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Analyzing the relationship between innovation and productivity: A case study of Kenya's manufacturing sector

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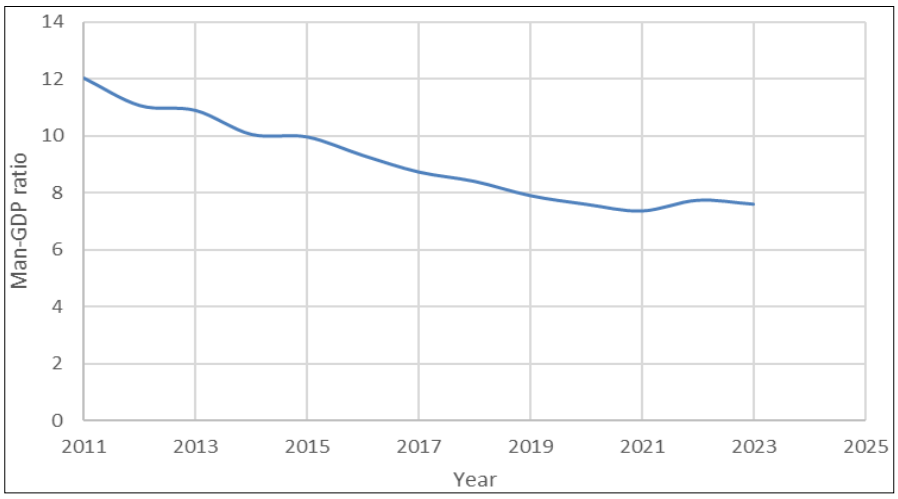
Abstract
Innovation is recognized as an important driver of productivity and economic growth, yet its dynamics within developing countries remain underexplored, especially in the context of the manufacturing sector. The manufacturing sector is important in achieving the Kenya's Vision 2030 that seeks to transform Kenya into a middle income country. However, the sector's growth has remained low at about 7 percent of GDP. The government and other industry stakeholders are actively seeking to raise the sector's share in the GDP by setting goals for example increasing it from 7.6 percent to 15 percent by 2027.One of the factors that may lead to such impressive growth is innovation by the firms in the manufacturing sector. The role of innovation in the performance of the firms in the manufacturing sector is underexplored in Kenya. This study therefore investigates the relationship between innovation and firm level productivity in Kenya's manufacturing sector. The study uses the micro, small and medium enterprise survey data. On using Propensity score matching, the study finding show that manufacturing firms that innovate on average realize KES 6 million more than their non-innovating counterparts. The study therefore recommends the implementation of policies that promote innovation adoption among manufacturing firms so as to boost productivity and foster industrial growth in Kenya.

Keywords: Innovation, manufacturing sector, productivity

Introduction

Manufacturing plays an important role in the economic growth and development of many countries across the world. According to the United Nations Industrial Development Organization (2024), the manufacturing sector's global production remained low in 2024, further extending the lackluster performance experienced since 2022. The success of manufacturing sector in any country is majorly determined by numerous factors such as innovation (UNIDO, 2024). Most countries in Africa, especially in Sub-Saharan Africa, experience challenges related to innovation as a result of multiple factors such as low incomes that characterizes micro, small and medium enterprises in the region (Ayinaddis, 2022). Therefore, in attempts to optimize productivity in the manufacturing industry, there is a need to pay equal attention to innovation as the most important determinant of the performance of the manufacturing sector. According to Zoogah (2023) [20], Kenya was ranked at the seventh position in terms of manufacturing value addition for top producers in Africa in 2017, with a growth rate of 5 percent, yet the country's rate of FDI remains constant between 2000 and 2017. Based on this reason, the manufacturing is undeniably one of the most importantl avenues of achieving economic stability and sustainability in Kenya. The Kenyan government has prioritized manufacturing as one of its key pillars for development.

The manufacturing sector is vital to Kenya's economic growth, job creation, and industrialization efforts under the Big Four Agenda and Vision 2030. However, the sector has continued to register negative growth for the last one decade. The Figure below shows the performance of Kenya's manufacturing sector for the period running from 2012 to 2023.



Source: World Bank, 2024.

Fig 1: The Performance of Kenya's manufacturing sector

The adoption of innovation is low, which restricts the sector's competitiveness in local and international markets. Despite numerous policy measures, Kenya's manufacturing industry still trails other emerging economies in technology adoption, efficiency, and value-added production. Kenya's manufacturing sector is varied, including industries such as food processing, textiles, chemicals, construction materials, and machinery. In Kenya, the manufacturing industry accounts for about 7.2% of GDP (Republic of Kenya, 2023) [14] and is a central element of the Kenya Vision 2030, aiming to raise its contribution to 15% of GDP. Despite sector's role in the country's economic growth, the sector share in GDP has continued to reduce. This unlike South Africa and Egypt which have vibrant manufacturing sectors. Major challenges that are likely to be impending the Kenya manufacturing sector from reaching its potential include high production costs, limited access to advanced technologies and insufficient investment in research and development. Kenya's invest only 0.8 percent of its GDP to Research and Development (R& D). This much less when compared to African average of 1 percent of GDP.

Innovation including product, process, organizational and marketing innovations boosts competitiveness. UNIDO (2022) reveals that companies investing in digital technologies such as Artificial Intelligence (AI), Internet of Things (IoT) and automation experience between 20 and 30 percent increase in their productivity.

The link between technological innovation and economic growth has been a central focus in various theoretical frameworks, including those by Solow (1956) [18], Romer (1986) [15], and Lucas (1988) [8]. Growth theory both in its theoretical and empirical forms have generated a substantial and diverse body of research. Solow (1956) [18] treated technological advancement as an external factor, meaning it operates independently of the economic environment, mainly to improve variable measurement in growth models and reduce unexplained residuals. In contrast, Romer (1986) [15] and Lucas (1988) [8] incorporated technology as an internal, or endogenous, factor influencing growth. From this standpoint, proponents of endogenous growth theory argue that economic growth stems from investments that drive technological advancement. Within the Schumpeterian growth framework, Aghion *et al*. (2014) [1] proposed that new innovators benefit from the knowledge spillovers of earlier ones, although they also replace existing technologies. They further suggested that Schumpeterian theory bridges the gap between growth and development by introducing the importance of tailored growth policies and institutional frameworks. For instance, they highlighted that democracy tends to foster higher growth in advanced economies. Additionally, they identified factors like intense competition, easier market entry, increased trade openness, and prioritizing education as drivers of growth in less advanced countries.

A substantial body of empirical research linking innovation and productivity has been executed but at an expanded scope by considering countries GDP (Ahmad *et al*., 2023; I. Khan *et al*., 2023; Manigandan *et al*., 2023; Meirun *et al*., 2021; Phung *et al*., 2019; Wang *et al*., 2023; Mtar & Belazreg, 2023) [2, 7, 9, 10, 11, 13, 19]. However, to the best of our knowledge no study has investigates the role of innovation on the productivity of the manufacturing sector. This study therefore investigates the relationship of innovation and productivity in Kenya using Micro, Small and Medium Enterprise (MSMEs) 2016 cross sectional data.

The rest of the study is organized as follows: Section 2 covers the literature review, Section 3 outlines the research methodology, Section 4 presents the empirical results and discussion, and Section 5 concludes with recommendations.

Literature Review

In developed countries, Hashi and Stojčić (2020) [6] used Crépon-Duguet-Mairesse model (CDM) to investigate the role of innovation in the performance of manufacturing firms across Central and Eastern Europe countries. The study results showed that both the product and process innovations had a positive and significant effect the manufacturing sector's productivity. However, the authors showed that for their to be effective innovation, there was need for countries to invest in both R&D investment and the human capital development. In another cross-country study, Cirera, Cruz, and Li (2021) [3] investigated the role of innovation on the performance of the manufacturing sector. The study used firm-level panel data from among the developing countries. The study's findings showed that manufacturing firms that had embraced innovation realized higher performance when compared to those that had not. However, the study emphasized the need for firms to boost their managerial practices and external collaboration for innovation to realize better outcome. In a related study, Hall, Lotti, and Mairesse (2022) [5] in using structural CDM-style multi-stage econometric model investigated the effect of innovation on the manufacturing sector's performance among the advanced economies**.** The **s**tudy results showed that innovation through investment in R&D led a positive and significant effect on the performance of the manufacturing. The study showed that the effect of innovation on the performance of the manufacturing sector was even more pronounced for firms that had adopted digital technology. In addition, a similar study, Dziallas and Blind (2021) [4] investigated the role of innovation on the performance of manufacturing sector. The study carried out an extensive literature analysis. In their findings, the study showed that innovation leads to improved performance of the manufacturing firms among the developed countries.

In developing countries, Shi *et al*. (2020) [17] used the Common Data Model (CDM) to investigate the relationship between innovation and manufacturing sector productivity in China. Their findings showed that a positive relationship between innovation and the performance of the manufacturing sector in China. In another study, Mugogo (2020) [12] investigated the effect of innovation on the performance of small and medium enterprises (SMEs) in manufacturing sector of Zimbabwe. In using hierarchical regression analysis, the study found that product and process innovation had a positive and significant effect on firm performance. In another study, Wang *et al*. (2023) [19], using data from 30 Chinese regions (2009–2020) and a Generalized Method of Moments (GMM) model, found that TI enhances green economy growth efficiency, especially in western China. In a related study, Meirun *et al*. (2021) [10] used a bootstrap ARDL method to show the positive impact of green technology innovation on growth in Singapore. Phung *et al*. (2019) [13], analyzing data from 69 countries (2006–2014) with GMM, found innovation, openness, and FDI inflows all positively affect EG, with institutional quality further enhancing this effect.

Methodology

1. Methods of Data Collection

The study utilized secondary data. Cross section data from the Micro, Small and Medium Enterprise (MSMEs) 2016 survey was considered for analysis.

2. Estimation Technique

The study used the Propensity Score Matching (PSM) to estimate the effect of digitalization on performance of MSMEs.

3. Model Specification

In order to estimate the effect of innovation on the performance of manufacturing sector in Kenya, the following regression model was specified

$$perfmanu_i = \alpha + \beta_1 innov_i + \beta_2 electr_i + \beta_3 seduc_i + \beta_4 teduc_i + \beta_5 grad_i + \mu_i \quad \ldots\ldots\ldots\ldots 1$$

Where perfmanu represents performance of the manufacturing sector, the dependent variable measured by labour productivity, innov represents innovation, the independent variable measured by a dummy variable taking the value 1 if the manufacturing firm implemented a new marketing method and zero otherwise. With respect to control variables, we include $electr$ to represent access to electricity. Controlling for access to electricity was informed by the fact that electricity is a key infrastructural constraint and can have a direct effect on a firm's productivity (Handayani, Nasrudin & Rezki, 2024). The study also controlled for education of the owner of MSME. Education is a proxy for human capital, which is regarded as a significant factor in stimulating innovation activities thus leading to high sales turnover (Leiponen, 2005; Schneider *et al*., 2010).

However, since selecting a firm into innovation is not randomized, establishing a cause effect relationship with adoption of innovation require one to control for adverse selection. In order to of reduce selection on observables, the study adopted PSM method which is built on the conditional probability of adopting innovation given certain covariates. The covariates are illustrated in equation 1. Estimating propensity scores relied on the availability of the mentioned covariates in MSME 2016 data. This reduced the bias brought about by the differences in the observed covariates therefore balancing the covariates between the firms that embraced innovation and those that did not. After applying the multiple regression in the estimation of (PS) and attaining the balance of PS between the firms that had embraced innovation and those that had not embraced. The aim was to estimate Average Treatment Effect (ATE), that is, the effect of innovation. ATE is obtained as a difference in the mean response for those manufacturing firms that had embraced innovation and those that are not. The ATE is illustrated in equation 2.

$$ATE = \sum_{i=0}^{n} (Y_{1i} - Y_{0i})) \quad \ldots.2$$

Where n is number of manufacturing firms, Y_{1i} is the outcome for those that implemented a new marketing method and Y_{0i} is the outcomes for those that did not implemented a new marketing method. However, equation 3 cannot be estimated since both Y_{1i} and Y_{0i} cannot be observed for every manufacturing firm. In addition, since the study is an observational one, there is a high probability that the outcome of study's interest, that is, implemented a new marketing method depends on a treatment thus leading to a biased ATE. The study thus uses regression results to obtained PM to estimate the causal relationship of innovation and performance of the manufacturing firms. Specifically, the study estimated and reported the Average Treatment Effect on Treated (ATT), that is, the average response to the treatment (embracing innovation). From the ATE equation illustrated in Equation 3, the study estimated the ATT as shown in Equation 3.

$$ATT = E(Y_{1i} + Y_{10}|W, Z) = 1) \quad \ldots\ldots\ldots 3$$

Where W is a vector of the covariates and Z is the concerned treatment, embracing innovation in this case. The estimation of ATT is anchored on the following assumptions (Morgan & Winship, 2007). First is that there is a stable unit treatment value assumption (SUTVA). This means that the treatment applied to one entity does not affect the outcome of any other. In other words, we mean there is no interference among the manufacturing firms. The second assumption indicates the presence of non-zero probability in obtaining every treatment level, embracing innovation in this case for the combination of the exposure values and the covariates among elements in the study population, MSMES in this case. This is called the positivity assumption. This assumption is made when each of the homogeneous elements can be subjected to treatment (embracing innovation) or the control group (those that didn't embrace innovation). The last assumption is that the treatment assignment mechanism is said to be unconfounded if the treatment status T_i is conditionally independent of the potential outcomes, given a set of covariates X_i. This is represented as illustrated in equation 4.

$$T_i || Y_{0i}, Y_{1i} | X_i \quad \ldots\ldots\ldots 4$$

These assumptions made it possible for the construction of the matched innovation samples. This was built on a balancing score, that is the PS (Rosenbaum & Rubin, 1983) and the estimation of the relationship of innovation by kernel, stratification and the nearest neighbour matching. Inverse probability weighting (IPW) was also conducted since this was an observational cross-sectional study with one treatment variable (Bender and Lange, 2001).

Results

1. Summary Statistics

The characteristics of the MSMEs are presented in Table 1.

Table 1: Summary Statistics

Variable	Obs	Mean	Standard Deviation	Minimum	Maximum
ln labour productivity	87	11.281	2.07	5.809	16.341
Innovation	127	0.378	0.487	0	1
Primary Education	124	0.315	0.466	0	1
Secondary Education	124	0.242	0.43	0	1
Tertiary Education	124	0.274	0.448	0	1
graduate	124	0.169	0.377	0	1
Acess to Electricity	127	0.819	0.387	0	1

Source: Computations of the author based on data from MSME 2016 data

From Table 1 it is evident that about 38 percent of the manufacturing firms adopted carried out an innovation through implementing a new marketing method. In addition, the results showed that on average a manufacturing firm had a labour productivity of KES 79 221 million, that is the antilogarithm of 11.281. The results also revealed that about 81.9 percent of the manufacturing firms had access to electricity. According to Republic of Kenya (2014), the high access to electricity can be attributed to reduced cost of the electricity in the country. The results also revealed that out of 124 owners of the manufacturing firms, those with basic education (primary and secondary education) were the highest translating to 55.7 percent. According to Carmichael, Darko, & Kanji (2021), this finding can be attributed to the fact that basic education in Kenya emphasize on theoretical and not practical skills that can make one to be absorbed in formal employment. This means the basic education levers have to resort to the MSMEs for survival. On sorting summary statistics by those that had implemented a new marketing method or not the statistics in Table 2 were obtained. A question was posed on whether a manufacturing firm had implemented a new marketing method or not.

Table 2: Summary Statistics by Adoption of Innovation

	N	Mean	Standard Deviation	Minimum	Maximum
No					
ln labour productivity	56	10.935	2.108	5.809	14.732
Primary education	77	0.363	0.484	0	1
Secondary education	77	0.338	0.476	0	1
Tertiary education	77	0.208	0.408	0	1
Graduate	77	0.091	0.289	0	1
Access to electricity	79	0.835	0.373	0	1
Yes					
ln labor productivity	31	11.905	1.873	8.112	16.341
Primary education	47	0.234	0.428	0	1
Secondary education	47	0.085	0.282	0	1
Tertiary education	47	0.383	0.491	0	1
Graduate	47	0.298	0.462	0	1
Access to electricity	48	0.792	0.410	0	1

Source: Computations of the author based on data from MSME 2016 data

From Table 2, it is evident that the manufacturing firms that embraced innovation realized higher labour productivity that is KES 148 million (Antilog of 11.905) as compared to those that had not. Those that had not embraced innovation had labour productivity of KES 56 106 million (antilog of 10.945). In addition, it is revealed that 29.8 percent of the firms that have embraced innovation are owned by graduates compared to 9.1 percent of those that are not. This may be due to the fact that university education improves human capital which is a significant factor in stimulating innovation activities.

2. Empirical Results

Table 3 shows the results for regression model shown in equation 1.

Table 3: Regression Results

Dependent Variable: Natural Logarithm of Labour Productivity				
Independent variable	Coefficient	Standard error	t	P>t
Innovation	1.331	0.513	2.60	0.011
Secondary Education	0.795	0.666	1.19	0.236
Tertiary Education	-0.388	0.619	-0.63	0.532
Graduate	-0.037	0.7955	-0.05	0.963
Access to electricity	-0.431	0.582	-0.74	0.462
Constant	11.151	0.576	19.37	0.000

Source: Computations of the author based on data from MSME 2016 data

The regression results shown in Table 3 indicated that firms that had embraced innovation realized KES 4 million (antilogarithm of 1.331) more sales than those that had not. The coefficient is statistically significant at 5 percent level of significance indicating the innovation is important determinant of performance of manufacturing sector in Kenya. These results are in line with Dziallas and Blind (2021) [4], Hall, Lotti and Mairesse (2022) [5] and Mugogo (2020) [12] which showed that adoption of innovation has a positive effect on the performance of manufacturing sector. The study established that education, access to electricity and access to credit had insignificant coefficients. This illustrated that the factors are not important determinant of performance of the manufacturing sector in Kenya.

The study used the explanatory variables to estimate the propensity scores. The results from which propensity scores were obtained are shown in Table 4.

Table 4: The Logistic Results

Dependent Variable: Innovation				
Independent Variables	Coefficient	Standard Error	t	P>t
Secondary Education	-0.4157043	0.3753839	-1.11	0.268
Tertiary Education	0.7530379	0.3181048	2.37	0.018
Graduate	1.141036	0.3721487	3.07	0.002
Access to Electricity	-0.3863584	0.3229969	-1.20	0.232
Constant	-0.3469917	0.2853752	-1.22	0.224

Source: Computations of the author based on data from MSME 2016 data

From Table 4, it was established that manufacturing firms whose owners have tertiary education and graduate are connection are likely to embrace digital connection innovation as compared to those whose owners have primary education. This was informed by positive and significant coefficents at 5 percent of significance. Finding undercores the fact that tertiary and university education that focus on practical teaching improves human capital which is a significant factor in stimulating innovation activities.

The propensity scores were obtained from above regression were used in estimating causal relationship of embracing innovation and the performance of manufacturing firms in Kenya. Specifically, the study estimated the 'Average Treatment Effect on the Treated' (ATT) with Nearest Neighbour Matching method. The results are shown in Table 5.

Table 5: Average Treatment Effect on the Treated' (ATT) with Nearest Neighbour Matching method Results

Number of Treatment	Number of control individuals.	ATT	Standard Error	t
47	54	1.775	0.704	2.519

Source: Computations of the author based on data from MSME 2016 data

The results revealed that a manufacturing firm that has embraced innovation realize KES 6 million (antilogarithm of 1.775 more in labour productivity than one that has not embraced innovation. As it is evident, the t value is greater than 2 implying that there is significant differences between manufacturing firm that has embraced innovation and one that has not. This finding conforms to economic theory. The results are also in agreement with Dziallas and Blind (2021) [4], Hall, Lotti and Mairesse (2022) [5] and Mugogo (2020) [12] studies which show that innovation adoption has a positive effect on the performance of the manufacturing sector. As such, this study adds to the literature by showing that innovation is important for the performance of the manufacturing sector in Kenya.

Conclusion And Recommendation

This study investigated the effect of innovation on labour productivity among the manufacturing firms in Kenya using the Propensity Score Matching (PSM) method to address potential selection bias. The study used MSMEs 2016 data. The results showed that manufacturing firms that have embraced innovation realize, on average, KES 6 million more in labour productivity than their non-innovating counterparts.

These findings are consistent with both economic theory and empirical evidence from prior studies, including Dziallas and Blind (2021) [4], Hall, Lotti, and Mairesse (2022) [5], and Mugogo (2020) [12], all of which established a positive relationship between innovation adoption and firm performance in the manufacturing sector. By providing empirical evidence from the Kenyan context, this study contributes to the growing body of literature underscoring the pivotal role of innovation in enhancing productivity in the manufacturing sector. Consequently, policies that promote innovation adoption among manufacturing firms could play a critical role in boosting productivity and fostering industrial growth in Kenya.

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