Asian Journal of Economic Modelling
ISSN(e): 2312-3656
ISSN(p): 2313-2884
DOI: 10.55493/5009.v13i4.5658
Vol. 13, No. 4, 517-532.

URL: www.aessweb.com

Sectoral linkages and spillover effects: Can growth in manufacturing stimulate wider employment in South Africa?

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Article History
Received: 15 July 2025
Revised: 10 September 2025
Accepted: 6 October 2025
Published: 4 November 2025

Keywords
COVID-19
Employment
Manufacturing output
Sectoral spillovers
South Africa
Structural ARDL
Structural transformation.

JEL Classification:
E24; O14; O55; C32.

ABSTRACT

This study examines whether growth in manufacturing output stimulates employment across South Africa's broader economy, focusing on sectoral linkages and spillover effects. Anchored in the structural transformation literature, the analysis investigates the extent to which manufacturing acts as a catalyst for inclusive job creation beyond its own sector. Using quarterly time series data from 1963 to 2024 and applying a Structural Autoregressive Distributed Lag (SARDL) model, the study estimates both short-run and long-run effects across six sectors: manufacturing, construction, mining, financial services, trade, and public services. To account for exogenous shocks, interaction terms between manufacturing output and a COVID-19 dummy variable are included. The results reveal strong positive spillovers from manufacturing to employment in the construction, trade, and financial services sectors, while mining and public services exhibit limited responsiveness. Pandemic-induced disruptions significantly weakened these linkages, as evidenced by negative and significant COVID-19 interaction effects. The findings underscore manufacturing's pivotal role in employment generation and support policies promoting manufacturing-led industrialization and intersectoral integration. This study contributes to debates on structural transformation and labor market dynamics in emerging economies. The study confirms that manufacturing remains a cornerstone of employment generation in South Africa, both within the sector and across the wider economy.

Contribution/ Originality: This paper quantifies economy-wide employment spillovers from South Africa's manufacturing growth using a Structural ARDL on 1963–2024 quarterly data across six sectors, with COVID-19 interactions. We document positive spillovers to construction, trade, and finance, weaker links to mining/public services, and policy-relevant evidence that reindustrialisation and value-chain integration yield inclusive jobs.

1. INTRODUCTION

Manufacturing has long been recognized as a fundamental pillar of economic growth, largely due to its historical contribution to employment generation, productivity enhancement, and structural transformation (Szirmai, 2012). Empirical evidence across countries consistently identifies manufacturing as a key driver of economic expansion, particularly in developing contexts. According to Szirmai (2012), a dynamic and resilient manufacturing sector not only creates employment opportunities but also fosters productivity levels that surpass those in most other sectors, potentially serving as a catalyst for far-reaching structural change. Since the onset of the Industrial Revolution, manufacturing has demonstrated a unique capacity to generate employment, drive technological advancement, and produce positive spillover effects across the broader economy.

Historically, rapid industrialization has coincided with periods of sustained economic growth in both advanced and emerging economies (Haraguchi, Cheng, & Smeets, 2017; Rodrik, 2013). This pattern has reinvigorated interest in reindustrialisation strategies as mechanisms to boost employment and reduce poverty. However, in many countries, the share of manufacturing in GDP and total employment has been declining a phenomenon described in the literature as "premature deindustrialisation" (Felipe, Mehta, & Rhee, 2019; Palma, 2014; Rodrik, 2016).

Of particular concern is that developing economies are experiencing this deindustrialisation trend at significantly lower income levels than those observed in developed nations (Rodrik, 2016; Tregenna, 2009). This shift has generated uncertainty around the traditional model of manufacturing-led job creation, especially as economies become increasingly service-oriented.

In the context of Sub-Saharan Africa, these concerns are particularly acute due to intense demographic pressure and the urgent need for large-scale employment creation. Structural transformation in many African economies is being driven primarily by the services sector, often in low-productivity areas (Diao, McMillan, & Rodrik, 2019; Fox, Thomas, & Haines, 2017; Gollin, Jedwab, & Vollrath, 2016; Kruse, Mensah, Sen, & De Vries, 2021; Newfarmer, Page, & Tarp, 2018).

This trend has raised serious concerns among development economists and policymakers, as service-led growth has not consistently delivered the scale or quality of employment required to meet the region's demographic demands.

While considerable empirical attention has been given to the direct relationship between manufacturing output and employment within the sector (Szirmai, 2012; Tregenna, 2008), less focus has been placed on the broader employment effects generated through intersectoral linkages. Some studies such as Black, Makundi, McLennan, and Roberts (2019) and Lavopa and Szirmai (2018), have explored these indirect effects, emphasising the role of manufacturing in stimulating employment in sectors such as agriculture, construction, and services through increased demand for intermediate inputs, logistics, and ancillary services (Szirmai & Verspagen, 2015; Zalk, 2014). However, the scale and nature of these spillovers are context-specific, influenced by the structure of domestic value chains and the composition of manufacturing activities (Del Prete, Giovannetti, & Marvasi, 2017; Gereffi & Fernandez-Stark, 2016).

For instance, Andreoni and Tregenna (2020) and Chitambara (2020), using input–output analysis and social accounting matrices, find that subsectors such as agro-processing, chemicals, and metals exhibit stronger forward and backward linkages than other manufacturing branches.

South Africa presents a particularly relevant case study due to its persistently high rates of youth unemployment and the structural challenges in its labour market (Bhorat & Kanbur, 2006; Seekings & Nattrass, 2005). These challenges reflect a combination of demand-supply mismatches, low absorption capacity in key sectors, and the lingering spatial and institutional legacies of apartheid (Banerjee, Galiani, Levinsohn, McLaren, & Woolard, 2008; Leibbrandt, Woolard, Finn, & Argent, 2010). Despite various efforts to diversify the economy, the share of manufacturing in both GDP and employment has stagnated or modestly declined over the past two decades (Andreoni & Tregenna, 2020; Tregenna, 2008; Zalk, 2014) while mining and services have continued to dominate. As of 2023, manufacturing accounted for roughly 12% of GDP down from over 20% in the 1990s thereby limiting its role as a source of inclusive growth and employment.

Nonetheless, manufacturing remains integral to the economy due to its intersectoral linkages and potential to influence broader employment dynamics. Examining the sector through the lens of spillover effects and sectoral interdependence can yield a more comprehensive understanding of its role in employment creation. This perspective is particularly relevant for informing inclusive industrial and labour market policies. Unlike Tregenna (2008), who focused primarily on the relationship between manufacturing growth and aggregate economic expansion, this study investigates the extent to which manufacturing production contributes to employment growth both within the sector and across related segments of the economy.

The remainder of the paper is organized as follows: Section 2 reviews the theoretical framework and relevant empirical literature. Section 3 outlines the empirical methodology. Section 4 presents and discusses the results. Section 5 concludes with key findings and policy implications.

2. THEORY AND EMPRICS

This section presents the theoretical underpinnings and empirical evidence concerning the spillover effects of manufacturing.

2.1. Theoretical Foundation

Theoretically, both classical and mainstream economic thought offer a foundation for exploring the spillover effects of manufacturing. However, the central theoretical framework guiding this study is derived from Hirschman (1958)'s seminal work, *The Strategy of Economic Development*. Hirschman introduced the concept of linkages to explain how targeted investments in specific sectors particularly manufacturing can stimulate broader economic development through intersectoral connections. He argued that economic growth is best propelled by strategic imbalances, where key sectors with strong forward and backward linkages serve as catalysts for wider development.

Backward linkages arise when growth in a sector like manufacturing increases demand for inputs from upstream industries such as agriculture, mining, or intermediate goods production. Conversely, forward linkages occur when manufacturing output serves as inputs for downstream sectors such as construction, retail, and services. According to Hirschman, sectors with dense linkage structures not only attract complementary investments but also stimulate employment and capacity development across the economy.

He emphasized that manufacturing holds especially high potential to generate both types of linkages due to its central role in modern production chains.

This study applies Hirschman's framework to the South African context by empirically testing whether manufacturing output generates employment spillovers in other sectors. Specifically, we assess whether increases in manufacturing activity stimulate job creation beyond the sector itself through its input-output relationships. In line with Hirschman's theory, we hypothesize that manufacturing functions as a strategic node capable of promoting inclusive growth via its intersectoral connections.

In summary, this study draws on Hirschman's theory of unbalanced growth and sectoral linkages to examine the extent to which manufacturing performance drives employment spillovers in South Africa, offering a lens through which to evaluate its broader developmental role.

2.2. Empirical Review

Recent empirical studies have increasingly highlighted the evolving dynamics of manufacturing and its broader economic implications, particularly in terms of productivity, employment, and sectoral interdependence. In high-income countries, the decline in manufacturing employment is often attributed not to trade-related factors but to rising productivity and structural shifts in consumer demand. For instance, Autor and Salomons (2017) argue that technological advancement and changing demand patterns are primarily responsible for shrinking manufacturing jobs. Similarly, Bessen (2019) finds that automation and efficiency improvements, rather than offshoring, are the leading drivers of job losses in the sector.

In developing countries, research has focused more on transmission mechanisms and intersectoral spillovers. Odhiambo (2025), for example, the study examines foreign direct investment (FDI)-induced productivity spillovers in Kenya and finds that backward linkages may negatively affect domestic firms' productivity. In China, Wang and Zhang (2024) assess how labour misallocation impacts economic growth in the manufacturing sector, revealing that sectoral interlinkages can mitigate the adverse effects of misallocation. Kazekami (2024), focusing on Japan, argues that simply promoting the manufacturing industry is insufficient for income and job growth without considering productivity and spillover effects across sectors.

Using spatial econometrics, Peng and Hong (2013) show that inter-sectoral linkages, rather than geographic proximity, drive productivity spillovers in China. Similarly, Li, Liu, and Parker (2001) highlight how the nature of FDI and local firm ownership structures influence the extent of productivity spillovers, with competition playing a key mediating role.

In South Africa, Tregenna (2008) underscores the strong backward linkages between manufacturing and the rest of the economy, suggesting that the sector serves as a major source of demand for services and other industries. Comparable results are found by Stare and Damijan (2015), who report that innovation spillovers in vertically connected sectors significantly enhance employment and skills in consuming industries. Likewise, Wei and Liu (2006) find that R&D, exports, and FDI in China's manufacturing sector produce positive spillovers on domestic firms.

The Ghanaian context offers additional insight. A growing body of literature (e.g., (Koomson, 2019; Mensah & Seidu, 2021)) confirms manufacturing's role in promoting employment and economic growth. Studies by Kodjo and Osei-Boateng (2018) and Mensah and Aryeetey (2005) link manufacturing output to GDP expansion, while Amissah and Adu-Gyamfi (2021) highlight the role of technological innovation in enhancing sector competitiveness and productivity spillovers. Other empirical efforts, such as those by Ackah and Tsegba (2017) and Aidoo and Amoah (2014), use input-output and VAR models to show dynamic sectoral interactions, revealing complementary relationships among agriculture, manufacturing, and services.

In summary, both international and African evidence underscores the strategic importance of manufacturing not just for direct employment but also for its potential to drive broader economic transformation through forward and backward linkages. However, in South Africa, this catalytic role remains underexplored. This study aims to fill that gap by examining how manufacturing production influences employment patterns across sectors. By shedding light on these interconnections, it seeks to support the design of more integrated and inclusive industrial and employment policies.

3. DATA AND METHODS

3.1. Data and Sources

This study utilizes quarterly time series data from 1963Q1 to 2024Q4, obtained from the South African Reserve Bank (SARB). The dataset includes real, seasonally adjusted manufacturing output as well as disaggregated employment figures across key sectors manufacturing, construction, mining, public sector, financial services, and trade. Sectoral employment data are used to reflect the structuralist perspective advanced by Hirschman (1958), which highlights the backward and forward linkages between manufacturing and other parts of the economy. To account for potential structural shifts in labor market dynamics caused by the COVID-19 pandemic, we introduce a dummy variable (D2020), which takes the value of 1 from 2020Q1 onward and 0 otherwise. This variable enables us to capture both the immediate employment shocks and any changes in how manufacturing output influences other sectors during the pandemic period.

3.2. Empirical Strategy and Model Specification

The empirical analysis adopts the Structural Autoregressive Distributed Lag (SARDL) modeling approach within an error-correction framework, estimated using the *dynamac* package in R. This approach is employed to examine the spillover effects of manufacturing output on employment across major sectors of the South African economy. The SARDL model, an extension of the ARDL methodology developed by Pesaran, Shin, and Smith (2001), is particularly suitable for analyzing relationships among variables with mixed integration orders (I(0) and I(1)) and offers flexibility in specifying lag lengths. The methodological design is grounded in Hirschman (1958) unbalanced growth theory, which argues that targeted investment in strategic sectors like manufacturing can stimulate economic activity through forward and backward linkages.

Given the time-series nature of the data covering 1963Q1 to 2024Q1, we first conducted unit root tests using the Augmented Dickey-Fuller (ADF) method. The results confirmed a mix of stationary and non-stationary variables, supporting the use of the ARDL framework. To capture structural changes related to the COVID-19 pandemic, a dummy variable was included taking a value of 1 from 2020Q1 onward and 0 otherwise. Additionally, this dummy was interacted with the manufacturing output variable to account for potential changes in the effect of manufacturing on employment in the post-pandemic period.

For each sector $i \in (MAN, CS, MS, PUS, FS, TRADE)$, the SARDL model is constructed as follows:

$$EMP_i^{(t)} = \alpha_0 + \sum_{i=0}^{p} \beta_i MAN\_OUT_{t-i} + \sum_{i=0}^{p} \delta_i (MAN\_OUT_{t-i} * D2020) + \gamma D2020_t + \sum_{k=1}^{p} \theta_k \Delta EMP_{t-k}^{j} + \varepsilon_t$$

Note that:

$EMP_t^{(j)}$= Employment in sector j at time t.

MAN_OUT_{t-i}= Lagged of manufacturing output.

$D2020$= COVID-19 dummy variable.

p and q= Lag length.

Δ= First difference operator.

ε_t = Error term.

The interaction term $MAN\_OUT_{t-i} * D2020$ captures potential changes in the marginal effect of manufacturing output on employment during the pandemic period. This specification allows for the identification of both short-run and long-run effects, while also accounting for structural shifts resulting from exogenous shocks such as COVID-19. The lag structure for each model is selected using the Akaike Information Criterion (AIC) and validated through standard diagnostic checks. Each employment sector is estimated separately to isolate the sector-specific employment spillover effects from manufacturing output. The models are based on quarterly data and include two lags of the independent variable, as identified by AIC. This setup facilitates the analysis of short-run spillover dynamics as well as structural shifts linked to major macroeconomic shocks. The Structural ARDL (SARDL) framework is particularly well-suited for this analysis, as it mirrors the underlying economic structure in which manufacturing serves as the growth anchor. Additionally, SARDL accommodates variables with mixed integration orders (I(0) and I(1)) and is capable of capturing the effects of structural or policy shocks, such as those triggered by the COVID-19 pandemic. Table 1 contains the variables' definitions employed in the empirical modeling approach.

Table 1. Definitions of variables.

Variable	Description
MAN_OUT	Manufacturing output
EMP_MAN	Employment in manufacturing
EMP_CS	Employment in construction
EMP_MS	Employment in mining
EMP_PUS	Employment in the public sector
EMP_FS	Employment in financial services
EMP_TRADE	Employment in the trade sector
D2020	Dummy variable for COVID-19

4. EMPIRICAL FINDINGS

Table 2 provides descriptive statistics for the variables used in the analysis, based on 248 quarterly observations from 1963Q1 to 2024Q4. The dataset includes manufacturing output (MAN_OUT) and employment figures across six sectors: manufacturing (EMP_MAN), construction (EMP_CS), mining (EMP_MS), public sector (EMP_PUS), financial services (EMP_FS), and trade (EMP_TRADE).

The proximity of mean and median values for most variables suggests relatively symmetric distributions. Among the variables, manufacturing output (MAN_OUT) and mining employment (EMP_MS) exhibit the highest mean values, reflecting their historical dominance in output and labor absorption. Conversely, financial services employment (EMP_FS) records the lowest average, indicating its relatively smaller size in the earlier decades of the dataset.

Standard deviations differ by sector, with EMP_FS showing the highest variability (0.8691), indicating significant fluctuations in employment over time. In contrast, EMP_MAN and EMP_MS display lower dispersion, suggesting more stable employment patterns. Most variables are negatively skewed, particularly EMP_CS (−1.7160), indicating a left-skewed distribution with a concentration of higher values. Manufacturing output and manufacturing employment are moderately skewed (−1.2039 and −1.0018, respectively).

Kurtosis results show that EMP_CS is leptokurtic (kurtosis > 3), implying a sharper peak and heavier tails compared to a normal distribution. The other variables generally show mesokurtic to mildly platykurtic distributions, with kurtosis values around or below 3.

These summary statistics offer preliminary insights into the underlying distributional features of the variables and inform the choice of appropriate econometric models, such as the Structural ARDL, used for the time-series analysis in this study.

Table 2. Summary properties of the variables.

Statistics	MAN-OUT	EMP-MAN	EMP-CS	EMP-MS	EMP-PUS	EMP-FS	EMP-TRADE
Mean	5.34	4.64	4.46	4.79	4.27	3.81	4.11
Median	5.42	4.65	4.58	4.84	4.36	4.19	4.12
Maximum	5.76	4.91	4.79	5.17	4.74	4.65	4.67
Minimum	4.17	3.97	3.23	4.43	3.52	1.58	2.83
Std. Dev.	0.38	0.20	0.31	0.22	0.32	0.87	0.47
Skewness	-1.20	-1.00	-1.72	0.09	-0.93	-0.88	-0.68
Kurtosis	3.68	3.81	6.16	1.72	2.82	2.49	2.60
Observation	248	248	248	248	248	248	248

Figure 1 presents time series plots of seven key economic indicators from 1960 to 2024: employment in manufacturing (EMP_MAN), construction (EMP_CS), mining (EMP_MS), public sector (EMP_PUS), financial services (EMP_FS), and trade (EMP_TRADE), along with manufacturing output (MAN_OUT).

Most indicators particularly EMP_FS, EMP_TRADE, and MAN_OUT exhibit a clear long-term upward trajectory, reflecting sustained economic expansion. In contrast, EMP_MAN and EMP_CS show early growth followed by stagnation or decline from the early 2000s onward. The steady rise in EMP_FS suggests strong financial sector growth, likely tied to structural transformation and services-led development.

Mining employment (EMP_MS) reveals considerable volatility, consistent with fluctuations in global commodity markets and domestic policy shifts. Public sector employment (EMP_PUS) remains relatively stable, showing only modest gains, indicating constrained growth in government hiring.

While manufacturing output (MAN_OUT) has generally increased, employment in the sector (EMP_MAN) peaked in the 1990s and declined thereafter indicating a potential decoupling of output from labor demand, possibly due to productivity gains, automation, or industrial restructuring.

A notable dip across several indicators occurs around 2020, aligning with the economic disruptions caused by the COVID-19 pandemic. Overall, the figure underscores diverging employment trends across sectors and sets the stage for the study's core inquiry: whether and how manufacturing output influences employment spillovers in the broader economy.

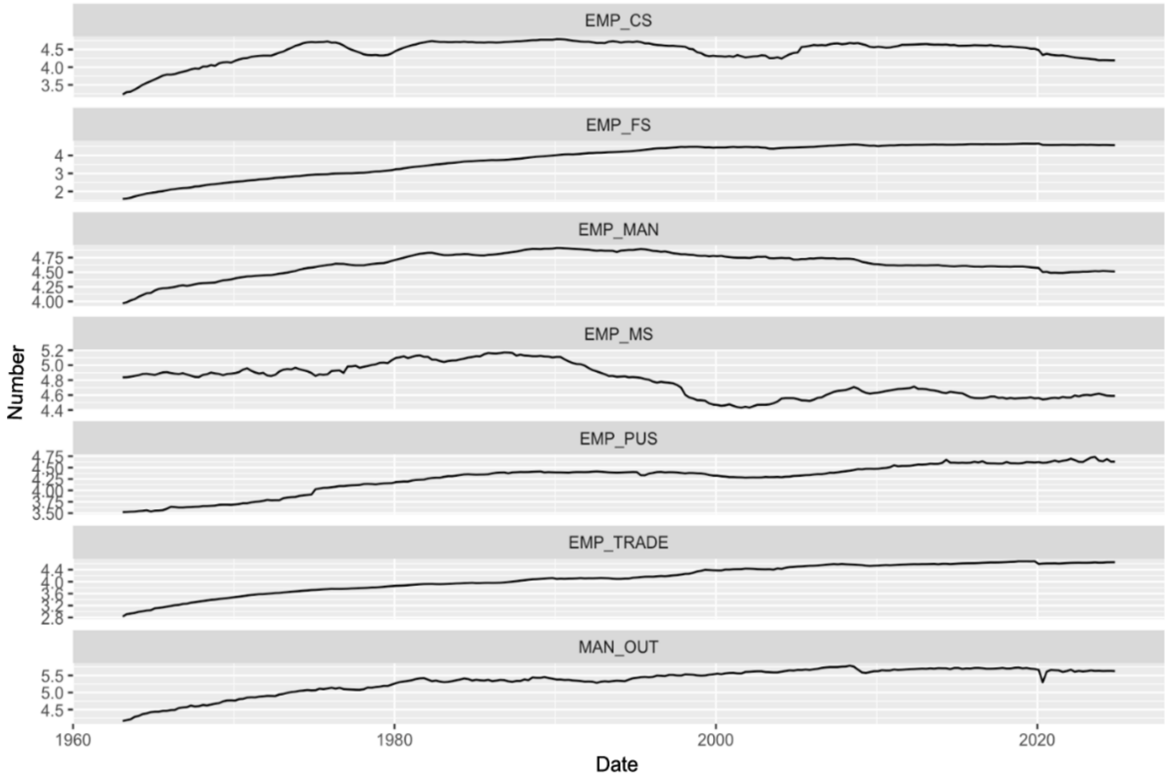

Figure 1. Graphical plot of the variables.

Figure 2 presents a correlation matrix plot illustrating the relationship between manufacturing output and employment across various sectors. The diagonal panels display histograms showing the distribution of each variable. For instance, EMP_FS is noticeably left-skewed, whereas EMP_MAN appears more symmetrically distributed.

The lower triangle panels (bottom-left) feature scatterplots with red smoothed trend lines, offering visual insights into linear or nonlinear associations. For example, the scatterplot of MAN_OUT versus EMP_FS suggests a strong positive linear relationship.

The upper triangle panels (top-right) display Pearson correlation coefficients for each variable pair. Several strong correlations are evident:

- MAN_OUT & EMP_TRADE: r = 0.97 — a very strong positive relationship, suggesting that manufacturing output and trade sector employment tend to move closely together.
- MAN_OUT & EMP_FS: r = 0.97 — indicates a strong synergy between manufacturing and financial services employment, possibly reflecting inter-industry dependencies.
- MAN_OUT & EMP_MAN: r = 0.96 — as expected, output and employment in manufacturing are closely aligned.
- MAN_OUT & EMP_PUS: r = 0.94 — surprisingly high, possibly due to public sector investments linked to industrial growth.
- MAN_OUT & EMP_CS: r = 0.67 — a moderate positive correlation, suggesting the construction sector benefits from manufacturing activity.
- MAN_OUT & EMP_MS: r = -0.59 — a moderate negative correlation, possibly reflecting a decoupling between industrial expansion and a declining mining sector.

Together, the matrix provides preliminary evidence of manufacturing's strong employment spillovers into key sectors, reinforcing the study's theoretical and empirical focus.

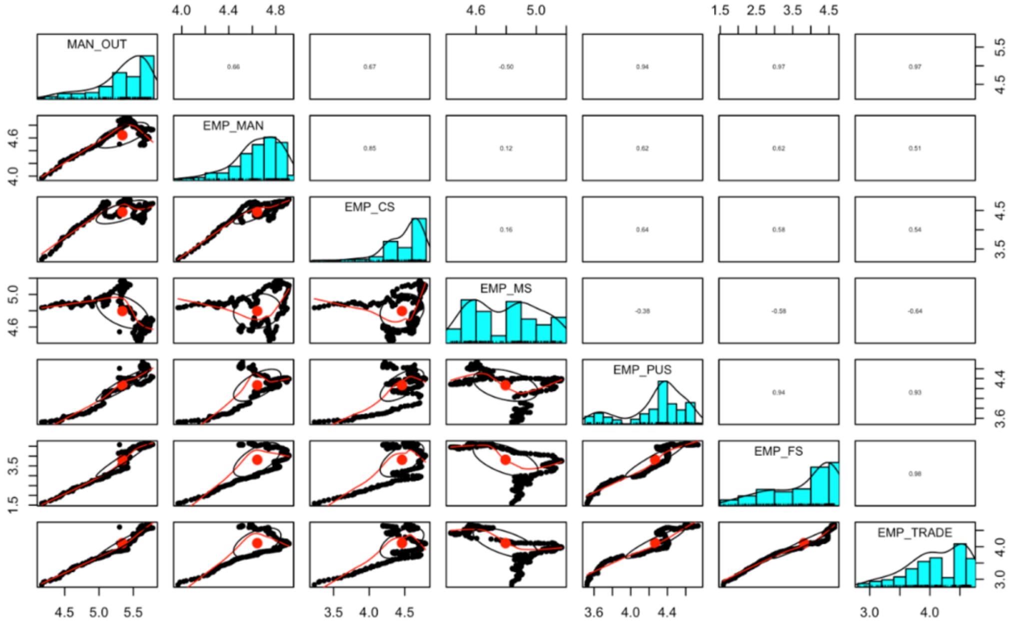

Figure 2. Correlation matrix plot.

Stationarity means that a time series maintains constant statistical properties such as its mean and variance over time. In contrast, non-stationary series can lead to misleading or spurious regression results, making stationarity testing and appropriate data transformation (e.g., differencing) a critical step in time series modeling, particularly for SARDL analysis. The stationarity result is contained in Table 3. Our stationarity tests indicate that all variables are stationary at level, except for employment in the mining and public sectors, which become stationary only after first differencing. Importantly, both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests consistently confirm the same order of integration for each variable, reinforcing the robustness of our results.

Table 3. Unit Root Test Results.

Variables	ADF p-value		PP p-value	
	Level	1st difference	Level	1st difference
MAN-OUT	0.00	0.00	0.00	0.00
EMP-MAN	0.02	0.00	0.00	0.00
EMP-CS	0.01	0.00	0.00	0.00
EMP-MS	0.81	0.00	0.82	0.00
EMP-PUS	0.058	0.00	0.06	0.00
EMP-FS	0.00	0.00	0.00	0.00
EMP-TRA	0.00	0.00	0.00	0.00

To assess whether a long-term relationship exists between manufacturing output and employment across different sectors, the ARDL bounds testing approach was applied to both Model 1 and Model 2. As presented in Table 4, the F-statistics for each sector exceed the critical value bounds at the 5% significance level, indicating statistically significant evidence of co-integration between manufacturing output and sectoral employment.

Table 4. Bound test co-integration results.

Sector	F-statistic	Critical Value I(0)	Critical Value I(1)	Cointegration Status
Manufacturing	6.04	2.79	3.67	Cointegrated (F > I(1))
Construction	4.19	2.79	3.67	Cointegrated (F > I(1))
Mining	0.83	2.79	3.67	No cointegration (F < I(0))
Public	6.41	2.79	3.67	Cointegrated (F > I(1))
Financial	15.26	2.79	3.67	Cointegrated (F > I(1))
Trade	24.10	2.79	3.67	Cointegrated (F > I(1))

The F-statistics from the bounds test exceed the upper critical value (3.67) for the manufacturing, construction, public, financial, and trade sectors. This allows us to reject the null hypothesis of no co-integration, confirming the existence of a long-run equilibrium relationship between manufacturing output and employment in these sectors. The relationship is especially strong in the financial (F = 15.26) and trade (F = 24.10) sectors. However, the F-statistic for the mining sector (0.8325) falls below the lower bound, indicating no evidence of co-integration suggesting that manufacturing output does not have a long-run influence on mining employment.

These results support the idea that manufacturing acts as a driver of employment in most sectors particularly construction, public services, finance, and trade through sectoral spillovers. In contrast, mining appears to follow a distinct trajectory, likely due to different structural dynamics.

Following the confirmation of co-integration, ARDL estimations were conducted for each sector, with diagnostic test results also reported. Table 5 presents the ARDL results for the manufacturing sector. In the case of manufacturing employment, the short-run results indicate that a 1% increase in manufacturing output leads to a 0.067% rise in employment under non-COVID conditions. The interaction term (INT_MANUF), representing the differential effect during the COVID-19 period, shows a marginal impact of −0.053%, which is statistically insignificant (p = 0.1788), suggesting a muted or delayed employment response to output gains during the pandemic.

The significance of the lagged interaction term, Δ(INT_MANUF(-1)), indicates that the employment effects of output increases during COVID were delayed possibly due to policy uncertainty or slower transmission of industrial gains to the labor market. Additionally, the significance of D(D2020(-1)) suggests a lagged positive adjustment in employment during the pandemic period, potentially driven by fiscal interventions or shifts toward informal work.

The error correction term (ECT) is negative and significant, confirming the presence of a stable long-run relationship between manufacturing output and employment. An adjustment speed of 0.44% per quarter suggests slow reversion to equilibrium, implying that full adjustment to output shocks may take several years without structural policy support.

In summary, manufacturing output has a significant and positive effect on employment in both the short and long run. COVID-related shocks had complex and lagged effects, while the long-term relationship remains robust, affirming manufacturing's role as a growth and employment anchor in South Africa.

Table 5. Results for manufacturing sector employment.

Variables	Coefficient	Standard Error	T-statistics	Prob.
Short-run estimates				
Δ (MAN_OUT)	0.07	0.02	2.91	0.00
Δ (MAN_OUT (-1))	0.06	0.02	2.96	0.00
Δ (INT_MANUF)	-0.06	0.04	-1.39	0.18
Δ (INT_MANUF (-1))	-0.12	0.03	-4.16	0.00
D2020	0.29	0.22	1.34	0.18
Δ (D2020(-1))	0.64	0.16	3.89	0.00
CointEq (−1)	−0.004	0.00	-5.54	0.00
Long-run ARDL estimates				
MAN_OUT	0.07	0.02	2.84	0.00
INT_MANUF	-0.05	0.12	-0.42	0.67
Δ 2020	0.29	0.71	0.42	0.67
C	0.06	0.01	4.39	0.00
Diagnostic test results	Stat.	Conclusion		
Durbin-Watson (Autocorrelation)	2.14	No autocorrelation		
Bruesch-Godfrey (Serial Correlation)	1. 57(0.24)	No serial correlation		
Bruesch- Pagan (Heteroskedasticity)	1.69 (0.25)	No heteroscedasticity		
Ramsey RESET test	1.69 (0.06)	Model is stable		
R2	0.99			
F-statistics	15140.14 (0.00)			

The results presented in Table 6 indicate that manufacturing output does not have an immediate statistically significant effect on construction sector employment. However, a significant positive impact emerges after one quarter, with an even stronger spillover observed at the second lag. This implies that growth in manufacturing output stimulates construction employment, but with a delayed response. During the COVID-19 pandemic, manufacturing output had a significant negative effect on construction employment, and this adverse impact persisted through lagged effects. Interestingly, the initial pandemic quarter saw a temporary boost in construction employment, likely driven by public stimulus or infrastructure spending, but this effect quickly reversed, indicating its short-lived nature.

The Error Correction Term (ECT) is negative and highly significant, confirming the presence of a stable long-run relationship between manufacturing output and construction employment. The adjustment speed is relatively slow at 1.85% per quarter, suggesting that the sector gradually returns to its long-run equilibrium following a shock.

In the long run, the effect of manufacturing output on construction employment is positive but statistically insignificant, indicating that the spillover effects are more pronounced in the short run. The interaction term INT_MANUF(−1) reveals a significant negative long-term impact of the pandemic, implying that manufacturing's ability to support construction employment was weakened during this period. On the other hand, the long-run effect of the COVID period itself is positive, suggesting a possible structural shift in the construction sector, potentially driven by infrastructure investments.

Overall, the findings show that manufacturing output significantly influences construction employment in the short run, especially with lags of one to two quarters. However, this influence diminishes over time, particularly under the disruptive conditions of the pandemic. The slow speed of adjustment reinforces the need for targeted policies that enhance the resilience of the construction sector to external shocks. Stimulus-driven infrastructure programs appear to offer temporary relief, but sustained employment gains require stable manufacturing growth and proactive policy design.

Table 6. Results for construction sector employment.

Variables	Coefficient	Standard error	T-statistics	Prob.
Short-run estimates				
Δ (MAN_OUT)	0.09	0.07	1.32	0.19
Δ (MAN_OUT (-1))	0.17	0.05	3.32	0.00
Δ(MAN_OUT (-2))	0.184	0.042	4.39	0.00
Δ (INT_MANUF)	-0.61	0.22	-2.80	0.01
Δ (INT_MANUF (-1))	-0.12	0.03	-4.16	0.00
D2020	3.41	1.22	2.77	0.00
Δ (D2020(-1))	-0.26	0.07	-3.62	0.00
CointEq (−1)	-0.01	0.00	-4.61	0.00
Long-run ARDL estimates				
MAN_OUT	0.09	0.07	1.26	0.21
INT_MANUF(-1)	-0.34	0.12	-2.78	0.01
Δ 2020(-1)	1.64	0.70	2.33	0.02
C	0.08	0.03	2.77	0.01
Diagnostic test results	Stat.	Conclusion		
Durbin-Watson (Autocorrelation)	2.19	No autocorrelation		
Bruesch-Godfrey (Serial Correlation)	1. 22(0.23)	No serial correlation		
Bruesch-Pagan (Heteroskedasticity)	1.77(0.62)	No heteroscedasticity		
Ramsey RESET test	1.90 (0.15)	Model is stable		
R2	0.99			
F-statistics	2889.240(0.00)			

The short-run results from Table 7 indicate that approximately 29% of the previous quarter's change in mining employment persists into the current quarter. This coefficient is highly significant ($p = 0.0000$), suggesting strong inertia in mining employment and a dependence on past values. Both the current and lagged values of manufacturing output have positive and statistically significant effects, indicating that manufacturing activity stimulates mining employment both immediately and with a one-quarter delay likely driven by increased demand for raw materials and intermediate inputs.

The Error Correction Term is negative and significant, confirming the presence of a long-run relationship. However, the adjustment speed is slow, with only 0.46% of disequilibrium corrected per quarter, highlighting weak long-run convergence.

In the long run, a 1% increase in manufacturing output is associated with a 0.097% rise in mining employment, confirming a sustained upstream linkage between the two sectors. However, the interaction term (INT_MANUF), which captures the differential impact of manufacturing output during the COVID-19 period, is not statistically significant. This suggests that the manufacturing-mining linkage was not meaningfully disrupted by the pandemic. Furthermore, the COVID-19 dummy variable (D2020) is also not significant, indicating that the pandemic had no direct statistical impact on mining employment. This may reflect the sector's capital-intensive structure and its relative insulation from the types of disruptions that affected more labor-intensive sectors like construction and services.

Overall, the results suggest that manufacturing output is a key driver of mining employment in both the short and long run, although the sector adjusts slowly and was largely resilient to pandemic-related shocks.

Table 7. Results for mining sector employment.

Variables	Coefficient	Standard error	T-statistics	Prob.
Short-run estimates				
Δ(EMP_MS(-1))	0.29	0.06	4.79	0.00
Δ (MAN_OUT)	0.09	0.03	3.04	0.00
Δ (MAN_OUT (-1))	0.06	0.02	1.99	0.04
CointEq (−1)	-0.00	0.00	-2.06	0.04
Long-run ARDL estimates				
MAN_OUT	0.09	0.04	2.39	0.01
INT_MANUF	-0.06	0.07	-0.95	0.34
D2020	0.37	0.38	0.96	0.34
C	0.02	0.04	0.66	0.51
Diagnostic test results	Stat.	Conclusion		
Durbin-Watson (Autocorrelation)	2.09	No autocorrelation		
Bruesch-Godfrey (Serial Correlation)	0. 98(0.43)	No serial correlation		
Bruesch- Pagan (Heteroskedasticity)	1.65(0.32)	No heteroscedasticity		
Ramsey RESET test	1.70(0.61)	Model is Stable		
R2	0.99			
F-statistics	5622.432(0.00)			

Based on the results in Table 8, the short-run analysis reveals that past changes in financial sector employment significantly influence current employment levels. Manufacturing output also has a positive and significant effect on financial sector employment, with this impact persisting into the following period indicating that growth in manufacturing supports job creation in the financial sector.

However, during the COVID-19 pandemic, the influence of manufacturing output on employment in the financial sector weakened substantially, becoming less positive or even negative. This negative effect continued in the periods following the initial shock, reflecting a lagged disruption of the employment linkage caused by the pandemic.

The speed of adjustment back to long-run equilibrium is slow but statistically significant at 0.67% per quarter, confirming the existence of a long-run relationship. Over the long term, manufacturing output maintains a positive impact on financial sector employment: a 1% increase in manufacturing output corresponds to roughly a 0.08% rise in financial employment. This likely reflects increased demand for financial services such as loans, insurance, and payment processing linked to industrial growth.

The long-run coefficient for the interaction term (INT_MANUF), which measures the effect of manufacturing output on financial employment during the COVID-19 period, is not statistically significant at the 5% level (p = 0.0768). This suggests that despite short-term disruptions, there is no strong evidence that the pandemic fundamentally changed the long-run relationship between manufacturing output and financial sector employment.

Moreover, after controlling for other factors, the COVID-19 dummy variable (D2020) is not significant, indicating no conclusive long-term structural shift in financial employment directly attributable to the pandemic. In practical terms, while temporary short-run adjustments occurred during COVID-19, these did not result in a permanent alteration of employment trends within the financial sector.

Table 8. Results for financial service sector employment.

Variables	Coefficient	Standard error	T-statistics	Prob.
Short-run estimates				
Δ(EMP_FS(-1))	0.31	0.06	5.48	0.00
Δ(MAN_OUT)	0.08	0.02	3.26	0.00
Δ(MAN_OUT (-1))	0.06	0.02	3.29	0.00
Δ(INT_MANUF)	-0.26	0.03	-8.72	0.00
Δ (INT_MANUF (-1))	-0.02	0.00	-7.19	0.00
CointEq (−1)	-0.01	0.00	-8.81	0.00
Long-run ARDL estimates				
EMP_FS(-1)	1.30	0.05	22.4	0.01
MAN_OUT	0.08	0.03	3.07	0.00
INT_MANUF	-0.26	0.42	-1.78	0.08
D2020	1.50	0.84	1.79	0.08
C	0.04	0.00	13.0	0.00
Diagnostic test results	Stat.	Conclusion		
Durbin-Watson (Autocorrelation)	2.14	No Autocorrelation		
Bruesch-Godfrey (Serial Correlation)	0. 52(0. 14)	No serial correlation		
Bruesch- Pagan (Heteroskedasticity)	1.65 (0.32)	No heteroscedasticity		
Ramsey RESET test	1.70 (0.61)	Model is Stable		
R2	0.99			
F-statistics	177274.3(0.00)			

From Table 9, a 1% increase in current manufacturing output leads to a 0.06% rise in trade sector employment in the short run, indicating a positive immediate spillover effect. Similarly, a 1% increase in lagged manufacturing output results in a 0.04% increase in trade employment, highlighting the persistence of this linkage over time.

However, the interaction between manufacturing output and the COVID-19 dummy significantly reduces trade employment by 0.13%, showing that the pandemic weakened the positive influence of manufacturing output on trade jobs. The error correction term is negative and significant, indicating a stable adjustment toward long-run equilibrium, though at a very slow pace of approximately 0.09% per period.

In the long run, a 1% increase in manufacturing output is associated with a 0.06% increase in trade employment, confirming a sustained positive spillover from industrial growth. The interaction term remains significantly negative, reinforcing that the pandemic disrupted the traditional relationship between manufacturing and trade employment beyond the immediate crisis.

Interestingly, the COVID-19 period itself had a substantial positive long-term effect on trade sector employment an increase of about 65% which may reflect growth in digital trade, informal retail, or essential goods distribution during the pandemic.

Overall, manufacturing output consistently drives trade sector employment in both the short and long term. While COVID-19 disrupted this relationship, as evidenced by the significant negative interaction effect, the pandemic period (captured by D2020) showed a positive and significant net effect on trade employment. This suggests that despite disruptions, the trade sector expanded overall, likely supported by digital adaptation, heightened demand for essential goods, and resilience within the informal sector. The model is robust, well-specified, and provides valuable insights for policy formulation.

Table 9. Results for trade sector employment.

Variables	Coefficient	Standard error	T-statistics	Prob.
Short-run estimates				
Δ(MAN_OUT)	0.06	0.02	3.43	0.00
Δ(MAN_OUT (-1))	0.04	0.02	2.69	0.00
Δ(INT_MANUF)	-0.13	0.0104	-12.4704	0.0000
CointEq (−1)	-0.00	0.000	-11.1	0.00
Long-run ARDL estimates				
EMP_Trade(-1)	1.09	0.06	18.5	0.00
MAN_OUT	0.06	0.02	2.69	0.01
INT_MANUF	-0.13	0.04	-3.19	0.00
D2020	0.65	0.23	2.80	0.00
C	0.06	0.01	3.35	0.00
Diagnostic test results	Stat.	Conclusion		
Durbin-Watson (Autocorrelation)	2.07	No autocorrelation		
Bruesch-Godfrey (Serial correlation)	0. 91(0. 72)	No serial correlation		
Bruesch- Pagan (Heteroskedasticity)	1.56 (0.75)	No heteroscedasticity		
Ramsey RESET test	1.20(0.21)	Model is Stable		
R2	0.99			
F-statistics	72921.913(0.00)			

The empirical findings of this study highlight the crucial role of manufacturing output in shaping employment dynamics across various sectors of the South African economy, though the magnitude and timing of these effects differ by sector. Consistent with structural transformation theories (Lewis, 1954; Rodrik, 2008), the results confirm that manufacturing not only drives employment within its own sector but also generates significant short-run spillover effects on employment in sectors such as construction, trade, and financial services. This supports existing evidence that industrial development in middle-income countries can act as a catalyst for broader economic participation and job creation (Szirmai, 2012). For example, construction and trade sectors demonstrated strong short- and long-run employment responses to manufacturing output changes, reflecting robust backward and forward linkages. These insights are particularly relevant for South Africa, where industrial policy frameworks like the Industrial Policy Action Plan (IPAP) and the Re-imagined Industrial Strategy prioritize reindustrialization as a key route to inclusive growth.

At the same time, the varying effects across sectors illustrate the complexity of employment transmission mechanisms. The financial and mining sectors exhibited moderate responses to manufacturing activity, with COVID-19-related interaction terms indicating some weakening of these linkages during crises. The public sector showed the weakest employment response, likely due to its relative insulation from market-driven industrial forces. These findings align with recent studies (Black, McKinley, & Loubser, 2021; Tregenna, 2016) that stresses the importance of targeted, sector-specific policies to fully harness manufacturing's employment potential.

Given South Africa's challenges of high unemployment and deindustrialization, the results suggest the need for integrated policy approaches that not only enhance manufacturing competitiveness but also amplify its spillover benefits through coordinated investments in infrastructure, logistics, financial services, and skills development. In particular, post-COVID recovery strategies should prioritize manufacturing-led growth with a strong focus on building resilience and promoting equitable outcomes.

5. CONCLUSION AND POLICY RECOMMENDATION

This study aimed to examine whether growth in South Africa's manufacturing sector leads to broader employment gains across key sectors of the economy. The findings confirm that manufacturing output has strong and statistically significant positive spillover effects on employment in the construction, trade, and financial services sectors, both in the short and long run. These results align with classical and structuralist development theories, which highlight manufacturing's ability—through its forward and backward linkages to stimulate activity and job creation in non-manufacturing sectors. In contrast, spillover effects on the mining and public sectors are weaker or statistically insignificant, likely due to the capital-intensive nature of mining and the institutional characteristics of the public sector.

The interaction between manufacturing output and the COVID-19 period (captured by the INT_MANUF term) reveals that the pandemic significantly disrupted manufacturing's employment-generating capacity, especially in service-oriented sectors like finance and trade. This underscores the vulnerability of sectoral employment linkages to systemic shocks and highlights the importance of building industrial resilience.

Despite these disruptions, manufacturing itself demonstrated strong endogenous employment effects, reaffirming its central role in South Africa's employment landscape. Given the consistent positive spillovers into labor-intensive sectors, government and policymakers should enhance industrial policy frameworks to support labor-intensive manufacturing. This could include incentives for local production, infrastructure investment, and value chain development.

Stronger intersectoral coordination particularly between manufacturing and construction, trade, and financial services should be prioritized through targeted infrastructure projects, supply chain strengthening, and improved credit access for SMEs linked to manufacturing. The pandemic-related disruptions also emphasize the need for safeguards such as counter-cyclical measures like wage subsidies, industrial relief funds, and employment guarantees to maintain employment spillovers during downturns. For sectors like mining and public services, policy interventions should focus on reskilling, technological adaptation, and alignment with green industrial policies to boost their responsiveness to broader industrial growth.

In conclusion, this study confirms that manufacturing remains a cornerstone of employment generation in South Africa, both within the sector and across the wider economy. Unlocking its full employment potential will require strategic policy coordination, resilience planning, and sector-specific interventions to ensure manufacturing growth translates into inclusive, economy-wide job creation.

Funding: The authors received no financial support for the research. The APC for this article was funded by North West University, South Africa.
Institutional Review Board Statement: Not applicable.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: Upon a reasonable request, the supporting data of this study can be provided by the corresponding author.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: Both authors contributed equally to the conception and design of the study. Both authors have read and agreed to the published version of the manuscript.

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