Does Africa’s Industrialization Foster Sustainable Emission Decoupled Economic Growth? The Case of Zambia and South Africa

Kalimanshi Nsakaza¹, Joshua Simuchimba², Evelyn Banda³
United Nations World Food Programme¹, International Organization for Migration², United Nations Economic Commission for Africa³

ABSTRACT

In fostering sustainable growth for many developing nations, there is an urgent need to re-engineer the industrial sector towards one that promotes value addition, particularly on the industrial base. Zambia and South Africa’s major economic challenges revolve around their persistent economic dependence on copper and gold. Within the context of their broader goals to diversify their economies, Zambia has struggled to reduce its reliance on copper despite various initiatives, while South Africa faces declining gold production and the need to adapt to global sustainability trends and changing resource demands. Using a dynamic Panel ARDL model, this study thus analysed the effects of industrialization on sustainable emission decoupled economic growth using data from 1970-2022 for South Africa and Zambia. Our results showed that the metallic, food and beverages, paper, and wood products industries significantly affected emission decoupled economic growth in South Africa, while only the fabricated metal and wood industry significantly fostered economic growth in Zambia in the short run. In the long run, for both countries, only the paper and non-metallic industries affected economic growth significantly. The study concluded that while extractive and high emitting industries are the most feasible in the case of most African countries; to be able to accelerate sustainable economic growth through the industrial sector, these nations will have to re-engineer their industrial sectors towards a more commodity-aligned approach that puts value addition and emission reduction through regional value chains at the pinnacle of policy and national development strategies.

INTRODUCTION

Zambia and South Africa are two Southern African countries with significant natural resource endowments, particularly in minerals and agricultural commodities. Over the years, both nations have pursued industrialization strategies centred on these commodities to enhance economic growth and development. The countries’ major economic challenges, however, revolve around their persistent economic
dependence on copper and gold. Within the context of its broader goals to diversify its economy, Zambia has struggled to reduce its reliance on copper despite various initiatives, while South Africa faces declining gold production and the need to adapt to global sustainability trends and changing resource demands. Both countries have, however, over the years sought solutions to transition to diversified industrial economies, addressing the challenges and opportunities presented by evolving global mining and resource landscapes. Among the major alternatives at the two countries’ disposal has been transitioning towards a commodity-based industrial sector that anchors on value addition as a fuel for economic growth.

Despite experiencing economic growth driven partly by the aforementioned commodities and sound governance, these countries have persistently faced limited sustainable industrial growth due to a range of supply-side constraints, including inadequate industrial capacities, limited entrepreneurial support, energy and infrastructure challenges, and the low purchasing power of the majority of the population. Even more, numerous external factors contribute to this underperformance in the industrial sector, including historical legacies such as resource extraction and exploitation during the colonial and post-colonial eras (Moyo, 2015). Although several studies on African countries have attempted to comprehend the effect of industrialization on economic growth, very few studies have comprehensively tackled the impact of the industrial sector on emission decoupled economic growth with a specific focus on the most competitive industrial sectors. This paper thus offers policymakers a novel strategy to enhance economic growth through pursuing a sustainable industrial approach.

Without taking into account changes in prices, the Index of Industrial Production (IIP) measures the increase in the total amount of industrial production in actual terms. The index shows the increase in gross production, even though yearly industrial growth rates typically relate to increases in manufacturing value added, or output net of intermediate consumption. Figure 1 shows that for Zambia and South Africa, the growth and trends in terms of their industrial capacity have exhibited a significant amount of variability. Specifically, Zambia’s economy has seen higher growth rates in industries such as fabricated metal and wood while South Africa’s economy has possessed a competitive edge over its basic metal industry. South Africa’s paper industry has also seen sharp steady growth since 2015, while its non-metallic industry saw a decline over the same period.

Figure 1. Index of Industrial Production and countries GDP growth rate
Industrialization-Economic Growth Nexus

The debate on whether industrialization promotes economic growth is not new from a theoretical standpoint. Nonetheless, current patterns of de-industrialization in the majority of African economies offer an opportunity to revive the discussion and raise some questions about that previously perceived link. Furthermore, recent examples of China and India as successful stories of domestic services-driven economic growth have cast doubt on the role of industrialization as a major driver of growth (Hobday, 2013). In a similar vein, Timmer and Vries (2015) contend that increases in market services productivity have a greater bearing on recent economic accelerations in emerging nations than increases in manufacturing productivity. It is thus crucial to discuss the underpinnings of the relationship between industrialization and economic growth in light of these relatively recent developments that cast doubt on it.

Kaldor's pioneering work regarding manufacturing as the engine of growth also comes to the discussion of most recent literature when examining the causal relationship between industrialization and economic growth (Felipe, 2009; Weiss & Jalilian, 2016). In 1966 and 1967, Kaldor outlined a number of arguments supporting his view that the manufacturing sector had distinctive, advantageous characteristics in comparison to other industries such as domestic services or agriculture, as it fosters an enabling environment for increasing both static and dynamic returns, economies of scale, and strong forward and backward links with other sectors (Kaldor, 1967). Weiss and Jalilian's (2016) theory that technological imitation, adaptation, and modification, as well as the benefits of increased specialisation in manufacturing, also comes to the discussion as it is divided into more specialised forms, which theoretically support Kaldor's argument about the positive relationship between GDP growth and manufacturing growth. The implication of this argument is that first, cumulative growth over time rather than just size or production level is the key to reducing unit costs and enhancing the competitiveness of the industrial base. Furthermore, the productivity increase that is induced in the manufacturing sector as well as in other sectors forms part of the explanation for the causal relationship (Thirlwall, 2015). Kaldor's second proposition that the pace of growth of industrial productivity and employment will increase in proportion to the rise in manufacturing output may be seen as a process wherein growing manufacturing productivity and output are strongly associated, with productivity spillovers occurring into non-manufacturing sectors as well. Worth noting is that the case for the relationship between economic growth and industrialization dates back before Kaldor's analysis, as the notion that industrialization propels economic growth was also seen in the works of classic development pioneers including Gerschenkron, Rostow, and Lewis (Kregel, 2016). However, Raul Prebisch was the most significant development economist to produce a theory and a set of principles. This fundamental tenet of structuralism is that economic growth is primarily driven by industrialization (United Nation, 1949).
Vera (2013) claims that the experiences of emerging nations during World War II provided a catalyst for structuralist economists' strong convictions that industrialization would trigger a more intricate and quick mechanism for structural change. Industrialization is an inevitable aspect of the transformation process that goes hand in hand with a steady increase in income per capita (Vera, 2013). ECLAC (2012) demonstrates that not all structural changes, nevertheless, result in economic growth and argues that when knowledge-intensive industries gain a larger proportion of both international trade and output, structural transformation is beneficial. In a similar vein, a constructive structural shift entails profitable diversification into industries where both internal and external demand are rising quickly. This allows domestic supply to meet demand, further expanding imports and exports in a balanced way without placing undue strain on the balance of payments (ECLAC, 2012).

Some schools of thought, however, view economic growth as either neutral or indifferent to sectors and activities, whereas post-Keynesians view it as a phenomenon particular to certain sectors and activities. The Solow (1956) model, its augmented versions, and contemporary endogenous growth formulations like those in Mankiw and Weil (1992) are examples of neoclassical models of growth. These models hold that economic growth under a typical production function ultimately depends on an unobservable, exogenous, and contentious residual known as total factor productivity. In a neoclassical paradigm, savings and the accumulation of human and physical capital drive economic growth, regardless of the industry or activity. The production function is predicated on the idea that all nations have equal access to the same degree of technology, or at the very least, equal technological capability. However, the aggregation problem is the primary cause of the neoclassical models' perception of economic development as being sector-indifferent (Palma, 2005). In actuality, the production function is more than just a collection of small-scale production tasks from many businesses, industries, and pursuits. Neoclassical production functions do not consider any specific sector in this way. Felipe (2009) provides a thorough critique of the aggregate production function, arguing that industrialization is not considered desirable to drive economic growth, or at least no more desirable than any other economic sector, in part due to the numerous industries in the manufacturing sector.

Furthermore, most of the new theories on economic growth began in the 20th century. Prior to the 20th century, economic growth during the mercantilist era for instance was mainly disregarded, as a nation's competitiveness was primarily determined by the amount of ores and precious metals it had (Cameron and Neal, 2004). Analyses of new theories on economic growth began with Schumpeter (1934), who disagreed with the classics in that he believed capital accumulation was not the primary factor causing economic growth. He referred to the entrepreneur-innovator as a "hero of development" and gave the idea a lot of weight. He believed that the originality and inventiveness of business owners impacted economic growth. Schumpeter was persuaded by the imbalanced character of economic growth and explained that process by the jump's characteristics (Schumpeter, 1934).
Lewis (1954) also tackled the problem of emerging countries with opulent labour populations in his theory of economic growth. Lewis did not always agree with the diagnosis and methods of classical economics, but he did support maintaining a low quality of life in the short run. Nevertheless, he agreed with these economists' overall viewpoint. As a result, Lewis's model showed that a short-term increase in national inequality is necessary to produce long-term growth. Simon Kuznets, who developed the "Kuznets's curve," subsequently endorsed this theory (Kuznets, 1976). An alternative theory of economic growth was developed by Rostow (1960) a few years before Kuznets' hypothesis. Like Lewis, Rostow identified five stages of growth and deemed the accumulation of capital a prerequisite for economic growth (Rostow, 1960). According to Rostow, getting to the third stage, or "take off," is the largest challenge for developing nations. Poor nations struggle with breaking the "vicious circle" that has been built up over time, Rostow suggested using capital accumulation to break it. He, however, also saw that outside assistance would be required if there were no prospects for internal accumulation to expand. Furthermore, Rostow said that transforming the economy from one based on agriculture to one based on industry would enable economic growth to spread throughout the whole nation and foster a sixth stage of growth in the economy known as "quality," which he defined by a constant rise in the calibre of goods and services (Rostow, 1971).

Empirical Review

Industrialization and economic growth have been the subject of several empirical studies that have used data from single and cross-country sources to analyse the link. In their study, Wells and Thirlwall (2003) looked at 45 African countries between 1980 and 1996 and found a relationship between economic growth and industrialization. Adugna (2014) additionally examined how manufacturing contributed to Ethiopia's economic growth and determined the industry's importance to the national economy using an ordinary least squares estimation. Alexiou and Tsaliki (2010) found a significant relationship between mobilising industrial resources and attaining higher rates of economic growth between 1975 and 2006. However, Mamgain (1999) found that in emerging industrialized nations like Singapore, Thailand, Malaysia, Indonesia, and Mauritius, significant increases in manufacturing and industrial capacity were not translated into economic growth, although they did have an impact on the South Korean economy.

Kniivil (2007) established other contradictory findings, although he did indicate that industrial development was a major factor in the economies of the Republic of Korea, China, Taiwan, and Indonesia. Using data from 1995 to 2008, Zhao and Tang (2018) contrasted the link between manufacturing, industrialization, and growth in the economies of China and Russia. The findings were contradictory, with the data in China supporting the positive impact of manufacturing on GDP growth and the data in Russia supporting the positive relationship between the service sector and economic growth. McCausland and Theodossiou (2012) used a fixed effect and feasible generalised least squares approach for data collected on 11 countries between 1992 and 2012 and confirmed Kaldor's theory of the positive relationship between

Using quarterly data and the Autoregressive Distributed Lag model, Yamak et al. (2016) showed that industrialization was the driving force behind economic growth in Turkey. Szirmai and Verspagen (2015) also found a somewhat positive and significant relationship between manufacturing and economic growth. Chakravarty and Mitra (2009); Kathuria and Natarajan (2013) also presented evidence in favour of the idea that industrialization is a catalyst for economic growth in their examination of data from India. Using the panel cointegration approach on data from 1965 to 2012, Mercan et al. (2015) found a positive causal relationship between the development of manufacturing production and GDP growth in South Africa, Mexico, China, India, Indonesia, Brazil, Malaysia, the Philippines, Thailand, and Turkey. This positive relationship was also demonstrated by panel data analysis of China between 1979 and 2004 (Jeon, 2006). Using the expanded technique of moments, Cantore (2017) examined the hypothesis that there is a positive association between industrialization and economic development in 80 countries between 1980 and 2013, and he was unable to disprove it. Su and Yao (2017) examined data from 1950 to 2013 and, using panel granger causality techniques, discovered a significant correlation between industrialization and economic development.

Decoupling Growth and emissions

In order to combat climate change, many nations have applied consented efforts on lowering GHG emissions, through the decoupling index and general approach (Francey et al., 2013). Since its introduction in 2002, the decoupling approach has been extensively used to examine the concurrent changes between CO2 emissions and economic development (Xuefeng and Yaşar, 2016). Subsequently, further scholarly research on decoupling has emerged, contributing to the enhancement and refinement of the decoupling theory framework to some degree. Mikayilov et al. (2018) investigated the decoupling between economic growth and carbon emissions, accounting for variations in income levels over time, using 12 European nations and concluded that relevant environmental policies aimed at reducing carbon emissions include initiatives to improve energy efficiency, carbon pricing tools in production and domestic and international trade, and national social awareness campaigns to educate the public about the harmful effects of pollution. Wang et al. (2017) focused on changes in the decoupling indicator between energy-related CO2 emissions and GDP in China to examine the impact of industrialization and urbanization and suggested the implementation of policies encouraging utilisation of low carbon fuels, such as natural gas and crude oil, and policy enforcement for the reduction of direct combustion gases.
Summary and measurability of Variables

Measure of Industrialization: An Extension to the Industrial Production Index (IIP)

In measuring industrialization, this study adopted the Industrial Production Index as revised by Perlo (1962), which takes into consideration the Laspeyres stepwise derivation. We however extend on the conventional Industrial Production Index by incorporating a weighted parameter that measures merchandise trade as a proportion of total trade. This is done particularly to identify the effect of industrialization as it pertains to final goods and services on economic growth. The aim of the IIP is to quantify changes in the amount of industrial production. As a result, any deviation from price effects ought to be removed. We employed product data as values or quantities, the "value of output" was the variable employed to express the production values, in which case the deflation technique was applied to extend on the IIPs. The value indices and not the volume indices were determined under the IIP at the product group level since the deflation approach was employed:

$$V_{ALP}I_{k,0,t} = \sum_{j=1}^{n} (\frac{V_{ALP}V_{j,t}}{V_{ALP}V_{j,0}})w_{j} \propto b,$$

Where $V_{ALP}I_{k,0,t} = \text{Value Index for Period } t \text{ relative to period } 0 \text{ for product group } k$, $V_{ALP}V_{j,t}$ and $V_{ALP}V_{j,0}$ denote the value data of product $j$ in periods $t$ and $0$, respectively;

$$w_{j,b} = \frac{V_{ALP}V_{j,b}}{\sum_{j=1}^{n} V_{ALP}V_{j,b}}$$

Are the weights (with $b \leq 0$). As the study was primarily focused on understanding the effect of a particular form of industrialization implied as “Commodity-based Industrialization’ which focuses on the production of finished rather than Intermediate goods, we further extended by imposing a structural parameter to the weights which shows the proportion of merchandise trade of total trade;

$$\propto = \left(\frac{\text{merchandise exports}}{\text{Total exports}}\right)^{\frac{2}{3}}$$

To this, deflation is required because the value indices are calculated at product level, product group level and industry level. Deflation is used to isolate the volume component from variables that have price and volume elements.

To incorporate the aspect of volume, the index is re-specified as;

$$V_{OLI}_{l,0,t} = \frac{V_{OLI}_{l,0,t}}{p_{l,0,t}}$$

where $V_{OLI}_{l,0,t}$ denotes the IIP (volume index) for period $t$ relative to period $0$ for ISIC class $l$. 


\( VAL_{t0,t} \) = value index for period t relative to period 0 for ISIC class s,

\( pl_{t0,t} \) = deflator (price index) for period t relative to period 0 for ISIC class 1 (International Recommendations for the IIP, 2010, para. 5.122).

**Measure of Economic Growth: Emission Decoupled GDP Growth rate**

This study applied the emission decoupling theory of economic growth to Zambia and South Africa’s as developed by Xing et al. (2020) and was originally developed by Tapio (2005). The environmental negative impact is represented by a structurally imposed \( CO_2 \) emissions from industrial production in Zambia and South Africa.

\[
e^{\Delta CO_2/GDP} = \left( \frac{\Delta GDP}{GDP_{t-1}} \right) \times \left( \frac{\Delta CO_2}{CO_{2t-1}} \right)^\propto
\]

Where; \( \Delta GDP \) represents the Change in GDP from period t-1 to period t and \( GDP_{t-1} \) represents the GDP in the initial period. \( \Delta CO_2 \) and \( CO_{2t-1} \) represent the change in emissions and emissions in the previous period. On the emission, we impose a structural parameter \( \propto \), that measures the proportion of commodity trade of a nation and this in turn provides the basis of the contribution of emissions towards the growth rate of GDP.

\[
\propto = \left( \frac{\text{merchandise exports}}{\text{Total exports}} \right)^2
\]

**Summary Statistics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP Growth</td>
<td>overall</td>
<td>3.843946</td>
<td>2.913514</td>
<td>-5.963358</td>
<td>N = 48</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>2.189191</td>
<td>2.295954</td>
<td>5.391937</td>
<td>n = 2</td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>2.457906</td>
<td>-4.413567</td>
<td>8.750232</td>
<td>T = 24</td>
</tr>
<tr>
<td>Metal Ind.</td>
<td>overall</td>
<td>99.44815</td>
<td>20.27035</td>
<td>57.90485</td>
<td>N = 41</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>19.85995</td>
<td>83.00744</td>
<td>111.0936</td>
<td>n = 2</td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>14.6506</td>
<td>74.34555</td>
<td>122.3553</td>
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</tr>
<tr>
<td>Fabric Ind.</td>
<td>overall</td>
<td>93.46202</td>
<td>7.330824</td>
<td>88.27834</td>
<td>N = 48</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>9.400767</td>
<td>66.48342</td>
<td>115.8654</td>
<td>n = 2</td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>9.241526</td>
<td>73.28219</td>
<td>115.8654</td>
<td>T = 24</td>
</tr>
<tr>
<td>Food Ind.</td>
<td>overall</td>
<td>79.81694</td>
<td>20.56222</td>
<td>35.63202</td>
<td>N = 48</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>9.241526</td>
<td>73.28219</td>
<td>86.35168</td>
<td>n = 2</td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>9.47289</td>
<td>42.16676</td>
<td>112.016</td>
<td>T = 24</td>
</tr>
<tr>
<td>Non-Metal Ind.</td>
<td>overall</td>
<td>80.77252</td>
<td>27.76254</td>
<td>27.23309</td>
<td>N = 48</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>26.72163</td>
<td>61.87747</td>
<td>99.66737</td>
<td>n = 2</td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>20.1529</td>
<td>46.12814</td>
<td>139.2362</td>
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</tr>
<tr>
<td>Paper Ind.</td>
<td>overall</td>
<td>80.88129</td>
<td>24.16209</td>
<td>32.69717</td>
<td>N = 48</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>15.23295</td>
<td>70.10997</td>
<td>91.65261</td>
<td>n = 2</td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>21.5712</td>
<td>43.46849</td>
<td>116.7142</td>
<td>T = 24</td>
</tr>
<tr>
<td>Wood Ind.</td>
<td>overall</td>
<td>86.57494</td>
<td>19.34102</td>
<td>37.60831</td>
<td>N = 48</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>11.57952</td>
<td>78.38698</td>
<td>94.7629</td>
<td>n = 2</td>
</tr>
</tbody>
</table>
Table 1 shows that with respect to the variability in the variables as measured by the standard deviation, the non-metallic industry had the highest overall and between the cross-sectional variability followed by the paper industry, while the growth rate of real GDP exhibited the least variability both within the cross-sectional aspect and between the two panels examined. With regard to the mean of the variables, table 1 shows that the metal industry was the most competitive across the panels with an average Industrial Production Index of 99 followed by the fabricated metal industry which had an Index of 94. The food and beverages industry performed the poorest with an Index of 79.8.

**Methodology**

Suppose that given data on time periods, \( t = 1, 2, \ldots, T \), and groups, \( i = 1, 2, \ldots, N \), and we estimate a panel ARDL(\( p, q, q, \ldots, q \)) Model,

\[
y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \sigma_{ij} X_{i,t-j} + \mu + \varepsilon_{it}
\]

Where \( X_{it} \) (\( k \times 1 \)) is the vector of explanatory variables for group \( i \), \( \mu_{i} \) represent the fixed effects, the coefficients of the lagged dependent variables, \( \lambda_{ij} \), are scalers and \( \sigma_{ij} \) are \( k \times 1 \) coefficient vectors. \( T \) must be large enough such that we can estimate the model for each group separately. For notational convenience, we use a common \( T \) and \( p \) across groups and a common \( q \) across regressors. The equation can be re-parametrized;

\[
\Delta y_{it} = \varphi_{i} y_{i,t-1} + \beta_{i}^{\prime} X_{it} + \sum_{j=1}^{p-1} \lambda_{im,j=1}^{\prime} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \Delta X_{i,t-j} + \mu + \varepsilon_{it}
\]

\( i = 1, 2, \ldots, N, \text{ and } t = 1, 2, \ldots, T, \text{ where } \varphi_{i} = -(1 - \sum_{j=1}^{p} \lambda_{ij}), \beta = \sum_{j=0}^{q} \delta_{ij} \)

\[
\lambda_{ij} = - \sum_{m=j+1}^{p} \lambda_{im,j=1,2,\ldots,p-1} \text{ and } \delta_{ij} = - \sum_{m=j+1}^{q} \delta_{im,j=1,2,\ldots,q-1}
\]

If we stack the time-series observations for each group, the initial equation falls to;

\[
\Delta y_{i} = \varphi_{i} y_{i,-1} + X_{i} \beta_{i} + \sum_{j=1}^{p-1} \lambda_{i,j}^{\prime} \Delta y_{i,-j} + \sum_{j=0}^{q-1} \Delta X_{i,-j} \delta_{ij}^{\prime} + \mu_i + \varepsilon_{i}
\]

\( i = 1, 2, \ldots, N, \text{ where } y_{i} = (y_{i1}, \ldots, y_{iT})^{\prime} \) is a \( T \times 1 \) vector of the observation on the dependent variable of the \( i \)-th group, \( X_{i} = (X_{i1}, \ldots, X_{iT})^{\prime} \) a \( T \times k \) matrix of observations on the regressors that vary both across groups and time periods, \( l = (1, \ldots, l)^{\prime} \) a \( T \times 1 \) Vector of ones, \( y_{i,-j} \) and \( X_{i,-j} \) are \( j \) periods lagged values of \( y_{i} \) and \( X_{i} \), \( \Delta y_{i} = y_{i} - y_{i,-1} \Delta X_{i} = X_{i} - X_{i,-1} \Delta y_{i,-j} \) and \( \Delta X_{i,-j} \) are \( j \) period lagged values of \( \Delta y_{i} \) and \( \Delta X_{i} \), and \( \varepsilon_{i} = (\varepsilon_{i1}, \ldots, \varepsilon_{iT})^{\prime} \).
Model Assumptions:

**Assumption 1:** The disturbance $\varepsilon_{it}, i = 1,2,\ldots,N, t = 1,2,\ldots,T$ are independently distributed across $i$ and $t$, with zero means, variances greater than 0 and finite fourth-order moments. They are also distributed independently of the regressors, $X_{it}$.

**Assumption 2:** The $ARDL (p, q, q, \ldots, q)$ model is stable in that the roots of:

$$\sum_{j=1}^{p} \lambda_{ij} z^{j} = 1, i = 1,2,\ldots,N,$$

**Assumption 3:** The long run coefficients on $X$, defined by $\theta_{i} = -\beta_{i}/\phi_{i}$, are the same across the groups.

**The Pooled Mean Group Estimator**

The maximum likelihood (ML) estimation of the long run coefficients, $\theta$ and the group-specific error-correction coefficients, $\phi$, can be compiled by maximizing on assumption three and these ML estimators will be referred to as the “Pooled Mean Group” estimators in order to highlight both the pooling implied by the homogeneity restrictions on the long-run coefficients and the averaging across groups used to obtain means of the estimated error-correction coefficients and other short-run parameters of the model.

We thus specified our PMG model as our initial model given:

$$\Delta y_{it} = \phi_{i} y_{i,t-1} + \beta_{i}' X_{it} + \sum_{j=1}^{p-1} \lambda^{*}\Delta y_{i,t-j} + \sum_{j=0}^{q-1} \Delta X_{i,t-j} + \mu + \varepsilon_{it}$$

Where: $\sum_{j=0}^{q-1} \Delta X_{i,t-j}$ and $\sum_{j=1}^{p-1} \lambda^{*}\Delta y_{i,t-j}$ are the short-run terms and $\phi_{i} y_{i,t-1} + \beta_{i}' X_{it}$ are the long run terms of our model.

### RESULTS AND DISCUSSIONS

**Cointegration analysis**

<table>
<thead>
<tr>
<th>Ho: No cointegration</th>
<th>Number of panels = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ha: All panels are cointegrated</td>
<td>Avg. number of periods = 19.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cointegrating vector: Panel specific</th>
<th>Included</th>
<th>Kernel: Bartlett</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time trend: Included</td>
<td>Lags: 0.00 (Newey-West)</td>
<td></td>
</tr>
<tr>
<td>AR parameter: Panel specific</td>
<td>Augmented lags: 1</td>
<td></td>
</tr>
<tr>
<td>Statistic</td>
<td>p-value</td>
<td></td>
</tr>
<tr>
<td>Modified Phillips-Perron t</td>
<td>-0.1309</td>
<td>0.4479</td>
</tr>
</tbody>
</table>

Table 2. Pedron’s test of Cointegration
To test the presence of cointegration among the variables and ascertain the existence of long-run relation the study employed the Pedroni test of cointegration. Given the null hypothesis of no cointegration, table 2 shows that the variables according to the Philips-Perron and the augmented Dickey fuller tests exhibited long-run cointegration. This is also implied within the long-run coefficients of the model to be estimated as under the ARDL dynamic panel model, cointegration is implied within the significance of the long-run model. Here, the paper however provides a formalized test to re-affirm the presence of cointegration.

**Model Selection Criteria**

<table>
<thead>
<tr>
<th>Table 3. Hausman Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficients</td>
</tr>
<tr>
<td>(b)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Metal Ind</td>
</tr>
<tr>
<td>Fabricated Ind</td>
</tr>
<tr>
<td>Food Ind</td>
</tr>
<tr>
<td>Non Metallic Ind</td>
</tr>
<tr>
<td>Paper Products Ind</td>
</tr>
<tr>
<td>Wood Products Ind</td>
</tr>
</tbody>
</table>

\[
\text{chi2}(6) = (b-B)'[(V_b-V_B)^{(-1)}](b-B) = 0.08 \\
\text{Prob>chi2} = 1.0000 \\
(V_b-V_B \text{ is not positive definite})
\]

In the application of dynamic panel models, we employed the Hausman test to understand which model was the most appropriate. In deciding between the Mean group and Pooled Mean group estimators, the conducted Hausman test employs the following hypotheses;

\[
H_0 = \text{Pooled Mean group estimator is more appropriate} \\
H_1 = \text{Mean Group estimator is more appropriate}
\]

Given the P-value of 1 as seen in table 3, we failed to reject the null hypothesis that the Pooled Mean Group estimator (PMG) is the most appropriate model and thus followed to estimate our model using this estimator of Dynamic panels.

**Model estimation**

<table>
<thead>
<tr>
<th>Table 4. Pooled Mean group estimator</th>
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<tbody>
<tr>
<td>Pooled Mean Group Regression</td>
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<tr>
<td>(Estimate results saved as PMG)</td>
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</table>
Table 4 shows that the metallic, food and beverages, paper and wood products industries significantly affected emissions decoupled economic growth in South Africa while only the fabricated metal and wood industry significantly fostered economic growth in Zambia. This is partly due to the fact that with regards to emission, highly industrialized countries such as South Africa have had challenges to decouple their emissions from their productive capabilities as both their production and
consumption-based emissions move in proportion with their economic growth even after the effect of emissions is detached.

**Figure 2.** GDP growth rate and Consumption/Production based CO2 Emissions

Source: Authors computation based on data from our world in data

As shown in Figure 2, in South Africa, the manufacturing, industry, and transport sectors have been the primary contributors to the country’s total emissions. O’Neill (2023) further shows that the contribution of these sectors, particularly agriculture, towards GDP had been around 2.57 percent for South Africa, whereas industry and services had contributed 24.44 and 62.61 percent of the total value added towards GDP, respectively, in 2022. This further raised the argument of whether emission reduction or decoupling from economic growth and industrial development could slow down economic growth. Grossman and Krueger (1991) addressed this by stating that economic growth implies increased pollution levels simply due to increased output and increased output requires increased input and as more natural resources are used, pollution levels rise. The implications of Grossman’s findings would thus suggest a possible linkage between industrialization and emissions. This would therefore call for emission reduction through re-engineering the industrial structure of most economies that could seek to curb their emissions. Ayodele et al. (2023), however, contend that the interaction of energy consumption and industrialization on carbon emissions is significant only in the short run. However, they concluded that energy consumption through further industrialization of highly industrialized countries being the major driver of carbon emissions in the world is not out of place. Considering the relationship between the metal industry and the growth rate of GDP, Our results were opposed by those of Kregel (2016), who established a reverse causality running from GDP towards the consumption of steel and metal items. They argue that an increase in the production as a result of growth would increase demand for the basic production of steel.

In the long-run, we established that for both South Africa and Zambia, only the effects of the non-metallic and paper industries were significant enough to foster sustainable economic growth. This result is interesting as it feeds directly into the discussion of sustainability. Royer (2023) points out that by leveraging technology to digitalize the value chain, paper and fibre companies can increase local innovations
that will lead to more resilient capabilities as well as unparalleled agility. This will support the global quest for simplifying and harmonising the entire value chain while at the same time ensuring production flexibility in the face of rapid demand fluctuation of most industrial entities. Compared to other industries, paper manufacturing has great potential to be truly sustainable and ecological (Porritt, 2021). The paper industry is a highly certified industry, with a fully renewable raw material and a circular product, using renewable raw material to produce a recyclable product. The industry itself is also decoupling as the direct link between production and impact has been broken, meaning that more production no longer means more impact.

**Boosting of Regional Value Chains to enhance competitiveness of Sustainable Industrialization**

The significance of industrial sectors such as paper and wood speak to the need for re-enforcement and coordinated development of regional value chains as a vehicle to attain sustainable economic growth both within Southern Africa and the entire continent. With the establishment of the African Continental Free Trade Area (AfCFTA), this goal is well within the capabilities of most African economies, as by providing an environment conducive for the establishment of regional value chains, the AfCFTA not only liberates Africa from dependency on imports of industrial goods but also creates jobs, generates wealth, and upgrades skills and technology. Furthermore, the development of regional value chains can contribute to technology transfer and knowledge sharing among countries. As African nations collaborate on different production stages, they can pool resources and expertise, fostering innovation and the adoption of advanced technologies. This shared learning will not only lead to improvements in productivity but also strengthen the continent’s overall technological capabilities, which will in turn increase the continent’s capacity to foster sustainable economic growth. For countries such as South Africa, where the food and beverages, wood, and paper industries positively foster sustainable emission decoupled economic growth, the development of robust agri-food value chains at the national level is also a prerequisite for the establishment of regional value chains that can serve the region and ensure continental food security.

While we cannot dispute the significance of emission intensive industrialization on economic growth, particularly for low- and medium-income countries like South Africa and Zambia, the argument we make is that benefits of such significance have not been recoupled due to the policy and structure of the industrial base in these economies. To a large extent, the effects of industrialization on these economies have seen the emergence of two main phenomena: jobless growth and premature deindustrialization (Victor & Anthuvan, 2005). The major cause of industrial sickness, which raises unemployment rates in Zambia and South Africa, is said to be the local market's stagnation and industries' inability to compete on the global market because of their expensive and low-quality products (Victor & Anthuvan, 2005). To be able to survive in the local market, most industries have chosen the shortcut of small-scale industries, which directly feed into premature industrialization. In achieving the benefits of the significant relationship established...
in our study, we suggest that these economies focus more on value addition as a measure of performance than volume of production. The rationale for this comes from the fact that, as the pooled mean growth estimator results have shown, although constituting a significant amount of total employment in both Zambia and South Africa, metal and fabricated metal industries were seen to insignificantly affect sustainable economic growth in the long run. This is because even though these sectors produce huge volumes and constitute a large portion of total domestic production, the production is mainly of raw, unprocessed, and low value commodities. Another important aspect with regard to the enhancement of these countries’ industrial bases is that of Foreign Direct Investment (FDI). While the effect of FDI in Africa has over the years unarguably been strongly positive and significant, the argument we make here is that the distribution of this FDI has been rather misplaced.

Figure 3. Foreign direct Investment by sector
Source: Authors’ computation based on data from the Bank of Zambia

For example, Table 3 shows that for Zambia, in 2018-2019, a great portion of the Foreign Direct Investment ($406 million) was channeled towards mining and quarrying, a predominantly extractive sector with less value addition, while the lowest amount of FDI ($1.7 million) was channeled to the agricultural sector, a sector which employs 70 percent of the entire force. This can be seen as a gap that needs to be addressed because by their very nature of being under-developed, most African economies do not have the capacity to take a leading role in value addition with respect to very sophisticated production processes and thus have a very competitive edge in the agricultural sector due to favorable climatic conditions that would see them taking a leading role in the production of very high-value agricultural products and further foster growth.

CONCLUSION

In conclusion, we argue that while extractive and low-value Industrial sectors are the most feasible in the case of most African countries to be able to accelerate sustainable economic growth through the industrial sector, these nations will have to
re-engineer their industrial sector towards a more commodity-aligned approach that puts value addition through regional value chains at the pinnacle of regional and national development strategies and plans.

REFERENCES


