Research article

Economic sectoral diversification: A case study of the Gauteng provincial region, South Africa

Daniel Francois Meyer*

College of Business and Economics, University of Johannesburg, South Africa.

* **Correspondence:** Email: dfmeyer@uj.ac.za.

Abstract: From a theoretical point of view, a more diversified economy across all major sectors has more potential to grow and is more resilient to survive external shocks than more sectoral concentrated economies. The economy's diversification is a process; in most cases, structural change is required through policy implementation. The primary aim of this study was to analyze the relationships between the level of diversity (Tress Index) across sectors of the economy, GDP per capita (a proxy for economic development), domestic investment, employment and exports. The Gauteng province was selected as the study region because this region is a leading economic region in South Africa and the African continent. A quantitative methodology used time series secondary data from 1993 to 2021, with the diversification index selected as the dependent variable. Interesting results were achieved, leading to a new theory in development economics. When a region experiences an economic down-swing, sectoral concentration occurs, while diversification across sectors occurs in an economic growth environment. A positive relationship has been identified between economic diversification and the predictive variables, including economic development, domestic investment, employment and export. A policy of increased diversification across all economic sectors is a viable economic development strategy developing countries should implement within an environment for growth and investment.

Keywords: diversification; economic growth; Gauteng province; regional development; sectoral analysis; structural change

JEL Codes: O11, O18

1. Introduction

The literature indicates that economic diversification could lead to economic development, structural change and eventually, more employment opportunities across all the major economic sectors (Freire, 2017). Increased economic sectoral diversification requires structural changes, increasing the options for moving production factors to sectors with higher productivity levels (OECD, 2019). Economic sectoral diversification refers to the equal development of all major economic sectors across a regional economy and the reduction of dependence on a single sector (Dissart, 2003). According to Ngouhouo and Nchofoung (2021), economic diversification is a well-known regional strategy to promote economic stability, reduce risk and vulnerability to external shocks and facilitate long-term growth.

However, the debate is on within the research field of Regional Economics regarding what is more appropriate: A fully diversified economy across all sectors or a concentration in only a few sectors with comparative advantage. A well-diversified economy is well-buffered against most shocks, but concentration could also have benefits such as high levels of specialization and competitiveness. However, economic diversification is a long-term process, and structural change is needed to move to an economy with well-developed primary, secondary and tertiary sectors (OECD, 2019; ECLAC, 2017).

Information from the Gauteng City Region (2023) indicates that Gauteng is the smallest of the nine South African provinces, contributing only 1.5% of the total land area. Gauteng also has the highest population density of all the provinces and a population of more than 16 million, contributing approximately 27% to the national population. The study region has two major cities: Johannesburg, the provincial and financial capital, and Pretoria, South Africa's national capital. The province contributes approximately 33% of the South African GDP and 10% of the African economy.

We aim to analyze sectoral diversification in the Gauteng Province in South Africa, a leading economic region in Africa, and its relationship with economic growth and development, investment, employment and exports. The sub-aims of the study are two-fold: First, to assess the level of diversification from 1993 to 2021; second, to econometrically test the relationships between changes in diversification and other variables as listed. The initial hypothesis is that a more diversified economy across all sectors allows for higher growth, and diversification improves with economic growth and declines in times of recession. This research contributes to the fact that such a study has yet to be conducted in South Africa on a regional level, and economic diversification has yet to be assessed in this way. The significance of the research is that it could provide new insights in regional sectoral analysis and could even lead to a new regional economic theory related to the role of diversification.

2. Literature review

World Bank (2023) states that sectoral economic diversification is essential for economic development. All countries or regions should strive for a more diverse production and trade structure.

High levels of sectoral diversification could be associated with lower levels of vulnerability. High levels of sectoral diversification contribute to higher resilience to external shocks, which can negatively impact the long-term economic outlook. The World Bank defines economic diversification "*as the shift toward a more varied structure of domestic production and trade to increase productivity, create jobs and provide the base for sustained poverty-reducing growth*". Successful diversification is dependent on structural transformation and the reallocation of domestic production resources across industries from low-productivity activities to those with higher productivity.

In addition, sectoral economic diversification means changes in the economy from a single sector focus to a growing range of sectors contributing to the economy. It has traditionally been applied to encourage positive economic growth and development (UN, 2023). Economic diversification is a shift to a more varied spread across economic sectors related to production, productivity, international trade and employment towards inclusive growth and a sustainable economy (OECD, 2019).

According to the OECD (2019), there are several paths towards a more diversified economy, which include a focus on new firms and growth of existing local firms, ensuring technological growth with improved value chains and transport costs, pro-competitive regulatory reforms and (4) movement of production factors and resources from low-productivity firms and high-productivity firms.

According to ECLAC (2017), diversification is a process, and changes occur over the long run. Diversification takes a long time due to the level of complication of coordination and development of human capital. According to the OECD (2019), governance and policy development could significantly impact the diversification of developing countries and regions if effective incentives are available, investment policy reforms, possible reallocation of resources and actions to fix policy implementation mistakes of the past.

According to Madjd-Sadjadi (2019), economic diversification has many definitions depending on which point of view it is seen, but it is linked to economic complexity. Complexity means a wide range of economic sectors contributes to the economy. Economic complexity or diversification usually results in lower volatility and higher resilience levels in economic growth. According to Lei and Zhang (2014), more diversified economies usually have higher levels of growth and development. Higher levels of diversification could also lead to higher exports of more sophisticated products and services (Hausmann & Hidalgo, 2011).

According to Gelb (2010), the following are important factors for diversification: Political commitment for improved economic development and social stability; an export growth policy focus; attraction of investment both local and foreign; quality institutions and policy implementation; and the development of human capital.

Freire (2017) developed an economic diversification theory based on a structural economic dynamics framework with endogenous technological change. In its simplest form, the theory is explained within an international trade environment with labor as the only production factor. The number of sectors contributing to the economy's growth is used as the measurement within the model. Each sector produces only a single product. Each economic sector is evaluated by the level of technology used in production, which predicts the level of productivity. According to the theory, countries only produce products with sufficient demand, at an acceptable price level, and with labor availability. Only countries that are competitive in producing specific products will continue to

produce those products in the long run. Over time, the economy changes concerning innovation and technology, leading to new products and economic diversification.

The theory of economic base sectors is essential in a second theory with linkages to economic sectoral diversification. Economic base sectors are also known as export-oriented sectors. These sectors produce enough goods and services for local use and export, generating income from outside the specific region via exports, attracting investment and wages. Economic base sectors also have multiplier effect capabilities supporting other non-economic base sectors. Economic base sectors include manufacturing production, agriculture and agri-processing, mining, tourism and high-tech service sectors, including software exports and IT services. Economic progression is achievable if these sectors and sub-sectors are well developed across the sectors (Medina-Smith, 2000).

In terms of empirical review, the following studies were analyzed. Saviotti et al. (2020) studied the relationships between economic diversity, structural change and economic growth. A structural change could include the emergence and growth of new economic sectors, increased quality, productivity and differentiation of sectoral output and the changing interactions between the economic base and services sectors. Structural change is a fundamental mechanism for growth. This structural change gives rise to a growing diversification across economic sectors through the co-evolution of industrial sectors, technologies and institutions. Imbs and Wacziarg (2003) assessed the evolution of sectoral diversification and concentration about the level of per capita income. The results indicate that various measures of sectoral concentration follow a U-shaped pattern across various data sources: countries first diversify in the sense that economic activity is spread more equally across sectors, but later in the development process, the economy starts specializing in specific sectors again. The study results indicate a positive relationship between income and diversification.

Brown (2012) studied the US's economic diversification and economic growth nexus on regional development. This time series analysis over 30 years tested if diversification could explain growth and stability. The findings confirmed a positive relationship between diversification and growth stability, especially regarding employment across economic sectors. Pirasteh et al. (2009) assessed levels of concentration or diversification and the relationship with economic growth in the EU region from 1995 to 2004. The outcome of this study confirmed the importance of diversification. Export product and service diversification positively impacted economic growth rates with increased economic performance and stability. Shearmur and Polèse (2005) explored the linkages between regional economic diversity and changes in employment growth trends between 1971 and 2001, including 382 Canadian regional areas, including urban and rural regions. The results show that diversification in some regions converts to increased employment, and no evidence was found of a link between diversification and growth. Also, proximity to large diversified economic regions such as metropolitan areas is associated with higher levels of growth.

Mikheeva (2017) analysed the diversification of regional economies in Russia by assessing changes in sectoral employment, gross value-added production and industrial production from 2000 to 2014. Results indicate that sectoral structures of employment and production remain stable in the long run, but sectoral structures are most flexible in lagging regions and more stable in leading regions. Overall, during the study period, diversification improved employment. Furthermore, the diversification related to GVA and production in the manufacturing sub-sectors declined. Employment diversification is positively related to GVA, income levels and productivity. The study provides an

interesting hypothesis. It is confirmed that sectoral diversification could lead to regional economic growth and development but not at a high rate. Accelerated growth could be facilitated via specialization in specific sub-sectors of the economy.

Esanov (2012) studied sectoral economic diversification, including policy implications for countries and regions heavily dependent on natural resources. The results from the study indicate that the "resource curse" does affect economic growth and export diversification negatively. Natural Resource-rich regions have lower growth rates compared to other developed economies. These countries generally need higher levels of diversification, productivity and technology in manufacturing. In addition, these countries have low-quality institutions and need more infrastructural development and capacity. Economic diversification is supported through export diversification and investment. Jolo et al. (2022) state that sustainable development could be achieved via higher levels of economic diversification as this could lead to structural change in the long term. Results from the study are that some evidence indicates that economic growth and structural factors do impact diversification. Of importance is that studies (literature) on economic diversification do not provide consensus due to different variables, methodologies, countries and periods, for example. This research assessed the factors fueling economic diversification in 14 resource-rich countries between 2001 and 2019. The results from the research found the following factors for successful diversification: Domestic investment, high levels of labor force participation and job creation, skills development and good governance.

Shayah (2015) also found that the sectoral diversification of the economy is vital for growth in the oil-exporting UAE. Results from the study show that the UAE seems to be more diversified than other Arab countries and that the tourism and trade sectors contribute to economic growth and diversification. Albassam (2015) in Saudi Arabia also found that economic diversification is important for economic growth and development, as supported by Gylfason (2016), especially in the long run. An economy dependent on only one or two sectors for income is vulnerable and unstable from an economic point of view. Diversification could create employment and improve governance with less corruption and institutional quality.

Sharpley (2002) assessed the possible impact of the tourism sector on economic diversification in Abu Dhabi, with its economy being dominated by oil exports. Over the last few decades, the tourism sector has been identified globally as an essential strategy for economic growth and the diversification of economies. The study results showed that tourism could play an important role in economic diversification by accelerated investment in product development and promotion of alternative economic base sectors. Sheng (2011) focused on the tourism sector as an economic base in a study that analysed specialization compared to diversification. His findings include that regional economies can benefit by specializing in goods and services with efficient productivity and comparative advantages. Tourism development and specialization benefits include additional employment opportunities, an inflow of capital due to international tourists and increased investment in infrastructure.

Yusof (2013) focused on economic diversification in Malaysia. The Malaysian government used diversification to achieve high economic growth rates, including structural change. In this process, the development and diversification of the manufacturing sector have played a key role in export growth. Over the long run (50 years), the diversification of the economy leads to economic success, including high growth rates, export growth, improved technology and innovation, development of the manufacturing sector and lastly, effective and quality institutions.

The OECD (2019) states that the Chilean government facilitated a successful diversification strategy by promoting value-added manufacturing processes, upgrading logistics, general diversification across various sectors and effective spatial policies related to growth poles and special economic zones (SEZs). The OECD (2019) listed the following best practice components for successful diversification: Quality governance and institutions with effective policy implementation; export promoting policy focus; focus on value-added production from natural resources; and human capital development (Gelb, 2010).

Hammouda et al. (2010) assessed diversification and its relationship with economic growth and productivity in Africa. The findings indicate that accelerated economic diversification could contribute to higher productivity levels. Kapunda (2003) tested the relationship between diversification and poverty eradication in Botswana and confirmed the above-listed results but also found that diversification could lead to a reduction in poverty levels.

Esu and Udonwa (2015) focused on the diversification process in Nigeria using time series data and estimating an econometric model from 1980 to 2011. Results indicate that the country can potentially have a much more diversified economy. Increased diversification could be achieved through accelerated industrialization, promotion of new technology across all economic sectors, and increased investment in all economic base sectors. Owan et al. (2020) tested the relationship between economic diversification and economic growth in Nigeria between 1981 and 2016. Findings indicated that non-oil-related GDP positively impacted economic growth, while non-oil-related exports and investment also had positive impacts. Research recommendations include expanding and diversifying exports and increasing productivity in the real sector.

Arayama and Miyoshi (2004) assessed the role of regional economic diversity in economic growth in regions in China. The findings are as follows: Domestic investment significantly contributed to growth in the early phases of the development of the economy, but the impact of investment lessened as a region achieved higher growth and development levels; employment diversification and the structure changed significantly over time, especially in the secondary sector until 1992, but stabilized over time; and technologies vary from region to region.

Longmore et al. (2014) tested the levels of economic diversification in Trinidad and Tobago, a small island state. Econometric techniques were applied to identify the obstacles to economic diversification between 1980 and 2011. It was found that attracting FDI for island states is critical for economic growth and structural change.

From the literature, and in summary, regional diversification's benefits are that it reduces the risk for significant economic resections, especially on the regional level, and allows for more resilient and sustainable economic growth and diverse employment opportunities. Higher levels of sectoral economic diversification also facilitate increased competition, opportunities for establishing new businesses, higher productivity levels through innovation, increased exports and domestic investment. Governments can play a significant role in the economy's diversification through policy formulation and implementation. Some of the main components of such policies include investing in infrastructure, transport and supply chains; entrepreneurship development; and incentives for economic sector development (Williams & Vorley, 2014; Brown & Greenbaum, 2017; Rocchetta & Mina, 2019).

Rodrik (2005) formulated several design principles for economic diversification: Allocate incentives and subsidies for sectoral development; target economic activities related to innovation and

technology transfer; ensure implementation of policies and monitor and control of support activities; and ensure and maintain partnerships between public and private sectors. The literature review shows that highly diversified economies across sectors could accelerate economic growth with all its associated benefits. In addition, value-added processes are required in well-diversified sectors through increased technological and skills development.

3. Methodology

The theoretical paradigm of this research methodology is founded in the functionalist paradigm and is based on a quantitative research methodology. The objectives of the research are to assess the level of sectoral economic diversification from 1993 to 2021 in the study region and, second, to econometrically test the relationships between changes in sectoral economic diversification and other variables, as listed in Table 1. The objectives are achieved using an intensive literature review, followed by a descriptive analysis of the diversification data and an econometric model, testing the relationships between the selected variables. The study region selected is the Gauteng province, the economic hub in South Africa and the African continent. South Africa, and the Gauteng region, is a proxy of a well-governed democratic developing country on a global scale.

Table 1. Summary of variables included in the study.

Variable	Abbreviations (log format in brackets)	Role of the variable and anticipated impact
TRESS Index (dependent variable)	TRESS (LTRESS)	The Tress index can measure a region's economic sectoral diversification or concentration. A stress index of zero represents a fully diversified economy, while the higher the index (closer to 100), the more concentrated or vulnerable the region's economy is to exogenous variables.
GDP per capita	GDPC (LGDPC)	The total regional gross domestic product (GDP) is divided by the total population to determine the GDP per capita, a proxy for economic development. Listed in Rand values
Domestic investment (GFCF)	GFCF (LGFCF)	All improvements related to plant, machinery and equipment purchases; Improvement of the public and private sector infrastructure. Listed in Rand values.
Total employment	TOTEMP (LTOTEMP)	This includes regional estimates of all employment (formal and informal). Listed as the total number of people employed.
Total export	TOTEXP (LTOTEXP)	Includes the exports by 50 Standard Industrial Classification categories (most manufacturing and business services down to 3-digit level and the rest down to 2-digit level) in Real R million.

Source: Quantec Easy Data, (2023).

This study's outcomes are important as it could assist both developed and developing countries in better understanding the importance of sectoral economic diversification. All variables were converted into natural logarithms to simplify the reporting of results and minimize the possibility of

any variance within the dataset. Stationarity testing of variables was used to determine the econometric methods and processes selected for the study. The options for the econometric analysis were the Johansen cointegration model and/or the Autoregressive Distributed Lag (ARDL) model as developed by Pesaran et al. (2001). Test results from the unit root tests indicated a single level of stationarity, namely I (1); therefore, either model could be used, but in this case, the ARDL model was selected as the most suitable for this study due to its superior capabilities when working with smaller data sets.

The data analysis included both descriptive and advanced econometric time series data analysis. An (ARDL) model was used to estimate the long and short-run impacts of GDP per capita, investment, employment and exports on the TRESS index. Granger causality tests were also used to evaluate the existence of any causality between the variables. Secondary data used in the study were collected from Quantec Easy Data (2023).

The ARDL model equation, as estimated, is listed as follows:

$$LTRESS_t = a_0 + \alpha_1 LTRESS_{t-1} + \alpha_2 LagLGDPC_{t-1}$$
$$+\alpha_3 LagLGFCF_{t-1} + \alpha_4 LagLTOTEMP_{t-1} + \alpha_5 LTOTEXP_{t-1} \tag{1}$$

where $LTRESS_t$ represents the change in the natural logarithm value of the TRESS index at time t; $LGDPC_t$ denotes a change in the natural logarithm value of GDP per capita at time t; $LGFCF_t$ denotes a change in the natural logarithm value of the domestic investment at time t; $LTOTEMP$ is the logarithm of the total employment at time t, and $LTOTEXP_t$ denotes a change in the natural logarithm value of the total export at time t. The a_0 denotes the intercept, and n represents the optimum number of lags. The parameters α_i, i=1,2,3,4,5 indicate the long-run multipliers.

The econometric modelling process included the following steps: the Augmented Dickey-Fuller (ADF) tests were used to determine the level of stationarity, also known as unit root tests; the estimation of the possibility of long-run relationships using the Bound-test for cointegration, and included the estimation of error correction model and also testing for short-run relationships; Granger causality tests; and lastly diagnostic and model stability tests. Regarding the Bounds test, the calculated F-statistic value is compared to the upper and lower critical values in the estimation. If the F-statistic is below the lower and upper bound, no cointegration exists between the variables. After confirmation of the long-run and cointegration via the Bounds-test, the error correction model (ECM) was estimated and included short- and long-run dynamics. The ECM's coefficient must be negative, with a significant p-value, indicating convergence to equilibrium and cointegration between variables. Lastly, model diagnostic and stability checks were done by testing for robustness. Two tests were conducted to test for serial correlation, normal distribution and heteroskedasticity. Last, the CUSUM test was used to test the stability of the model.

4. Results and discussion

4.1. Descriptive analysis

Table 2 provides a summary of the relative contributions of the main economic sectors to the regional GDP of the Gauteng province. All values are listed in Rand (millions) at constant prices for

2022. The services sector, part of the tertiary sector, contributes the most to the regional economy at 26.2% of the total GDP. The manufacturing sector delivers the second highest contribution at 23.8% as part of the secondary sector, followed by the community service sector and the transport, storage and communication sector at 13.68% and 13.64%, respectively.

Table 2. Regional Gross Domestic Product (RDGP) of Gauteng province for 2022.

Economic sector	Total (Rand millions at constant prices)	% share of RGDP
Agriculture	R 23 263	0.74
Mining	R 44 326	1.40
Manufacturing	R 753 648	23.84
Utilities	R 72 224	2.28
Construction	R 102 099	3.23
Wholesale and retail trade	R 310 385	9.82
Transport, storage and communications	R 431 367	13.64
Finance, insurance and real estate	R 829 022	26.22
General Government	R 163 031	5.16
Community services	R 432 406	13.68
Total RGDP	R 3161 772	100

Source: Quantec, 2023.

The descriptive data are further discussed based on the results indicated in Table 3 and Graph 1. First, the TRESS index is assessed. A TRESS index closer to 0 indicates near equal contribution of the 50 sub-sectors used in the study. In contrast, a value closer to 100 indicates near-complete concentration on a single sub-sector. An index above 50 indicates an economy more concentrated than diversified and vice versa. The Gauteng economy is well developed, but results indicate that the economy is more concentrated on a few sectors than diversified. A mean value of 68.8 was achieved over the study period. The regional economy has shown a clear concentration trend across the 50 subsectors used in this analysis, from an index value of 66.8 in 1993 to 72.6 in 2021, a decline of 8.7%.

Second, GDP per capita (a proxy for economic development) reached a maximum value of R240 878 in 2008, with a mean value of R206 696 over the period. However, since 2008, the real value of the GDP per capita has declined to a low point of R 19385 in 2021, resulting in an annual decline of 1.84%. Regarding domestic investment (GFCF), the average investment value over the study period was R 181 606 million, with a maximum value of an investment in 2016 of R 248948. The trend over the last five years was that of decline, with a low value of R 194439 in 2021, a decline of 5.6% per annum.

Total employment has since 2010 been increasing steadily up to 2019 with an annual growth rate of 0.67%. However, COVID-19 significantly impacted employment, and from a peak of 5 400403 in 2019, employment declined to 4 838430 in 2021. The total export trend increased until 2019 but declined sharply during COVID-19 between 2020 and 2021. According to the Jargue-Bera test values, all variables are normally distributed, with values above 0.05. Regarding the Kurtosis values, all variables should have a value of below 3, thus indicating the data set has a limited tendency for outliers.

Table 3. Descriptive statistics.

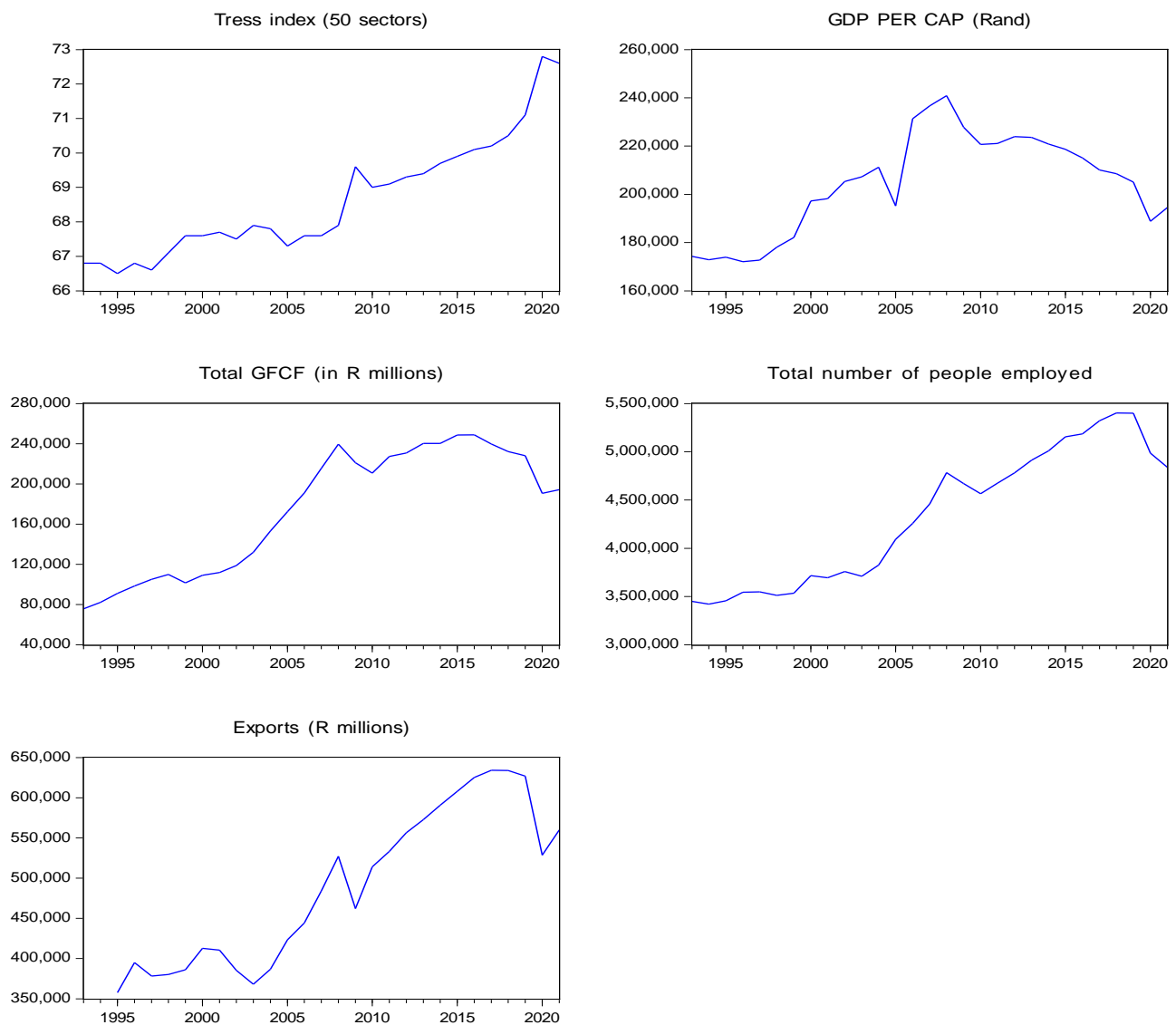|	Tress Index (TRESS)	GDP per capita (GDPC) in Rand value	Domestic investment (GFCF) in Rand million values	Total employment (TOTEMP) is the total number of people employed	Total exports (TOTEXP) in Rand million value
Mean	68.77	206 696	181 606	4 399 995	488 331
Median	67.90	208 507	194 402	4 564 850	484 066
Maximum	72.80	240 878	248 948	5 402 897	634 228
Minimum	66.50	172 117	91 151	3 456 545	357 522
Std. Dev.	1.71	19 764	57 388	675 354	96 493
Kurtosis	2.87	2.13	1.48	1.51	1.53
Jarque-Bera	2.69	1.16	3.21	2.51	2.55

Figure 1. Trends.

Figure 2 is a graphical representation of the differenced natural logarithm trends of all the variables included in the study. The trends are interesting. GDP per capita peaked in 2006, just before the global financial crisis. Economic conditions were favorable, and the country and region experienced economic development. However, from 2007 to 2009, the region experienced a recession. This situation recovered in 2010 when the Soccer World Cup was hosted in South Africa and Gauteng province. The second significant event impacting on economic development was COVID-19. GDP per capita started declining in 2019 before the pandemic started and recovered again in 2021. Domestic investment followed a similar trend with a boom from 2002 to 2005 but experienced negative periods with the global financial crises and COVID-19.

The most interesting result or trend from the graph is found in the TRESS index curve. The curve is relatively stable, especially from 1993 to 2008. However, with the financial crises and subsequent recession from 2008 to 2009, the economy showed concentration rather than diversification. This happened while all the other variables declined. This means the region's economy concentrates instead of diversifying across sub-sectors in times of economic downturn. In contrast, in the boom time preceding the financial crises, the economy showed higher levels of diversification. During the recession of the COVID-19 period, again, the economy concentrated and needed to diversify. These results are included in a new theory to be formulated in the conclusions of this paper. Possible reasons for this phenomenon of concentration and diversification could be found at the foundation of any regional economy. In periods of recession, demand for products and services will decline, leading to fewer opportunities for business development and the closure of marginal firms. Economic sectors have forward and backward linkages, and during times of recession, these linkages also decline. Lastly, during a recession, consumers reduce their spending, especially on non-essential goods and services, leading to concentration across economic sectors. The opposite is then also true during periods of expansion and rapid growth.
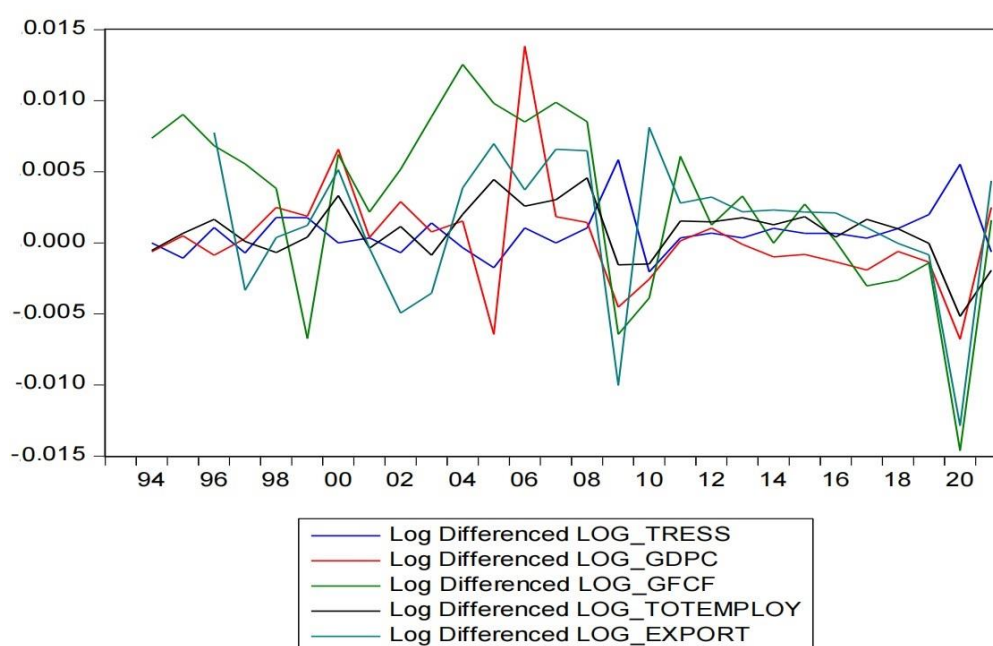

Figure 2. Differenced Natural logarithm trends analysis.

4.2. Unit root tests

The unit root test results are listed in Table 4. The Augmented Dickey-Fuller (ADF) test completed the unit roots estimations. The tests indicated that all variables are stationary at I (1). The results of the unit root tests indicated that an ARDL model or a cointegration method could be used for this study. After pre-tests using both methods, it was decided to proceed with the ARDL method due to the relatively smaller number of observations.

Table 4. Unit root tests.

Variables	Stationarity		Result
	ADF levels I (0)	ADF 1st difference I (1)	
LTRESS	0.9881	0.0001*	I (1)
LGDPC	0.4474	0.0002*	I (1)
LGFCF	0.3234	0.0269*	I (1)
LTOTEMP	0.6959	0.0191*	I (1)
LTOTEXP	0.5993	0.0002*	I (1)

Note: *denotes the rejection of the null hypothesis of unit root at the 5% level of significance.

4.3. Bounds tests and Long-run results

The lag length selection was estimated after selecting the econometric model based on the ARDL methodology. A lag of one (1) was selected during the lag length selection estimation. The Akaike information criterion indicated the selected and best-performing model as 2;1;2;1;2.

The next step in the econometric methodology was the Bounds test for possible cointegration and long-run relationships between the variables. In the Bounds-TEST, the F-statistic was determined at 4.897 with an upper bound value of 5.0 per cent significance at 3.49. Based on the above-listed estimation results, it could be concluded and confirmed that long-run relationships do exist between the variables selected in the model. Equation (2) presents the long-run relationships:

Long-run Equation:

$$LTRESS = +(-0.225 * LGDPC) + (-0.058 * LGFCF) + \\ (-0.447 * \text{LTOTEMP}) + (-0.271 * \text{LTOTEXP}) \tag{2}$$

From Equation (2), the long-run regression, the coefficients of all independent variables were negative. This result confirms the initial theory from the descriptive analysis that in times of positive economic progression, the TRESS index lowers in value, meaning more diversification and vice versa. The independent variable or predicting variable with the highest coefficient was employment at 0.447, meaning a 1% increase in LTOTEMP could lead to a decrease of 0.45% in LTRESS, which indicates a relatively high impact if the slow changes in the Index are taken into account. The variable with the second highest impact on the TRESS index was total exports, with a coefficient of 0.271, followed by GDP per capita with 0.225. Domestic investment had a surprisingly low impact of only 0.06%. Brown (2012) and Yusof (2013) found similar results with economic growth leading to a more diversified economy. Mikheeva (2017) and Albassam (2015) also found that diversification and employment had

a positive relationship, and as a region's level of diversification increased, employment also increased. In a study in resource-rich countries, including Nigeria, Esanov (2012) and Owan et al. (2020) confirmed the diversification and export nexus. Esu and Udonwa (2015) confirmed the positive relationship between investment and diversification.

4.4. ECM and short-run results

Table 5 summarizes the error correction model (ECM) and short-run results. The ECM confirms the long-run relationship between the variables included in the model. The ECM test results are negative and significant. All independent variables have a negative short-run relationship with the dependent variable (LTRESS) regarding the short-run results. It is important to note that not all variables have a significant short-run impact. Only LGFCF and LTOTEXP have significant short-run impacts on LTRESS, with LTOTEXP having the highest coefficient of only 0.09.

Table 5. Short-run relationship and error-correction results.

Variable (D (LTRESS is the dependent variable)	Coefficient	Std. Error	P-value
D(LGDPC)	−0.0417	0.0291	0.2586
D(LGFCF)	−0.0521	0.0224	0.0334*
D(LTOTEMP)	−0.0798	0.0662	0.2458
D(LTOTEXP)	−0.0896	0.0246	0.0022*
CointEq(−1)*	−0.6111	0.0604	0.0003*

Note: *rejection of null hypothesis at 5% level of significance.

4.5. Granger causality

Table 6 summarizes the Granger causality tests (which are results in the short-run), with all variables as dependent or independent variables. However, this study focuses on LTRESS as the dependent variable. The results indicate that there is no causality between LTRESS and LGDPC. On the other hand, LTRESS also causes changes in LGFCF, as well as LTOTEMP. Also, LTOTEMP does cause changes in LTRESS, while LTOTEXP also cause changes in LTRESS.

Table 6. Granger Causality Test results.

Null hypothesis	F-stat	p-value
LGDPC does not granger cause LTRESS	0.5517	0.4645
LTRESS does not granger cause LGDPC	0.9772	0.3323
LGFCF does not granger cause LTRESS	2.3660	0.1366
LTRESS does not granger cause LGFCF	3.3989	0.0771**
LTOTEMP does not granger cause LTRESS	7.3091	0.0122*
LTRESS does not granger cause LTOTEMP	3.4454	0.0753**
LTOTEXP does not granger cause LTRESS	6.5846	0.0173*
LTRESS does not granger cause LTOTEXP	0.7022	0.4107

Note: *rejection of null hypothesis at 5% significance level; and ** rejection at 10% level.

4.6. Diagnostics

Various diagnostic and stability tests were performed to determine the appropriateness and stability of the models and methods used in the study. This was performed to test for serial correlation and the standard distribution test. The results indicated that the residuals were not auto-correlated using the Breusch-Godfrey LM Test. Furthermore, the series was tested via the Jarque-Bera Test and found to be normally distributed. The Breusch-Pagan-Godfrey test was used for heteroscedasticity, and the series was homoscedastic. Also, the model was tested for stability using the CUSUM test. The results confirmed a stable model. These results as contained in Table 7, confirm that the findings, as estimated, are trustworthy.

Table 7. Diagnostic and stability tests.

Component	P-Value and level of significance
Breusch-Godfrey Serial Correlation LM Test	0.1133
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.1879

5. Conclusions

Although a substantial volume of research has been conducted on economic diversification, we aim to contribute to the body of knowledge. Economic sectoral diversification makes a regional economy more stable and resilient during a recession. The major results, based on the descriptive and econometric analysis, were the formulation of a conceptual theory in the field of development economics. The theory relates to regional economic development and economic sectoral diversification. A regional economy experiences times of growth and times of recession. In times of growth, the economy with its sectors expands in terms of employment, investment and exports and, therefore, diversifies in terms of the Tress Index. The opposite is also true; the economy across the sectors concentrates in times of recession and contraction. As determined in the literature review section, diversification across economic sectors does have a positive relationship with other economic variables such as employment, exports, investment and economic growth. However, diversification usually occurs in the initial phases of development, after which some specialization and concentration within sectors occur.

This research implies that employment and exports have the highest impact on sectoral diversification in the long run. In terms of causality in the short-run, sectoral diversification does cause changes to domestic investment, while a bi-directional causality was determined between diversification and employment. Exports also caused changes in the level of diversification in the short run. When formulating policy, these relationships need to be taken into account. Future research will focus on the processes of diversification and the roles of different variables. More detailed research will also be conducted on the diversification versus concentration nexus. Regional comparisons will also be conducted within developing and developed countries and regions.

The following final policy guiding recommendations are listed: Economic sectoral diversification is important for economic stability within a structural change paradigm; entrepreneurship and business

support allow for increased diversification; development and promotion of innovation and technology; ensure transport and supply chain systems are cost-effective; ensure quality governance and institutions and an enabling environment to attract investment; promotion of exports; the development of human capital; and lastly the development of all economic base sectors within the economy.

In the final conclusion, economic diversity and economic complexity are important concepts for robust growth and development. A well-diversified economy is much more resilient in repelling all types of shocks, including health pandemics, recessions and even natural disasters.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The author declares no conflicts of interest in this paper.

References

Albassam BA (2015) Economic diversification in Saudi Arabia: Myth or reality? *Resour Policy* 44: 112–117. https://doi.org/10.1016/j.resourpol.2015.02.005

Arayama Y, Miyoshi K (2004) Regional diversity and sources of economic growth in China. *World Econ* 27: 1583–1607. https://doi.org/10.1111/j.1467-9701.2004.00668.x

Brown L, Greenbaum RT (2017) The role of industrial diversity in economic resilience: An empirical examination across 35 years. *Urban Stud* 54: 1347–1366. https://doi.org/10.1177/0042098015624870

Brown CC (2012) The impact of changing diversification on stability and growth in a regional economy. *Res Bus Econ J* 5: 1–10.

Dissart JC (2003) Regional economic diversity and regional economic stability: research results and agenda. *Int Reg Sci Rev* 26: 423–446. https://doi.org/10.1177/0160017603259083

Economic Commission for Latin America and the Caribbean (ECLAC) (2017) Economic diversification. Available from: https://repositorio.cepal.org/bitstream/handle/11362/42399/FOCUSIssue2Apr-Jun2017.pdf.

Esanov A (2012) Economic diversification: dynamics, determinants and policy implications. Available from: https://edc.gov.bz/wp-content/uploads/2016/11/ED-6.pdf.

Esu GE, Udonwa U (2015) Economic diversification and economic growth: Evidence from Nigeria. *J Econ Sustain Dev* 6: 56–68.

Fonchamnyo DC, Akame AR (2017) Determinants of export diversification in Sub-Sahara African region: A fractionalised Logit Estimation Model. *J Econ Finan* 41: 330–342. https://doi.org/10.1007/s12197-016-9352-z

Freire C (2017) Economic diversification: Explaining the pattern of diversification in the global economy and its implications for fostering diversification in poorer countries. United Nations, Department of Economic and Social Affairs.

Gauteng City Region (2023) The Gauteng City-Region. Available from: https://www.gcro.ac.za/about/the-gauteng-city-region/.

Gelb A (2010) Economic Diversification in Resources Rich Countries, Washington, DC: Centre for Global Development.

Gylfason T (2016) From economic diversification to growth. In forthcoming in a proceedings volume from a High-Level Seminar on Natural Resources, Finance & Growth sponsored by the Bank of Algeria, Algiers.

Hammouda HB, Karingi SN, Njuguna AE, et al. (2010) Growth, productivity and diversification in Africa. *J Prod Anal* 33: 125–146. https://doi.org/10.1007/s11123-009-0155-5

Hausmann R, Hidalgo C (2011) The network structure of economic output. *J Econ Growth* 16: 309–342. https://doi.org/10.1007/s10887-011-9071-4

Imbs J, Wacziarg R (2003) Stages of diversification. *Am Econ Rev* 93: 63–86. https://doi.org/10.1257/000282803321455160

Jolo AM, Ari I, Koç M (2022) Driving factors of economic diversification in resource-rich countries via panel data evidence. *Sustainability* 14: 2797. https://doi.org/10.3390/su14052797

Kapunda SM (2003) Diversification and poverty eradication in Botswana. *J Afr Stud* 17: 51–57.

Lei H, Zhang J (2014) Capabilities's substitutability and the "S" curve of export diversity. *EPL* 105: 68003. https://doi.org/10.1209/0295-5075/105/68003

Longmore R, Jaupart P, Cazorla MR (2014) Toward economic diversification in Trinidad and Tobago. World Bank Policy Research Working Paper.

Madjd-Sadjadi Z (2019) Economic diversification. Available from: https://www.quora.com/What-is-the-definition-of-economic-diversification.

Medina-Smith EJ (2000) Is the export-led growth hypothesis valid for developing countries? A case study of Costa Rica. United Nations. Available from: https://unctad.org/system/files/official-document/itcdtab8_en.pdf.

Mikheeva NN (2017) Diversification of regional economic structure as a growth strategy: Pros and cons. *Reg Res Russ* 7: 303–310. https://doi.org/10.1134/S2079970517040062

Ngouhouo I, Nchofoung TN (2021) Economic resilience in Sub-Saharan Africa: Evidence from composite indicators. *J Knowl Econ* 13: 70–91. https://doi.org/10.1007/s13132-020-00717-2

OECD (2019) Aid for trade at a glance 2019: Economic diversification and empowerment. Available from: https://www.wto.org/english/res_e/booksp_e/aid4trade19_chap5_e.pdf.

Owan VJ, Ndibe V, Anyanwu CC (2020) Diversification and economic growth in Nigeria (1981–2016): An econometric approach based on ordinary least squares (OLS). *Eur J Sustain Dev Res* 4: 1–10. https://doi.org/10.29333/ejosdr/8285

Pesaran MH, Shin Y, Smith RJ (2001) Bounds testing approaches to the analysis of level relationships. *J Appl Econ* 16: 289–326. https://doi.org/10.1002/jae.616

Pirasteh H, Sayadi M, Saghafi M (2009) Economic Growth and Stability in the Euro-Med Region: Concentration or Diversification? *Iran Econ Rev* 14:1–26.

Quantec (2023) Regional data. Available from: https://www.quantec.co.za/easydata/.

Rocchetta S, Mina A (2019) Technological coherence and the adaptive resilience of regional economies. *Reg Stud* 53: 1421–1434. https://doi.org/10.1080/00343404.2019.1577552

Rodrik D (2005) Policies for economic diversification. *Cepal Rev* 2005: 7–23. https://doi.org/10.18356/0c2fac0c-en

Saviotti PP, Pyka A, Jun B (2020) Diversification, structural change, and economic development. *J Evol Econ* 30: 1301–1335. https://doi.org/10.1007/s00191-020-00672-w

Sharpley R (2002) The challenges of economic diversification through tourism: the case of Abu Dhabi. *Int J Tour Res* 4: 221–235. https://doi.org/10.1002/jtr.378

Shayah MH (2015) Economic diversification by boosting non-oil exports (case of UAE). *J Bus Econ Manag* 3: 735–738. https://doi.org/10.7763/JOEBM.2015.V3.276

Shearmur R, Polèse M (2005) Diversity and employment growth in Canada, 1971–2001: Can diversification policies succeed? *Can Geogr* 49: 272–290. https://doi.org/10.1111/j.0008-3658.2005.00095.x

Sheng L (2011) Specialisation versus diversification: A simple model for tourist cities. *Tour Manag* 32: 1229–1231. https://doi.org/10.1016/j.tourman.2010.09.012

United Nations (2023) Economic diversification. Available from: https://unfccc.int/topics/resilience/resources/economic-diversification#:~:text=Economic%20diversification%20is%20the%20process,positive%20economic%20growth%20and%20development.

Williams N, Vorley T (2014) Economic resilience and entrepreneurship: lessons from the Sheffield City Region. *Entrepreneurship Reg Dev* 26: 257–281. https://doi.org/10.1080/08985626.2014.894129

World Bank (2023) Chapter 5: Economic Diversification: Lessons from Practice. Available from: https://www.wto.org/english/res_e/booksp_e/aid4trade19_chap5_e.pdf.

Yusof Z (2013) Economic Diversification: The Case of Malaysia. Revenue Watch Institute.