

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(6), 157-178.

Labour Market Dynamics, Environmental Degradation, and Employment Determinants in Ghana: The Interplay of Industrialisation, Trade Openness, and Carbon Intensity

Samuel Asuamah Yeboah*, Ernest Kumi, Alex Ofori

Faculty of Business and Management Studies, Sunyani Technical University, Ghana. *Email: nelkonsegal4655@gmail.com

Received: 02 August 2026 **Accepted:** 29 October 2026 **DOI:** https://doi.org/10.32479/ijeep.25166

ABSTRACT

This study examines the macroeconomic and environmental determinants of employment dynamics in Ghana, highlighting the nexus between energy-intensive manufacturing development, trade openness, capital formation, and carbon dioxide (CO_2) emissions. Utilising annual time-series data from 1970 to 2023, the study applies the autoregressive distributed lag (ARDL) bounds-testing procedure, error-correction modelling, and VAR-based Granger causality analysis to evaluate short- and long-run employment responses. The cointegration analysis confirms a robust long-run equilibrium relationship among employment, manufacturing value-added, trade openness, capital accumulation, and carbon emissions. The error-correction coefficient is negative and statistically significant, confirming that short-run disequilibrium adjusts toward long-run equilibrium, albeit slowly. The empirical results reveal that manufacturing value-added exerts a statistically significant negative effect on employment, indicating that Ghana's industrial growth path, driven by carbon- and energy-intensive manufacturing, has lacked sufficient labour-absorbing capacity. Conversely, trade openness demonstrates a positive employment effect through short-run lagged dynamics and Granger causality, indicating that external sector integration yields employment benefits when domestic firms capitalise on expanded market access. Capital formation exhibits a weak and statistically insignificant effect on labour demand, suggesting that capital accumulation has not been adequately aligned with job creation. Furthermore, including CO_2 emissions highlights the structural trade-off between environmental degradation and employment expansion. The study concludes that achieving employment-rich, sustainable transformation requires green manufacturing policies targeting labour-intensive, energy-efficient production; trade strategies that foster local value addition; and investment frameworks that align capital deepening with environmental sustainability and workforce employability.

Keywords: Employment Determinants, Energy Intensity, Carbon Emissions, Manufacturing Development
JEL Classifications: Q43, Q56, J21, O14

1. INTRODUCTION

Ghana currently faces a persistent labour-market challenge: Economic growth, structural transformation, and investment expansion do not consistently produce sufficient, productive, and decent employment. Although the country is continuing to pursue macroeconomic recovery, industrial development, export diversification and private-sector-led growth, employment outcomes are still reflecting unemployment, underemployment, informality, skills mismatch, gender disparities and uneven access to formal wage employment (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Ghana Statistical Service, 2023; 2024; 2025; Amankwah et al., 2024; World Bank, 2025). This concern is becoming more important because Ghana's development agenda is not only requiring higher output growth but also the creation of productive, inclusive, and sustainable employment opportunities. In this context, labour-market performance is increasingly becoming a key indicator of whether Ghana's economic transformation is producing meaningful welfare gains for households, workers and firms.

This Journal is licensed under a Creative Commons Attribution 4.0 International License

The employment challenge is especially relevant because many African economies are continuing to grow without creating enough high-quality jobs. The International Labour Organisation shows that global and African labour markets still face slow employment recovery, youth unemployment, informality, and decent work deficits (International Labour Organisation, 2020; 2024; 2025). Similarly, the World Bank emphasises that Ghana's labour-market outcomes are shaped by employment choice, educational attainment, location, gender, firm characteristics, and structural constraints within the economy (Amankwah et al., 2024). The World Bank also stresses that Ghana faces the urgent task of addressing labour-market challenges while creating opportunities in a changing economic landscape (World Bank, 2025). These concerns suggest that Ghana's employment problem is not simply a short-term macroeconomic issue; it is a structural development problem connected to production, trade, investment and the organisation of economic activity.

Manufacturing development, trade openness, and capital formation are central to this debate because they are directly connected to an economy's capacity to generate employment. Manufacturing development is expected to create jobs by expanding industrial output, increasing firm-level production, strengthening domestic value chains and generating demand for both skilled and semi-skilled labour (Abreha et al., 2021; Dinh, 2023; Edeme et al., 2020; Teal, 2023; United Nations Industrial Development Organisation, 2023; 2024). Trade openness is expected to influence employment through export expansion, import competition, technology transfer, market access and participation in global and regional value chains (African Union, 2024; Gonese et al., 2023; Saani et al., 2026; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). Capital formation is also expected to influence employment because investment in infrastructure, machinery, buildings and productive assets expands production capacity and affects labour demand (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; World Bank, 2024a). However, the employment effects of these variables are not automatic. They depend on the structure of the economy, the labour intensity of production, the competitiveness of firms and the degree to which investment and trade support domestic productive capacity.

Theoretically, manufacturing development sits at the Centre of the employment-growth relationship. Kaldor's growth laws suggest that manufacturing drives growth because it generates increasing returns, productivity gains, and strong linkages with other sectors of the economy (Kaldor, 1966). From this perspective, manufacturing expansion should stimulate employment by increasing industrial production and creating demand across supply chains. Endogenous growth theory also provides a useful foundation because it emphasises human capital, technological learning, innovation and increasing returns as drivers of long-term growth and employment opportunities (Lucas, 1988; Romer, 1986). The neoclassical growth model further explains how capital accumulation and technological progress shape output growth, labour productivity, and employment outcomes (Solow, 1956). In addition, labour-market search and matching theory shows that employment creation depends not only on aggregate growth but also on the interactions among firms, workers, vacancies, and labour-market frictions (Mortensen and Pissarides, 1994). These theoretical perspectives jointly indicate that Ghana's employment outcomes are being shaped by manufacturing capacity, investment accumulation, trade integration and labour-market adjustment processes.

Manufacturing development remains important for Ghana because the country is still searching for a growth path that can generate productive employment and reduce dependence on low-productivity activities. In developing economies, manufacturing is often expected to absorb labour from agriculture and informal services, strengthen technological capability, raise productivity and support export diversification (Abreha et al., 2021; Dinh, 2023; United Nations Industrial Development Organisation, 2023; 2024). Evidence from African economies suggests that manufacturing value added, infrastructure, exports and foreign direct investment can influence employment, although the magnitude and direction of effects vary across countries and sectors (Edeme et al., 2020; Habanabakize and Mncayi, 2022; Ojo and Ogunleye, 2021; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024). In Ghana, the issue is particularly important because manufacturing development is being promoted as a pathway to industrialisation, productivity growth and job creation, but the sector's ability to generate large-scale employment remains uncertain (Teal, 2023; World Bank, 2021; 2024; 2025). This uncertainty necessitates examining whether manufacturing value added significantly influences employment in Ghana.

Trade openness is also becoming a major issue in Ghana's labour-market debate. Openness can create employment by enabling domestic firms to access larger markets, import productive inputs, adopt new technologies, and participate in regional and global value chains (African Union, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). The African Continental Free Trade Area is also attracting increasing attention for the employment potential of regional integration, especially by enabling countries to expand exports, develop manufacturing capacity, and strengthen intra-African trade (African Union, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025). However, trade openness may also reduce employment when import competition weakens domestic firms, when exports remain concentrated in primary commodities, or when local industries lack competitiveness (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026). This means the employment effect of trade openness is conditional. It depends on whether openness supports productive transformation or exposes weak domestic industries to external competition without sufficient industrial upgrading.

Capital formation provides another important channel through which employment outcomes are being shaped. Investment in productive assets can stimulate employment by expanding firm capacity, improving infrastructure, increasing output and supporting industrial growth (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020). However, capital formation can also produce weak employment effects when investment is concentrated in

capital-intensive sectors or when firms adopt technologies that substitute for rather than complement labour. This distinction matters for Ghana because the country seeks investment-led growth while also facing unemployment, underemployment, and informality (World Bank, 2021; 2024; 2025). If capital formation is labour-complementing, it should increase employment by expanding production and strengthening enterprise growth. If it is labour-substituting, it may raise output without producing sufficient jobs. Therefore, examining the relationship between capital formation and employment is essential for understanding whether Ghana's investment path is inclusive and employment-generating.

The existing empirical literature provides important but fragmented evidence. Ghana-specific studies examine unemployment duration, gendered labour-market outcomes, inflation, public debt, labour-market participation, and employment choice (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Saani et al., 2024; Amankwah et al., 2024; World Bank, 2025). Other studies across Africa are examining the effects of manufacturing value added, exports, foreign direct investment, trade openness, gross fixed capital formation, unemployment and economic growth (Edeme et al., 2020; Gonese et al., 2023; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Osuma and Nzimande, 2024; Pasara and Garidzirai, 2020). Policy-oriented reports are also highlighting the importance of industrialisation, private-sector development, regional trade integration and employment-centred transformation in Africa (African Development Bank [AfDB], 2024; 2025; African Union, 2024; International Labour Organisation, 2024; 2025; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa 2025; World Bank, 2021; 2025). Despite these contributions, the literature still does not adequately explain how manufacturing development, trade openness, and capital formation jointly influence employment dynamics in Ghana.

This gap is important for three reasons. First, employment creation is not determined by a single macroeconomic variable. Manufacturing development may influence employment directly through industrial production, but its effect may depend on investment, export capacity and the competitiveness of domestic firms. Second, trade openness may create employment when it supports exports and industrial upgrading, but it may weaken employment when imports displace domestic production. Third, capital formation may increase employment when investment supports labour-intensive production, but it may produce limited employment effects when investment is capital-intensive. Therefore, analysing manufacturing development, trade openness and capital formation separately may underestimate the interdependent nature of employment determination in Ghana (Gonese et al., 2023; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2026; Teal, 2023).

Methodologically, Ghana's employment dynamics also require a time-series approach that captures both short- and long-run relationships among macroeconomic variables. Labour-market outcomes often respond gradually to changes in manufacturing output, investment, and trade openness because firms need time to adjust production, hire workers, adopt technology, and respond to market conditions. For this reason, applied macroeconomic studies commonly use dynamic econometric techniques to examine long-run relationships and causal interactions among variables (Akaike, 1974; Dickey and Fuller, 1979; Granger, 1969; Kwiatkowski et al., 1992; Pesaran et al., 2001; Toda and Yamamoto, 1995). These methods help researchers examine stationarity, cointegration, model selection, dynamic adjustment, and causal direction in time-series data. Applying such methods to Ghana's employment question can therefore provide stronger evidence for policy and academic debates.

This study addresses the identified gap by examining labour market dynamics and employment determinants in Ghana, with specific evidence from manufacturing development, trade openness, and capital formation. The study positions employment as the dependent variable and analyses how manufacturing value added, trade openness, and capital formation influence employment outcomes over time. The study is therefore asking whether Ghana's manufacturing development is creating employment, whether trade openness is strengthening or weakening labour-market outcomes, and whether capital formation is supporting labour demand. In doing so, the study contributes to the literature by integrating three major structural determinants of employment into a single Ghana-specific empirical model.

The study makes three main contributions. First, it contributes to the Ghanaian labour-market literature by moving beyond general discussions of unemployment and labour participation to examine the structural macroeconomic drivers of employment. Second, it contributes to the African industrialisation and trade literature by assessing whether manufacturing development and trade openness are generating employment benefits in a small, open, developing economy. Third, it contributes to the investment-employment literature by examining whether capital formation translates into labour demand in Ghana. These contributions matter because Ghana's policy agenda increasingly focuses on industrial transformation, private-sector development, regional trade participation, and investment mobilisation. Yet, the employment effects of these strategies remain empirically under-examined.

The study's policy relevance is also significant. Ghana is currently pursuing industrialisation, trade expansion, investment promotion and private-sector-led development. However, these strategies will have limited developmental value if they do not create productive and decent employment. If manufacturing development significantly increases employment, policy should strengthen industrial financing, infrastructure provision, technology upgrading, skills development, and local value-chain participation. If trade openness is not improving employment, policy should shift attention towards export competitiveness, import-substitution capacity, local content development and productive firm-level upgrading. If capital formation is not generating employment, investment policy should prioritise labour-complementing sectors, small and medium-sized enterprises, manufacturing expansion and infrastructure that supports employment-intensive production.

Against this background, this study examines the dynamic relationship between employment, manufacturing development, trade openness, and capital formation in Ghana. The central argument is that Ghana's labour-market outcomes are being shaped not only by aggregate economic growth but also by the structure of production, the direction of trade integration and the nature of capital accumulation. Understanding these relationships is essential for designing policies that do not merely increase output but also create jobs, improve productivity, reduce vulnerability, and support inclusive structural transformation.

2. LITERATURE REVIEW

The literature on labour market dynamics is increasingly linking employment outcomes to both human resource development and macroeconomic transformation. From the human resource perspective, employment is not simply reflecting the number of people working; it is also showing the extent to which an economy is absorbing skills, deploying human capital, improving labour productivity, reducing mismatch and creating decent work opportunities (International Labour Organisation, 2020; 2024; 2025; Amankwah et al., 2024; World Bank, 2025). From the applied macroeconomic perspective, employment is being influenced by the structure of production, manufacturing value added, trade openness, capital formation, macroeconomic stability and private-sector competitiveness (Abreha et al., 2021; Saani et al., 2024; 2026; Teal, 2023; World Bank, 2021; 2024; 2025). This review therefore integrates HR and applied macroeconomics by examining how manufacturing development, trade openness, and capital formation shape labour demand, labour absorption, skills utilisation, and employment creation in Ghana.

In Ghana, labour-market dynamics are receiving increasing research and policy attention because employment outcomes are still being shaped by unemployment duration, gender disparities, informality, labour-force participation challenges, macroeconomic instability and weak job quality (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Ghana Statistical Service, 2023; 2024; 2025; Saani et al., 2024; Amankwah et al., 2024; World Bank, 2025). This makes employment both an economic and HR issue. Economically, employment responds to changes in manufacturing value added, trade openness, investment, and capital accumulation (Edeme et al., 2020; Gonese et al., 2023; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2026). From the HR viewpoint, employment reflects the country's ability to develop, match and utilise labour in productive sectors such as manufacturing, trade-related services, logistics and industrial supply chains (Fox, 2021; International Labour Organisation, 2020; 2024, 2025; Abdychev et al., 2018; Amankwah et al., 2024; World Bank, 2025).

2.1. Theoretical Review

2.1.1. Manufacturing-led growth theory and labour absorption

Kaldor's manufacturing-led growth theory provides a major theoretical foundation for linking manufacturing development to employment creation. Kaldor (1966) argues that manufacturing drives economic growth because it generates increasing returns, productivity gains, technological learning, and strong linkages with other sectors. This theory is relevant to Ghana because manufacturing development is promoted as a pathway to structural transformation, productivity improvement, and job creation (Abreha et al., 2021; Dinh, 2023; Teal, 2023; United Nations Industrial Development Organisation, 2023; 2024; World Bank, 2021). Under this framework, manufacturing value added is expected to increase employment by expanding firm output, stimulating supplier demand, raising labour productivity and creating wage employment across industrial value chains (Edeme et al., 2020; Habanabakize and Mncayi, 2022; Teal, 2023). From an HR perspective, Kaldorian theory matters because manufacturing-led growth increases demand for technical workers, machine operators, production supervisors, quality-control personnel, logistics staff, and supply-chain professionals (Abreha et al., 2021; Dinh, 2023; Ojo and Ogunleye, 2021; Teal, 2023). Manufacturing development is therefore not only about expanding output; it also requires workforce planning, skills development, industrial training, and productivity-oriented human resource management (International Labour Organisation, 2020; 2024; Abdychev et al., 2018; World Bank, 2024a; 2025). However, manufacturing's employment effect is not automatic because it may become capital-intensive, technologically selective, or weakly linked to domestic supply chains (Ojo and Ogunleye, 2021; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; Teal, 2023). Therefore, the Kaldorian argument supports the expectation that manufacturing development should influence employment, but it also requires empirical testing in Ghana.

2.1.2. Neoclassical growth theory, capital formation and employment

The neoclassical growth model provides another theoretical basis for examining the relationship between capital formation and employment. Solow (1956) explains that output growth is driven by capital accumulation, labour and technological progress. In this framework, capital formation expands productive capacity through investment in machinery, buildings, infrastructure, and other productive assets (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; World Bank, 2024a). Capital formation should therefore increase employment when investment expands firms, improves infrastructure, reduces production costs and strengthens labour demand (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; World Bank, 2021; 2024; 2025). However, neoclassical theory also allows capital and labour to complement or substitute for each other (Solow, 1956). When investment is labour-complementing, capital formation increases employment by expanding production and improving worker productivity (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020). When investment is labour-substituting, capital formation may increase output without producing proportional employment growth because firms may adopt capital-intensive technologies (Abdychev et al., 2018; Fox, 2021; World Bank, 2024a). This distinction is critical for Ghana because the country is seeking investment-led transformation while still confronting unemployment, underemployment and informal work (Ghana Statistical Service, 2023; 2024; 2025; World Bank, 2024a; 2025). From an HR perspective, capital formation also creates demand for workers who can operate new technologies, manage production systems, and support higher

productivity (International Labour Organisation, 2020; 2024; Abdychev et al., 2018; World Bank, 2024a).

2.1.3. Endogenous growth theory, human capital and workforce capability

Endogenous growth theory strengthens the HR dimension of the study by emphasising human capital, innovation, knowledge accumulation and learning as internal drivers of growth (Lucas, 1988; Romer, 1986). Romer (1986) argues that increasing returns and knowledge accumulation can sustain long-run growth, while Lucas (1988) places human capital at the Centre of economic development. This matters for Ghana because job creation depends not only on manufacturing output, trade openness, and investment; it also depends on whether the workforce has the skills expanding sectors require (Adinkra-Darko and Ahiakpor, 2024; International Labour Organisation, 2020; 2024; 2025; Amankwah et al., 2024; World Bank, 2025). From an HR perspective, endogenous growth theory shows that education, training, technical competence, employability, and labour productivity shape employment outcomes (Lucas, 1988; Romer, 1986; International Labour Organisation, 2020; 2024; Amankwah et al., 2024). Manufacturing development may fail to create adequate employment if workers lack technical and vocational skills (Abreha et al., 2021; Dinh, 2023; Ojo and Ogunleye, 2021). Trade openness may fail to support employment if firms lack workers with export-readiness, logistics, quality assurance and supply-chain coordination skills (African Union, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). Capital formation may also fail to create jobs if new investment requires skills that are not available in the labour market (Abdychev et al., 2018; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Amankwah et al., 2024). Therefore, endogenous growth theory supports an integrated HR–macroeconomic approach to employment analysis.

2.1.4. Search and matching theory of labour-market dynamics

The search-and-matching theory of Mortensen and Pissarides (1994) explains employment creation through the interaction between workers searching for jobs and firms creating vacancies. The theory is useful because it shows that employment does not automatically increase when output, trade, or investment increases; instead, employment depends on matching efficiency, hiring costs, wage bargaining, labour-market information, skills compatibility, and vacancy creation (Mortensen and Pissarides, 1994). This is relevant to Ghana, where unemployment duration, employment choice, and labour-market participation are influenced by individual, regional, gender, and structural factors (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Ghana Statistical Service, 2023; 2024; 2025; Amankwah et al., 2024; World Bank, 2025). From an HR perspective, search and matching theory is important because it explains why skills mismatches, weak employability, poor labour-market information, and limited training may reduce employment even when macroeconomic activity is expanding (International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Amankwah et al., 2024). From the macroeconomic perspective, the theory explains why manufacturing development, trade openness and capital formation may have delayed or weak employment effects where firms do not create enough vacancies or where workers cannot meet firm-level skill requirements (Edeme et al., 2020; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Teal, 2023). Therefore, the theory supports the argument that Ghana's employment dynamics should be analysed through both structural macroeconomic determinants and HR-related labour-market frictions.

2.1.5. Trade openness theory and labour-market adjustment

Trade theory suggests that openness can improve employment by enabling firms to access larger markets, import productive inputs, acquire technology, and participate in global or regional value chains (World Bank, 2020; United Nations Conference on Trade and Development, 2024; African Union, 2024; United Nations Economic Commission for Africa, 2025). In the African context, trade integration is being promoted as a mechanism for industrialisation, export diversification and employment generation, particularly through the African Continental Free Trade Area (African Union, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; African Development Bank, 2024; 2025). Ghana's participation in trade integration is therefore expected to influence employment through manufacturing competitiveness, private-sector development, export expansion and investment flows (Saani et al., 2026; World Bank, 2020; 2024). However, trade openness may also create labour-market adjustment pressures. Openness may reduce employment when domestic firms face import competition, when exports remain concentrated in primary commodities, or when local production lacks competitiveness (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026). From the HR perspective, trade openness is changing skill requirements because firms exposed to regional and global markets need workers with stronger technical, digital, quality-control, logistics and supply-chain capabilities (International Labour Organisation, 2020; 2024; Abdychev et al., 2018; Amankwah et al., 2024). Thus, trade openness can generate employment only when supported by manufacturing capacity, productive investment, and workforce readiness (Abreha et al., 2021; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020; 2024).

2.1.6. Integrated HR–applied macroeconomic framework

The theoretical review suggests that the interaction among production structure, trade integration, investment accumulation, and workforce capability shapes employment in Ghana. Kaldor's theory links manufacturing development to industrial employment and structural transformation (Kaldor, 1966; Abreha et al., 2021; Teal, 2023). Neoclassical growth theory links capital formation to productive capacity, labour demand and investment-led growth (Solow, 1956; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020). Endogenous growth theory links employment capacity to human capital, knowledge, innovation and skills development (Lucas, 1988; Romer, 1986; International Labour Organisation, 2020; 2024; Amankwah et al., 2024). Search and matching theory links employment outcomes to labour-market frictions, vacancies, employability and skills matching (Mortensen and Pissarides, 1994; Adinkra-Darko and Ahiakpor, 2024; Amankwah et al., 2024). Trade theory links openness to market access, competitiveness,

labour reallocation and value-chain participation (World Bank, 2020; Gonese et al., 2023; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025). This integrated framework is appropriate because Ghana's employment problem is both an HR issue and a macroeconomic issue. It is an HR issue because job creation depends on labour absorption, employability, skills development, productivity and workforce readiness (International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Amankwah et al., 2024; World Bank, 2025). It is a macroeconomic issue because employment is being influenced by manufacturing value added, trade openness, capital formation, macroeconomic stability and private-sector development (Edeme et al., 2020; Habanabakize and Mncayi, 2022; Saani et al., 2024; 2026; Teal, 2023; World Bank, 2021; 2024; 2025). Therefore, this study uses an integrated theoretical lens to examine how manufacturing development, trade openness, and capital formation determine employment in Ghana.

2.2. Empirical Review

2.2.1. Labour-market dynamics and employment in Ghana

Empirical evidence from Ghana's labour market shows that structural, demographic, macroeconomic, and institutional factors influence employment outcomes. Adinkra-Darko and Ahiakpor (2024) examine unemployment duration and its covariates in four administrative regions of Ghana, highlighting that unemployment is not only a macroeconomic outcome but also a regional and individual-level labour-market problem. Baah-Boateng et al. (2022) examine gender differences in extractive activities in Ghana, showing that gendered participation and sectoral differences also shape labour-market outcomes. The Ghana Statistical Service (2023; 2024; 2025) provides labour statistics highlighting ongoing concerns about labour-force participation, employment, unemployment, and underemployment. Amankwah et al. (2024) also examine labour-market participation and employment choice in Ghana, while World Bank (2025) frames Ghana's labour-market challenge as a major development policy issue.

The Ghanaian literature further shows that employment is sensitive to macroeconomic instability. Saani et al. (2024) examine the inflation, public debt and unemployment nexus in Ghana using an ARDL approach, indicating that inflationary pressure and public debt dynamics are relevant to unemployment outcomes. This matters because macroeconomic instability can reduce firm expansion, weaken investment decisions, and constrain hiring (Saani et al., 2024; Amankwah et al., 2024; World Bank, 2025). From the HR perspective, instability can also affect recruitment, wage growth, job security and employment quality (International Labour Organisation, 2024; 2025; Fox, 2021). Therefore, Ghana's employment dynamics must be understood as the outcome of both macroeconomic conditions and workforce-level constraints (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Ghana Statistical Service, 2023; 2024; 2025; Saani et al., 2024; Amankwah et al., 2024; World Bank, 2025).

2.2.2. Manufacturing development, industrialisation and employment

The empirical literature consistently identifies manufacturing development as a major pathway for employment creation and structural transformation. Abreha et al. (2021) argue that Sub-Saharan Africa can seize industrialisation opportunities through global value chains, while Dinh (2023) discusses the policy challenges and opportunities of industrialisation in Africa. United Nations Industrial Development Organisation (2023; 2024) provides industrial statistics that reinforce manufacturing's importance to development and structural transformation. African Development Bank (2024; 2025) also places industrialisation at the centre of Africa's transformation agenda. These studies and reports suggest that manufacturing development can influence employment through productivity growth, firm expansion, industrial linkages and value-chain participation (Abreha et al., 2021; African Development Bank, 2024; 2025; Dinh, 2023; United Nations Industrial Development Organisation, 2023; 2024).

Empirical studies from Africa also support the link between manufacturing and employment. Edeme et al. (2020) examine the impact of infrastructural development on manufacturing value added and employment in African emerging economies, showing that infrastructure and manufacturing capacity matter for employment outcomes. Habanabakize and Mncayi (2022) models the effects of gross value added, foreign direct investment and exports on employment in South Africa, showing that productive-sector variables influence employment. Ojo and Ogunleye (2021) examine technological leapfrogging and manufacturing value added in Sub-Saharan Africa, indicating that technology and industrial upgrading matter for manufacturing performance. Ongo Nkoa and Fonguen-Kong-Ngoh (2024) link industrialisation in Africa to energy transition, suggesting that industrial employment is increasingly affected by energy systems and sustainable production capacity. Teal (2023) focuses directly on firm size, employment and value added in African manufacturing firms and argues that Ghana needs stronger high-performing firms to support employment and value creation.

For Ghana, manufacturing development matters because the economy is seeking to move from low-productivity activities into higher-productivity sectors that can create wage employment and improve labour productivity (Teal, 2023; World Bank, 2021; 2024; 2025). However, the empirical literature suggests that manufacturing employment depends on firm size, infrastructure, technological capability, energy access, export potential and domestic value-chain linkages (Abreha et al., 2021; Edeme et al., 2020; Ojo and Ogunleye, 2021; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; Teal, 2023). From an HR perspective, manufacturing growth increases demand for technical skills, vocational training, industrial relations systems, workplace learning and productivity management (International Labour Organisation, 2020; 2024; Abdychev et al., 2018; World Bank, 2024a). Therefore, the empirical literature supports the expectation that manufacturing value added should influence employment. Still, the strength of the effect depends on whether manufacturing expansion is labour-absorbing and skill-supportive.

2.2.3. Trade openness and employment

Trade openness is widely discussed as a determinant of employment because it affects market access, competition, exports,

imports, technology transfer and value-chain participation. World Bank (2020) explains the importance of trade for development in the age of global value chains, while United Nations Conference on Trade and Development (2024) emphasises Africa's need to unlock trade potential. The African Union (2024) presents the African Continental Free Trade Area as a platform for creating a single African market, and United Nations Economic Commission for Africa (2025) highlights the importance of advancing AfCFTA implementation. African Development Bank (2024; 2025) also connects Africa's transformation agenda to trade, industrial development and productivity growth. These sources suggest that trade openness can support employment by expanding export opportunities, deepening regional value chains, and strengthening manufacturing competitiveness (African Union, 2024; African Development Bank, 2024; 2025; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020).

However, empirical evidence also shows that trade openness can have mixed effects on employment. Gonese et al. (2023) examine trade openness and unemployment in selected Southern African Development Community countries and show that openness may influence unemployment depending on country-level conditions. Osuma and Nzimande (2024) explore the dynamic link between trade openness, external debt and economic growth in Sub-Saharan Africa, indicating that trade openness interacts with wider macroeconomic vulnerabilities. Saani et al. (2026) examine trade openness and investment synergy in Ghana's growth trajectory using an ARDL bounds testing approach and find that trade openness and investment are important for Ghana's macroeconomic performance. These studies suggest that openness can generate employment when it supports production and exports, but it may weaken employment where domestic firms are not competitive (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026).

From an HR perspective, trade openness shifts the skill profile firms demand. Open economies require workers who can support quality standards, logistics management, export documentation, production efficiency, digital systems and supply-chain coordination (International Labour Organisation, 2020; 2024; Abdychev et al., 2018; World Bank, 2020; 2024). Therefore, trade openness may not improve employment if the labour force lacks the skills export-oriented and trade-exposed firms require (African Union, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2024a). In Ghana, the employment effect of trade openness is therefore likely to depend on the strength of manufacturing development, the quality of human capital, the competitiveness of firms and the direction of capital formation (Abreha et al., 2021; Saani et al., 2026; Teal, 2023; World Bank, 2024a, 2025).

2.2.4. Capital formation, investment and employment

Capital formation is another important determinant of employment because investment expands productive capacity and affects labour demand. Meyer and Sanusi (2019) examine the causal relationship between gross fixed capital formation, economic growth, and employment in South Africa, while Pasara and Garidzirai (2020) analyse the causal effects among gross capital formation, unemployment, and economic growth in South Africa. These studies suggest that investment and capital accumulation are important for employment, although the direction and strength of the relationship may differ across contexts (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020). Saani et al. (2026) also show that trade openness and investment synergy matter for Ghana's growth trajectory, suggesting that capital formation should not be examined separately from openness and productive-sector development.

The capital formation-employment relationship depends on whether investment is labour-complementing or labour-substituting. Investment in infrastructure, manufacturing plants, logistics facilities, agro-processing, and small and medium-sized enterprises can expand employment by increasing labour demand (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; World Bank, 2021; 2024; 2025). However, investment in highly capital-intensive technologies may raise output without generating sufficient employment (Fox, 2021; Abdychev et al., 2018; World Bank, 2024a). This issue matters for Ghana because the country seeks to attract investment and expand private-sector activity while still experiencing unemployment, underemployment, and informality (Ghana Statistical Service, 2023; 2024; 2025; World Bank, 2024a; 2025).

From an HR perspective, capital formation also increases demand for workforce capability. New investment often requires technicians, engineers, machine operators, procurement officers, supply-chain professionals, production managers and maintenance workers (International Labour Organisation, 2020; 2024; Abdychev et al., 2018; Amankwah et al., 2024). Therefore, investment-led employment depends on the availability of skilled labour and HR systems' ability to train, match, and retain workers (International Labour Organisation, 2020; 2024; 2025; Amankwah et al., 2024). The empirical literature therefore supports the inclusion of capital formation in Ghana's employment model, while also requiring careful interpretation of whether capital formation is supporting labour absorption or reflecting capital-intensive growth (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2026; Amankwah et al., 2024; World Bank, 2025).

2.2.5. HR Development, skills mismatch and employment absorption

The HR literature and policy evidence suggest that employment outcomes depend on the labour market's ability to absorb and utilise human capital. International Labour Organisation (2020) highlights youth employment challenges in Africa, while International Labour Organisation (2024; 2025) discusses global employment trends, decent work deficits and labour-market vulnerability. Abdychev et al. (2018) also examine the future of work in Sub-Saharan Africa, emphasising technology, demographic pressures and skills transformation. Fox (2021) argues that Africa is creating jobs, but the employment narrative is complicated because job creation differs by sector, quality and productivity. These sources suggest that employment analysis must go beyond aggregate job numbers to examine employability, skills

utilisation, job quality and workforce productivity (Fox, 2021; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018).

In Ghana, the HR dimension is especially important because skills, education, location, gender, and sectoral opportunities influence labour-market participation and employment choice (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Amankwah et al., 2024). Manufacturing development may generate employment only when the workforce has relevant technical and vocational skills (Abreha et al., 2021; Dinh, 2023; Teal, 2023). Trade openness may generate employment only when firms have workers capable of supporting export competitiveness, compliance and supply-chain integration (African Union, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). Capital formation may generate employment only when labour can complement new investment and technology (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Amankwah et al., 2024). Therefore, the HR dimension strengthens the macroeconomic analysis by showing that employment creation depends on both labour demand and workforce readiness.

2.2.6. Macroeconomic instability, private-sector constraints and employment

Macroeconomic instability can weaken employment creation by reducing investment, increasing production costs and limiting firm expansion. Saani et al. (2024) examine inflation, public debt and unemployment in Ghana and show that macroeconomic variables are relevant to unemployment outcomes. World Bank (2024a) discusses Ghana's private-sector constraints, while World Bank (2025) highlights labour-market challenges and opportunities in Ghana's economic landscape. These sources suggest that employment creation depends not only on manufacturing, trade and investment, but also on a stable macroeconomic environment that supports private-sector growth (Saani et al., 2024; Amankwah et al., 2024; World Bank, 2025).

From the HR perspective, macroeconomic instability affects recruitment, job security, wages, training budgets and workforce retention (International Labour Organisation, 2024; 2025; Abdychev et al., 2018). High inflation can reduce real wages and increase firm costs, while public debt pressures can reduce fiscal space for infrastructure, education and employment programmes (Saani et al., 2024; World Bank, 2025). Private-sector constraints may also limit firm-level job creation even as trade openness and capital formation increase (Amankwah et al., 2024). Therefore, Ghana's employment outcomes must be interpreted within the broader macroeconomic environment (Ghana Statistical Service, 2023; 2024; 2025; Saani et al., 2024; Amankwah et al., 2024; World Bank, 2025).

2.2.7. Environmental and structural control variables in employment modelling

Recent macroeconomic literature increasingly considers environmental and structural control variables because industrialisation, trade openness and employment are linked to energy use, emissions and sustainability. Udeagha and Breitenbach (2023) examine the asymmetric effects of trade openness on CO_2 emissions in SADC using a nonlinear ARDL approach. Friedlingstein et al. (2025) provide evidence on the global carbon budget, while the World Bank (2024c) provides the World Development Indicators, widely used in macroeconomic modelling. These sources are relevant because manufacturing development and trade openness may influence both employment and environmental quality (Udeagha and Breitenbach, 2023; Friedlingstein et al., 2025; World Bank, 2024c).

Although environmental quality is not the core dependent variable in this study, including structural controls can reduce omitted-variable bias in employment modelling. For example, CO_2 emissions may proxy industrial activity, energy intensity or production expansion in some macroeconomic models (Udeagha and Breitenbach, 2023; Friedlingstein et al., 2025; World Bank, 2024c). From the HR perspective, sustainable employment should also consider the quality and long-term viability of work, especially where manufacturing and industrial expansion are linked to environmental risks (International Labour Organisation, 2024; 2025; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024). Therefore, environmental and structural indicators may support a broader interpretation of employment dynamics, industrialisation and sustainable labour-market transformation.

2.2.8. Methodological evidence in applied macroeconomic employment studies

The empirical literature on employment determinants commonly relies on time-series techniques because labour-market outcomes respond dynamically to changes in production, trade, capital formation and macroeconomic conditions. Akaike (1974) provides the information criterion for model selection, while Dickey and Fuller (1979) establish the foundation for unit-root testing. Kwiatkowski et al. (1992) provide an alternative stationarity testing approach, and Brown et al. (1975) provide techniques for testing the constancy of regression relationships. Pesaran et al. (2001) provide the ARDL bounds testing approach for examining level relationships, while Granger (1969) and Toda and Yamamoto (1995) provide foundations for causality analysis. Feenstra et al. (2015) also provide a basis for using Penn World Table data in macroeconomic analysis.

These methodological sources are relevant because employment may respond to manufacturing development, trade openness, and capital formation in both the short and long run (Akaike, 1974; Dickey and Fuller, 1979; Pesaran et al., 2001; Toda and Yamamoto, 1995). Manufacturing value added may influence employment gradually because firms need time to expand production and hire workers (Edeme et al., 2020; Habanabakize and Mncayi, 2022; Teal, 2023). Trade openness may influence employment through delayed export, import and competitiveness channels (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026). Capital formation may also influence employment with lags because investment takes time to become productive (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020). Therefore, a dynamic time-series framework is suitable for analysing the determinants of Ghana's employment.

From an HR perspective, the methodological approach should not only report coefficients but also interpret the results in terms of labour absorption, skills demand, workforce planning, and employment quality (International Labour Organisation, 2020; 2024; 2025; Amankwah et al., 2024; World Bank, 2025). A positive long-run effect of manufacturing value added may suggest stronger industrial labour absorption (Kaldor, 1966; Teal, 2023). A negative or insignificant trade openness effect may suggest import competition, weak export capacity or limited firm competitiveness (Gonese et al., 2023; Saani et al., 2026; World Bank, 2020). A weak capital formation effect may suggest capital-intensive investment or skills mismatch (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Abdychev et al., 2018). Therefore, the econometric method must be connected to HR interpretation and policy implications.

2.2.9. Synthesis of Empirical Literature and Research Gap

The empirical literature shows that Ghana's employment outcomes are being shaped by labour-market characteristics, macroeconomic instability, manufacturing development, trade openness, capital formation, private-sector constraints and workforce capability (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Ghana Statistical Service, 2023, 2024; 2025; Saani et al., 2024; 2026; Teal, 2023; World Bank, 2021; 2024; 2025). African and regional studies also show that manufacturing value added, infrastructure, exports, foreign direct investment, trade openness, investment and gross capital formation influence employment and unemployment outcomes (Abreha et al., 2021; Edeme et al., 2020; Gonese et al., 2023; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Osuma and Nzimande, 2024; Pasara and Garidzirai, 2020). Policy reports further show that Africa's employment challenge is connected to youth employment, decent work, industrial transformation, trade integration, private-sector development and future-of-work transitions (African Development Bank, 2024; 2025; African Union, 2024; Fox, 2021; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020; 2021; 2024; 2025).

Despite these contributions, three important gaps remain. First, Ghana-specific studies still do not sufficiently integrate manufacturing development, trade openness, and capital formation into a single dynamic employment model (Adinkra-Darko and Ahiakpor, 2024; Saani et al., 2024; 2026; Teal, 2023; Amankwah et al., 2024; World Bank, 2025). Second, many macroeconomic studies treat employment as an aggregate outcome and pay insufficient attention to HR-related issues such as employability, labour absorption, skills mismatch, workforce readiness, and employment quality (International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Fox, 2021; Amankwah et al., 2024). Third, the existing literature does not adequately explain whether Ghana's manufacturing development, trade openness and capital formation are jointly creating employment or whether Ghana is experiencing growth that is not sufficiently labour-absorbing (Abreha et al., 2021; Gonese et al., 2023; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2026; Teal, 2023; World Bank, 2025).

This study addresses these gaps by examining labour market dynamics and employment determinants in Ghana through an integrated HR and applied macroeconomic lens. The study argues that employment is not only a macroeconomic outcome but also a human resource outcome, as it reflects the economy's capacity to absorb labour, utilise skills, improve productivity, and create decent work (International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Amankwah et al., 2024; World Bank, 2025). Manufacturing development, trade openness and capital formation are therefore expected to influence employment, but their effects depend on industrial capacity, firm competitiveness, investment quality, labour-market matching and workforce capability (Kaldor, 1966; Lucas, 1988; Mortensen and Pissarides, 1994; Romer, 1986; Solow, 1956; Abreha et al., 2021; Saani et al., 2026; Teal, 2023). This integrated approach strengthens the paper's contribution to both HR scholarship and applied macroeconomic employment research.

3. METHODOLOGY

This study adopts a quantitative, *ex post* facto design using historical macroeconomic time-series data to examine the relationships among employment, manufacturing development, trade openness, and capital formation in Ghana. The design is appropriate because the variables are observed rather than manipulated and the analysis focuses on dynamic associations, long-run relationships, and causal patterns.

The study integrates applied macroeconomics and human resource development. Employment is treated as a labour-market outcome influenced by productive-sector development, openness, and investment accumulation (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2024; 2026; Teal, 2023), while also reflecting labour absorption, skills utilisation, workforce participation, and productive engagement (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; International Labour Organisation, 2020; 2024; 2025; Amankwah et al., 2024; World Bank, 2025).

Accordingly, the empirical analysis estimates the effects of manufacturing value added, trade openness, and capital formation on employment. At the same time, the HR interpretation considers implications for employability, labour absorption, decent work, skills demand, workforce development, and structural labour-market transformation (Fox, 2021; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Amankwah et al., 2024; World Bank, 2025).

3.1. Research Design

The study uses a time-series research design because the main objective is to examine how Ghana's employment dynamics are shaped by manufacturing development, trade openness, and capital formation over time. This design suits applied macroeconomic employment studies because labour-market outcomes usually respond to changes in output, investment, and openness with both contemporaneous and lagged effects (Akaike, 1974; Granger, 1969; Pesaran et al., 2001; Toda and Yamamoto, 1995). The study also uses an explanatory design because it tests whether

variations in manufacturing value added, trade openness, and capital formation explain variations in employment. This is consistent with previous employment and macroeconomic studies that investigate the effects of manufacturing output, trade openness, investment, inflation, debt and growth-related variables on labour-market outcomes (Edeme et al., 2020; Gonese et al., 2023; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2024; 2026).

3.2. Data Sources and Period of Study

The study uses annual time-series data for Ghana from 1970 to 2023, subject to data availability. This period captures Ghana's long-run labour-market dynamics across different phases of economic restructuring, trade liberalisation, industrial policy adjustment, private-sector development, and capital accumulation. A long annual series also provides sufficient observations for unit-root testing, lag selection, cointegration analysis, error-correction estimation, and causality testing (Akaike, 1974; Dickey and Fuller, 1979; Kwiatkowski et al., 1992; Pesaran et al., 2001; Toda and Yamamoto, 1995).

The data are obtained from reputable international and national sources. Employment, manufacturing value added, trade openness and CO_2 emissions are sourced from the World Development Indicators of the World Bank (World Bank, 2024c). Capital formation or capital stock is obtained from the Penn World Table, where appropriate, because it provides internationally comparable macroeconomic indicators for capital, productivity, and national accounts analysis (Feenstra et al., 2015). Ghana Statistical Service labour reports also support contextual interpretation of employment, unemployment, underemployment, and labour-force participation in Ghana (Ghana Statistical Service, 2023; 2024; 2025).

Official secondary data are appropriate because the study focuses on macro-level relationships rather than individual respondent behaviour. This also aligns with recent Ghana and African employment-related studies that use macroeconomic and labour-market data to examine unemployment, growth, trade, investment, and productive-sector dynamics (Saani et al., 2024; 2026; World Bank, 2021; 2024; 2025).

3.3. Variable Description and Measurement

Table 1 presents the data and sources.

3.3.1. Employment

The dependent variable is employment. Employment captures labour-market absorption and reflects the extent to which the Ghanaian economy is creating work opportunities for the labour force. In the HR interpretation, employment is not merely indicating the number of workers engaged in production; it is also reflecting the economy's ability to utilise human capital, improve labour participation and support productive work (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; International Labour Organisation, 2020; 2024; 2025; World Bank, 2024a; 2025). Employment is transformed to the natural logarithm and represented as lnEMP.

3.3.2. Manufacturing development

The first explanatory variable is manufacturing development, measured by manufacturing value added. Manufacturing value added captures manufacturing's contribution to total output and reflects the industrial sector's productive capacity. Manufacturing is included because the literature treats industrialisation as a major channel through which developing economies create jobs, improve productivity and support structural transformation (Abreha et al., 2021; Dinh, 2023; Edeme et al., 2020; Habanabakize and Mncayi, 2022; Teal, 2023; United Nations Industrial Development Organisation, 2023, 2024). Manufacturing value added is expected to positively affect employment because expansion in manufacturing output should increase labour demand, especially where industrial production is labour-absorbing. It is transformed into natural logarithm form and represented as ln(MVA).

3.3.3. Trade openness

The second explanatory variable is trade openness. Trade openness captures Ghana's degree of integration into the global economy and is usually measured as the sum of exports and imports as a percentage of GDP. Trade openness is included because it can influence employment through export expansion, import competition, technology transfer, market access and participation in global and regional value chains (African Union, 2024; Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). The expected effect of trade openness is ambiguous. It may increase employment if openness supports exports, manufacturing competitiveness and domestic production. However, it may reduce employment if import competition weakens local firms and limits labour demand (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026). Trade openness is transformed to the natural logarithm and represented as lnTRD.

Table 1: Variable description, measurement and expected signs

Variable	Symbol	Measurement	Expected sign	Data source
Employment	lnEMP	Total employment/labour-market indicator (log)	DV	WDI; Ghana Statistical Service
Manufacturing development	lnMVA	Manufacturing value added (log)	+	WDI; United Nations Industrial Development Organisation
Trade openness	lnTRD	Exports+imports as % of GDP (log).	+/–	WDI
Capital formation	lnK	Gross capital formation/fixed capital formation/ capital stock (log).	+	WDI; PWT
CO_2 emissions	lnCO_2	CO_2 emissions (log).	+/–	WDI; Global Carbon Project
Dependent variable	Employment (lnEMP)			
Independent variables	Manufacturing development, Capital formation, Trade openness, CO_2 emissions			

3.3.4. Capital formation

The third explanatory variable is capital formation. Capital formation captures investment in productive assets such as machinery, infrastructure, buildings and equipment. It is included because investment expands productive capacity and can influence labour demand (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2026). Capital formation is expected to positively affect employment if investment complements labour and expands productive activity. However, the effect may be weak or negative if investment is capital-intensive and substitutes labour through mechanisation or automation (Fox, 2021; Abdychev et al., 2018; World Bank, 2024a; 2025). Capital formation is transformed into natural logarithm form and represented as lnK.

3.3.5. CO_2 emissions as control variable

The study includes CO_2 emissions as a structural control variable. CO_2 emissions are used because industrialisation, manufacturing expansion, trade openness and capital accumulation may be associated with energy use and production intensity (Friedlingstein et al., 2025; Udeagha and Breitenbach, 2023; World Bank, 2024c). Including CO_2 emissions helps control for the environmental and industrial-intensity dimension of Ghana's production structure. It also allows the study to account for the possibility that employment dynamics are connected to broader industrial and energy-use patterns (Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; Udeagha and Breitenbach, 2023). CO_2 emissions are transformed into natural logarithms and represented as $lnCO_2$.

3.4. Model Specification

The empirical model examines the effect of manufacturing development, trade openness, and capital formation on employment in Ghana. Following the applied macroeconomic literature on employment, production and investment dynamics, employment is modelled as a function of manufacturing value added, trade openness, capital formation and a structural control variable (Edeme et al., 2020; Gonese et al., 2023; Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Saani et al., 2024; 2026).

The functional form of the model is expressed as in equation (1):

$$EMP_t = f(MVA_t, TRD_t, K_t, CO2_t) \quad (1)$$

where EMPt represents employment, MVAt represents manufacturing value added, TRDt represents trade openness, Kt represents capital formation, and CO_2t represents CO_2 emissions.

To reduce scale differences, minimise heteroscedasticity and allow coefficients to be interpreted as elasticities, the variables are transformed into natural logarithms. The log-linear model is specified as in equation (2):

$$lnEMP_t = \beta 0 + \beta_1 lnMVA_t + \beta_2 lnTRD_t + \beta_3 lnK_t + \beta_4 lnCO2_t + \varepsilon_t \quad (2)$$

where β_0 is the intercept, β_1, β_2, β_3 and β_4 are the elasticity coefficients, and ε_t is the stochastic error term.

The expected signs are as follows:

$$\beta_1 > 0, \beta_2 \gtrless 0, \beta 3 > 0, \beta 4 \gtrless 0$$

Manufacturing value added is expected to increase employment because industrial expansion should stimulate labour demand (Abreha et al., 2021; Edeme et al., 2020; Habanabakize and Mncayi, 2022; Teal, 2023). Trade openness has an ambiguous expected sign because it may support employment through exports and competitiveness or reduce employment through import competition (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026). Capital formation is expected to increase employment where investment complements labour and expands productive capacity (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020). CO_2 emissions may have either a positive or negative sign, depending on whether they reflect industrial expansion or environmentally costly production that does not necessarily create employment (Friedlingstein et al., 2025; Udeagha and Breitenbach, 2023).

3.5. Estimation Procedure

The study follows a systematic time-series estimation procedure. First, the study conducts descriptive statistical analysis to examine the mean, standard deviation, minimum, maximum, skewness and kurtosis of the variables. This provides preliminary information on the distributional characteristics of employment, manufacturing development, trade openness, capital formation and CO_2 emissions. Descriptive analysis is important because it helps identify data behaviour, volatility and possible outliers before formal econometric estimation.

Second, the study conducts a correlation analysis to examine the preliminary association among the variables. Correlation analysis helps identify the direction and strength of the association between employment and the explanatory variables. However, correlation does not imply causality; therefore, the study proceeds to dynamic time-series estimation and causality testing (Granger, 1969; Toda and Yamamoto, 1995).

Third, the study examines variable stationarity using the Augmented Dickey-Fuller and Kwiatkowski-Phillips-Schmidt-Shin tests. The ADF test tests the null hypothesis of a unit root, while the KPSS test tests the null hypothesis of stationarity (Dickey and Fuller, 1979; Kwiatkowski et al., 1992). Using both tests improves robustness because they have different null hypotheses. This step is necessary because estimating non-stationary time-series variables without proper transformation or cointegration analysis can lead to spurious regression results.

Fourth, the study determines the optimal lag length using the Akaike Information Criterion. The AIC is appropriate because it supports selecting a model that balances goodness-of-fit with parsimony (Akaike, 1974). Appropriate lag selection is essential in dynamic models because employment may respond to manufacturing value added, trade openness and capital formation with time lags. Firms may not immediately adjust employment following changes in output, trade exposure or investment, making

lag structure important for capturing dynamic labour-market responses (Habanabakize and Mncayi, 2022; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020).

Fifth, the study applies the Autoregressive Distributed Lag bounds testing approach to examine whether a long-run relationship exists among the variables. The ARDL approach is appropriate when the variables are integrated of order zero (I[0]) and order one (I[1]), but not of order two (I[2] (Pesaran et al., 2001). The ARDL method is also suitable for small-sample time-series studies and allows the simultaneous estimation of short-run and long-run relationships. This matters for Ghana because employment may respond differently to manufacturing development, trade openness, and capital formation in the short run and long run (Saani et al., 2024; 2026).

The unrestricted error correction representation of the ARDL model is specified as in equation (3):

$$\Delta lnEMP_t = \alpha_0 + \Sigma\alpha_1 \Delta lnEMP_{t-i} + \Sigma\alpha_2 \Delta lnMVA_{t-i} + \Sigma\alpha_3 \Delta lnTRD_{t-i} + \Sigma\alpha_4 \Delta lnK_{t-i} + \Sigma\alpha_5 \Delta lnCO2_{t-i} + \lambda_1 lnEMP_{t-1} + \lambda_2 lnMVA_{t-1} + \lambda_3 lnTRD_{t-1} + \lambda_4 lnK_{t-1} + \lambda_5 lnCO2_{t-1} + \mu_t \quad (3)$$

Where Δ is the first-difference operator; the summation terms capture short-run dynamics; the lagged level terms capture the long-run relationship; and μt is the white-noise error term.

The null hypothesis for the bounds test is that there is no long-run relationship among the variables:

$$H0: \lambda 1 = \lambda 2 = \lambda 3 = \lambda 4 = \lambda 5 = 0$$

The alternative hypothesis is that a long-run relationship exists:

$$H1: \lambda 1 \neq \lambda 2 \neq \lambda 3 \neq \lambda 4 \neq \lambda 5 \neq 0$$

If the computed F-statistic exceeds the upper-bound critical value, the null hypothesis of no cointegration is rejected. If it falls below the lower bound of the critical value, the null hypothesis is not rejected. If it falls between the lower and upper bounds, the result is inconclusive (Pesaran et al., 2001).

3.6. Error Correction Model

When cointegration is established, the study estimates an error-correction model to capture short-run dynamics and the speed of adjustment to long-run equilibrium. The error correction model is specified as in equation (4):

$$\Delta lnEMP_t = \alpha_0 + \Sigma\alpha_1 \Delta lnEMP_t i + \Sigma\alpha_2 \Delta lnMVA_{t-i} + \Sigma\alpha_3 \Delta lnTRD_{t-i} + \Sigma\alpha_4 \Delta lnK_{t-i} + \Sigma\alpha_5 \Delta lnCO2_{t-i} + \varphi ECT_{t-1} + \mu_t \quad (4)$$

Where ECTt−1 is the lagged error correction term and φ measures the speed of adjustment. The error correction term coefficient is expected to be negative and statistically significant. A negative and significant ECTt−1 indicates that deviations from the long-run employment equilibrium are corrected over time (Pesaran et al., 2001). From an HR perspective, the speed of adjustment indicates how quickly Ghana's labour market responds to changes in manufacturing development, trade openness, and capital formation. A slow adjustment process may indicate labour-market rigidities, skills mismatch, weak firm expansion or delayed workforce absorption (Adinkra-Darko and Ahiakpor, 2024; International Labour Organisation, 2024; 2025; Amankwah et al., 2024; World Bank, 2025).

3.7. Causality Analysis

After estimating the long- and short-run relationships, the study conducts a causality analysis to examine the direction of influence among employment, manufacturing development, trade openness, capital formation, and CO_2 emissions. Causality analysis matters because cointegration or association does not necessarily indicate the direction of influence (Granger, 1969; Toda and Yamamoto, 1995). The study therefore applies the Toda-Yamamoto causality approach because it allows for causality testing in a vector autoregressive framework even when variables have different integration orders, provided that the maximum integration order is correctly identified (Toda and Yamamoto, 1995).

The Toda-Yamamoto procedure estimates an augmented VAR model with k + dmax lags, where k is the optimal lag length selected by information criteria, and dmax is the maximum order of integration among the variables. The model is then tested using modified Wald statistics. This approach is suitable because it reduces the risk of pre-test bias related to cointegration and stationarity (Toda and Yamamoto, 1995).

The causality analysis is especially useful for policy interpretation. If manufacturing value added causes employment, industrial policy can be justified as an employment strategy. If trade openness causes employment, trade policy can be interpreted as a labour-market instrument. If capital formation causes employment, investment policy can be positioned as a job-creation strategy. Conversely, if employment drives manufacturing development, trade openness, or capital formation, the findings may suggest that labour-market capacity and workforce participation also influence Ghana's productive transformation.

3.8. Diagnostic and Stability Tests

The reliability of the estimated model is assessed using diagnostic and stability tests. Serial correlation is tested to determine whether the residuals are correlated over time. The Breusch-Godfrey (Breusch, 1978; Breusch and Pagan, 1979; Godfrey, 1978) serial correlation LM test is used for this purpose. Heteroscedasticity is tested to determine whether the error variance is constant. The Breusch-Pagan-Godfrey (Breusch, 1978; Breusch and Pagan, 1979; Godfrey, 1978) or White heteroscedasticity test (White, 1980) may be used depending on the estimation output. Normality is assessed using the Jarque-Bera test, while model specification is examined using the Ramsey RESET test (Ramsey, 1969). These diagnostic tests are important because violations of classical regression assumptions can weaken the reliability of parameter estimates and statistical inference. The study also tests parameter stability using the cumulative sum and cumulative sum of squares tests. These tests, based on Brown et al. (1975), help assess whether the estimated parameters remain stable over the study period. Stability testing is necessary because Ghana's economy has

experienced policy reforms, trade liberalisation, macroeconomic instability, structural adjustment and industrial policy changes over time. If the model is stable, the estimated relationships can be considered reliable for interpretation and policy analysis (Brown et al., 1975).

3.9. Robustness Checks

To improve the reliability of the findings, the study conducts robustness checks. First, the study considers alternative lag structures using the Akaike Information Criterion and other information criteria, as appropriate (Akaike, 1974). Second, the study compares ADF and KPSS unit-root outcomes to ensure the variables' integration properties are not misclassified (Dickey and Fuller, 1979; Kwiatkowski et al., 1992). Third, the causality results from the Toda-Yamamoto approach complement the ARDL results and provide additional evidence on the direction of relationships (Granger, 1969; Toda and Yamamoto, 1995). Fourth, where necessary, we may consider alternative proxies for employment, capital formation, or industrial activity, depending on data availability from the World Development Indicators and the Penn World Table (Feenstra et al., 2015; World Bank, 2024c). These robustness checks strengthen the validity of the findings and support the credibility of the study's conclusions. They also improve the paper's suitability for high-quality applied macroeconomic publication because robust time-series research requires careful attention to stationarity, model selection, cointegration, causality and diagnostic reliability (Akaike, 1974; Brown et al., 1975; Dickey and Fuller, 1979; Kwiatkowski et al., 1992; Pesaran et al., 2001; Toda and Yamamoto, 1995).

3.10. Ethical Considerations

The study uses secondary annual macroeconomic data from publicly available, reputable sources such as the World Bank, the Penn World Table, and the Ghana Statistical Service. Since the study does not involve human respondents, interviews, surveys or personal-level data, there are no direct risks to individual participants. However, the study maintains academic integrity by accurately reporting data sources, using transparent methods and presenting findings objectively. The study also ensures that all sources are properly cited in line with APA referencing standards.

4. EMPIRICAL REVIEW

This section presents the empirical results on labour market dynamics and employment determinants in Ghana. The analysis focuses on employment, manufacturing value added, trade openness, capital formation and carbon emissions. The section reports condensed results to fit the page limit of a 20-page journal article. Move full econometric outputs to the appendix.

4.1. Descriptive Statistics

Table 2 presents the descriptive properties of the variables. The results show that the study uses 54 annual observations. Employment has a mean of 7.585, while manufacturing value added has a mean of 9.377. Trade openness averages 57.414, indicating that Ghana's economy has remained considerably exposed to external trade over the period. Capital formation records the highest dispersion, with a standard deviation of 130,860.9, suggesting strong variation in investment accumulation. Trade openness also records substantial variation, confirming Ghana's changing degree of external-sector integration.

The Jarque-Bera (Jarque and Bera, 1980) statistics indicate that employment and trade openness are approximately normally distributed, whereas manufacturing value added, carbon emissions, and capital formation deviate from normality. This is expected in long-run macroeconomic series because structural reforms, trade liberalisation, industrial changes and investment cycles often generate non-normal data patterns.

The trend plots (Figures A1-A5, in Appendix A) show that employment and capital formation generally rise over time, while trade openness fluctuates substantially. The movement in trade openness reflects Ghana's exposure to external trade shocks, liberalisation episodes and changing import-export conditions. Manufacturing value added also shows long-run movement, but its employment effect requires formal econometric testing.

4.2. Unit-Root Test Results

Table 3 presents the Augmented Dickey-Fuller unit-root results. The results show mixed integration properties. Manufacturing value added is stationary at level when the model includes a constant. Employment, carbon emissions, trade openness and capital formation are non-stationary at the level but become stationary after first differencing. Since none of the variables is integrated of order two, the ARDL bounds-testing approach is appropriate.

The mixed order of integration supports ARDL because the method accommodates variables integrated at levels and in first differences, provided none is I(2). This aligns with applied macroeconomic practice in employment, trade, and investment studies.

4.3. Correlation Analysis

Table 4 reports the correlations between employment and the explanatory variables. Employment is strongly correlated with capital formation and carbon emissions, moderately correlated with trade openness and weakly correlated with manufacturing value added.

The weak correlation between employment and manufacturing value added suggests that manufacturing expansion has not

Table 2: Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum	JB probability
MVA	9.377	2.043	3.606	13.950	0.049
EMP	7.585	3.138	3.023	13.221	0.113
CO_2	0.351	0.168	0.133	0.769	0.011
TRD	57.414	27.132	6.320	116.048	0.548
K	234,471.8	130,860.9	128,487.4	595,565.1	0.000

Source: Authors' computation. MVA: Manufacturing value added, EMP: Employment, CO_2: Carbon emissions, TRD: Trade openness, K: Capital formation, JB: Jarque-Bera

Table 3: ADF unit-root test results

Variable	Level ADF statistic	Level P-value	First-difference ADF statistic	First-difference P-value	Decision
MVA	−3.263	0.017	−6.394	0.000	I (0)/I (1)
EMP	0.439	0.985	−5.100	0.000	I (1)
CO_2	0.934	0.996	−6.426	0.000	I (1)
TRD	−1.413	0.578	−6.632	0.000	I (1)
K	3.969	1.000	−5.571	0.000	I (1)

Source: Authors' computation. The table reports ADF results with an intercept. The results confirm that the variables are a mixture of I (0) and I (1), supporting the ARDL procedure of Pesaran et al. (2001)

Table 4: Correlation between employment and explanatory variables

Variable paired with employment	Correlation coefficient
MVA	0.042
CO_2	0.895
TRD	0.586
K	0.922

Source: Authors' computation

Table 5: ARDL model selection and bounds test

Item	Result
Selected model	ARDL (2,1,0,2,1)
Included observations	52
Model selection criterion	AIC
Number of models evaluated	162
R-squared	0.9979
Adjusted R-squared	0.9974
F-statistic	1995.385
Prob. F-statistic	0.000
Durbin-Watson statistic	1.917
Bounds-test F-statistic	5.877
5% lower bound, I (0)	2.823
5% upper bound, I (1)	3.872
Decision	Cointegration confirmed

Source: Authors' computation

automatically moved together with employment growth. This preliminary evidence already questions the assumption that manufacturing development is strongly labour-absorbing in Ghana. The strong correlation between employment and capital formation suggests that investment accumulation is associated with employment movements, although correlation does not establish causality.

4.4. ARDL Model Selection and Bounds Test

The Akaike Information Criterion selects ARDL (2,1,0,2,1) as the preferred model. This means employment enters the model with two lags, manufacturing value added with one lag, carbon emissions with no lag, trade openness with two lags and capital formation with one lag. The model is estimated with a restricted constant and no trend. The results are shown in Table 5.

The bounds-test F-statistic of 5.877 exceeds the 5% upper-bound critical value of 3.872. The null hypothesis of no long-run relationship is therefore rejected. This confirms that employment, manufacturing value added, carbon emissions, trade openness and capital formation move together in the long run. The result supports the view that Ghana's employment path is structurally linked to production, trade and investment conditions.

4.5. Long-Run Estimates

Table 6 presents the conditional level coefficients and the implied normalised long-run elasticities. The implied long-run elasticities are obtained by normalising the level coefficients with respect to the coefficient on lagged employment.

The results show that manufacturing value added has a negative and statistically significant long-run relationship with employment. This implies that Ghana's manufacturing development has not been sufficiently labour-absorbing over the study period. Instead of generating broad employment gains, manufacturing expansion may reflect productivity improvements, mechanisation, concentration among larger firms, or weak labour-intensive value-chain linkages. This finding is important because it challenges the conventional Kaldorian expectation that manufacturing automatically serves as an employment engine.

Trade openness has a positive but weakly significant long-run elasticity. This suggests that openness may support employment through market access, imported inputs, export opportunities and value-chain participation, but the effect remains weak. This implies that Ghana has not fully converted trade openness into strong employment creation. This result is consistent with the argument that openness generates employment only when domestic firms are competitive and can participate meaningfully in regional and global value chains.

Capital formation has a positive but insignificant long-run effect. This suggests that investment accumulation is not independently associated with strong employment gains after controlling for manufacturing, trade openness, and emissions. The result may reflect capital-intensive investment, delayed employment effects or weak linkage between investment and labour-absorbing sectors. Carbon emissions also have an insignificant effect, suggesting that employment is not directly driven by emissions-intensive production after controlling for the main structural variables.

Table 7 reports the error correction results. The error-correction term is negative and statistically significant, confirming an adjustment towards the long-run equilibrium.

The error-correction term coefficient is −0.0691 and is significant at the 1% level. This means that approximately 6.9% of the employment disequilibrium is corrected each year. The adjustment speed is slow, suggesting that Ghana's labour market responds gradually to shocks in manufacturing development, trade openness and capital formation. The lagged change in employment is positive and significant, indicating employment persistence. The

Table 6: Conditional long-run employment relationship

Variable	Conditional level coefficient	P-value	Implied long-run elasticity	Interpretation
LMVA	−0.0348	0.0209	−0.504	Significant negative effect
LCO_2	−0.0130	0.7007	−0.188	Insignificant negative effect
LTRD	0.0160	0.1001	0.231	Positive, weakly significant effect
LK	0.0550	0.2107	0.796	Positive, insignificant effect

Source: Authors' computation. The implied long-run elasticity is computed by normalising each level coefficient on the lagged employment coefficient. Significance is inferred from the conditional-level estimates

Table 7: Short-run ECM results

Variable	Coefficient	Standard error	t-statistic	P-value
COINTEQ(−1)	−0.0691	0.0110	−6.290	0.000
D (LEMP[−1])	0.2279	0.1078	2.113	0.040
D (LMVA)	0.0050	0.0171	0.292	0.772
D (LTRD)	−0.0068	0.0128	−0.531	0.598
D (LTRD[−1])	0.0300	0.0142	2.113	0.040
D (LK)	−0.1193	0.0639	−1.867	0.068

Source: Authors' computation

lagged change in trade openness is also positive and significant, suggesting that trade openness supports employment with a delayed effect. This suggests firms may need time to respond to trade opportunities, imported inputs, export demand, and market expansion. Manufacturing value added has no significant short-run effect, reinforcing the finding that manufacturing expansion does not immediately translate into employment growth. Capital formation has a negative, marginally significant short-run effect, suggesting that investment may initially be capital-intensive or disruptive before employment benefits emerge.

4.6. Diagnostic and stability tests

Table 8 presents the diagnostic tests. The results confirm that the estimated ARDL model satisfies the major post-estimation requirements.

The diagnostic results show that the model does not suffer from serial correlation, heteroscedasticity, non-normal residuals or functional-form misspecification. The Durbin-Watson statistic of 1.917 also supports the absence of serious autocorrelation (Durbin and Watson, 1950, 1951). These results strengthen confidence in the ARDL estimates.

The CUSUM statistic (Figure 1) rises through much of the 1990s and 2000s, then declines toward the end of the sample. The CUSUM of squares (Figure 2) approaches its lower critical bound in the late 2010s before turning upward again. Overall, both statistics remain within their 5% critical bounds throughout the plotted period, so neither test rejects the stability of the estimated equation.

4.7. VAR Estimates and Dynamic Linkages

Table 9 condenses the key employment-equation results from the VAR model. The results show that employment is strongly persistent, while manufacturing value added and trade openness are dynamically relevant to employment.

The VAR evidence confirms that employment is path-dependent. The significant positive coefficient for LEMP(−1) indicates that previous employment strongly influences current employment. The first lag of manufacturing value added has a significant negative

Table 8: Diagnostic and stability tests

Test	Statistic	P-value	Decision
Breusch-Godfrey LM test	F=0.503	0.608	No serial correlation
Breusch-Godfrey Chi-square	1.308	0.520	No serial correlation
Breusch-Pagan-Godfrey test	F=1.636	0.131	No heteroscedasticity
Breusch-Pagan Chi-square	14.831	0.138	No heteroscedasticity
Jarque-Bera normality test	3.637	0.162	Residuals are normal
Ramsey RESET test	F=0.341	0.563	Model correctly specified

Source: Authors' computation

Table 9: Condensed VAR employment equation

Variable	Coefficient	t-statistic	Interpretation
LEMP(−1)	1.1125	7.504	Strong positive employment persistence
LEMP(−2)	−0.2049	−1.473	Insignificant lagged adjustment
LMVA(−1)	−0.0455	−2.454	Significant negative manufacturing effect
LMVA(−2)	0.0125	0.626	Insignificant effect
LCO_2(−1)	−0.0328	−0.801	Insignificant effect
LCO_2(−2)	−0.0068	−0.216	Insignificant effect
LTRD(−1)	0.0385	2.391	Significant positive trade effect
LTRD(−2)	−0.0187	−0.967	Insignificant effect
LK(−1)	−0.0270	−0.307	Insignificant effect
LK(−2)	0.1225	1.231	Insignificant effect

Source: Authors' computation

effect on employment, which supports the ARDL evidence that Ghana's manufacturing development has not been strongly labour-absorbing. The first lag of trade openness has a significant positive effect on employment, confirming that external-sector integration contributes to employment dynamics with a delay.

Figure 3 traces the VAR responses to shocks in employment, manufacturing value added, carbon emissions, trade openness and capital formation over ten periods. Employment responds modestly to most shocks, whereas manufacturing value added exhibits larger initial adjustments that decay gradually. Several estimated responses persist across periods, indicating differing speeds of adjustment. The 95% confidence intervals contain zero at many horizons, constraining the statistical evidence for shock transmission at those horizons.

4.8. Variance Decomposition of Employment

Table 10 presents the condensed variance decomposition of employment. The table reports selected periods to save space.

The variance decomposition shows that employment shocks initially explain all variation in employment. However, over time, employment's own explanatory power declines from 100% in period 1-58.078% in period 10. Manufacturing value added becomes the second most important source of employment variation, explaining 20.415% by period 10. Carbon emissions account for 17.651%, while trade openness and capital formation account for 3.130% and 0.727%, respectively. This result indicates that employment dynamics are persistent but increasingly shaped by structural variables. Manufacturing value added matters for employment variation over time, although its coefficient effect is negative. Capital formation contributes very little to employment variation, suggesting that Ghana's investment accumulation has not been a dominant source of employment fluctuations.

Figure 1: CUSUM plots

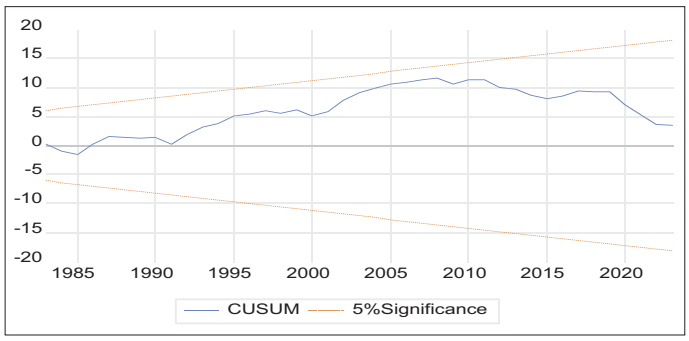


Figure 2: CUSUMSQ stability plots

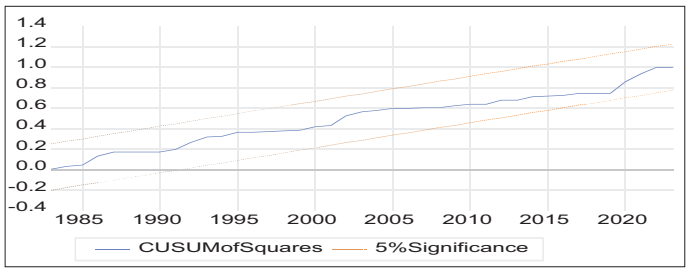


Table 10: Variance decomposition of employment

Period	LEMP	LMVA	LCO_2	LTRD	LK
1	100.000	0.000	0.000	0.000	0.000
5	63.825	16.241	15.490	4.364	0.080
10	58.078	20.415	17.651	3.130	0.727

Source: Authors' computation

4.9. VAR block exogeneity results

Table 11 reports the results for the condensed VAR block exogeneity. The table focuses on the most relevant causal pathways for employment and structural interpretation.

The results show that manufacturing value added and trade openness significantly Granger-cause employment. This confirms that employment in Ghana is dynamically linked to production structure and external-sector integration. Trade openness also causes manufacturing value added, suggesting that trade conditions partly shape Ghana's manufacturing performance. Capital formation does not significantly affect employment, which reinforces the ARDL finding that investment accumulation is not independently associated with strong employment effects. The results also show that employment, trade openness and capital formation cause carbon emissions. This suggests that labour-market activity, trade integration and investment accumulation are connected to environmental and production intensity. The other variables do not significantly explain trade openness, suggesting that Ghana's trade exposure may be driven more by external conditions, policy choices, and structural openness than by domestic employment or investment dynamics.

4.10. Summary of Empirical Results

The empirical evidence confirms a long-run relationship among employment, manufacturing value added, trade openness, capital formation and carbon emissions in Ghana. The ARDL bounds test supports cointegration, and the significant error-correction term indicates that employment adjusts towards the long-run equilibrium. However, adjustment is slow, with only 6.9% of disequilibrium corrected each year.

Manufacturing value added has a significant negative long-run and dynamic effect on employment. This indicates that Ghana's manufacturing development has not been sufficiently labour-absorbing. Trade openness shows positive employment effects, especially in the short-run lagged dynamics and VAR causality results. Capital formation has weak, mostly insignificant employment effects, suggesting that investment accumulation does not translate strongly into labour demand. The diagnostic tests confirm the model's statistical reliability. The variance

Table 11: VAR block exogeneity results

Dependent variable	Excluded variable	Chi-square	P-value	Direction
LEMP	LMVA	8.105	0.017	MVA causes employment
LEMP	LCO_2	1.347	0.510	No causality
LEMP	LTRD	11.090	0.004	Trade openness causes employment.
LEMP	LK	4.188	0.123	No causality
LEMP	All variables	19.520	0.012	Joint causality
LMVA	LTRD	15.210	0.001	Trade openness causes MVA.
LMVA	All variables	16.773	0.033	Joint causality
LCO_2	LEMP	8.005	0.018	Employment causes CO_2
LCO_2	LTRD	18.153	0.000	Trade openness causes CO_2.
LCO_2	LK	12.189	0.002	Capital formation causes CO_2
LTRD	All variables	5.537	0.699	No joint causality
LK	All variables	12.611	0.126	No joint causality

Source: Authors' computation

decomposition and block exogeneity results further show that manufacturing value added and trade openness are important structural determinants of employment dynamics in Ghana.

5. DISCUSSION OF FINDINGS

The section discusses the findings in relation to labour-market persistence, manufacturing development, trade openness, capital formation, environmental conditions, and the integrated HR–applied macroeconomic framework.

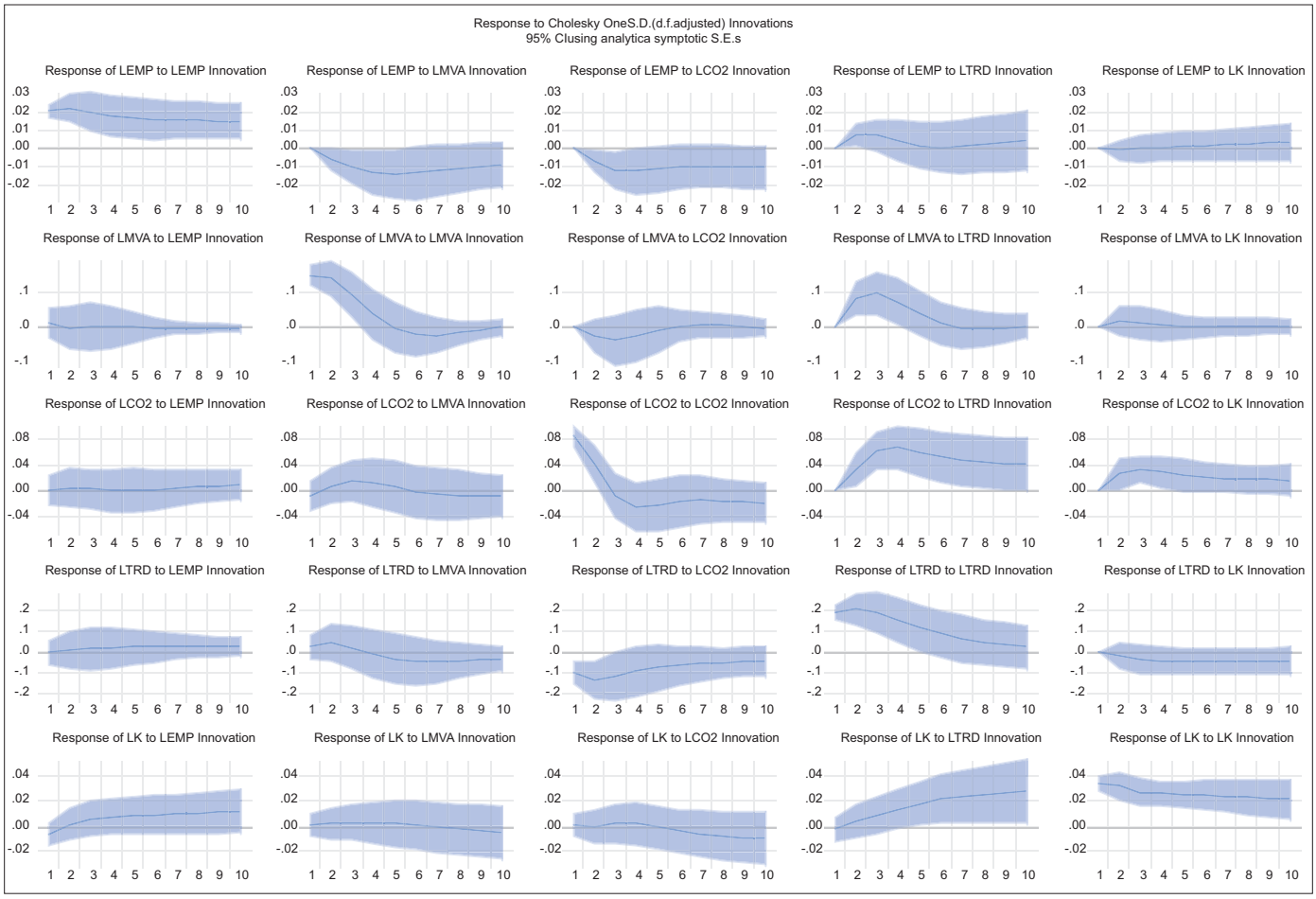
5.1. Labour-Market Dynamics and Employment Persistence

Employment in Ghana exhibits substantial persistence and adjusts slowly to structural shocks. The significant error-correction term confirms a long-run relationship among employment, manufacturing development, trade openness, capital formation, and carbon emissions. At the same time, the low adjustment speed indicates that labour-market responses to changes in production, trade, and investment are gradual. This is consistent with evidence that employment dynamics are shaped by structural frictions, job-search processes, skills mismatch, informality, regional disparities, and sectoral employment patterns (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Ghana Statistical Service, 2023; 2024; 2025; Mortensen and Pissarides, 1994; World Bank, 2024c; 2025). From an HR perspective, slow adjustment also suggests a workforce-absorption constraint. Weak labour-market information, limited technical capabilities, and firm-level hiring constraints can delay employment responses even when macroeconomic conditions improve (Fox, 2021; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; World Bank, 2024c). Ghana's employment challenge therefore concerns not only output growth but also employability, labour-market matching, technical training, and workforce planning.

5.2. Manufacturing Development and Employment Creation

The significant negative relationship between manufacturing value added and employment is the most notable result. It qualifies the traditional Kaldorian proposition that manufacturing automatically serves as an engine of employment creation (Kaldor, 1966). Although manufacturing can generate productivity gains and industrial linkages, Ghana's experience suggests that its recent expansion has not been sufficiently labour-absorbing, consistent with evidence that employment outcomes depend on firm size, capability, and the concentration of productive activity (Teal, 2023). This interpretation aligns with wider African industrialisation evidence showing that manufacturing does not necessarily generate mass employment unless firms are competitive, value chains are sufficiently developed, infrastructure is supportive, and industrial expansion is connected to domestic labour demand (Abreha et al., 2021; Dinh, 2023; Edeme et al.,

Figure 3: Impulse response functions



2020; Habanabakize and Mncayi, 2022; Ojo and Ogunleye, 2021; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; United Nations Industrial Development Organization, 2023; 2024). Productivity improvements, mechanisation, import-dependent production, and firm concentration may therefore allow manufacturing output to increase without proportionate employment growth. The result also has an HR dimension. Manufacturing increasingly requires technical, vocational, production, logistics, quality-control, and supervisory capabilities. Where such skills are scarce, output growth may not translate into stronger labour demand (International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Amankwah et al., 2024; World Bank, 2025). Industrial development should therefore be linked more closely to vocational education, apprenticeship, workplace learning, and supply-chain skills development.

5.3. Trade Openness and Employment Dynamics

Trade openness has a positive employment effect, particularly through lagged short-run dynamics and causality evidence. The delayed response is plausible because firms require time to adjust production, inputs, exports, and employment to changing external opportunities. The result is consistent with evidence that trade can promote employment through market access, technology transfer, imported intermediate inputs, and participation in regional and global value chains (African Union, 2024; Saani et al., 2026; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020).

However, the weak long-run association indicates that openness alone does not guarantee employment creation. Its effects depend on industrial competitiveness, export composition, import dependence, and macroeconomic conditions (Gonese et al., 2023; Osuma and Nzimande, 2024; Saani et al., 2026). Ghana's employment gains from trade therefore appear constrained by limited export diversification, weak domestic manufacturing capacity, and insufficient value addition. Trade integration also shifts the skills firms demand. Export-oriented and trade-exposed enterprises increasingly require capabilities in quality assurance, logistics, export documentation, digital systems, production efficiency, and supply-chain coordination (International Labour Organisation, 2024; 2025; Abdychev et al., 2018; World Bank, 2024a). Stronger employment gains from openness therefore require closer integration of trade policy with workforce development and firm-level productivity enhancement.

5.4. Capital Formation and Labour Demand

Capital formation has a positive but statistically weak long-run relationship with employment and does not emerge as a strong causal driver. This suggests that investment accumulation has not translated into labour demand sufficiently. Such an outcome is consistent with the proposition that investment generates stronger employment effects when capital complements labour, whereas capital-intensive, technology-driven, or low-labour-absorption investment may create relatively few jobs (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Solow, 1956). This result is important given Ghana's continued emphasis on investment-led private-sector and industrial development (African Development Bank, 2024; 2025; World Bank, 2021; 2024; 2025). Investment-led growth does not necessarily translate into employment-led growth when capital concentrates in infrastructure, machinery, extractive activities, or import-dependent production with limited labour intensity (Fox, 2021; Abdychev et al., 2018; World Bank, 2024a). From an HR perspective, new investment creates sustainable employment only when workforce capabilities complement new technologies and production systems (International Labour Organisation, 2020; 2024; 2025; Lucas, 1988; Romer, 1986). Investment promotion should therefore be linked to technical training, SME development, employment targets, and labour-complementing industrial activities.

5.5. Environmental and Structural Production Effects

Carbon emissions do not exert a strong direct effect on employment, although evidence on causality indicates broader interactions among employment, trade openness, capital formation, and emissions. This suggests that labour-market outcomes are embedded within Ghana's wider production and energy-use structure, consistent with evidence linking trade, industrialisation, and energy transition in African development (Friedlingstein et al., 2025; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; Udeagha and Breitenbach, 2023; World Bank, 2024c). Employment policy should therefore be considered alongside environmental sustainability. Where industrial employment depends on energy-intensive production, the relevant policy challenge is not to constrain industrialisation but to encourage cleaner production, energy efficiency, and environmentally sustainable manufacturing. This requires combining employment-intensive structural transformation with greener industrial development (African Development Bank, 2024; 2025; United Nations Industrial Development Organisation, 2023; 2024; United Nations Economic Commission for Africa, 2025).

5.6. Integrated HR and Applied Macroeconomic Interpretation

Taken together, the results support an integrated HR-applied macroeconomic interpretation of employment in Ghana. Employment is cointegrated with manufacturing development, trade openness, capital formation, and carbon emissions, while manufacturing and trade openness also Granger-cause employment. These relationships confirm that production structure and external-sector integration matter for labour-market outcomes, but they also show that macroeconomic expansion does not automatically generate productive employment without skills development, labour-market matching, workforce readiness, and employment-centred industrial policy (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; International Labour Organisation, 2020; 2024; 2025; Mortensen and Pissarides, 1994; World Bank, 2024c; 2025). The study therefore contributes three main insights. First, manufacturing is structurally important but is not currently operating as a sufficiently labour-absorbing engine of employment, qualifying a simple Kaldorian interpretation (Kaldor, 1966; Teal, 2023). Second, trade openness has comparatively favourable employment effects, although these depend on domestic productive capacity and value-chain participation (African Union, 2024; Gonese et al., 2023; Saani et al., 2026; United Nations Conference on Trade and Development, 2024; World Bank, 2020). Third, capital formation alone cannot

generate employment unless investment complements labour and is supported by human-capital development (Lucas, 1988; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Romer, 1986; Solow, 1956). Overall, the evidence points to the need for closer coordination among industrial, trade, investment, and human-resource policies. Manufacturing needs to become more labour-absorbing, trade integration should support domestic value addition and export competitiveness, investment should favour labour-complementing activities, and HR systems should strengthen technical skills, employability, and workforce productivity. Such integration is central to converting Ghana's structural transformation into sustained employment creation.

5.7. Implications of the Findings

The findings have important theoretical, human-resource, and policy implications. The negative relationship between manufacturing value added and employment suggests that Ghana should apply the traditional Kaldorian view of manufacturing as an automatic engine of employment cautiously (Kaldor, 1966; Teal, 2023). Manufacturing remains central to structural transformation, but its employment effect depends on whether industrial growth is labour-absorbing, locally embedded, and supported by firm expansion, skills development, and stronger value-chain linkages (Abreha et al., 2021; Dinh, 2023; Edeme et al., 2020; Habanabakize and Mncayi, 2022; Ojo and Ogunleye, 2021; United Nations Industrial Development Organisation, 2023; 2024). Industrial policy should therefore assess not only manufacturing output growth, but also its employment content.

From an HR perspective, the slow adjustment implied by the error-correction process suggests that employment responds gradually to changes in manufacturing, trade openness, and capital formation. This may reflect skills mismatch, weak employability, informality, limited labour-market information, and insufficient firm-level training (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Mortensen and Pissarides, 1994; Amankwah et al., 2024; World Bank, 2025). Employment policy should therefore integrate technical and vocational education, apprenticeship, industrial training, career-transition support, and sector-specific skills planning.

The trade-openness results indicate that external integration can support employment through market access, imported inputs, export opportunities, and value-chain participation (African Union, 2024; Saani et al., 2026; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). However, the weak long-run effect suggests that openness alone is insufficient. Stronger employment outcomes require export competitiveness, local-content development, agro-processing, deeper manufacturing value chains, and greater AfCFTA readiness (African Development Bank, 2024; 2025; Gonese et al., 2023; Osuma and Nzimande, 2024; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025).

The weak employment effect of capital formation similarly suggests that investment is not automatically translating into labour demand. Capital accumulation may be concentrated in capital-intensive activities, weakly linked to domestic firms, or directed toward sectors with limited labour absorption (Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Solow, 1956; World Bank, 2021; 2024; 2025). Investment policy should therefore prioritise labour-complementing sectors, manufacturing SMEs, agro-processing, construction value chains, logistics, industrial parks, and export-oriented enterprises, while linking incentives to job creation, skills transfer, local sourcing, and productivity upgrading.

The environmental results further imply that employment creation should be embedded within sustainable industrialisation. Although carbon emissions do not directly explain employment in the main ARDL estimates, the broader dynamic relationships among employment, trade, capital formation, production intensity, and environmental outcomes support cleaner production, energy-efficient manufacturing, and low-carbon job creation (Friedlingstein et al., 2025; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; Udeagha and Breitenbach, 2023; World Bank, 2024c). Ghana should therefore pursue employment growth through environmentally sustainable rather than pollution-intensive industrial expansion.

Overall, the results point to the need for a coordinated policy framework in which manufacturing policy promotes labour-intensive industrialisation, trade policy strengthens export competitiveness and domestic value addition, investment policy favours labour-complementing capital formation, and HR policy improves skills, employability, and productivity. This integrated approach is consistent with recent evidence that Africa's employment challenge requires coordination across industrial policy, labour-market reform, trade integration, private-sector development, and human-capital investment (African Development Bank, 2024; 2025; Fox, 2021; Ghana Statistical Service, 2023; 2024; 2025; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; World Bank, 2021; 2024; 2025).

6. CONCLUSION

This study examined the structural determinants of employment in Ghana, focusing on manufacturing development, trade openness, capital formation and environmental conditions within an integrated applied-macroeconomics and human-resource framework. Using annual time-series data and an ARDL-based strategy, the analysis identified a long-run relationship among employment, manufacturing value added, trade openness, capital formation and carbon emissions. The results indicate that employment outcomes are shaped not only by aggregate growth but also by the structure of production, investment, trade integration and the economy's capacity to absorb labour productively (Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; International Labour Organisation, 2020; 2024; 2025; Pesaran et al., 2001; Saani et al., 2024; 2026; World Bank, 2024c; 2025).

A key finding is the significant negative relationship between manufacturing value added and employment. This does not imply

that manufacturing is inherently employment-reducing; rather, it suggests that manufacturing expansion in Ghana may not have been sufficiently labour-absorbing. Mechanisation, productivity-enhancing technologies, firm concentration, weak domestic linkages and limited growth in labour-intensive subsectors may help explain this outcome. The result therefore qualifies the conventional Kaldorian expectation that manufacturing automatically generates employment and instead highlights the importance of the composition and organisation of industrial growth (Kaldor, 1966; Abreha et al., 2021; Dinh, 2023; Edeme et al., 2020; Habanabakize and Mncayi, 2022; Ojo and Ogunleye, 2021; Teal, 2023; United Nations Industrial Development Organisation, 2023; 2024).

Trade openness shows more favourable employment effects, particularly through short-run dynamics and causality evidence, suggesting that external integration can support employment through market access, imported inputs, export opportunities and value-chain participation (African Union, 2024; Gonese et al., 2023; Saani et al., 2026; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; World Bank, 2020). However, the weak long-run effect implies that openness alone is insufficient without improvements in productive capacity, export competitiveness, industrial value addition and domestic firm development (African Development Bank, 2024, 2025; Osuma and Nzimande, 2024; World Bank, 2024a; 2025). Capital formation also shows weak and statistically insignificant employment effects, indicating that investment accumulation has not consistently translated into labour demand. This underscores the need to direct investment towards labour-complementing activities and to combine capital accumulation with skills development, technical training and effective labour-market matching (Fox, 2021; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Lucas, 1988; Meyer and Sanusi, 2019; Pasara and Garidzirai, 2020; Romer, 1986; Solow, 1956; World Bank, 2024a).

The policy implication is that Ghana's employment challenge is structural rather than merely cyclical. Employment-rich transformation requires industrial policy that places greater weight on labour absorption, local sourcing, supplier development, SME linkages, skills transfer, and value-chain deepening. Labour-intensive sectors such as agro-processing, textiles and garments, food processing, pharmaceuticals, light engineering, packaging and construction materials deserve greater attention, while technical and vocational education should be aligned more closely with industrial skill requirements (Abreha et al., 2021; Adinkra-Darko and Ahiakpor, 2024; Baah-Boateng et al., 2022; Dinh, 2023; International Labour Organisation, 2020; 2024; 2025; Teal, 2023; United Nations Industrial Development Organisation, 2023; 2024; World Bank, 2021; 2024; 2025). Trade and investment policy should similarly promote export competitiveness, AfCFTA readiness, local-content development, technology diffusion, local procurement and employment-linked investment incentives, supported by stronger labour-market information systems (African Union, 2024; Ghana Statistical Service, 2023; 2024; 2025; Gonese et al., 2023; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025; Amankwah et al., 2024). These objectives should be pursued within a sustainable industrialisation framework that encourages cleaner production, energy efficiency and green-job creation (Friedlingstein et al., 2025; Ongo Nkoa and Fonguen-Kong-Ngoh, 2024; Udeagha and Breitenbach, 2023; Amankwah et al., 2024).

Future research should extend the analysis by disaggregating manufacturing into subsectors, incorporating measures of education, vocational training, human capital, labour productivity and skills mismatch, and examining nonlinear or asymmetric employment responses to trade and investment shocks (Abreha et al., 2021; Dinh, 2023; International Labour Organisation, 2020; 2024; 2025; Abdychev et al., 2018; Lucas, 1988; Romer, 1986; Teal, 2023; United Nations Industrial Development Organisation, 2023; 2024; Amankwah et al., 2024; World Bank, 2025). Comparative Sub-Saharan African evidence could also clarify whether Ghana's experience reflects wider regional patterns (African Development Bank, 2024, 2025; Gonese et al., 2023; Osuma and Nzimande, 2024; Udeagha and Breitenbach, 2023; United Nations Conference on Trade and Development, 2024; United Nations Economic Commission for Africa, 2025). Finally, future work should move beyond aggregate employment counts to examine employment quality, including informality, wages, underemployment, youth and female employment, vulnerable work and decent-work outcomes.

REFERENCES

Abdychev, A., Alonso, C., Alper, E., Desruelle, D., Kothari, S., Liu, Y., Perinet, M., Rehman, S., Schimmelpfennig, A., Sharma, P. (2018), The Future of Work in Sub-Saharan Africa (Departmental Paper No. 2018/018). Washington, DC: International Monetary Fund.

Abreha, K.G., Kassa, W., Lartey, E.K.K., Mengistae, T., Zeufack, A.G. (2021), Industrialisation in Sub-Saharan Africa: Seizing Opportunities in Global Value Chains. Washington, DC: World Bank.

Adinkra-Darko, E., Ahiakpor, F. (2024), Unemployment duration and its covariates: Evidence from selected regions in Ghana. SAGE Open, 14(4), 1-16.

African Development Bank. (2024), African Economic Outlook 2024: Driving Africa's Transformation-The Reform of the Global Financial Architecture. Available from: https://www.afdb.org/en/documents/african-economic-outlook-2024

African Development Bank. (2025), African Economic Outlook 2025: Making Africa's Capital Work Better for Africa's Development. Available from: https://www.afdb.org/en/documents/african-economic-outlook-2025

African Union. (2024), The African Continental Free Trade Area: Creating one African Market. Available from: https://oneafricanmarket.org/publications-resources

Akaike, H. (1974), A new look at the statistical model identification. IEEE Transactions on Automatic Control, 19(6), 716-723.

Amankwah, A., Castaing, P., Owoo, N.S., Palacios-Lopez, A. (2024), Labour Market Participation and Employment Choice in Ghana: Do Individual Personality Traits and Gender Role Attitudes Matter? (Policy Research Working Paper No. 10664), World Bank. Available from: https://documents1.worldbank.org/curated/en/099847101102435095/pdf/idu-b8779418-d58c-435d-8ef5-bf24092eacd1.pdf

Baah-Boateng, W., Twum, E.K., Akyeampong, E.K. (2022), Gender differences in extractive activities: Evidence from Ghana.

International Journal of Social Economics, 49(7), 961-975.
Breusch, T.S. (1978), Testing for autocorrelation in dynamic linear models. Australian Economic Papers, 17(31), 334-355.
Breusch, T.S., Pagan, A.R. (1979), A simple test for heteroscedasticity and random coefficient variation. Econometrica, 47(5), 1287-1294.
Brown, R.L., Durbin, J., Evans, J.M. (1975), Techniques for testing the constancy of regression relationships over time. Journal of the Royal Statistical Society: Series B (Methodological), 37(2), 149-192.
Dickey, D.A., Fuller, W.A. (1979), Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366a), 427-431.
Dinh, H.T. (2023), Industrialisation in Africa: Issues and Policies. Policy Centre for the New South. Available from: https://www.policycenter.ma
Durbin, J., Watson, G.S. (1950), Testing for serial correlation in least squares regression: I. Biometrika, 37(3-4), 409-428.
Durbin, J., Watson, G.S. (1951), Testing for serial correlation in least squares regression: II. Biometrika, 38(1-2), 159-177.
Edeme, R.K., Buzugbe, N.P., Nkalu, N.C., Arazu, W.O. (2020), Assessing the impact of infrastructural development on manufacturing value added and employment in Africa's emerging economies. Journal of Applied Economic Sciences, 15(2), 366-376.
Feenstra, R.C., Inklaar, R., Timmer, M.P. (2015), The next generation of the Penn World Table. American Economic Review, 105(10), 3150-3182.
Fox, L. (2021), Good News, Africa is Creating Jobs-but the Narrative is Complicated. Brookings Institution. Available from: https://www.brookings.edu/articles/africa-is-creating-jobs-but-the-narrative-is-complicated
Friedlingstein, P., O'Sullivan, M., Jones, M.W., Andrew, R.M., Hauck, J., Landschützer, P., Le Quéré, C., Li, H., Luijkx, I.T., Alin, S.R., Arneth, A., Arora, V., Bates, N.R.,… & Zeng, J. (2025), Global carbon budget 2024. Earth System Science Data, 17(3), 965-1039.
Ghana Statistical Service. (2023), Annual Household Income and Expenditure Survey (AHIES) 2023. Available from: https://www.microdata.statsghana.gov.gh/index.php/catalog/119
Ghana Statistical Service. (2024), 2023 Quarter 3 Labour Statistics Bulletin. Available from: https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/2023_quarter_labour_statistics_bulletin_full_report.pdf
Ghana Statistical Service. (2025), Quarterly Labour Statistics Bulletin. Available from: https://statsghana.gov.gh
Godfrey, L.G. (1978), Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. Econometrica, 46(6), 1293-1301.
Gonese, D., Sibanda, K., Ngonisa, P. (2023), Trade openness and unemployment in selected southern African development community countries. Economies, 11(10), 252.
Granger, C.W.J. (1969), Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37(3), 424-438.
Habanabakize, T., Mncayi, P. (2022), Modelling the effects of gross value added, foreign direct investment, labour productivity and producer price index on manufacturing employment. Journal of Contemporary Management, 19(1), 57-81.
International Labour Organisation. (2020), Global Employment Trends for Youth 2020: Technology and the Future of Jobs. Available from: https://www.ilo.org/publications/major-publications/global-employment-trends-youth-2020-technology-and-future-jobs
International Labour Organisation. (2024), World Employment and Social Outlook: Trends 2024. Available from: https://www.ilo.org/publications/flagship-reports/world-employment-and-social-outlook-trends-2024
International Labour Organisation. (2025), World Employment and Social Outlook: Trends 2025. Geneva: International Labour Organisation.
Jarque, C.M., Bera, A.K. (1980), Efficient tests for normality, homoscedasticity and serial independence of regression residuals. Economics Letters, 6(3), 255-259.
Kaldor, N. (1966), Causes of the Slow Rate of Economic Growth of the United Kingdom. Cambridge: Cambridge University Press.
Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y. (1992), Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? Journal of Econometrics, 54(1-3), 159-178.
Lucas, R.E., Jr. (1988), On the mechanics of economic development. Journal of Monetary Economics, 22(1), 3-42.
Meyer, D.F., Sanusi, K.A. (2019), A causality analysis of the relationships between gross fixed capital formation, economic growth and employment in South Africa. Studia Universitatis Babeș-Bolyai Oeconomica, 64(1), 33-44.
Mortensen, D.T., Pissarides, C.A. (1994), Job creation and job destruction in the theory of unemployment. The Review of Economic Studies, 61(3), 397-415.
Ojo, S.M., Ogunleye, E.O. (2021), Technological Leapfrogging and Manufacturing Value-Added in Sub-Saharan African (1990-2018). arXiv [Preprint].
Ongo Nkoa, B.E., Fonguen-Kong-Ngoh, A.B. (2024), Industrialisation in Africa: The role of energy transition. Energy Policy, 193, 114271.
Osuma, G., Nzimande, N.P. (2024), Exploring the dynamic link between trade openness, external debt, and economic growth in sub-saharan Africa: Challenges and considerations. Economies, 12(11), 283.
Pasara, M.T., Garidzirai, R. (2020), Causality effects among gross capital formation, unemployment and economic growth in South Africa. Economies, 8(2), 26.
Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.
Ramsey, J.B. (1969), Tests for specification errors in classical linear least-squares regression analysis. Journal of the Royal Statistical Society: Series B (Methodological), 31(2), 350-371.
Romer, P.M. (1986), Increasing returns and long-run growth. Journal of Political Economy, 94(5), 1002-1037.
Saani, M.R., Abdulai, A.M., Alhassan, M.M. (2026), Analysing the trade openness and investment synergy in Ghana's growth trajectory: An ARDL bound test approach. SN Business and Economics, 6(6), 1-18.
Saani, M.R., Abdulai, A.M., Salifu, M. (2024), Inflation, public debt and unemployment nexus in Ghana. An ARDL analysis. Cogent Economics and Finance, 12(1), 2345296.
Solow, R.M. (1956), A contribution to the theory of economic growth. The Quarterly Journal of Economics, 70(1), 65-94.
Teal, F. (2023), Firm size, employment and value added in African manufacturing firms: Why Ghana needs its 1%. Journal of African Economies, 32(2), 118-136.
Toda, H.Y., Yamamoto, T. (1995), Statistical inference in vector autoregressions with possibly integrated processes. Journal of Econometrics, 66(1-2), 225-250.
Udeagha, M.C., Breitenbach, M.C. (2023), On the asymmetric effects of trade openness on CO_2 emissions in SADC with a nonlinear ARDL approach. Discover Sustainability, 4(1), 2.
United Nations Conference on Trade and Development. (2024), Economic Development in Africa Report 2024: Unlocking Africa's Trade Potential-Boosting Regional Markets and Reducing Risks. Available from: https://unctad.org/publication/economic-development-africa-report-2024
United Nations Economic Commission for Africa. (2025), Economic Report on Africa 2025: Advancing the implementation of the Agreement Establishing the African Continental Free Trade Area-Proposing transformative strategic actions. Available from: https://

uneca.org/economic-report-on-africa-2025
United Nations Industrial Development Organisation. (2023), International Yearbook of Industrial Statistics 2023. Available from: https://www.unido.org/publications/international-yearbook-industrial-statistics
United Nations Industrial Development Organisation. (2024), International Yearbook of Industrial Statistics 2024. Available from: https://stat.unido.org/publications/international-yearbook-industrial-statistics-2024
White, H. (1980), A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica, 48(4), 817-838.
World Bank. (2020), World Development Report 2020: Trading for Development in the Age of Global Value Chains. Available from: https://www.worldbank.org/en/publication/wdr2020
World Bank. (2021), Ghana Rising: Accelerating Economic Transformation and Creating Jobs (Ghana Country Economic Memorandum). Available from: https://documents.worldbank.org/curated/en/178001636617909989
World Bank. (2024a), Creating Markets in Ghana: Country Private Sector Diagnostic. Available from: https://documents1.worldbank.org/curated/en/536511531311975214/pdf/creating-markets-in-ghana-country-private-sector-diagnostic.pdf
World Bank. (2024c), World Development Indicators. Available from: https://databank.worldbank.org/source/world-development-indicators
World Bank. (2025), Ninth Ghana Economic Update: Addressing Labour Market Challenges and Opportunities in Ghana's Economic Landscape. Available from: https://www.worldbank.org

APPENDIX A

Figure 1: Trends in employment, manufacturing value added, trade openness and capital formation, 1970-2023

Figure A1: Trends in manufacturing value added, 1970-2023



Figure A2: Trends in employment, 1970-2023

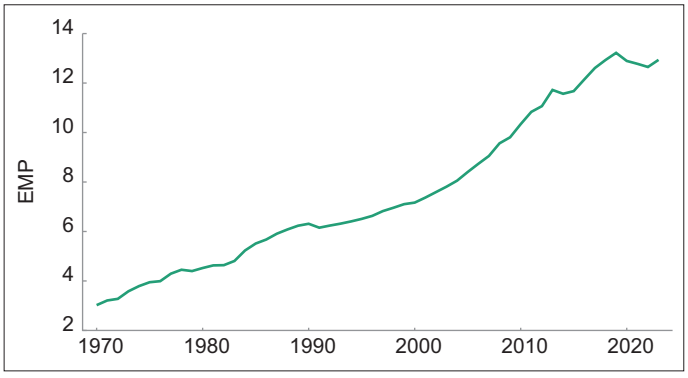


Figure A3: Trends in carbon emissions, 1970-2023

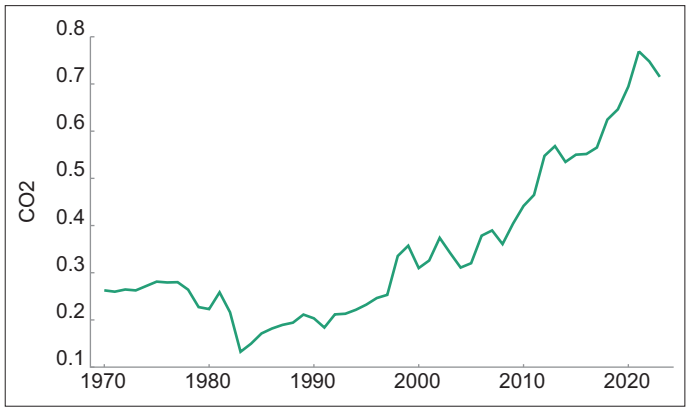


Figure A4: Trends in trade, 1970-2023

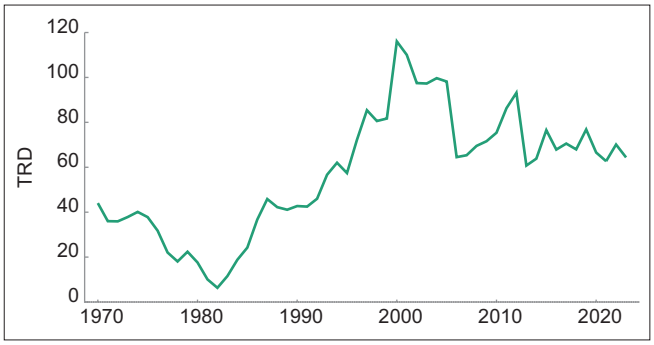


Figure A5: Trends in capital formation, 1970-2023

