (2020). In the contrary, Medase and Wyrwich (2021) found a negative and significant effect of sales growth on employment. It can also be deduced that an increase in the firms' foreign ownership share has the tendency to increase employment level. This effect is only significant at 10 per cent. This implies that foreign-owned manufacturing firms have the tendency to absorb more labour force than those owned majorly by domestic individuals, companies, or organizations. The effect can be linked to the fact that FDI is often associated with introduction of physical resources and technological know-how and hence heightens the need for more labour force (Baffour et al., 2020).

The presence of technology licensed by a foreign firm is noted to have the effect of increasing employment level. It can also be deduced that as top managers become more experienced, there is a tendency of firms to cut down their employment. However, the effect of technology licensed by foreign firms and years of experience of top manager were not significant. Finally, the findings of this study reveal a positive and significant effect of firm size on employment. This was highly expected since firm size as used in this paper was a categorical variable constructed based on the number of employees. We find this result to support those by Cirera and Sabetti (2019), although for them the effect was insignificant.

6. Conclusion and Recommendations

This paper provides evidence that sheds light on a fundamental topic of how employment is driven by innovation. Although this is a critical subject, especially if examined in the context of stimulating economic development, it is yet to attract substantial empirical investigation especially in Kenya. The preliminary analysis shows weak correlation between most variables, except between growth in sales and productivity and between log of employment and firm size. Econometric analysis shows that both process and product innovations have a positive effect on employment. However, such effect is only significant for product innovation. These findings support the argument that introduction of new products or services in the manufacturing sector has the effect of increasing employment in the sector. Since the introduction of innovation is considered for about three years before the survey period, the authors argue that the response of employment to innovation is not necessarily instantaneous.

Thus, the paper argues that for manufacturing firms to support the country in battling the unemployment menace, they should consider striving to innovate products and services, since this has been shown to push up their employment levels and help scale up employment opportunities in the entire labour market. For example, in reference to Kenya's National ICT Policy (2019), there is evidence that the policy has a target of advancing her industrialization vision, create dignified employment and pave way for greater innovation. This policy serves as an example of the government's commitment to support innovation. Some of the agencies that spearhead the implementation of the Government of Kenya innovation policies include NACOSTI, KENIA and NRF. These agencies, among others, in conjunction with other relevant stakeholders, need to beef up their support to the innovative activities within the manufacturing sector as this will step up the fight against joblessness in the country. More effort needs to be directed towards development, promotion, transfer and diffusion of new ideas into products and processes to replace obsolete technologies. This will be achieved by creating more innovation incubation centres to nurture innovators.

The Ministry of Education in collaboration with other stakeholders (KENIA, KIRDI, NACOSTI, NITA, Private Sector) should also strengthen academic and industrial linkages to enhance the development of human capital in innovation and commercialization. Use of applied research and exchange programmes on innovative strategies and approaches is necessary.

Finally, there is need for an enabling environment for less costly and sustainable innovations to thrive. There is need to mobilize more funding and provide other incentives to support and encourage innovations, especially by MSMEs. The use of local resources also needs be encouraged.

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Appendices

Table A1: GII ranking by pillar for selected top performers

Country	Inputs Indicators					Outputs Indicator	
	Institutions	Human Capital and Research	Infra-structure	Market Sophisti-cation	Business Sophisti-cation	Knowledge and Tech-nology	Creative Outputs
Switzerland	13	6	3	6	2	1	2
Sweden	11	3	2	12	1	2	7
US	9	12	24	2	5	3	11
UK	16	10	6	5	19	9	5
Netherlands	7	14	18	23	4	8	6
Mauritius	22	69	64	16	117	79	43
South Africa	55	70	79	15	50	45	56
Kenya	78	110	114	57	68	70	91
Tanzania	101	126	105	87	118	106	45
Botswana	60	53	103	96	99	89	111

Data Source: GII Report (2020)

Table A2: Sectorial distribution

Industrial Screener Sector	**Frequency**	**Percentage**	**Cumulative**
Food	73	36.500	36.500
Textiles	17	8.500	45.000
Garments	6	3.000	48.000
Leather	3	1.500	49.500
Wood	3	1.500	51.000
Paper	4	2.000	53.000
Publishing, printing and Recorded media	12	6.000	59.000
Plastics and rubber	10	5.000	75.500
Non-metallic mineral products	5	2.500	78.000
Basic metals	1	0.500	78.500
Fabricated metal products	4	2.000	80.500
Machinery and equipment (29-30)	10	5.000	85.500
Electronic (31-32)	6	3.000	88.500
Precision instruments	1	0.500	94.500
Transport machines (34-35)	11	5.500	94.50
Furniture	11	5.500	100.000
Total	**200**	**100.000**	

Table A3: Regional distribution

Region of the Establishment	Frequency	Percentage	Cumulative
Mombasa	40	20.000	20.000
Machakos	1	0.500	20.500
Kirinyaga	16	8.000	28.500
Kiambu	24	12.000	40.500
Nakuru	24	12.000	52.50
Kisumu	8	4.000	56.500
Nairobi	87	43.500	100.00
Total	200	100.000	

Table A4: Breusch and Pagan Lagrangian Multiplier test

Variance	1.467	Standrd Deviation
Log of Employment		1.211
Chibar2(01)		0.000
Prob>chibar2		0.500

Table A5: POLS results for product innovation only

Log of Employment	Coefficient
Product Innovation	.342*** (.127)
Log of Wage	-.084* (.046)
Productivity Growth	-1.580*** (.643)
Sales Growth	.490*** (.175)
Log of Firm Age	.157* (.096)
Log of Foreign Direct Investment Share	.709* (.396)
Foreign Licensed Technology	.214 (.203)
Log of Experience	-.074 (.108)
Firm Size Medium	.991*** (.156)
Firm Size Large	2.283*** (.212)

Region	
Machakos	.994*** (.265)
Kirinyaga	.468 (.315)
Kiambu	-.160 (.185)
Nakuru	-.324 (.220)
Kisumu	-.208 (.351)
Nairobi	-.088 (.220)
Sector	
Textiles and Garments	-.178 (.275)
Chemical, Pharmaceutical and Plastic	.035 (.207)
Other Manufacturing Sectors	-.047 (.144)
Year Dummy	.136 (.153)
Constant	3.378*** (.740)

Table A6: POLS results for process innovation only

Log of Employment	**Coefficient**
Process Innovation	.210 (.149)
Log of Wage	-.103** (.047)
Productivity Growth	-1.646*** (.587)
Sales Growth	.502*** (.167)
Log of Firm Age	.180* (.100)
Log of Foreign Direct Investment Share	.751* (.433)
Foreign Licensed Technology	.244 (.217)
Log of Experience	-.086 (.110)
Firm Size Medium	1.022*** (.151)

Firm Size Large	2.349*** (.215)
Region	
Machakos	.921*** (.273)
Kirinyaga	.371 (.306)
Kiambu	-.126 (.196)
Nakuru	-.322 (.232)
Kisumu	-.125 (.362)
Nairobi	-.023 (.224)
Sector	
Textiles and Garments	-.204 (.288)
Chemical, Pharmaceutical and Plastic	.011 (.211)
Other Manufacturing Sectors	-.094 (.148)
Year Dummy	.142 (.170)
Constant	3.618*** (.800)

Table A7: POLS results for both innovations

Log of Employment	Coefficient
Both Innovations	.340** (.166)
Log of Wage	-.084* (.049)
Productivity Growth	-1.607*** (.580)
Sales Growth	.474*** (.167)
Log of Firm Age	.166* (.098)
Log of Foreign Direct Investment Share	.819** (.418)
Foreign Licensed Technology	.211 (.213)

Log of Experience	-.076 (.108)
Firm Size Medium	1.003*** (.151)
Firm Size Large	2.334*** (.205)
Region	
Machakos	.949*** (.268)
Kirinyaga	. 475 (.304)
Kiambu	-.132 (.184)
Nakuru	-.300 (.224)
Kisumu	-.115 (.341)
Nairobi	-.051 (.215)
Sector	
Textiles and Garments	-.144 (.283)
Chemical, Pharmaceutical and Plastic	.022 (.204)
Other Manufacturing Sectors	-.086 (.142)
Year Dummy	.202 (.178)
Constant	3.338*** (.811)

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