Asian Journal of Economics, Business and Accounting

21(10): 17-34, 2021; Article no.AJEBA.71076
ISSN: 2456-639X

Effect of Inflation on Growth of Manufacturing Sector in Kenya (2008-2017)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJEBA/2021/v21i1030428
Editor(s):
(1) Prof. Chun-Chien Kuo, National Taipei University of Business, China.
Reviewers:
(1) Ekomane Jean Louis, University of Douala, Cameroun.
(2) Musa Abdullahi Sakanko, University of Jos, Nigeria.
Complete Peer review History: https://www.sdiarticle4.com/review-history/71076

Original Research Article

Received 15 May 2021
Accepted 19 July 2021
Published 20 July 2021

ABSTRACT

Aim: This study sought to address the effect of inflation on the growth of the manufacturing sector in Kenya.
Research design: The study used descriptive, correlational, and inferential research designs. The study used secondary data, specifically, from the World Bank, United Nations Conference on Trade and Development (UNCTAD), International Monetary Fund (IMF), Central Bank of Kenya (CBK), and Kenya National Bureau of Statistics (KNBS) for the period 2008-2017.
Methodology: Time series data were analyzed quarterly using EViews software. The study employed descriptive statistics, correlation analysis, and regression analysis. Pre-test analysis entailed Augmented Dickey-Fuller (ADF) tests for unit root, Bai-Perron Multiple Breakpoint tests, and Bounds Cointegration tests. The post-test analysis included the Breusch-Godfrey tests for autocorrelation, the Breusch-Pagan-Godfrey tests for heteroscedasticity, Variance Inflation Factors (VIF) tests for multicollinearity, Jarque-Bera statistics tests for normality, and CUSUM tests for model stability.
Results: The regression model estimates for inflation were (-0.19269, $p<0.05$). The results imply that holding other factors constant, a unit increase in inflation reduces manufacturing value-added by 0.19269 units.
Conclusion: Inflation has a statistically and significant negative effect on the growth of the manufacturing sector in Kenya. To achieve manufacturing value-added growth, the study

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recommends that the Central Bank of Kenya (CBK) should have inflation targets and adopt appropriate monetary policies to monitor fluctuating inflation rates. Furthermore, the CBK should keep lending interest rates as low as possible so that manufacturers incur less on acquiring credit from commercial banks and ultimately produce goods at affordable prices.

Keywords: Inflation; Consumer Price Index (CPI); manufacturing value added; time series data.

1. INTRODUCTION

Manufacturing plays a significant role in the growth and development world over. According to the United Nations Industrial Development Organization [1], the sector contributes 16% and 14% to the global GDP and employment, respectively. Manufacturing success in any country is largely determined by numerous macro-economic variables such as the value of the national currency (exchange rate), the stability of prices of goods and services (inflation), taxation, and the extent to which investors, especially from other countries, are allowed to invest in a particular country [2]. Most countries in Africa, especially in Sub-Saharan Africa, experience challenges related to these four macro-economic factors as a result of multiple factors such as poverty rates and overall low levels of economic development [2]. Therefore, in attempts to optimize productivity in the manufacturing industry, there is a need to pay equal attention to taxation, exchange rates, inflation, and foreign direct investment as the most important determinants of economic growth.

According to UNIDO [1], the world's manufacturing value added (MVA) increased by 3.6 percent in 2018, a slight decrease from 3.8 percent recorded in 2017. Additionally, the MVA growth rate for developed countries recorded a 2.3 percent increase in 2018, down from 2.6 percent in 2017. For the emerging industrial economies worldwide, the growth rate in 2018 was 3.8 percent compared to 4.1 percent in 2017 [1]. African countries continue to struggle to catch up with the industrial development of the rest of the world. The average share of manufacturing in the GDP of African least developed countries (LDCs) has further dropped to 8.3 percent compared to the 19.6 percent average of the developing countries and emerging industrial economies group [3]. This represents a serious challenge to the Sustainable Development Goal 9 target of doubling the MVA share in GDP in LDCs by 2030. In addition to the positive impact of manufacturing on the economy, it is instructive to consider how the process of manufacturing will be accomplished, given the limitation of financial and policy issues in the local economic environment [3,4]. Kenya was ranked at the seventh position in terms of MVA 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 [5]. By identifying the nature of the effect caused by various macro-economic factors on the progress of the manufacturing sector in Kenya, it becomes easier to channel the available resources effectively into the industry with the view of achieving optimal productivity.

Aside from achieving optimum macroeconomic factors, namely, exchange rates, inflation, taxation, and FDI, Kenya's other strategies, such as appeal to external loans, infrastructure, and monetary policies greatly matters in determining the effectiveness of the intervening strategies. Therefore, the internal environment matters, both demographically and economically. For instance, upon the release of the 2019 census results that revealed a spurt in the national population, the urgency to have more sustainable plans for the people acquired the direst urgency than ever before [6]. Based on these reasons, manufacturing is undeniably one of the most crucial avenues of achieving economic stability and sustainability in Kenya, yet it continues to suffer the limitations caused by both national and international challenges. The Kenyan government has prioritized manufacturing as one of its key pillars for development [7]. To achieve this, it needs to address all challenges inhibiting the growth of the sector.

Kenya faced two major setbacks in the year 2008; the global economic recess, and post-election violence over the disputed presidential election. Since then, the percentage contribution of the manufacturing sector to the GDP has continued to decline, posing a serious threat to its economic growth. Therefore, manufacturing deserves serious attention. Kenya being an emerging economy that has experienced radical shifts in economic dimensions has attempted to respond by formulating policies aimed at achieving stability in the production of goods and services. This is evidenced by the Big 4 Agenda in which manufacturing is given the greatest focus. However, the government is still far from actualizing its aspirations because the agenda itself is still in the initial implementation stages. This delay places national ambitions like increasing employment rates and ensuring a sustainable economy at stake. Currently, manufacturing contributes 10% to the GDP of Kenya. The government plans to raise it to at least 15% by 2022 in its big 4 agenda. Inflation is one of the overarching concerns that may affect the success of manufacturing. Notably, growth in the manufacturing sector is crucial because it creates jobs for the economy. Besides, if Kenya improves its manufacturing sector, it is likely to reduce the number of imported goods and boost its exports, which will boost the GDP of the country. This study, therefore, sought to examine the effect of inflation on the growth of the manufacturing sector in Kenya from 2008-2017. Previous studies focused on methodological aspects that can be adopted in the current study without much focus on the variables being investigated in the current study. For instance, manufacturing value added is the measure for growth in manufacturing in the current study, but is inadequately addressed in previous studies. Also, previous studies generalized manufacturing with other sectors of the economy, hence portraying a general rather than a specific trend on the effect that inflation has on manufacturing. Thus, this study will be more specific.

The research adopted a null hypothesis H_0 1: There is no statistically significant effect of inflation on the growth of the manufacturing sector from 2008-2017 in Kenya. This research is more urgent at a time when the country continues to encounter a low contribution of the manufacturing sector to the GDP, which seemingly inhibits the realization of the Big 4 Agenda. The agenda's main purpose is to forecast solutions to a number of economic challenges in the country such as high unemployment rates, extreme poverty among the households, and constraints experienced in managing public institutions. The results of this study constitute a substantial contribution to the general body of knowledge by informing the stakeholders especially in the national economic arena of the need to boost the growth of manufacturing by regulating the effect of the independent variable. Other researchers in the social sciences fields also stand to benefit from the findings of this study as a reference to future studies. Inflation has been compared to the rate at which the sector of manufacturing has been growing over a period of ten years (2008-2017). This period is appropriate because the greatest decline of the percentage contribution of manufacturing to the Kenyan GDP was realized from 2008 after post-election violence in Kenya and the global economic recession. The study uses the trends that have occurred in the sector to make recommendations for the national action aimed at strengthening the manufacturing sector based on the impacts caused by inflation.

2. LITERATURE REVIEW

This section begins by examining the structural theory of inflation (independent variable) and relates it to manufacturing growth (dependent variable). The theoretical review is followed by an empirical literature review, which focuses on how inflation affects the growth of the manufacturing sector. Using the available studies conducted in Kenya and other countries within the recent past, the review independently presents the studies on each one of the mentioned variables by establishing the coherence between each one of the factors and the impacts on the manufacturing sector in general.

2.1 Theoretical Literature Review

Among the inflation theories that have been developed regarding the economies of developing nations is the structural theory of inflation. The theory was discovered from the works of Myrdal and Streeten that were published in the year 1968 and 1972 respectively [8]. Other Latin American economists have written in support of the structural theory of inflation and among them is the work of Kirkpatrick and Nixon that was published in the year 1976 [8]. These economists are among the proponents of the structural theory of inflation. The theory is based on the argument as put by the economists that it is not correct to apply the aggregate demand and supply model in explaining the inflation rate in developing economies [9]. Myrdal and Streeten agree that there lacks a balanced integrated structure in developing countries hence creating a scenario where the flow of resources between different sectors of the economy is not smooth and quick. This makes it not possible to explain inflation in terms of aggregate demand and supply.

The proponents of the structural theory of inflation have been pushed against the application of aggregate demand and supply in determining the inflation rates in developing countries because they could not get the answer to their major questions. The economists questioned the fact as to why aggregate output has not been increasing despite the increase in demand created by the money supply and the investment expenditure [8]. Another issue that has led to the support of the structural theory of inflation is due to failure of voluntary savings to fully finance investment expenditure hence resulting in an excessive financing deficit [9]. Therefore, the structural theory of inflation suggests that prices and especially those of food and exports react more compared to the prices of other commodities hence implying that the inflation rate in developing countries is affected by changes in relative prices and the excessive supply of money. The manufacturing sector is subject to inflation since an increase in inflation leads to an increase in the cost of production. The profitability of the manufacturing industry is then reduced hence hindering growth especially in developing economies like Kenya.

The structural theory of inflation has some limitations. For instance, it is only applicable to developing countries. This is because their low development status has affected the food production sector [9]. The low productivity of food relative to the increasing demand contributes to inflation. The governments of developing countries such as Kenya have huge public spending and this is why inflation is common. Therefore, developing countries find themselves struggling to control inflation as compared to the developed ones hence limiting development in the manufacturing sector.

The structural theory of inflation is relevant to the study because challenges faced by developing countries such as Kenya are in the manufacturing sector, resources gap, and foreign exchange. The manufacturing sector faces problems that lead to the inelastic supply of commodities to the people. Among the structural factors limiting the adequate supply of goods in developing countries are disparities in ownership of factor inputs, urbanization, and population growth. Additionally, outdated manufacturing technologies hamper growth in the industry [8]. As a result, prices of goods react more since the deficit is imported and this contributes to inflation, unfavorable exchange rates, and unfavorable conditions for foreign direct investments hence hindering the growth of the manufacturing sector in the country.

Furthermore, resource constraint is among the challenges faced by developing countries, and the supporters of the structural theory of inflation claim that this hinders the financing of economic development. Manufacturing decisions and planning in developing countries such as Kenya are made by the government. This requires huge resources to finance public sector investments limiting the development of the manufacturing sector. Taxation and borrowing are among the means used to raise more funds and this has a direct effect on inflation and currency exchange rates [8]. Increased money supply due to high government spending leads to inflation. The theory is also relevant because the development of the manufacturing sector in Kenya requires huge imports of capital goods and essential raw materials. A combination of Kenya’s oil imports and other goods has rapidly risen the import expenditure [8]. Therefore, inflation is increasing as the value of the Kenyan currency gets weak hence limiting the growth of the manufacturing sector.

2.2 Empirical Literature Review

The volatility of inflation has had significant implications on the growth of various sectors in Kenya’s economy. The manufacturing industry has similarly suffered the perils of this radical shift. Banerjee [10] studied inflation volatility from the developing countries' perspective compared to the developed economies to establish a clear distinction between developing and developed nations. The approach adopted by Banerjee in his study was country-level analysis. The researcher determined the difference between the two economic set-ups by controlling the country-specific traits. A fixed-effect panel estimation was used through generalized methods of moments on the estimated Generalized Autoregressive Conditional Heteroscedastic (GARCH) series [10]. Based on the study's findings, the long-term variability of inflation is almost three and a half greater among the developing countries as contrasted to the developed economies. Further, these findings manifested a modest difference in conditional volatility of inflation between the two categories of the economy; the developed and developing economies. These findings manifest that developing countries such as Kenya experience higher inflation levels than developed nations. In turn, the impact of inflation on the developed nations' overall economic progress is lesser compared to the impact on the developing nations. However, the findings by Banerjee [10] differed from those of Mukoka [11]. Mukoka [11] carried out a study to establish the impact of inflation on Zimbabwe's economic growth for the period 1990 to 2017. The study applied Ordinary Least Squares (OLS) method. The findings indicated that inflation and Gross Domestic Product (GDP) had no relationship.

Uwilingiyimana, Munga'tu and Hererimana [12] carried out a study to investigate the effectiveness of ARIMA-GARCH models to forecast inflation in the Kenyan economic situation. Using time-series data, auto-regressive conditional heteroscedastic, and ordinary least square with the historical monthly data from 2000 to 2014, they found out that ARIMA (1,1,12) - GARCH (1,2) model provides the optimum forecasting results. The approach also improves forecasting accuracy in comparison with the ARCH model. Hence, ARIMA-GARCH models are worth considering as the appropriate forecasting methodologies in the current study of the effects of macroeconomic aggregates on the growth of the manufacturing sector in Kenya. The study, however, focuses on methodological aspects that can be adopted in analyzing growth in the manufacturing sector without much focus on the variables being investigated. The findings by Uwilingiyimana et al. [12] imply the need for sound strategies such as enhancing the manufacturing industry among the growing economies such as Kenya using both the past and the forecasted outcomes.

A study by Nyoni [13] reviewed the state of inflation in Kenya between 1960 and 2017 to establish a clear trend of inflation and ultimately predict its future trend. Nyoni [13] used document analysis and comparative literature review to gather the findings of the study. Findings indicated that annual inflation in Kenya is likely to continue rising in the coming years [13]. These findings are based on the continuous and steady rate of inflation from 1960 to 2017. The prediction can be considered to be strong since it is based on a wider duration. This study's implication is that policymakers in Kenya should stabilize the prices of goods and services in the country to reduce various economic adversities that come with inflation, including the possible negative effect on the manufacturing industry. The findings of Nyoni [13] are reaffirmed by Abou-Ali & Kheir-El-Din [14] who researched the effect of inflation on growth in Egypt. Abou-Ali & Kheir-El-Din [14] found that inflation at any level negatively impacts economic growth. Similarly, Adaramola & Dada [15] conducted a study on the effect of inflation on the Nigerian economic growth for the period 1980–2018. The research used the autoregressive distributed lag model. The findings revealed that inflation had a significant negative impact on economic growth. The same findings were realized by Nyenyia, Amlegab & Scholasticac [16] who researched the association between inflation and economic growth in the East African Community (EAC) countries for the period 1990-2014. The study employed correlation research design and Robust Least Square estimation method. Furthermore, the research applied the Solow growth model. The findings showed that inflation had a significant negative effect on economic growth. Studies by Nyoni [13], Abou-Ali & Kheir-El-Din [14], Adaramola & Dada [15] and Nyenyia et al. [16] are relevant since they link inflation and economic growth, where manufacturing is generalized together with other gross domestic product components.

Inflation has multiple impacts on the economy that increases volatility and instability. Amata, Muturi & Mbewa [17] investigated the relationship between inflation and stock market volatility using time series data that gathered qualitative data using 385 questionnaires that were completed by individual investors. The study covered a period of fourteen years from 2001 to 2014. According to the findings, there is a significant positive relationship between stock market volatility and inflation both in the long run and in the short run. Thus, the change in inflation rates causes market price fluctuations, hence, increases the prices of goods and services. As such sales for manufacturing firms decline, leading to low profits. The findings of Amata et al. [17] agree with those of Patjoshi [18] who researched on effects of inflation on the financial statement on the manufacturing industry in India and the corresponding effect on profitability for the period 2004-2009. Purchasing Power method, comparative and common-size statement analysis techniques were used. The findings indicated that a rise in inflation level led to a decline in profitability of the Indian manufacturing industry, hindering growth. The findings of Patjoshi [18] agree with those of Ulusoy, Cakir & Ogut [19] who carried out a study to establish the relationship between inflation and productivity in the Turkish manufacturing sector. The research employed a vector autoregressive (VAR) model. The findings showed that as inflation increases the productivity of the manufacturing sector declines. The same findings were realized by Hodge [20] who conducted a research on the relationship between inflation and growth in South Africa. The findings revealed that inflation is a barrier to South African economic growth in the long term. Studies by Amata et al. [17], Patjoshi [18], Ulusoy et al. [19] and Hodge [20] are relevant since they relate inflation and productivity in the manufacturing sector.

A study by Murunga and Mugambi [21] was also conducted to establish the relationship between inflation and manufacturing in Kenya. Murunga and Mugambi [21] sought to determine the specific contribution of various macro-economic factors in determining the success of manufacturing as projected by the Big 4 Agenda. The study adopted Phillips Perron and Zivot-Andrews and Augmented Dickey-Fuller test to determine the presence of unit root among the variables. Findings revealed that inflation, GDP and exchange rates are among the core factors determining the country's economic stability and manufacturing success. This study has a strong implication for the present study since they are closely related to the variables investigated. It relates manufacturing to inflation, which are the variables of the same study. The study is different from the previous studies by Banerjee [10] and Nyoni [13] since the previous studies portrayed the variable of inflation without relating it to manufacturing.

One of the indicators of advancement in the manufacturing sector is the country's exportation rate. Subsequently, Kiganda, Obange, and Adhiambo [22] conducted a study aimed at identifying the effect of exports on inflation in Kenya using monthly series data between January 2005 and December 2015 (132 months). Findings indicated a significant positive relationship between export and inflation. Based on the study findings, the reduction in total exports can reduce the rate of inflation in Kenya. Manufacturing stands out as one pertinent consideration for the Kenyan government to reduce the rate of exportation. The findings by Kiganda et al. [22] support the outcomes of the above studies, including Nyoni [13], Murunga & Mugambi, [21] and Banerjee [10] by suggesting the need to initiate the strategies that can enhance the manufacturing sector in the country as a strategy to reduce inflation.

Bans-Akutey, Yaw Deh, & Mohammed [23] carried out a study to investigate how inflation affects productivity in Ghana's manufacturing sector using time series data for 1968-2013. The reachers employed the Vector Error Correction Model (VECM), Johansen test (JT), and Ordinary Least Squares (OLS) regression test. The study findings showed that inflation and manufacturing had a long-run relationship. The OLS test showed a negative relationship between inflation and manufacturing productivity in Ghana. On the other hand, Judith & Chijindu [24] carried out a study to establish the association between inflation and the growth of the manufacturing sector in Nigeria for the period 1982-2014. The research employed regression analysis. The findings show that inflation has a negative and non-significant effect on the Nigerian manufacturing sector growth. Furthermore, the results showed that inflation had no causal effect on Nigerian output growth. In the same vein, Chaudhry, Ayyoub & Imran [25] researched the effect of inflation on the sectoral growth of Pakistan for the period 1972 to 2010. The study focused on the services, agriculture and manufacturing sectors. The findings showed that high rates of inflation hinder the growth of the manufacturing sector in Pakistan. Studies by Bans-Akutey et al. [23], Judith & Chijindu [24] and Chaudhry et al. [25] are relevant because they help to explain the relationship between inflation and growth in the manufacturing sector.

African Development Bank Group [26] conducted a research to find out nonlinearities in the inflation-growth nexus in Africa. The research applied panel threshold regression. The study findings show that there are nonlinearities in the inflation growth across Africa. The research also noted that growth in Africa is only realized when inflation rates are low, signifying a negative relationship between growth and inflation. Specifically, the study noted that inflation above 9% led to stagnated growth. Similar findings were realized by Munir, Mansur & Furuoka [27] who carried out a study on the association between inflation and GDP growth rate in Malaysia for the period 1970-2005. The research used new endogenous threshold autoregressive (TAR) models. The findings indicated that inflation rates above 3.89 percent hindered the GDP growth rate in Malaysia. Similarly, Thanh [28] carried out a study to establish the relationship between inflation and economic growth in 5 ASEAN countries over the period 1980–2011. The researcher employed Panel Smooth Transition Regression (PSTR) model. The study found out that inflation rates above 7.84% negatively affect the economic growth of ASEAN countries. However, different findings were achieved by Ali & Ibrahim [29] who researched the impact of inflation on the performance of manufacturing firms in Malaysia. The researchers applied a cross-sectional study and sampled 50 manufacturing companies. Furthermore, the research used correlation analysis. The findings indicated a positive relationship between inflation and profitability for manufacturing firms. Studies by the African Development Bank Group [26], Munir et al. [27], Thanh [28] and Ali & Ibrahim [29] are relevant in understanding how inflation is a determinant of success in the manufacturing sector.

3. METHODOLOGY

This study used descriptive, correlational, and inferential research designs. Descriptive design helped in explaining general trends of the study variables using mean, standard deviation, minimum and maximum values, skewness, and kurtosis as suggested by Kumar [30]. A correlational research design was appropriate because the study sought to establish whether there was a positive or negative relationship between the independent variable(inflation) and dependent variable (growth in the manufacturing sector). The inferential design was necessary for concluding that growth in the manufacturing sector depends on inflation.

The study used time-series secondary data for the last 10 years between 2008-2017. Data that was collected included inflation, which was measured by capturing values of the consumer price index (CPI) Also, the growth in manufacturing was measured by capturing the values of the manufacturing value added annual percentage growth. These data were obtained from the official World Bank, UNCTAD, IMF, CBK, and KNBS websites. The research used a document analysis method to collect data quarterly and arranged it in a table form. The data collected was compiled, cleaned, sorted, and coded using excel spreadsheet software.

The data analysis process entails summarizing raw data and interpreting it to derive meaning [31]. The quantitative data from secondary sources were analyzed through descriptive and inferential statistical methods. Correlation analysis was done to explain the strength and direction of the relationship between the growth of the manufacturing industry and inflation. On the other hand, multivariate regression analysis was estimated to show the influence of inflation on the growth of the manufacturing sector. In the same vein, hypothesis testing was done to determine if inflation was statistically significant in explaining growth in the manufacturing sector. The EViews software (version 10) was chosen to analyze the data because of its ability in time series data analysis.

The researcher computed a multiple regression analysis to test the hypothesis about the relationship between a dependent variable (Growth in the manufacturing sector), and an independent variable (inflation).

The following model was used $Y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \mu$ where;

Y=Total growth output realized from the manufacturing sector (Manufacturing Value Added annual % growth)
$\beta_0 =$ Amount of growth output when all independent variables are equals to zero
$\beta_1 =$is the correlation coefficient that explains the change in Y when X_1 changes by 1 unit.
$\beta_2 =$ is the correlation coefficient that explains the change in Y when X_2 changes by 1 unit.
$\beta_3 =$is the correlation coefficient that explains the change in Y when X_3 changes by 1 unit.
$x_1 =$ CPI index of inflation
$x_2 =$FDI net inflows as % of GDP
$x_3 =$Real Effective Exchange Rate (REER)
$\mu =$ error term
$t =$time series data

Table 1 gives a brief description of study variables, ways of measuring them, and expected signs.

Various pre-estimation diagnostic tests were conducted. The first one was descriptive statistics, where the researcher computed various statistical measures such as mean, standard deviation, minima, maxima, skewness and kurtosis to have a general view of the data summary. Raw data were used while analyzing descriptive statistics instead of transformed data as suggested by Aldous [32]. The second test was unit root test. Unit root tests are tests for stationarity in a time series [31]. A time series is considered to have stationarity if a shift in time doesn't cause a change in the shape of the distribution; unit roots are one cause for non-stationarity. Therefore, the researcher used the unit root test to establish whether time series variables were non-stationary and possessed a unit root. Because of time-series data, serial correlation can be an issue; hence, the Augmented Dickey-Fuller (ADF) test was used to test for stationarity.

Table 1. Measurement of variables

Variable	Description	Measurement	Prior Expected Sign
Manufacturing Value Added (MVA)	The net output of manufacturing activities	MVA Annual % Growth	+/-
Inflation	Rising prices of goods and services in the economy	Consumer Price Index (CPI)	+/-
Foreign Direct Investment (FDI)	Investments into the country by foreign nationals/companies	FDI net inflows % of GDP	+/-
Currency Exchange Rate	The rate at which local currency is exchanged for another currency	Real Effective Exchange	+/-
Taxation	Compulsory financial charges imposed on a business activity	Value Added Tax	+/-

Source: Author (2021)

The ADF handles bigger, more complex models. It does have the downside of a fairly high Type I error rate [30]. A unit root exists in time series of the value alpha=1 as shown below.

$$Y_t = \alpha Y_{t-1} + \beta X_e + \epsilon$$

Where; Y_t is the time series value at time 't', and X_e an explanatory time series variable at a time 't'. Therefore, the presence of a unit root implies non-stationarity in time series. Also, the number of unit roots determines the number of differencing operations needed to make the series stationary.

The ADF tests the null hypothesis that α =1, where α is the coefficient for the first lag on Y.

H_0: $\alpha = 1$

$$y_t = \beta_t + \alpha y_{t-1} + \phi_1 \Delta Y_{t-1} + \phi_2 \Delta Y_{t-2..} + \phi_p \Delta Y_{t-p} + e_t$$

$y_{(t-1)}$ =1st lag of time series

ΔY_{t-1} =first difference of the series at the time (t-1)

If the null hypothesis is not rejected, the series is taken to be non-stationery. The p-value must be less than the significance level (example 0.05) for the null hypothesis to be rejected, which would imply stationarity in the series. In cases where the data was found to be non-stationary after the test, the researcher used a differencing method to achieve stationarity. The differenced data was subjected to another unit root test to establish if it is stationary. The differencing process was repeated until all unit roots were eliminated.

The third pre-estimation test was Bai-Perron test for structural breaks. An unexpected shift in time series data constitutes structural breaks. The researcher did not have prior knowledge about multiple breaks in the series, hence opted to use Bai-Perron multiple breakpoint tests. As suggested by Casini & Perron [33] dummy variables for independent variables were added to correct structural breaks in the model. The fourth test was the determination of optimum lag length. The researcher identified the optimum lag length of unrestricted vector autoregressive (VAR) order before estimating the model. Mittelhammer [34] opines that this step helps to avoid too many lags, which can result in the loss of degrees of freedom and trigger serial correlation in the error terms or even cause multicollinearity. Akaike Information Criterion (AIC) was used in optimal lag length selection because it met the rule of the thumb, which holds that a model that gives the lowest value of the selection criteria should be chosen.

The final pre-estimation test was Bounds Cointegration Test. Cointegration exists when two or more nonstationary variables have a long-run linear relationship. Wolde-Rufael [35] opines that in a scenario where the variables in the model are integrated to different orders *1(0)*, *1(1),* and *1(2*), then Bounds Cointegration Test should be used. Therefore, the researcher used Bounds Cointegration Test because the study variables were integrated into different orders. The hypotheses adopted were;

Null hypothesis H_0: No cointegrating equation

Alternative hypothesis H_1: H_0 is not true

Decision criteria; rejection was made at 10%, 5%, 2.5%, and 1% level. The null hypothesis was rejected if the calculated *F* statistic was greater than the critical value for the upper bound 1(1), this would imply the presence of cointegration (a long-run relationship). However, if the calculated *F* statistic was lower than the critical value of the lower bound *1(0)*, the researcher failed to reject the null hypothesis and concluded that cointegration does not exist as suggested by Adom et al. [36].

The researcher also conducted post-estimation tests on regression residuals. The first test was autocorrelation. One of the OLS assumptions is that errors in subsequent observations should not be related [37]. Therefore, the test for autocorrelation was used to establish whether errors in subsequent observations were related. The research used the Breusch-Godfrey Serial Correlation LM Test to test for autocorrelation. The null hypothesis was that there was no autocorrelation; H0: p>0.05. At the same time, the alternative hypothesis was that autocorrelation was present; H1: p<0.05.

The second post-estimation test was heteroscedasticity. An important assumption of OLS is that the disturbance terms (μ) appearing in the population regression function are homoscedastic; error terms have the same variance [31]. The test for heteroscedasticity was conducted to test if the assumption for homoscedasticity was violated. The presence of heteroscedasticity would indicate that OLS estimators are unbiased but inefficient. Breusch–Pagan test, which is a chi-squared test was used to test for heteroscedasticity. The test statistic is distributed $n\chi^2$ with k degrees of freedom. In case the test statistic obtained a p-value less than the set threshold ($p < 0.05$) then the null hypothesis of homoscedasticity was rejected and heteroscedasticity assumed.

The third post-estimation test was multicollinearity. One of the OLS assumptions is that independent variables should not be linearly related [38]. Therefore, a test for multicollinearity helped to establish whether the independent variables were related or not. The research used the variance inflation factor (VIF) to test for multicollinearity. VIF identifies not only the correlation between predictor variables but also the strengths of that correlation [38]. VIF of 1 implies no correlation between one explanatory variable and any others. VIFs ranging from 1 to 5 indicates a moderate correlation, which doesn't need corrective measures. VIFs exceeding 5 suggest critical multicollinearity levels with poorly estimated coefficients and questionable p-values. No standardization/centering of variables was needed to eliminate multicollinearity issues since none was detected.

The fourth post-estimation test was the normality test. The assumption is that residuals should be normally distributed. The research used the Jarque-Bera statistics to test for normality in the model residuals. The null hypothesis was that residuals were normally distributed H_0>0.05, while the alternative hypothesis was that residuals were not normally distributed H_1<0.05. For the model residuals to be normally distributed, the p-value for the Jarque-Bera test was expected to be p>0.05 at a 5% level of significance as opined by Koizumi, Okamoto & Seo [39]. The final post-estimation test was the model stability test. The research used a CUSUM test to establish the stability of the regression model. As suggested by Zeileis (2004), the decision criterion of the test was that if all variables in the model lie within the 5% boundary then it would imply the model was stable.

4. RESULTS AND DISCUSSION

4.1 Descriptive Summary

Table 2 shows the results for descriptive analysis for manufacturing value added **(**MVA) and inflation measured by consumer price index (CPI).

Table 2. Descriptive Statistics

Variables	MVA % Growth	CPI %
Mean	2.678569	9.63163
Std. Dev.	2.701672	6.62458
Minimum	-1.505243	3.18293
Maximum	7.890208	35.1835
Skewness	0.132568	2.28712
Kurtosis	2.087942	8.27011
Observations	40	40

Source: Author's computation based on EViews 10

The results in Table 2 show that manufacturing value added (MVA) has a mean growth of 2.678569%, a standard deviation of 2.701672%, a minimum value of -1.505243%, and a maximum value of 7.890208%. MVA has a skewness of 0.132568, which is closer to 0 implying that the variable has a normal skewness. Also, MVA has a kurtosis of 2.087942<3(normal/mesokurtic), meaning it is platykurtic. Table 2 also shows that CPI has a mean of 9.63163%, a standard deviation of 6.624576%, a minimum value of 3.182933%, and a maximum value of 35.18353%. Besides, CPI has a positive skewness of 2.287117, meaning it has a long right tail, indicating it has more higher values than the mean. CPI also has a kurtosis value of 8.270106>3(normal/mesokurtic), implying that it is Leptokurtic.

4.2 Correlation Analysis

Table 3 shows the correlation analysis of manufacturing value added and inflation.

Table 3. Correlation Matrix Analysis

Variables	CPI	MVA
CPI	1.00000	-0.09320
MVA	-0.09320	1.00000

Source: *Author's computation based on EViews 10*

Table 3 indicates that manufacturing value added (MVA) and inflation measured by CPI have a weak negative relationship (r = -0.09320).

4.3 Test for Stationarity

The null hypothesis is that the series has a unit root. The decision criterion is that; if the ADF statistics absolute value is lower than the critical values then the null hypothesis is not rejected. Table 4 shows the test for stationarity results.

The results from Table 4 show that inflation measured by CPI has an absolute value of 3.655033> 5% critical value (2.941145), thus the null hypothesis is rejected to confirm stationarity in the series. Table 4 also shows that manufacturing value added (MVA) has an absolute value of 3.031949>5% critical value (2.951125), meaning the series is stationary.

4.4 Bai-perron Multiple Breakpoint Test: Test for Structural Breaks

The results from Table 5 show that the inflation series measured by CPI has three structural breaks at 2009Q3, 2011Q1, and 2012Q3.

Table 4. Dickey-fuller unit root test at levels

Variables	ADF test statistics z(t) value	Mackinnon approximat e P-value	test critical values at 1 %	test critical values at 5 %	test critical values at 10%	Conclusio n
CPI	-3.655033	0.009	-3.615588	-2.941145	-2.609066	*1(0)*
MVA	-3.031949	0.0419	-3.639407	-2.951125	-2.614300	*1(0)*

Source: Author's computation based on EViews 10

Table 5. Multiple breakpoint tests for CPI

Bai-Perron tests of L+1 vs. L sequentially determined breaks			
Sequential F-statistic determined breaks:	**3**		
Break Test	**F-statistic**	**Scaled F-statistic**	**Critical Value****
0 vs. 1 *	14.86556	14.86556	8.58
1 vs. 2 *	16.61481	16.61481	10.13
2 vs. 3 *	52.8578	52.8578	11.14
3 vs. 4	3.717257	3.717257	11.83
* Significant at the 0.05 level.			
** Bai-Perron (Econometric Journal, 2003) critical values.			
Break dates:			
	Sequential	**Repartition**	
1	2009Q3	2009Q3	
2	2011Q1	2011Q1	
3	2012Q3	2012Q3	

Source: Author computation based on EViews 10

4.5 Determination of Optimum Lag Length

Based on unrestricted VAR order, the results from Table 6 indicate that there are 3 lags to include in the model.
Table 6 shows that the AIC criteria has Asterix at lag 3 and has the least figure in this range. Therefore, lag 3 is the best optimal lag to choose for this model.

4.6 Bounds Cointegration Test

The hypotheses are;
Null hypothesis H_0: No cointegrating equation
Alternative hypothesis H_1: H_0 is not true

Table 7 shows the results of the bounds cointegration test.

From Table 7, F-statistic (2.74648) is less than the critical values 2.79, 3.15, and 3.65 of the lower bound *1(0)*, at 5%, 2.5%, and 1% significance levels respectively. Therefore, the researcher failed to reject the null hypothesis and concluded that cointegration does not exist between the variables. Hence, there is no long-run relationship between the variables in the model.

4.7 Regression Analysis

Table 8 shows the regression analysis output.

Table 6. Vector autoregressive lag selection criteria

Endogenous variables: MVA
Exogenous variables: C CPI
Sample: 2008Q1 2017Q4
Included observations: 37

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-89.509	NA	8.237171	4.946429	5.033505	4.977127
1	-66.286	42.68062	2.478491	3.745170	3.875785	3.791218
2	-61.135	9.187789*	1.981349	3.520807	3.694960*	3.582204
3	-59.436	2.939410	1.909403*	3.483004*	3.700696	3.559751*

*indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Author's computation based on EViews 10

Table 7. Bounds cointegration test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
			Asymptotic: n=1000	
F-statistic	2.74648	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.50%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	37		Finite Sample: n=40	
		10%	2.592	3.454
		5%	3.1	4.088
		1%	4.31	5.544
			Finite Sample: n=35	
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816

Source: Author's computation based on EViews 10

Table 8. Regression Analysis Results

Dependent variable: MVA
Method: Least Squares
Sample (adjusted): 2009Q2 2017Q4
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.89468	0.53914	5.36909	0.00000
MVA(-1)	0.64070	0.07465	8.58302	0.00000
CPI(-1)	-0.19269	0.05932	-3.24822	0.00290
D2FDI(-3)	1.98317	0.49287	4.02371	0.00040
DREER(-1)	-0.230342	0.06919	-3.329355	0.0023
R-squared	0.86371	Mean dependent var		2.97183
Adjusted R-squared	0.84553	S.D. dependent var		2.67609
S.E. of regression	1.05176	Akaike info criterion		3.07038
Sum squared resid	33.18617	Schwarz criterion		3.29257
Log likelihood	-48.73159	Hannan-Quinn criter.		3.14708
F-statistic	47.52804	Durbin-Watson stat		1.29836
Prob(F-statistic)	0.00000			

Source: Author's computation based on EViews 10

Table 8 shows the model was appropriate concerning the goodness of fit and overall statistical significance, with R^2 of 0.86371 and an F-statistical probability value of 0.00000. The results mean that 86.371 of variation in manufacturing value added growth is explained by the independent variables in the model while the remaining 13.629% is explained by other factors that are not under the consideration of this study. The F-statistic probability value of 0.00000 means that the model variables are jointly statistically significant in explaining manufacturing value-added growth at a 5% level of significance.

The main objective of this paper is to determine the level of association between inflation and manufacturing value added growth (MVA). Requisite diagnostic tests have been conducted and the model shows that explanatory variables are statistically significant in explaining MVA growth. The regression equation obtained from the analysis is;

$$MVA_t = 2.89468153598 + 0.640701420104*MVA_{t-1} - 0.192687175755*CPI_{t-1} + 1.98316770723*D2FDI_{t-3} - 0.230342104933*DREER_{t-1} + e_t$$

Where
MVA=Manufacturing value added % growth
MVA_{t-1}= Lag 1 of manufacturing value added % growth acting as an explanatory variable in the model.
CPI_{t-1}= Lag 1 of the consumer price index (measure for inflation in the model)
$D2FDI_{t-3}$= Lag 3 of the second difference of foreign direct investment net inflows % of GDP.
$DREER_{t-1}$=Lag 1 of the first difference of real effective exchange rate (measure for the exchange rate in the model)
e=the error term
$_t$=Time series data

4.7.1 Interpretation of the results

The probability for CPI in the model is 0.00290 <0.05, meaning that inflation is statistically significant in explaining manufacturing value-added growth. CPI also depicted a negative sign as expected, meaning inflation and manufacturing value added have a negative relationship, whereby an increase in inflation would lead to a decrease in manufacturing value added. β_1 = -0.19269 coefficient of CPI implies that a percentage increase in inflation is associated with 0.19269 percent decrease in manufacturing value added on average Ceteris Paribus in the short-run. This relationship can be explained by the fact that inflation hinders the inflow of foreign capital in Kenya. As the cost of factors of production goes up, foreign investment becomes less profitable in Kenya, hence foreign investors shy away and move to other countries with lower costs for factors of production, leading to a decline in manufacturing value-added in Kenya. Additionally, inflation has a negative effect on the volume of goods produced by manufacturers because the expectations of an increase in prices along with rising costs of inputs cause uncertainty in the economy [28]. As such, manufacturers produce less to avoid making losses. Furthermore, higher rates of inflation lead to a decline in the propensity to save. Reduced savings make it hard for manufacturers to invest in emerging technologies, making it hard to innovate and increase the competitiveness of Kenyan firms and ultimately leading to a decline in manufacturing value-added.

These findings agree with Bans-Akutey, Yaw Deh, & Mohammed [23] who used the Vector Error Correction Model (VECM), Johansen test, and Ordinary Least Square (OLS) regression to establish the effect of inflation on Ghana's manufacturing sector using time series data for between 1968-2013. The research findings identified the existence of a significant long-run relationship between inflation and manufacturing sector output. Finally, Bans-Akutey et al. [23] found out through the OLS regression that inflation and productivity in the manufacturing sector had a significant inverse relationship, which resonates with the findings of the current study. Furthermore, the research findings agree with the African Development Bank Group [26] who commissioned a research to establish the threshold impact of inflation on economic growth in Africa. The researchers used dynamic panel threshold regression in data analysis to examine nonlinearities in the rate of inflation growth in Africa. The research findings indicated that low inflation does not affect the growth of the manufacturing sector, which accounts for the natural rate of inflation. The research further noted that inflation above the natural rate negatively affects manufacturing output and economic growth in general. These findings concur with the current study results that a high rate of inflation leads to a decline in manufacturing value-added.

4.8 Post Estimation Diagnostic Tests

4.8.1 Test for serial correlation/ autocorrelation

The null hypothesis was that there was no autocorrelation; H_0: $p>0.05$ (Flick, 2020). On the other hand, the alternative hypothesis was that autocorrelation was present; H_1: $p<0.05$. Table 9 shows the Breusch-Godfrey Test results for autocorrelation.

From Table 9, the probability Chi-Squared (2) of the observed R-squared value is 0.0925, which is greater than 0.05. therefore, the researcher cannot reject the null hypothesis, meaning there is no autocorrelation in the model. Hence the null hypothesis is accepted at a 5% level of significance while the alternative hypothesis is rejected.

4.8.2 Test for heteroscedasticity

The null hypothesis states that there is no heteroscedasticity; H0: p>0.05 (Politano et al., 2018). The alternative hypothesis states that there is heteroscedasticity in the model; H1: p<0.05. Table 10 shows the Breusch-Pagan-Godfrey Test results for heteroscedasticity.

The results in Table 10 indicate that the observed R-squared value has a probability Chi-Square (4) of 0.6321, which is greater than 0.05. Hence, the researcher accepts the null hypothesis at a 5% level of significance and rejects the alternative hypothesis, implying that there is no heteroscedasticity in the model.

Table 9. Breusch-godfrey test

Breusch-godfrey serial correlation LM test:			
F-statistic	2.203899	Prob. F(2,28)	0.1292
Obs*R-squared	4.760364	Prob. Chi-Square(2)	0.0925

Source: Author's computation based on EViews 10

Table 10. Breusch-pagan-godfrey test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.594456	Prob. F(4,30)	0.6694
Obs*R-squared	2.570397	Prob. Chi-Square(4)	0.6321
Scaled explained SS	2.758881	Prob. Chi-Square(4)	0.5990

Source: Author's computation based on EViews 10.

4.8.3 Test for multicollinearity

Table 11 shows the Variance Inflation Factor Test results for Multicollinearity. The centered VIFs are considered while interpreting the results [38].

From Table 11, MVA(-1), CPI(-1), D2FDI(-3), and DREER(-1) have VFI values of 1.26114, 1.01748, 1.06498, and 1.28905 respectively, which are lower than 5. This means that there is no multicollinearity in the model.

4.8.4 Test for normality

The null hypothesis is that residuals are normally distributed $H_0>0.05$ [39]. The alternative hypothesis is that residuals are not normally distributed $H_1<0.05$. Fig. 1 shows the results for the Jarque-Bera statistics test results for normality.

From Fig. 1 results, the p-value for the Jarque-Bera test is 0.354908>0.05, therefore the researcher accepted the null hypothesis at a 5% level of significance and rejected the alternative hypothesis, indicating that the model residuals are normally distributed.

4.8.5 CUSUM test for model stability

Fig. 2 shows the CUSUM model stability test results.

Table 11. Variance inflation factor test for multicollinearity

Variance Inflation Factors
Sample: 2008Q1 2017Q4
Included observations: 35

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.29067	9.196695	NA
MVA(-1)	0.005572	2.792402	1.26114
CPI(-1)	0.003519	7.703482	1.01748
D2FDI(-3)	0.242922	1.065136	1.06498
DREER(-1)	0.004787	1.594073	1.28905

Source: Author's computation based on EViews 10

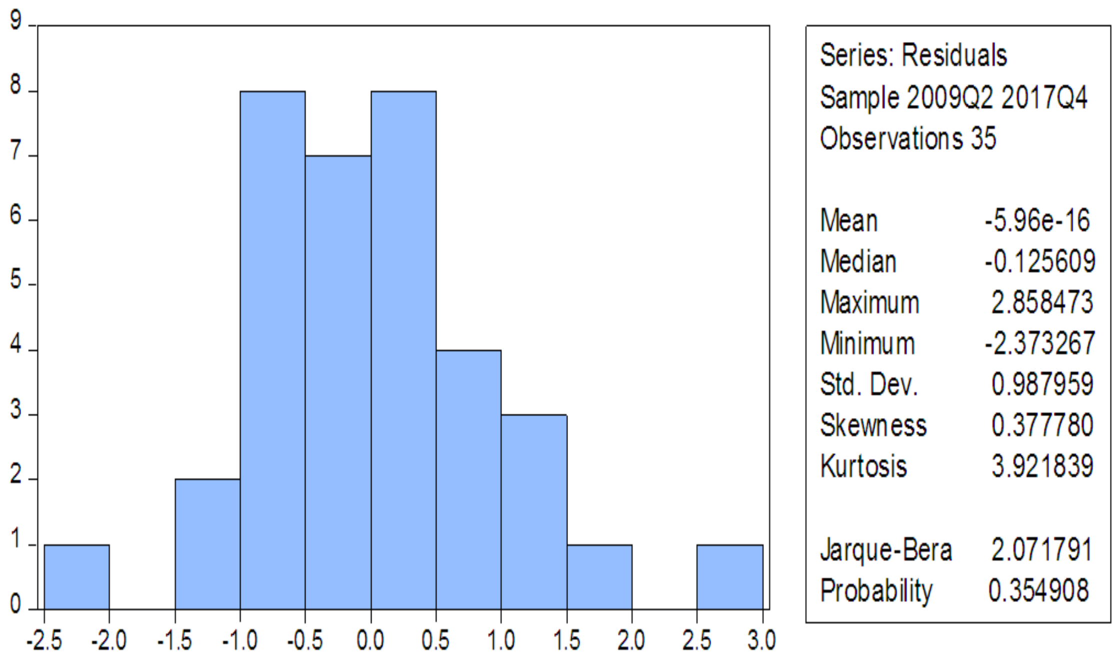

Fig. 1. Jarque-bera statistics test for normality
Source: Author's computation based on EViews 10

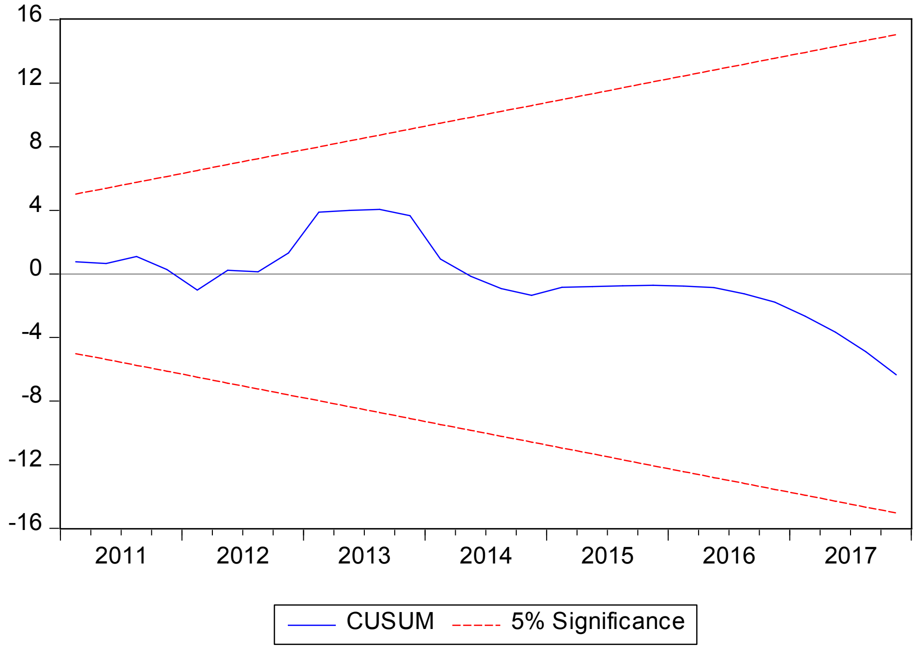

Fig. 2.CUSUM test for model stability
Source: Author's computation based on EViews 10

Fig. 2 shows that all variables in the model lie within the 5% boundary, meaning that the model is stable as supported by Zeileis [40].

5. SUMMARY, CONCLUSION AND POLICY RECOMMENDATION

5.1 Summary of the Key Findings

The results indicated that inflation negatively correlates with manufacturing value-added, even though the relationship is very weak as shown by the correlation coefficient value of r = -0.09320. In the regression model, inflation has a negative coefficient of β_1 = (-0.19269), and is statistically significant because it has a p-value of 0.00290<0.05. This means that inflation has a negative effect on manufacturing value-added growth in Kenya. A coefficient of -0.19269 means that holding other factors constant, a unit increase in inflation reduces manufacturing value-added by 0.19269 units. This can be explained by the fact that inflation hinders the inflow of foreign capital in Kenya. The high cost for factors of production reduces profitability for foreign investment in Kenya, thus foreign investors withdraw their capital and move to countries where factors of production are cheap. Also, expectations of an increase in prices along with rising costs of inputs cause uncertainty in the economy reducing the volume of goods produced by manufacturers Furthermore, higher rates of inflation lead to a decline in propensity to save, making it hard for manufacturers to invest in emerging technologies that can increase the competitiveness of Kenyan firms.

5.2 Conclusion

The study revealed that inflation has a significant negative effect on manufacturing value-added growth. Therefore, the null hypothesis that states there is no statistically significant effect of inflation on the growth of the manufacturing sector in Kenya was rejected. As such, an increase in inflation hinders growth in the manufacturing sector in Kenya.

The main challenge experienced by the study was variation in data for the same variables from one source to the other. For instance, inflation data had some variations even though minimal. However, the researcher used the triangulation method to select sources that are recognized nationally and internationally such as World Bank, UNCTAD, IMF, CBK, and KNBS. Later, retrieved data were compared and found to agree.

5.3 Recommendations

The study's descriptive statistics indicate that currently, average inflation in Kenya stands at 9.63163%. As such the study recommends the following:

- The Central Bank of Kenya (CBK) should have inflation targets and keep it below the set target.
- The CBK should adopt appropriate monetary policies to monitor fluctuating inflation rates.
- The CBK should keep lending interest rates as low as possible so that manufacturers incur less on acquiring credit from commercial banks and ultimately produce goods at affordable prices.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/71076