An Analysis of the Relationship between Manufacturing Growth and Economic Growth in South Africa: A Cointegration Approach

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Abstract—This paper examines the relationship between manufacturing growth and economic growth in South Africa using quarterly data ranging from 2001 to 2014. The paper employed the Johansen cointegration to test the Kaldor's hypothesis. The Johansen cointegration results revealed that there is a long run relationship between GDP, manufacturing, service and employment. The Granger causality results revealed that there is a unidirectional causality running from manufacturing growth to GDP growth. The overall findings of the study confirm that Kaldor's first law of growth is applicable in South African economy. Therefore, investment strategies and policies should be alignment towards promoting growth in the manufacturing sector in order to boost the economic growth of South Africa.

Keywords—Cointegration, economic growth, Kaldor's law, manufacturing growth.

I. INTRODUCTION

ECONOMIC growth is essential because it enhances the standard of living of the whole population and it also creates revenue and employment opportunities in the country [16]. Reference [5] indicated that the long run economic growth is considered healthy in the economy of the nation However, in South African economy, the main sectors that stimulate and keep economic growth sustainable are mining, agriculture, manufacturing, communication, tourism, wholesales and retails, finance and business services and investment intensives. Amongst the key sectors of economic growth in South Africa, manufacturing sector plays a very important role in sustaining growth and economic development. It was revealed by Statistics South Africa in 2014 that manufacturing sector contributed a share of 13.9% on South Africa's gross domestic product (GDP), making it the second biggest contributor on the GDP growth in South Africa [14].

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This paper employs the cointegration framework to examine the role that the manufacturing sector has played and continues to play in the economic growth of South Africa. Cointegration framework is used to establish the long run relationship among variables. Economic theories frequently suggest that two or more of economic or financial variables should have an economic long run relationship [18]. Many authors emphasised that manufacturing plays a very important role in the economy of unindustrialised and industrialised nations including South Africa. They also stated that manufacturing growth stimulates not only economic growth, it also creates indirect employment. Nevertheless, there are facts that have not been fully explored insofar as manufacturing growth and economic growth have the long run relationship particularly in South African context. South African economy is dependent on manufacturing for growth and sustainability.

The paper is set out as follows. Section II discusses literature review. Section III briefly outlines the methodological framework. Section IV presents the discussion of results. Concluding remarks are given in Section V.

II. LITERATURE REVIEW

Kaldor's first law of growth states that there is a strong positive causal relationship between manufacturing output growth and the growth of aggregate output (GDP) [8], [9]. Kaldor's law again argues that direction of causation between manufacturing and GDP growth runs from manufacturing to GDP. Furthermore, the relationship between manufacturing growth and GDP growth is not simply a repetition reflecting the fact that manufacturing contributes a larger share of GDP; rather it is based on the fact that manufacturing is the engine of growth and this view is based on the three values. Firstly, manufacturing is the exceptional economic activity as it generates returns for the country. Secondly, manufacturing products embody continually improving technology. Lastly, manufacturing output results in the increase of employment which in turn involves transfer of labour from lower productivity land-based activities.

Most of the studies such as [1], [11] concentrated on the international context to analyse the impact of manufacturing sector growth on economic growth. There is however, a lack of empirical studies concerning manufacturing performance and economic growth in South African context. The existing literature is mainly concerned with the short run relationship and the impact of manufacturing sector on economic growth. However, this paper will examine the short and long run

relationship between manufacturing sector performance and economic growth in South Africa.

Reference [13] used cross-sectional data of 86 countries for the period of 1970 to 2009 to examine the relationship between manufacturing exports and growth using regression tree analysis. The author argued that in order for a country to consider manufacturing sector as a benefit for economic growth it firstly needs to be developed. The study revealed that manufacturing exports are positively related to economic growth in countries with higher education and manufacturing exports are negatively related to economic growth in countries with lower education. The Kaldor's law in the United States of America (USA) was tested by [2] using the Johansen's cointegration and Granger causality tests. The study investigated the manufacturing sector output and labour productivity using parametric quarterly data for the period of 1987 to 2007 in USA. Reference [2] realised that in most studies, authors have been testing the Kaldor's law using different methodologies and encountered a number of statistical problems. The study found that there is cointegration between manufacturing output and labour productivity in manufacturing sector. The study further concluded that the Kaldor's law is applicable in the USA.

Reference [3] tested the Kaldor's law in India. The study investigated the evidence of deindustrialisation in emerging economies with low levels of income, unemployment growth and fast growth in informal sectors. The study also analyzes the manufacturing growth in the formal and informal sectors in the Indian economy. Their study revealed that manufacturing sector continues to be a key sector in Indian economy. It was also found that manufacturing and services sectors improved the balance of payments in India. Reference [19] conducted the study to seek to address the interrelated questions of what is the role of manufacturing in boosting economic growth and employment in South Africa. More precisely, does manufacturing continue to be the engine of growth in South Africa? The study by [19] argued that manufacturing growth continues to be the engine drive of fast economic growth in association with creation of employment. By testing the Kaldorian hypothesis using the econometric approach the study found that manufacturing heavily continues to play an important role in stimulating economic growth and employment creation in South Africa.

The study by [15] examined the contribution of manufacturing and services sectors to employment creation and economic growth in South Africa. The study used the input and output data to investigate the relationship between manufacturing, services and the economic growth. Reference [15] used various methods for the analysis in his study and found that decrease in manufacturing could negatively affect South Africa's medium and long term growth. Furthermore, manufacturing was found to be more important as a source of demand for services. On the other hand, services sector was found to be a higher significant multiplier for employment creation than manufacturing sector. Nevertheless, the study found that manufacturing is more important for economic growth while services sector is important for labour absorption.

The Kaldor's three laws of growth in the South African economy was tested by [12]. The study adopted econometric methodology using the ordinary least squares (OLS) to estimate linear regressions. The study found that South Africa's economy supports the Kaldorian growth laws, therefore manufacturing was found to be the key to economic growth in South Africa in the 21st century. Reference [17] analysed the relationship between direct foreign investments in manufacturing sector and economic growth in Asian economies using the regression model. The study found that foreign direct investment in manufacturing sector has a positive significant effect on economic growth in the host countries.

III. METHODOLOGY

The paper used seasonally adjusted quarterly data ranging from 2001 to 2014. Data was obtained from the South African Reserve Bank (SARB). The principal series used are GDP growth and manufacturing growth. Employment and services sector are used as the additional variables. All variables are transformed using the logarithmic transformation in order to stabilize variance. Eviews 8 software was used to run all the analysis.

In most cases, macroeconomics variables are non-stationary in their nature and it is said that non-stationary time series produce spurious results. According to economic theories, time series variable(s) are stationary when its mean and variance are constant and do not change with time [6]. It is therefore important to test whether the time series variables are stationary or non-stationary. Unit root test is a commonly used test of stationarity. In this paper, the Augmented Dickey Fuller (ADF) [4] test is used to test the presence of unit root in the concerned time series variables. The ADF test is based on the null hypothesis that the time series variable has a unit root. The ADF test is estimated using the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-1} + \varepsilon_t \qquad (1)$$

where ε_t is the white noise residual term, $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$ and so on. The null hypothesis test that $\delta = 0$ (meaning there is unit root, the series is non-stationary) and the alternative is $|\delta| < 0$ (meaning there is no unit root, the series is stationary). If the Ѣ (tau) p-values are less than 5% significance values, the null hypothesis is rejected in favour of the alternative. The relationship between manufacturing and GDP growth is estimated using the following linear regression model:

$$LnGDP_t = \beta_0 + \beta_1 LnMAN_t + \beta_2 LnSER_t + \beta_3 LnEMP_t + \varepsilon_t \ (2)$$

where GDP in the dependent variable and MAN (manufacturing), SER (services) and EMP (employment) are independent variables, the regression coefficients are denoted as β_i and ε_t is the stochastic error term. However, the long run relationship among the variables will be estimated using the

Johansen [7] cointegration technique. Vector Autoregressive (VAR) results are sensitive to the selection of lag length. Therefore, the optimal lag length 'p' must be sought [10]. VAR lag order selection methods employed in the paper are Akaike Information Criterion (AIC), Schwartz Bayesian Information Criterion (SBIC) and Hannan-Quinn (HQ). In choosing the optimal lag length, researchers faced the trade-off between the two opposite considerations, the expletive of dimensionality and current model specifications [10]. Once the lag length is selected, the next step is to compute the Johansen cointegration technique.

To determine the number of cointegrating vectors, Johansen derived two tests: Trace and Maximum Eigenvalue statistic. Trace statistic and Maximum Eigenvalue statistic are expressed as:

$$\Lambda_{trace}(r) = -n \sum_{i=1}^{m} Ln(1 - \hat{\lambda}_i) \quad (3)$$

$$\Lambda_{max}(r + 1) = -n \sum_{i=1}^{m} Ln(1 - \hat{\lambda}_{i+1}) \quad (4)$$

where r is the number of cointegrating equations or vectors, $-n$ is the number of the observations, m is the number of characteristic roots and $\hat{\lambda}_i$ is the estimated values of characteristic roots and $\hat{\lambda}_{i+1}$ succeeding estimated value of characteristic roots. If the presence of cointegration is established, the next step is to estimate the error correction model (ECM). The ECM is represented by:

$$\Delta GDP_t = \beta_0 + \sum_{i=1}^{n-1} \beta_i GDP_{t-1} + \sum_{i=0}^{m-1} Y_t \Delta MAN_{t-1} - \prod \hat{e}_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta MAN_t = \beta_0 + \sum_{i=1}^{n-1} \beta_i MAN_{t-1} + \sum_{i=0}^{m-1} Y_t \Delta GDP_{t-1} - \prod \hat{e}_{t-1} + \varepsilon_t \quad (6)$$

where $\prod$ is the error correction coefficient, ε_t is the equilibrium error and Δ represents the first difference operator. GDP_t and MAN_t are the level terms in the model that represents the long run parameters of the two variables. Furthermore, error correction model (5) and (6) presented above allows us to use it in the long run information and short run disequilibrium. ECM allows testing for short run or dynamic causality. In economics, causality is defined as the ability of one variable to predict the other. The study adopts the Granger causality test to examine the causality relationship among the concerned variables. The Granger test of causality estimates the following pair of regressions:

$$GDP_t = \sum_{i=1}^{n} \alpha_i MAN_{t-i} + \sum_{j=1}^{n} \beta_i GDP_{t-j} + \mu_{1t} \quad (7)$$

$$MAN_t = \sum_{i=1}^{n} \lambda_i MAN_{t-i} + \sum_{j=1}^{n} \delta_i GDP_{t-j} + \mu_{2t} \quad (8)$$

where μ_{1t} and μ_{2t} are called impulses in the language of VAR and it is assumed that μ_{1t} and μ_{2t} disturbances are uncorrelated. The Granger causality test the hypothesis of no causal relationship. The test statistic for Granger causality analysis is as:

$$F = \frac{(ESS_R - ESS_U)/p}{ESS_U/(n-2p-1)} \quad (9)$$

The null hypothesis is rejected if the value of the F test statistic is greater than the critical value or if the p-value of F test statistic is less than 0.05 level of significance. The residuals from the cointegration model must be normally distributed, serially uncorrelate and be homoscedastic. If these assumptions are encountered, it is declared that the chosen model is a fair presentation of reality.

IV. DISCUSSION OF RESULTS

The starting point of time series analysis is the visual inspection of the series plot of GDP, manufacturing, service and employment. The graphical presentations of the series are presented in Figs. 1-4.
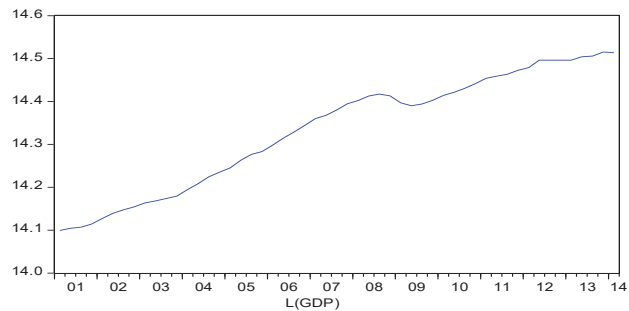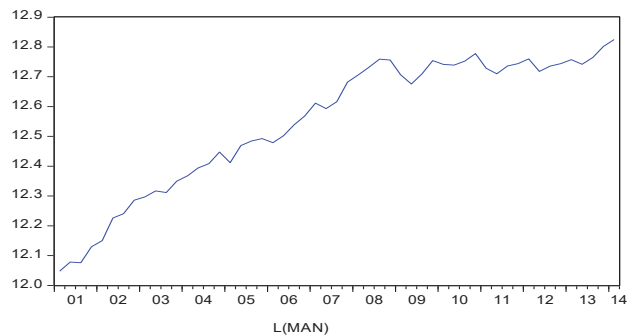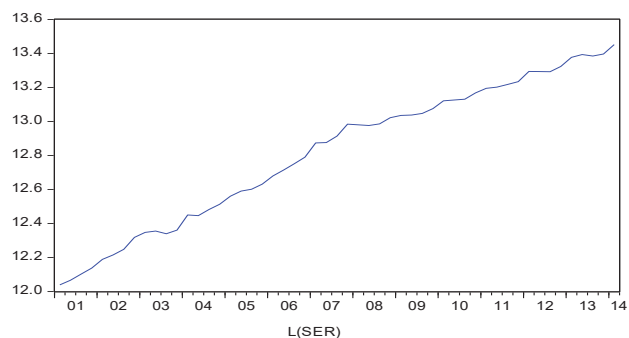

Fig. 1 GDP

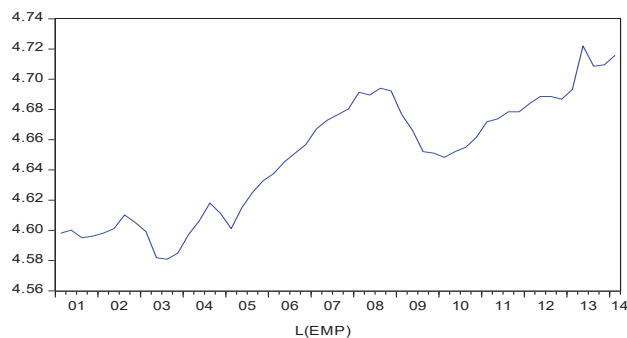Fig. 2 Manufacturing growth

Fig. 3 Services

Fig. 4 Employment rate

The plot of GDP, manufacturing and service have risen consistently since 2001 to 2014 with slight fluctuations. The employment series has also risen consistently since 2001 until the first quarter of 2009 where it was recessional and started booming in 2010. The employment rate have irregular fluctuations as compared to GDP, manufacturing and services. By visual inspection, all the four series are nonstationary therefore differencing was then applied. The first differenced series are presented in Fig. 5.
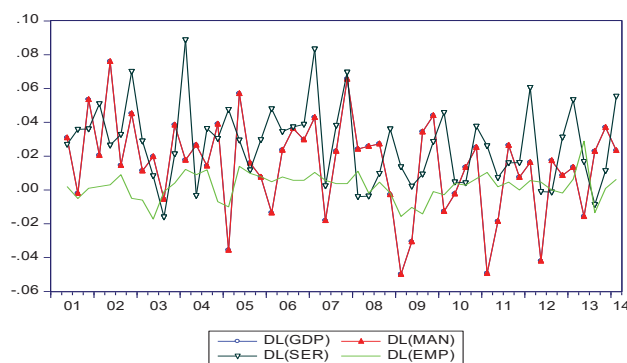

Fig. 5 First differenced series

Fig. 5 depicts that all variables roughly fluctuate around a constant mean of zero, implying that they are stationary. Graphically, these series may be stationary but this will be confirmed by the formal ADF test for unit root. Unit root results are summarised in the following Table I.

The results in Table I indicate that the null hypothesis of unit root cannot be rejected at levels with intercept, trend and intercept and none. The p-values of the ADF test of all the first difference series are significant at 5% significance level. Therefore, it is concluded that all the series are stationary at first difference. Since all the variables are stationary after integrated with the same order, *I (1)*, Johansen cointegration can be applied. The AIC selected optimum lag length as 6. Therefore 6 will be used for further analysis.

The results presented in Table II revealed that GDP growth, manufacturing growth, services and employment are found to be cointegrated. There are two cointegrating vectors as shown by the trace and maximum eigenvalue. Equations (10) and (11) present the long run relationship economic growth and

manufacturing respectively.

TABLE I
UNIT ROOT RESULTS

Series	Model	t-statistics	Prob.	Critical values	Conclusion(s)
LGDP	Intercept	-1.704	0.423	-2.920	Non-stationary
	Trend + intercept	-1.126	0.914	-3.500	Non-stationary
	None	2.674	0.998	-1.947	Non-stationary
DLGDP	Intercept	-3.570	0.010	-2.920	Stationary
LMAN	Intercept	-2.633	0.093	-2.919	Non-stationary
	Trend + intercept	-1.794	0.694	-3.499	Non-stationary
	None	3.866	0.999	-1.613	Non-stationary
DLMAN	Intercept	-6.898	0.000	-2.920	stationary
LSER	Intercept	-2.530	0.115	-2.921	Non-stationary
	Trend+ intercept	-1.672	0.749	-3.499	Non-stationary
	None	8.196	1.000	-1.947	Non-stationary
DLSER	Intercept	-6.693	0.000	-2.921	Stationary
LEMP	Intercept	-0.312	0.916	-2.919	Non-stationary
	Trend + intercept	-1.715	0.731	-3.499	Non-stationary
	None	1.970	0.987	-1.947	Non-stationary
DLEMP	Intercept	-5.553	0.000	-2.598	Stationary

TABLE II
JOHANSEN COINTEGRATION RESULTS

Hypothesized No. of CE(s)	Trace Statistic	Critical values	Prob.**	Max-Eigen Statistic	Critical values	Prob.**
None *	78.935	47.856	0.000	40.895	27.584	0.001
At most 1 *	38.040	29.797	0.005	27.948	21.132	0.005
At most 2	10.092	15.495	0.247	9.804	14.265	0.225
At most 3	0.289	3.841	0.591	0.289	3.841	0.591

Note: Trace test and Max-eigenvalue test indicates 2 cointegrating equations at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values.

$$LGDP_t = C + 0.046 LMAN_t - 0.214 LSER_t - 1.416 LEMP_t + \mu_t \quad (10)$$

$$LMAN_t = C - 1.991 LSER_t + 3.852 LEMP_t + \mu_t \quad (11)$$

The results further revealed that there is a positive long run relationship between manufacturing and GDP growth as it is expected from Kaldor's theory of growth. The coefficient for services and employment are both negative implying that both services and employment have a negative long run relationship with GDP growth as calculated in (10). The results estimated in (11) revealed that there is negative long run relationship between manufacturing and service and there is positive long run relationship between manufacturing growth and employment.

The results in Table III indicated that about 32.3% of disequilibrium has been corrected. This coefficient also implies that manufacturing growth, services and employment slowly adjust back towards long run equilibrium with GDP growth.

The results in Table IV suggest that there is a unidirectional causality running from manufacturing growth to GDP growth, from GDP growth to employment and from service to

manufacturing growth. This results are in line with the Kaldor's first law of growth.

TABLE III
ERROR CORRECTION MODEL

Variable	Dependent Variable: GDP
Constant	9.843*(0.267)
ECM(-1)	-0.323*(0.158)
DMAN(-1)	-0.007(0.082)
DSER(-1)	0.419*(0.154)
DEMP(-1)	0.372(0.283)
MAN(-4)	0.065(0.042)
SER(-3)	0.287*(0.023)
DGDP(-1)	1.299*(0.399)
R-squared	0.988
Adjusted R-squared	0.986
S.E. of regression	0.013

Note: * indicates significant at 5 percent. Parentheses indicate standard errors.

TABLE IV
GRANGER CAUSALITY RESULTS

Null Hypothesis:	Obs	F-Statistic	Prob.
MAN does not Granger Cause GDP	47	2.995	0.019*
GDP does not Granger Cause MAN		1.530	0.198
EMP does not Granger Cause GDP	47	1.362	0.258
GDP does not Granger Cause EMP		3.578	0.007*
SER does not Granger Cause GDP	47	0.673	0.672
GDP does not Granger Cause SER		1.011	0.435
EMP does not Granger Cause MAN	47	0.698	0.653
MAN does not Granger Cause EMP		1.653	0.163
SER does not Granger Cause MAN	47	2.738	0.028*
MAN does not Granger Cause SER		0.708	0.645
SER does not Granger Cause EMP	47	1.997	0.093
EMP does not Granger Cause SER		0.686	0.662

Note: * indicates statistical significance at 5% level of significance.

TABLE V
DIAGNOSTIC RESULTS

Test	Test statistic	Prob.
Breusch-Godfrey (BG)	18.880	0.275
White's test	169.452	0.703
Jarque-Bera (JB)	0.497	0.780

The BG test statistic revealed that there is no presence of serial correlation in the residuals. There is also no presence of heteroscedasticity since the probability value of the White's test is greater than 5% level of significance. This implies that residuals are homoscedastic. The probability value for JB test statistic is greater than 0.05. Therefore, the null hypothesis cannot be rejected and it is concluded that the residuals are normally distributed.

V. CONCLUSION

The paper employed the Johansen cointegration methodology. The unit root test rejects the null hypothesis and clearly confirms that the variables under consideration are stationary after first differencing. Johansen cointegration results provided the evidence that there is existing cointegration relationship between manufacturing growth, services, employment and GDP growth in South Africa. It is concluded that the Kaldor's first law of growth is applicable in the South African economy since the direction of causation between manufacturing and GDP growth runs from manufacturing to GDP.

Since there is evidence that the cointegration between the concerned variables, ECM was applied. The ECM results revealed that 32.3% of disequilibrium is corrected. The diagnostic testing of the classical linear regression assumptions were met and confirms that the model is not spurious. The paper recommends that the policy makers in South Africa to update the industrial policy and to import talent and skills in order to develop the manufacturing sector. The most important contributing factor for manufacturing growth is infrastructure and foreign investments. Thus, South Africa should consider foreign investments and improvements in infrastructure in boosting manufacturing growth in the country.

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