

Growth of the manufacturing sector, financial inclusion and the moderating role of financial development in Ghana

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Abstract

Purpose – This paper aims to use Ghana as a case study to examine the effect of financial inclusion on the growth of the manufacturing sector while considering the moderating role of financial development.

Design/methodology/approach – The study covers the period from 1960 to 2020 and uses the autoregressive distributed lag model and the fully modified ordinary least square as estimation strategies. The study uses three main indicators of financial inclusion, including financial knowledge, usage of financial services and financial availability.

Findings – The study reveals that all three indicators of financial inclusion significantly and positively influence growth in the manufacturing sector, with the usage of financial services exerting the strongest impact. Notably, the combined influence of financial inclusion and financial development surpasses their individual effects, suggesting a synergistic relationship. These results underscore the importance for policymakers to pursue a dual strategy, advancing both financial inclusion and financial development to effectively stimulate manufacturing sector performance.

Originality/value – The impact of financial inclusion on the growth of the manufacturing sector at the macro level is examined. The study also unveils the moderating effect of financial development.

Keywords Financial inclusion, Financial development and Manufacturing sector growth

Paper type Research paper

1. Introduction

Financial inclusion (FI), defined as the provision of accessible and affordable financial services to individuals and firms, has emerged as a focal point for policymakers and stakeholders in the financial sector (Group, 2013; Adabor *et al.*, 2023; Adabor and Mishra, 2023; Ayayi and Dout, 2024; Abokyi and Bettin, 2025). Its growing prominence stems from its recognition as a key enabler of sustainable development, contributing directly to the achievement of 8 out of the 17 sustainable development goals (SDGs) (Adabor *et al.*, 2023; Kuada, 2022). In this context, FI is



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increasingly viewed as a strategic instrument for promoting inclusive growth and sustainable development by 2030. Consequently, a robust body of empirical literature has emerged, primarily focusing on the micro-level impacts of FI. These studies examine how access to financial services influences poverty reduction, borrowing behaviour, asset accumulation, food security and educational outcomes, among other socio-economic indicators (Li, 2018; Davutyan and Öztürkkal, 2016; Chipunza and Fanta, 2023). However, despite this growing microeconomic evidence base, there remains a significant empirical gap at the macro level, particularly regarding the impact of FI on broader economic sectors such as manufacturing. To date, limited research has systematically explored the extent to which FI can drive manufacturing sector growth.

FI is likely to influence manufacturing sector growth for several reasons. Firstly, through FI, manufacturing firms can get easy access to credits, loans and other financial products to purchase modern machines or inputs, as well as hire more labourers to expand their scale of production (Nizam *et al.*, 2020; Andrianaivo and Kpodar, 2011). Put differently, FI can reduce barriers such as the cost and time of travelling to financial institutions, which enable firms to get easy access to financial services and products for production purposes (Ozili, 2021; Fungáčová and Weill, 2015). For instance, FI initiatives often support agent banking networks, where local shops or kiosks offer basic banking services (Sarma and Pais, 2011). This means firms no longer need to travel long distances to reach traditional bank branches. In developing countries, mobile money services allow users to send and receive money, save and even access credit via their mobile phones, greatly reducing the need for physical travel (Ahmad *et al.*, 2020).

Secondly, access to credit and loans remains a critical source of start-up capital for small- and medium-sized manufacturing enterprises (SMEs) in many developing economies, where internal capital generation is often constrained (Saldias and von Cramon-Taubadel, 2012; Fisman, 2001). Due to structural limitations in accessing capital markets, even established firms frequently depend on credit as their primary means of financing. FI, by improving access to formal credit channels, has the potential to not only facilitate the entry of new firms into the manufacturing sector but also enhance the longevity and resilience of existing ones. Thirdly, FI can foster innovation among manufacturing firms by easing access to financial resources needed to adopt and implement modern technologies (Galasso *et al.*, 2018; Yu and Fu, 2021; Alvarez *et al.*, 2023). With better access to credit, firms are more likely to invest in technological upgrades, process improvements and product innovation factors that are essential for improving productivity and competitiveness within the sector.

Access to credit is not solely dependent on the availability of financial services but also on the ability to navigate and use them effectively. In this regard, information asymmetry plays a critical role in determining firms' access to credit and other financial products (Mansour, 2014; Sony and Bhaduri, 2021). Financially excluded firms often lack timely and reliable information about loan opportunities, interest rates and banking procedures, placing them at a disadvantage when attempting to secure financing. This informational gap can significantly reduce their ability to access credit, thereby limiting their production capacity and growth potential. In contrast, financially included manufacturing firms are more likely to receive regular updates and guidance on credit terms, interest rate changes and available financial products. This access to relevant financial information can enhance their ability to make informed borrowing decisions, manage financial risks and invest in productive assets – ultimately improving firm performance and competitiveness (Sewaid *et al.*, 2021; Petacchi, 2015).

The current study examines the effect of FI on the growth of the manufacturing sector and explores the influential role of financial development. Ghana is a suitable setting to analyse

this because evidence suggests that manufacturing sector growth in the country has slowed down due to internal and external factors, including government ineffectiveness, poor institutional quality, depreciating exchange rate and others (Buabeng *et al.*, 2019; Adabor *et al.*, 2022b; Faruq and Yi, 2010; Amponsah-Kwatiah and Asiamah, 2021). Many manufacturing firms in Ghana do not last longer than five years in business (Adabor *et al.*, 2022b). For those that survive after five years, most of them are not able to expand their scale of production (Buabeng *et al.*, 2019). Additionally, the country has made manufacturing a key pillar of its economic transformation agenda, notably through the *One District, One Factory* (1D1F) initiative launched in 2017, which aims to establish at least one factory in each of the country's 261 districts to promote industrialization and job creation. As of 2023, over 296 1D1F projects had been initiated, with less than 148 under construction, signalling significant state-backed support for manufacturing expansion (Mensah *et al.*, 2021).

At the same time, FI in Ghana has experienced rapid progress. According to the *World Bank's Global Findex Database* (2021), the percentage of adults with access to a financial account rose from 41% in 2014 to 68% in 2021, largely driven by mobile money adoption. Ghana now ranks among Africa's leaders in mobile money usage, with active mobile money accounts reaching over 19 million in 2022 (*World Bank's Global Findex Database*, 2021). However, access to credit, especially for SMEs within the manufacturing sector, remains constrained due to high interest rates, limited collateral and perceived risk.

Furthermore, Ghana's financial sector has undergone substantial reforms in recent years. Between 2017 and 2019, the Bank of Ghana implemented a banking sector clean-up that reduced the number of licensed banks from 34 to 23, improved capitalization and strengthened regulatory oversight (Gyimah *et al.*, 2022). These reforms have improved financial soundness indicators, yet questions remain about the depth and inclusiveness of financial development, particularly in supporting the real sector. Given this backdrop of manufacturing policy initiatives, evolving FI trends and a transitioning financial sector, Ghana provides a unique context to examine how financial development may moderate the relationship between inclusive finance and manufacturing growth to inform policy actions to enhance the growth of the manufacturing sector.

Our study contributes to different strands of the literature. Firstly, we contribute to a broad literature examining the factors that influence the growth of the manufacturing sector, focusing on both internal and external factors, including inflation, exchange rate, institutional quality, capital, credit access, trade openness (TO), foreign direct investment (FDI) and others (Amponsah-Kwatiah and Asiamah, 2021; Buabeng *et al.*, 2019; Anwar, 2008; Vaz and Baer, 2014; Mlambo, 2020; Onakoya *et al.*, 2012). Within this literature, we add to a small body of literature that has started examining the factors that influence the growth of the manufacturing sector in Ghana (Buabeng *et al.*, 2019; Adabor *et al.*, 2022b; Faruq and Yi, 2010; Amponsah-Kwatiah and Asiamah, 2021). While this literature is growing, there is a dearth of evidence on how FI influences the growth of the manufacturing sector.

Our second contribution is to the literature that has examined the implications of FI at both micro and macro levels. At the micro level, these studies have identified that FI improves households' income, asset accumulation, health, investment and food security, as well as reducing household and child poverty (Koomson *et al.*, 2023b; Koomson *et al.*, 2023a; Zhang and Posso, 2019; Fomum and Jesse, 2017). At the macro level, the literature demonstrates that FI increases economic growth, urban population, TO, financial development and others (Adabor *et al.*, 2023; Kim *et al.*, 2018; Odugbesan *et al.*, 2022; Hajilee and Niroomand, 2019). These studies have shed deeper insight into the effect of FI on numerous outcomes at both the micro and macro levels; however, they offer little or no explanation of how FI influences the

growth of the manufacturing sector. This presents a significant shortcoming in this strand of the literature that we aim to fill through this study.

Our study is close to studies that examined the effect of FI on the growth of manufacturing firms (Nizam *et al.*, 2020; Efobi *et al.*, 2016; Chauvet and Jacolin, 2017). While these studies are at the micro level, they also focused on how FI influences the sales, revenue and profit of manufacturing firms. Also, most of these studies focused on some selected firms within the manufacturing sector and thus some firms may have been left out. Therefore, by examining the effect of FI on the growth of the manufacturing sector at the macro level, we can account for the contributions of all firms within the manufacturing sector, making our study different from these studies conducted at the micro level. Also, we differ from these studies by examining how financial development influences the relationship between FI and manufacturing sector growth. FI emerges out of financial development because it is based on a well-developed financial system that provides better financial services to people and firms at a reasonable cost. Intuitively, financial development and FI are interconnected and it is impossible to achieve FI without financial development (Lenka, 2022; Allen *et al.*, 2014; Odugbesan *et al.*, 2022). Specifically, financial development aims at providing a strong financial system which works together to ensure enforcement and reduce transaction costs and information asymmetry (Ang, 2008; Lenka, 2022), whereas FI aims at ensuring financial services are available and affordable to all sections of the society (Ozili, 2021; Adeola and Evans, 2017). Without a strong financial system, it is impossible to ensure that firms and individuals have easy access to financial services at a reasonable cost. Therefore, it is important to examine how financial development moderates the effect of FI on the growth of the manufacturing sector.

2. Literature review

Theoretically, the relationship between FI, financial development and growth of the manufacturing sector can be explained by finance-growth theory, endogenous growth theory and institutional theory (Levine, 2005; Aghion *et al.*, 1998; Romer, 1986). For instance, the finance-growth theory suggests that financial development, including greater access to financial services (i.e. FI), enhances economic growth by mobilizing savings, facilitating investments and improving resource allocation (Levine, 2005). Sectoral growth, such as in agriculture, manufacturing or services, benefits as credit becomes more accessible (Yu and Fu, 2021; Alvarez *et al.*, 2023).

2.1 Determinants of manufacturing sector growth

Several factors contribute to the growth of the manufacturing sector, ranging from general macroeconomic conditions to context-specific influences related to geography and production type. Low investment and weak institutional quality are consistently identified as major barriers to productivity growth in manufacturing. For instance, Petrović and Matić (2023), using panel data from 1995 to 2019, found that these factors significantly hinder productivity growth among manufacturing firms in Southern Europe. In India, Rath (2018) highlighted the role of technical change in driving total factor productivity, while Thampy and Tiwary (2021) demonstrated that the development of local banking infrastructure positively affects manufacturing growth by improving credit access. In the case of China, Wei *et al.* (2020) identified trade and FDI as key drivers of energy efficiency in manufacturing, with high-technology industries exhibiting the greatest efficiency gains – echoing similar findings on technology’s role in India (Rath, 2018).

Recent studies from Sub-Saharan Africa (SSA) highlight key constraints and enablers of manufacturing sector growth. Osei-Gyebi and Dramani (2023) found that electricity insecurity significantly hampers the performance of manufacturing firms across 28 SSA countries, with power outages reducing annual sales by an average of \$114.9 per firm, disproportionately

affecting small enterprises. In the Republic of Korea, [Kim \(2023\)](#) observed that technological shocks initially boost manufacturing employment through increased investment; however, over time, these shocks lead to a shift in labour from manufacturing to the service sector. In Ghana, [Teye-Gaga et al. \(2023\)](#) examined the impact of economic integration agreements on manufacturing performance, revealing that non-reciprocal preferential trade agreements enhance export performance by strengthening trade relationships.

Limited research has explored the direct relationship between FI and manufacturing sector growth at the micro level. Most existing studies focus on the impact of FI on firm-level outcomes rather than the manufacturing sector as a whole. [Kuada \(2022\)](#) emphasized the importance of FI for the growth of small businesses in SSA, noting that while entrepreneurial characteristics matter, both financial and non-financial support systems are critical for firm development. In Nigeria, [Efobi et al. \(2016\)](#) found that multidimensional FI significantly improves the sales performance of manufacturing firms through enhanced access to financial services. Similarly, [Koomson and Ibrahim \(2018\)](#) showed that in Ghana, increasing the FI of business owners boosts the revenue of non-farm enterprises by 43%, underscoring the broader relevance of FI to enterprise growth.

2.2 Effect of financial inclusion on sectoral growth

FI has been widely studied, with evidence linking it to positive economic outcomes. [Oz-Yalaman \(2019\)](#) found that greater FI boosts tax revenue across 137 countries by increasing income and tax compliance. [Lee et al. \(2020\)](#) observed that in developing countries, especially outside Asia and during stable periods, FI enhances firm sales. Similarly, [Nizam et al. \(2020\)](#) reported that in Asian countries like Indonesia and Vietnam, FI supports firm growth up to a certain threshold, beyond which its impact becomes negative.

Recent evidence highlights the multifaceted benefits of FI at both household and macroeconomic levels. In Ghana, [Takyi and Leon-Gonzalez \(2020\)](#) found that financially included households are more resilient to tax shocks, exhibiting smaller declines in consumption following increases in consumption and labour income taxes. At the continental level, [Kebede et al. \(2023\)](#) analysed data from 23 African countries (2004–2018) and demonstrated that FI contributes to reducing income inequality, thereby supporting inclusive growth in line with SDG 10. In Nigeria, [Osei-Gyebi et al. \(2023\)](#) showed that the positive impact of remittances on savings is significantly greater among financially included individuals. Similarly, [Adabor et al. \(2023\)](#) reported that the growth of Ghana's urban population from 1960 to 2020 was positively influenced by financial literacy, usage and access to financial services. Beyond these economic outcomes, the broader literature also emphasizes FI's role in enhancing human capital, reducing gender inequality, promoting financial development, empowering women and mitigating poverty ([Sarma and Pais, 2011](#); [Vong and Song, 2015](#); [Ozili, 2021](#); [Pal et al., 2022](#); [Inoue, 2011](#); [Mensah et al., 2025](#)).

3. Data and variables

Data and variables used in this study are discussed in this section.

3.1 Data

We use yearly time series data covering 1960 to 2020 for Ghana, taken from two different sources, the World Development Indicator (WDI) and the Global Financial Inclusion Indicator (GFI) conducted by the World Bank. Specifically, we obtained data on the growth of the manufacturing sector, gross fixed capital formation (GFCF), school enrolment rate,

inflation, TO and labour force participation (LFP) rate from WDI, while data on financial knowledge, financial availability and usage of financial services were drawn from GFI.

3.2 Variables

The manufacturing sector in Ghana is made up of a collection of firms that are involved in the processing or preparation of raw materials such as textiles, rubber, minerals and others into finished or semi-finished goods (Bigsten *et al.*, 2010). Therefore, we follow previous studies and measure manufacturing sector growth as the sum of all semi-final or final products that are produced by the manufacturing sector using raw materials (Adabor *et al.*, 2022b; Hauge and Chang, 2019; Buabeng *et al.*, 2019). This measure reflects Ghana's relative level of industrialization as it shows the value added to raw products by the manufacturing sector (source: WDI, 2011).

Based on the literature, we measure FI using three main indicators, including financial knowledge, financial availability and usage of financial services (Koomson and Danquah, 2021; Adabor and Mishra, 2023; Adabor *et al.*, 2023). Easy access to credit and loan information influences firms' informed credit and loan decisions. Hence, we measure financial knowledge with the ease of access to credit and loan information from private and or public registers or institutions. Financial availability captures the average of automated teller machines (ATMs) and commercial bank branches per 100,000 adults (Said and Acheampong, 2023; Yin *et al.*, 2023). This measure of FI reflects the extent of financial services' outreach or availability to people and firms in a particular geographical area. The usage of financial services captures the frequency with which bank customers use the financial products and services available to them. This proxy for FI comprises the proportion of firms or individuals who borrowed and saved from financial institutions, the percentage of people who made or received digital payments, the percentage of firms that acquired loans and other forms of credit (Sarpong and Nketiah-Amponsah, 2022; Demirgüç-Kunt and Klapper, 2012).

To minimize omitted variables bias, we include several covariates in our regression model, commonly used in the literature (Faruq and Yi, 2010; Amponsah-Kwatiah and Asiamah, 2021; Adabor *et al.*, 2022b). These covariates include GFCF, inflation (INF), LFP, school enrolment rate (SCH) and TO. Description and descriptive statistics for all the variables are in Table 1. *A priori*, we expect a positive relationship between gross fixed formation and manufacturing sector growth because capital is required to set up manufacturing firms (Anwar, 2008). Based on the literature, we expect LFP, school enrolment rate (SCH) and TO to exert a positive impact on the growth of the manufacturing sector (Fakih and Ghazalian, 2013; Onakoya *et al.*, 2012) whereas inflation is expected to exert an adverse effect on manufacturing sector growth (Bans-Akutey *et al.*, 2016; Judith and Chijindu, 2016). This is because labour is one of the inputs required for production and thus hiring new workers is expected to boost production, whereas being educated (that is, both formal and informal training) increases labour productivity as it enables workers to know how to use the modern tools for production purposes. TO ensures the free flow of FDI, of which some is channelled to the manufacturing sector to expand production. Inflation is likely to decrease manufacturing sector growth because high prices increase the cost of inputs such as raw materials and other tools used for production.

4. Data analysis

4.1 Descriptive statistics

Table 1 reports the summary statistics for the key variables used in the analysis over the period 1960 to 2020. Manufacturing sector growth recorded an average of 2.148 with a relatively low standard deviation of 0.266, indicating minimal year-to-year fluctuations. Financial knowledge averaged 2.543, with a standard deviation of 1.230 and a range from 10.500 to 14.877,

Table 1. Descriptive statistics of all variables

Variables	Description	Abbreviations	Source	Maximum	Minimum	Mean	SD
Growth of the manufacturing sector	The sum of all semi and final output produced by manufacturing firms expressed as a percentage of a country's total gross domestic product (GDP)	GMS	WDI	0.031	5.231	2.148	0.266
Financial knowledge	This captures the quality, scope and accessibility of credit information at private and/or public registers	FK	GFI	14.877	2.543	10.5	1.23
Financial availability	This captures the average of ATMs and commercial bank branches per 100,000 adults	FA	GFI	15.091	3.091	8.41	2.12
Usage of financial services	This variable represents the number of times customers or clients use financial products and services available to them over time, especially in a year	UFS	GFI	10.98	2.431	6.5	1.341
Gross fixed capital formation	It comprises private investment and businesses in a domestic economy	GFCF	WDI	23.500	18.843	20.891	8.911
Inflation	Inflation is measured using the consumer index, which depicts the basket of goods and services a consumer can afford	INF	WDI	17.007	6.940	5.231	28.321
Trade openness	Trade openness reflects the total volume of exports plus the total volume of imports of goods and services as a share of the GDP	TO	WDI	7.754	1.444	3.891	1.759
School enrolment rate	This variable reflects the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown	SCH	WDI	89.00	59.00	52.020	14.829
Labour force participation rate	It is measured as the percentage of the population aged 15–60 that are economically active and supply the labour force to produce goods and services as a percentage of the total population	LFP	WDI	4.991	2.766	3.929	0.158
Foreign direct investment	FDI refers to a category of cross-border investments made in the country of the present study by non-residents with a business interest. It is measured in our model as the FDI net inflows expressed as a share of the GDP	FDI	WDI	4.276	-3.094	2.248	1.614

Source(s): Authors' work

highlighting the generally low levels of financial literacy in Ghana during the study period. TO posted an average value of 3.891, with a standard deviation of 1.759 and a range between 1.444 and 7.754, suggesting limited integration of Ghana into the global trading system. Inflation exhibited an average annual increase of 5.231, with values ranging from 6.940 to 17.007, reflecting persistent inflationary pressures and elevated consumer prices. GFCF recorded the highest average among the variables at 20.891, alongside a substantial standard deviation, pointing to significant volatility in investment activity across the years. LFP averaged 3.929, with low variability, indicating a relatively stable labour market over the period. Finally, the school enrolment rate averaged 52.020, with a standard deviation of 14.829, suggesting moderate variation in access to education during the timeframe analysed.

4.2 Empirical model

Based on existing studies (Adabor *et al.*, 2023; Amponsah-Kwatiah and Asiamah, 2021), we examine the effect of FI on the growth of the manufacturing sector using the equation in functional form:

$$MSG_t = k(FI_{it}, GFCF_t, INF_t, LFP_t, TO_t, SCH_t) \quad (1)$$

where the outcome variable, MSG_t , is the overall growth of the manufacturing sector at the time t , which is the variable of interest and FI_{it} represents FI indicators, including financial availability, financial knowledge and usage of financial services. $GFCF_t$, INF_t , LFP_t , TO_t and SCH_t are used as covariates indicating GFCF, inflation, LFP, TO and school enrolment rate, respectively.

Equation (1) is in functional form and not estimable. Therefore, we transform equation (1) to an empirical form, which is estimable as specified below:

$$\ln MSG_t = \beta_0 + \beta_1 \ln FI_{it} + \beta_2 \ln GFCF_t + \beta_3 \ln INF_t + \beta_4 \ln LFP_t + \beta_5 \ln TO_t + \beta_6 \ln SCH_t + \mu_t \quad (2)$$

Such that all the variables are the same as in equation (1). β_0 is the intercept and μ_t is the error term. The parameters β_i ($i = 1, 2, \dots, 6$) are the coefficients of the respective variables. \ln and t represent the natural log and time trend, respectively. We took the natural log due to the following: firstly, many of the variables are either left- or right-skewed. Taking logs helps to normalize the distribution, making it more symmetric and suitable for statistical analysis that assumes normality. Secondly, many economic relationships are nonlinear in their raw form. Taking the natural log (usually \ln) can transform an exponential or multiplicative relationship into a linear one, which is easier to estimate using linear regression techniques.

Preliminary analysis reveals a high degree of correlation among the FI indicators, with Spearman's rank correlation coefficients exceeding 0.78. This strong correlation suggests potential multicollinearity issues if all three indicators are included simultaneously in the same regression model. To address this concern and avoid biased coefficient estimates, equation (2) is estimated three separate times, each specification incorporating a different proxy for FI.

To examine the moderating role of financial development, we estimate the following empirical model specified below:

$$\begin{aligned} \ln MSG_t = & \alpha_0 + \delta_1 \ln FI_t + \delta_2 FD_t + \alpha_3 (\ln FI_t * FD) + \delta_4 \ln GFCF_t + \alpha_5 \ln INF_t + \alpha_6 \ln LFP_t \\ & + \alpha_7 \ln TO_t + \alpha_8 \ln SCH_t + \mu_t \end{aligned} \quad (3)$$

where all the variables are the same as in equation (1) except for financial development. We measure financial development by developing an index for five indicators of financial

development, including net domestic credit (NDC), monetary sector credit to the private sector (MCP), ratio of liquid liabilities (DEPTH), narrow (NM) and broad money (BM). Specifically, we use the principal component analysis evident in existing studies (Chen and Woo, 2010; Sakyi *et al.*, 2017; Ayesu *et al.*, 2022) to compute an index of financial development based on the five indicators of financial development and the results are reported in Table 2. The PCA [1] creates an index for different variables that are a linear composite of the primary ones. The results in Table 2 show that the eigenvalues of the first three principal components are greater than one, suggesting that the financial development index (FD) is created from the first three variables.

5. Estimation strategy

To estimate equation (1), we use the autoregressive distributed lag model (ARDL) developed by Pesaran *et al.* (2001), evident in existing studies (Adabor *et al.*, 2022a; Sari *et al.*, 2008; Pata and Caglar, 2021). We use this approach over other conventional time series approaches because the ARDL approach addresses the endogeneity inherent in time series data. Specifically, the ARDL is effective in resolving endogeneity issues emanating from omitted variable bias and measurement errors. Also, the model automatically eliminates spurious regression results as well as differentiates between short-run and long-run elasticities. Furthermore, the ARDL model is well suited for series with a relatively short span, and it is also applicable if the order of the integration is mixed or uniform. The ARDL model is specified as:

$$\begin{aligned} \Delta \ln MSG_t = & \alpha_0 + \sum_{t=i}^q \pi_{1i} \Delta \ln MSG_{t-i} + \sum_{t=i}^r \pi_{2i} \Delta \ln FI_{t-i} + \sum_{t=i}^s \pi_{3i} \Delta \ln GFCF_{t-i} \\ & + \sum_{t=i}^t \pi_{4i} \Delta \ln INF_{t-i} + \sum_{t=i}^u \pi_{5i} \Delta \ln SCH_{t-i} + \sum_{t=i}^v \pi_{6i} \Delta \ln LFP_{t-i} \\ & + \sum_{t=i}^w \pi_{6i} \Delta \ln TO_{t-i} + \Gamma_1 \ln MSG_{t-1} + \Gamma_2 \ln FI_{t-1} + \Gamma_3 \ln GFCF_{t-1} \\ & + \Gamma_4 \ln INF_{t-1} + \Gamma_5 \ln SCH_{t-1} + \Gamma_6 \ln TO_{t-1} + \Gamma_7 \ln LFP_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

where the first difference operator is represented by Δ . The model is formally defined as ARDL (q, r, s, t, u, v and w), with “q” indicating the ideal lag order of the dependent variable,

Table 2. Financial development index using principal component analysis (PCA)

Computed index	Eigen values	Proportion explain	Primary variables	Eigen-vectors	Correlation coefficients	Bartlett (<i>p</i> -values)
Financial development	1.998	0.669	NDC	0.467	0.540	–
	1.978	0.265	MCP	0.479	0.789	–
	1.097	0.090	DEPTH	0.218	0.622	0.000
	0.404	0.020	BM	0.188	0.583	–
	0.517	0.013	NM	0.557	0.607	–

Note(s): We use the min–max transformation [2] to normalize the PCA scores to a scale of 0 to 1, where an increase from 0 to 1 indicates better values. The coefficient of correlation indicates the degree of association between the computed index and the five primary financial development indicators. The Kaiser criterion is used to select the number of principal components with eigenvalues greater than one. The null hypothesis of Bartlett’s test of sphericity suggests that there is no intercorrelation among the variables

Source(s): Authors’ work

whereas “r, s, t, u and v” represent the optimal lag of the independent variables. The short-run coefficients are represented by π_1 to π_6 while the long-run multipliers are represented by Γ_1 to Γ_7 . α_0 is the constant term and ε_t is the white noise error term. All the variables are the same as in equation (1). To obtain an optimal lag, we estimate an ARDL model in the form of $(q + 1)^p$ regression, with q and p representing the number of regressors and optimal lag, respectively. Using the Schwarz information criterion, a lag order of ARDL (0,0, 0, 0, 0, 0,0) is selected automatically. Also, we follow the ARDL bound test procedure to examine the long-run relationship between FI and manufacturing sector growth. The ARDL bound test procedure compares the F -statistic to critical bound values to test whether a long-run relationship exists between two variables (Pesaran and Smith, 1995). Specifically, the ARDL bond procedure seeks to test the following hypothesis:

$H_0 = \Gamma_1 = \Gamma_2 = \Gamma_3 = \Gamma_4 = \Gamma_5 = \Gamma_6 = \Gamma_7 = 0$; (no long-run association is present among the variables).

$H_1 \neq \Gamma_1 \neq \Gamma_2 \neq \Gamma_3 \neq \Gamma_4 \neq \Gamma_5 \neq \Gamma_6 \neq \Gamma_7 \neq 0$ (long-run association exists among the variables).

To test the above hypothesis, the estimated F -statistics are compared to the bound estimates. Consequently, the null hypothesis is rejected if the computed F -statistic is higher than the two sets of upper bound values (5% and 10%) estimated by Pesaran and Smith (1995) and vice versa.

To obtain the results involving the moderation role of financial development, we estimate the following ADRL model:

$$\begin{aligned} \Delta \ln MSG_t = & \beta_0 + \sum_{i=1}^c \delta_{1i} \Delta \ln MSG_{t-i} + \sum_{i=1}^d \delta_{2i} \Delta (\ln FI * \ln FD)_{t-i} + \sum_{i=1}^e \delta_{3i} \Delta \ln GFCE_{t-i} \\ & + \sum_{i=1}^f \delta_{4i} \Delta \ln INF_{t-i} + \sum_{i=1}^g \delta_{5i} \Delta \ln SCH_{t-i} + \sum_{i=1}^h \delta_{6i} \ln LFP_{t-i} \\ & + \sum_{i=1}^k \delta_{6i} \Delta \ln TO_{t-i} + \sum_{i=1}^g \delta_{7i} \Delta \ln FD_{t-i} + \sum_{i=1}^h \delta_{8i} \Delta \ln FI_{t-i} \\ & + \eta_1 \ln FD_{t-1} + \eta_2 \ln FI_{t-1} + \eta_3 \ln MSG_{t-1} + \eta_4 (\ln FI * \ln FD)_{t-1} + \eta_5 \ln GFCE_{t-1} \\ & + \eta_6 \ln INF_{t-1} + \eta_7 \ln SCH_{t-1} + \eta_8 \ln TO_{t-1} + \eta_9 \ln LFP_{t-1} + \varepsilon_t \end{aligned} \tag{5}$$

where FD represents the financial development index and the rest of the variables are the same as in equation (3). Regarding the interpretation of the parameters, those attached to variables without interaction terms capture the direct effect of the respective variable on the growth of the manufacturing sector. For those attached to variables with interaction, they measure the combined effect of the respective variables on the growth of the manufacturing sector.

Before applying the ARDL model to time series data, it is essential to test for stationarity, as non-stationary series can result in spurious regressions and misleading inferences. To assess the stationarity of the variables, we use the Phillips and Perron (1988) and Augmented Dickey and Fuller (1979) tests.

6. Results

We start the analysis by conducting a preliminary analysis, which includes a correlation test and a stationarity test. These tests are important as they provide a basis for sound empirical analysis.

6.1 Correlation matrix

Table 3 displays the correlation matrix for the key economic variables, illustrating the strength and direction of their linear relationships. Notably, several significant correlations

Table 3. Correlation coefficient estimates

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) lnGMS	1.000								
(2) lnFK	0.765	1.000							
(3) lnFA	0.901	0.781	1.000						
(4) lnUFS	0.722	0.731	0.751	1.000					
(5) lnINF	-0.678	-0.241	-0.156	-0.153	1.000				
(6) lnTO	0.567	0.167	0.258	0.223	0.231	1.000			
(7) lnGFCF	0.782	0.267	0.122	0.155	-0.151	0.111	1.000		
(8) lnLFP	0.668	0.131	0.167	0.221	-0.121	0.101	0.133	1.000	
(9) lnSCH	0.721	0.141	0.152	0.171	-0.131	0.123	0.145	0.145	1.000

Source(s): Authors' work

emerge, suggesting important economic linkages that may influence subsequent modelling and analysis.

We suspect a potential correlation among the FI indicators because they are closely related. Here, we conduct a correlation analysis among the three indicators of FI to address this issue. Table 3 reports the results for Spearman's rank correlation. It can be observed that the indicators of FI, namely, financial knowledge, financial availability and usage of financial services, are highly and positively correlated with each other. For instance, the correlation coefficient for financial knowledge and financial availability is 0.781, indicating a high positive association between these two variables. This estimate implies that we cannot include these two variables in the same regression model because it is a threat to our results. Thus, putting all three indicators of FI in the same regression could bias our estimates, leading to wrong inferences. Therefore, we put each indicator in a separate regression, leading to three different regression models. The correlation results also depict a strong positive correlation between the growth of the manufacturing sector and FI. For instance, the correlation estimate for the link between financial availability and manufacturing sector growth is 0.901, suggesting a strong positive association between manufacturing sector growth and the availability of financial services and products.

6.2 Unit root test results

To apply the ARDL model, the series must be integrated fractionally. Thus, the variables must be either integrated of order zero $I(0)$ or order one $I(1)$ and mix, but should not be beyond the integrated order of $I(2)$. Hence, we examine the stationarity properties of all our variables using the Augmented Dickey–Fuller and the Phillips–Perron tests. According to the stationarity results in Table 4, TO, GFCF, school enrolment rate and LFP were stationary at the level, while the rest of the variables required a first difference for them to be stationary. This is shown by both stationarity approaches. Also, the results confirm that integration of order two does not exist for any of the variables, as they were either stationary at order zero $I(0)$ or order one $I(1)$. Hence, the requirement for the estimation of an ARDL model is satisfied. Based on this, we proceed to conduct the co-integration test to verify if a long-run association exists among the variables.

6.3 Bounds test results

The results of co-integration tests based on the three alternative models are reported in Table 5. The three different specifications were needed due to the high correlation among the

Table 4. Unit root estimates

Variables	ADF test with intercept			Level	PP test with intercept		
	Level	1st difference	I(d)		Level	1st difference	I(d)
(1) lnMSG	0.414	-7.774***	I(1)	0.611	-4.621**	I(1)	
(2) lnFK	0.687	-6.117**	I(1)	0.155	-5.576**	I(1)	
(3) lnFA	0.885	-4.959**	I(1)	1.111	-9.851***	I(1)	
(4) lnUFS	0.885	-6.429***	I(1)	0.581	-8.158**	I(1)	
(5) lnINF	1.165	-7.099***	I(1)	1.386	-9.113**	I(1)	
(6) lnTO	-7.659**	-8.499***	I(0)	-4.699**	-6.430***	I(0)	
(7) lnGFCF	-6.891**	-4.099**	I(0)	-6.986***	-3.979**	I(0)	
(8) lnLFP	-5.891**	-6.798***	I(0)	-8.993***	6.113***	I(0)	
(9) lnSCH	-6.919**	-7.982***	I(0)	-9.993***	5.913***	I(0)	

Note(s): Augmented Dickey–Fuller (ADP) and Philip–Perron (PP) test results for all the variables used in our analysis. *** $p < 0.01$ and ** $p < 0.05$

Source(s): Authors' work

Table 5. Bounds test estimates

Models	Test statistics	p -value	Lower bound	Upper bound
(1) Model A	9.541	0.004	4.19	6.99
(2) Model B	7.981	0.002	3.99	5.88
(3) Model C	5.980	0.001	2.18	4.91

Note(s): Models A, B and C include financial knowledge, financial availability and usage of financial services as the key independent variables, respectively

Source(s): Authors' work

various proxies of FI, which does not warrant including all the FI indicators in a single regression model at a time (i.e. Models A, B and C). Models A, B and C include financial knowledge, financial availability and usage of financial services as the variables of interest, respectively. We observe that the bound test statistics of 9.541, 7.98 and 5.980 are all significant and greater than the upper bound limit of 6.99, 5.88 and 4.91, respectively. This is an indication of a long-run association among the variables, making the ARDL model a suitable approach.

6.4 Autoregressive distributed lag short-run results

In this section, we present the short-run ARDL estimation results, examining the dynamic relationship between FI and the growth of the manufacturing sector. The findings reveal how short-term fluctuations in FI indicators influence manufacturing sector performance.

Table 6 presents the short-run results from the autoregressive distributed lag (ARDL) model examining the impact of FI on manufacturing sector growth. The estimated coefficients of the error correction terms across all model specifications are negative, statistically significant and lie between 0 and 1. This confirms the presence of a stable, monotonic long-run equilibrium relationship among the variables, in line with the conditions outlined by Pesaran *et al.* (2001) and Narayan (2004).

The short-run dynamic results indicate that FI exerts a statistically significant and positive effect on manufacturing sector growth in Ghana across all FI proxies considered.

Table 6. ARDL dynamic short-run results

Variables	(1) lnMSG	(2) lnMSG	(3) lnMSG
lnFK	0.085** (0.015)	–	–
lnFA	–	0.109** (0.051)	–
lnUFS	–	–	0.279** (0.073)
lnGFCF	0.250** (0.082)	0.180** (0.052)	0.227** (0.086)
lnINF	–0.541** (0.091)	–0.402** (0.071)	–0.409** (0.079)
lnLFP	0.211** (0.098)	0.238** (0.051)	0.297** (0.088)
lnTO	0.451* (0.171)	0.329** (0.089)	0.299** (0.092)
lnSCH	0.370** (0.085)	0.211** (0.079)	0.111** (0.049)
ECM(–1)	–0.210** (0.051)	–0.253** (0.063)	–0.451** (0.056)

Note(s): The dependent variable is manufacturing sector growth. Standard errors are in parentheses. ** $p < 0.05$ and * $p < 0.1$

Source(s): Authors' work

Specifically, in Column 1, a 1% increase in financial knowledge is associated with an 8.5% increase in manufacturing sector growth, significant at the 5% level. The estimated short-run effects of the other FI proxies – financial availability and financial usage – are even larger. A 1% increase in financial availability leads to a 10.9% increase in manufacturing growth, while a similar rise in the usage of financial services results in a 27.9% increase.

Among the three proxies, the usage of financial services has the most substantial impact on manufacturing growth. This underscores the critical role that financial intermediation plays in the sector's development, particularly through mechanisms such as credit facilitation, trust-building and transaction cost reduction. For example, manufacturing firms often rely on access to credit for expansion and the ability of financial institutions to efficiently deliver such services is vital for supporting the sector's growth (Kuada, 2022).

6.5 Autoregressive distributed lag long-run results

In this section, we present the long-run ARDL estimates, capturing the sustained impact of FI on the growth of the manufacturing sector. The results provide insight into how long-term improvements in financial access and usage contribute to manufacturing sector growth.

Table 7 presents the long-run estimates of the impact of FI on manufacturing sector growth, with each column reporting the results for a distinct FI proxy: financial knowledge (Column 1), financial availability (Column 2) and financial services usage (Column 3). The results indicate that FI has a significant and positive long-run effect on the growth of Ghana's manufacturing sector. Specifically, a 1% increase in financial knowledge, financial availability and usage of financial services is associated with a 0.215%, 0.210% and 0.407% increase in manufacturing sector growth, respectively. Among the three proxies, the usage of financial services exerts the largest influence on manufacturing growth. This finding underscores the crucial role that the effective utilization of financial services plays in driving industrial expansion. In other words, merely improving access to financial services is not sufficient; manufacturing firms must actively engage with and use these services to realize growth benefits. This highlights the importance of reducing information asymmetries and improving financial literacy to ensure that firms can effectively leverage available financial tools.

These findings contribute to the growing body of literature emphasizing the role of FI in firm-level and sectoral growth in developing economies (Efobi *et al.*, 2016; Koomson and Ibrahim, 2018; Kuada, 2022). The novelty of this study lies in its macroeconomic focus and

Table 7. ARDL long-run estimates

Variables	(1) lnMSG	(2) lnMSG	(3) lnMSG
lnFK	0.215** (0.065)	–	–
lnFA	–	0.210** (0.061)	–
lnUFS	–	–	0.407*** (0.086)
lnGFCF	0.134*** (0.057)	0.216*** (0.062)	0.811** (0.198)
lnINF	–1.479*** (0.238)	–0.197** (0.063)	–0.541*** (0.091)
lnLFP	0.807*** (0.074)	0.293** (0.056)	0.451* (0.151)
lnTO	1.570*** (0.321)	0.950** (0.189)	0.710** (0.251)
lnSCH	0.570*** (0.031)	0.501** (0.109)	0.110** (0.051)
<i>Intercept</i>	2.031*** (0.098)	2.243*** (0.082)	3.082*** (0.041)

Note(s): The dependent variable is manufacturing sector growth. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

Source(s): Authors' work

the disaggregation of FI into distinct components, enabling a clearer understanding of their individual effects. Unlike previous studies, which often focus solely on access or knowledge, this research demonstrates that the usage of financial services is the most impactful channel for stimulating manufacturing sector growth in Ghana. Furthermore, the findings are particularly relevant in light of the recent financial sector reforms, offering policy-relevant insights on how tailored improvements in FI can support industrial development.

Also, Table 7 presents the results for how other variables like GFCF, inflation, school enrolment rate (SCH), LFP and TO influence the growth of the manufacturing sector in Ghana. While GFCF, LFP, SCH and TO have a positive effect on manufacturing sector growth, inflation harms manufacturing sector growth as expected. Specifically, a 1% increase in GFCF in Models 1, 2 and 3 leads to 0.134%, 0.216% and 0.811% increase in manufacturing sector growth, respectively. Similarly, in Columns 1,2 and 3, a 1% increase in LFP, respectively, results in 0.807%, 0.293% and 0.451% increase in manufacturing sector growth. Furthermore, a 1% increase in TO causes at least a 0.71% increase in manufacturing sector growth for the three estimated models, whereas a 1% increase in SCH causes at least a 0.11% increase in growth of the manufacturing sector in Columns 1, 2 and 3, respectively. However, a 1% increase in inflation has a 0.147%, 0.197% and 0.541% reduction in manufacturing sector growth for Columns 1, 2 and 3, respectively.

6.6 The moderating role of financial development

Achieving FI is unlikely without a well-developed financial system. Financial development facilitates broader and more affordable access to financial services and products for individuals and firms. This section explores how financial development moderates the relationship between FI and manufacturing sector growth by interacting the FD with the three FI indicators.

Table 8 presents the short-run estimates of the interaction between FI and financial development on manufacturing sector growth. The findings indicate that their combined effect is greater than their individual contributions. For example, in Column 1, a 1% increase in financial knowledge, when complemented by financial development, leads to an approximate 0.199% rise in manufacturing sector growth similar interpretations apply to the other interaction terms. Overall, both the short-run and long-run ARDL results underscore that enhancing firms' financial knowledge, usage and access to financial services yields significantly stronger growth outcomes when supported by a robust financial system. These

Table 8. Moderating role of financial development-ARDL dynamic short-run results

Variables	(1) lnMSG	(2) lnMSG	(3) lnMSG
lnFK	0.059** (0.065)		
lnFA		0.075** (0.025)	
lnUFS			0.099** (0.033)
lnFK * FD	0.199** (0.065)		
lnFA * FD		0.289** (0.087)	
lnUFS * FD			0.398** (0.053)
FD	0.087** (0.034)	0.114** (0.055)	0.191** (0.055)
lnGFCF	0.210** (0.082)	0.120** (0.062)	0.297** (0.098)
lnINF	-0.319** (0.089)	-0.127** (0.067)	-0.098** (0.039)
lnLFP	0.311** (0.098)	0.138** (0.057)	0.099 (0.088)
lnTO	0.351* (0.141)	0.298** (0.089)	0.199 (0.162)
lnSCH	0.170** (0.065)	0.298** (0.079)	0.211*** (0.049)
ECM (-1)	-0.180** (0.061)	-0.139** (0.058)	-0.251** (0.061)

Note(s): The dependent variable is the manufacturing sector growth. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

Source(s): Authors' work

findings highlight the necessity of establishing strong financial institutions as a foundation for effective FI and improved manufacturing sector performance.

Table 9 reports the long-run estimates of the combined effect of financial development and FI on manufacturing sector growth. Consistent with the long-run findings in Table 8, the results demonstrate that the interaction between financial development and FI has a greater impact than their individual effects. For example, Column 1 shows that the joint effect of financial development and financial knowledge yields a 0.357% increase in manufacturing sector growth, surpassing their separate effects of 0.190% and 0.105%, respectively. In

Table 9. Moderating role of financial development-ARDL long-run estimates

Variables	(1) lnMSG	(2) lnMSG	(3) lnMSG
lnFK	0.105** (0.058)		
lnFA		0.059** (0.018)	
lnUFS			0.089** (0.028)
lnFK * FD	0.357*** (0.035)		
lnFA * FD		0.410*** (0.041)	
lnUFS * FD			0.507** (0.186)
FD	0.190** (0.059)	0.210*** (0.032)	0.189*** (0.012)
lnGFCF	0.134** (0.057)	0.116 (0.112)	0.211** (0.098)
lnINF	-0.479** (0.108)	-0.099** (0.013)	-0.141** (0.061)
lnLFP	0.207* (0.094)	0.193** (0.046)	0.111** (0.051)
lnTO	0.270 (0.251)	0.150** (0.069)	0.310** (0.091)
lnSCH	0.270** (0.091)	0.201** (0.079)	0.310** (0.081)
Intercept	0.981*** (0.180)	1.243*** (0.042)	0.982*** (0.051)

Note(s): The dependent variable is the manufacturing sector growth. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

Source(s): Authors' work

Column 2, a 1% increase in financial availability, when supported by financial development, results in approximately a 0.41% increase in growth. Similarly, Column 3 reveals that a 1% rise in the use of financial services, in the context of a well-developed financial system, leads to a 0.507% increase in manufacturing sector growth. These findings underscore that FI has a more substantial impact on manufacturing sector performance when underpinned by a strong and efficient financial system.

7. Diagnostic test

This section presents a series of diagnostic tests conducted to validate the reliability of the ARDL model estimates. The accuracy of the ARDL results depends on the model being free from key econometric issues. To this end, we perform diagnostic checks for normality, serial correlation, heteroskedasticity, functional form specification and model stability. Specifically, the Jarque–Bera test is used to assess normality, the Breusch–Godfrey LM test for serial correlation and the Breusch–Pagan–Godfrey test for heteroskedasticity. The Ramsey RESET test evaluates the correctness of the model’s functional form, while model stability is examined using the CUSUM and CUSUMSQ tests.

The diagnostic results, presented in [Table 10](#), indicate no evidence of normality violations, autocorrelation, heteroskedasticity or functional form misspecification, as all corresponding *p*-values exceed the 0.05 significance threshold. Additionally, the CUSUM and CUSUMSQ plots (see [Figures A1, A2 and A3](#) in the [Appendix](#)) lie within the 5% critical bounds, confirming the model’s stability over the sample period. Collectively, these tests affirm the robustness and reliability of the ARDL estimates, supporting the validity of the study’s findings for informing policies aimed at enhancing the performance of Ghana’s manufacturing sector.

8. Robustness test

In our second robustness check, we use the fully modified ordinary least square (FM-OLS) introduced by [Phillips and Hansen \(1990\)](#) to examine the sensitivity of our results to an alternative technique. The FM-OLS is a suitable approach because it accounts for potential endogeneity and provides optimal estimates for co-integration regressions. The FM-OLS eliminates long-run correlation between the co-integrating variables and uses stochastic regressor changes to address the endogeneity problem in time series analysis. The FM-OLS is applied to variables that are non-stationary and cointegrated. Despite the non-stationarity, co-integration implies a stable long-run equilibrium. FM-OLS leverages this by making asymptotic modifications that ensure valid statistical testing. Hence, we exclude the I (0) variables from the model before applying the FM-OLS to produce unbiased and consistent

Table 10. Reliability test results

	Model A	Model B	Model C
Diagnostic test	Test statistics	Test statistics	Test statistics
Normality	1.561 (0.201)	2.172 (0.204)	0.989 (0.231)
Serial correlation	0.969 (0.104)	1.991 (0.109)	0.995 (0.204)
Heteroskedasticity	1.819 (0.219)	1.191 (0.201)	1.911 (0.119)
Functional form	0.914 (0.212)	1.088 (0.210)	1.819 (0.121)
<i>CUSUM</i>	Stable	Stable	Stable
<i>CUSUM square</i>	Stable	Stable	Stable

Note(s): Probability values in parentheses

Source(s): Authors’ work

estimates of long-run relationships, which standard OLS cannot guarantee in such cases. The results for the FM-OLS are reported in Tables 11 and 12.

Table 11 reports the direct effect of the various indicators of FI on the growth of the manufacturing sector using FM-OLS. We find that all three indicators of FI exert a positive and significant impact on manufacturing sector growth at a 5% significance level. This suggests that FI boosts the growth of the manufacturing sector, consistent with the main short and long-run ARDL results.

In Table 12, we report the results for the interactive effect of FI and financial development on manufacturing sector growth using FM-OLS. We find that the interaction of various indicators of FI and financial development on the growth of the manufacturing sector is larger than their separate effect. This suggests that an increase in FI in the presence of a strong financial system and quality institutions improves the performance of the manufacturing sector, consistent with the ARDL results in Tables 8 and 9. Overall, the results from the FM-OLS are in line with the ARDL results in terms of the direction of the effect, but the size of the effect differs.

Table 11. Effect of financial inclusion and growth of the manufacturing-FM-OLS

Variables	(1) lnMSG	(2) lnMSG	(3) lnMSG
lnFK	0.175** (0.057)		
lnFA		0.180** (0.075)	
lnUFS			0.098** (0.026)
lnGFCF	0.135** (0.057)	0.169** (0.047)	0.117** (0.046)
lnINF	-0.151** (0.063)	-0.213** (0.058)	-0.159** (0.051)
FD	0.111** (0.053)	0.205** (0.071)	0.117** (0.038)
lnFDI	0.211** (0.034)	0.199** (0.058)	0.177** (0.082)
Intercept	0.610** (0.168)	0.785** (0.211)	0.899** (0.308)

Note(s): The dependent variable is manufacturing sector growth. Standard errors are in parentheses. ** $p < 0.05$

Source(s): Authors' work

Table 12. Moderating effect of financial development-FM-OLS

Variables	(1) lnMSG	(2) lnMSG	(3) lnMSG
lnFK	0.097** (0.027)		
lnFA		0.089** (0.028)	
lnUFS			0.078** (0.024)
lnFK * FD	0.295** (0.067)		
lnFA * FD		0.190** (0.047)	
lnUFS * FD			0.189** (0.086)
FD	0.193** (0.048)	0.151*** (0.058)	0.192** (0.058)
lnINF	-0.139** (0.057)	-0.199** (0.061)	-0.183** (0.059)
lnFDI	0.175 (0.101)	0.138** (0.048)	0.169** (0.046)
Intercept	0.661*** (0.054)	0.779** (0.108)	0.789*** (0.067)

Note(s): The dependent variable is manufacturing sector growth. Standard errors are in parentheses. *** $p < 0.01$, and ** $p < 0.05$

Source(s): Authors' work

9. Conclusion and policy implications

Although numerous studies have examined the effect of FI on the growth of firms at the micro level (Koomson and Ibrahim, 2018; Chauvet and Jacolin, 2017; Lee *et al.*, 2020), the effect of FI on the growth of the manufacturing sector at the macro level is less explored. This study complements this strand of the literature by examining the direct effect of FI on the growth of the manufacturing sector. Specifically, we explore how three different financial indicators, namely, financial knowledge, financial availability and usage of financial services, influence the manufacturing sector's growth. Ensuring financial inclusivity dwells on a strong and well-developed financial system, and thus, it is implausible to achieve FI without financial development. Therefore, we further examine how financial development influences the link between FI and the growth of the manufacturing sector.

The following findings emerge from this study. Firstly, we find that the three indicators of FI exert a positive and significant impact on the growth of the manufacturing sector, suggesting that FI accelerates the performance of the manufacturing sector. However, the positive effect of FI on the growth of the manufacturing sector turned out to be bigger for the usage of financial services. An important policy suggestion emerging out of this finding is that although ensuring that financial services are closer and available to manufacturing firms is imperative, improving the usage of financial services and products among manufacturing firms by reducing information asymmetries turns out to be the most important. However, being close to financial institutions reduces the time and cost of travelling to financial institutions; therefore, it is also important to implement policies that encourage financial institutions to build branches that will be situated closer to manufacturing firms. Doing this is likely to increase the usage of financial services among manufacturing firms to boost the growth of the manufacturing sector. One of the factors that has been identified to weaken the usage of financial services is a lack of financial knowledge, and thus, it is important to use various channels to ensure that manufacturing firms get easy access to financial information.

Secondly, we find that financial development better enhances the positive effect of FI on the growth of the manufacturing sector. Specifically, the combined effect of FI and financial development is larger than their separate effect. The policy implications are that, alongside increasing financial knowledge, usage and availability of financial services and products to the manufacturing sector, it is important to build strong financial systems and institutions that will provide these financial services. Intuitively, without a strong financial market and institutions, it will be difficult to increase the utilization of financial services among manufacturing firms to boost their performance. Therefore, when policymakers are devising policies aimed at improving the growth of the manufacturing sector, they should consider both FI and financial development as both better the performance of the manufacturing sector than their separate effects.

In the Ghanaian context, our findings suggest that the country should continue expanding digital financial services, mobile banking and agency networks to reduce geographic and socio-economic barriers to financial access. Improved access can boost credit availability and working capital for small and medium manufacturing firms. Secondly, to maximize the benefits of FI, parallel investment in financial literacy for entrepreneurs and manufacturing business owners is necessary. This improves their ability to use financial services effectively and make informed investment decisions. Finally, since financial development enhances the positive effect of inclusion, policies should aim to improve the efficiency, stability and depth of Ghana's financial system. This includes regulatory reforms, fostering competition among banks and fintech's and improving risk assessment systems.

Notes

1. Following [Chen and Woo \(2010\)](#), the PCA is mathematically computed as the PCA component is computed as: $\frac{\sum_{i=1}^p \beta_i P C_i}{\sum_{i=1}^p \beta_i}$, where $\beta_i (i = 1, \dots, p)$ denotes the i th eigenvalue and PCl is the i th principal component selected based on the Kaiser criterion.
2. The min–max transformation (not “mix-max”) is a normalization technique commonly used in economic analysis, data science and machine learning to rescale data to a fixed range, typically between 0 and 1.

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Appendix

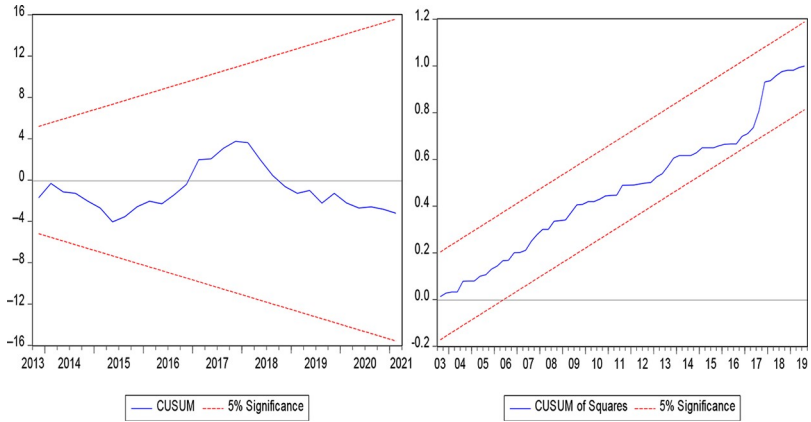


Figure A1. ARDL CUSUM and CUSUM square plots for Model 1
Source: Authors' work

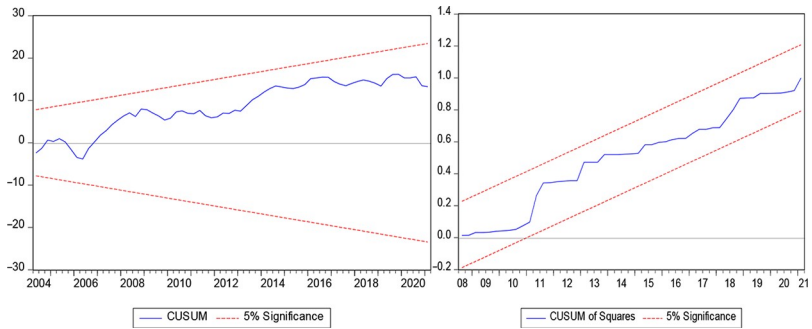


Figure A2. ARDL CUSUM and CUSUM square plots for Model 2
Source: Authors' work

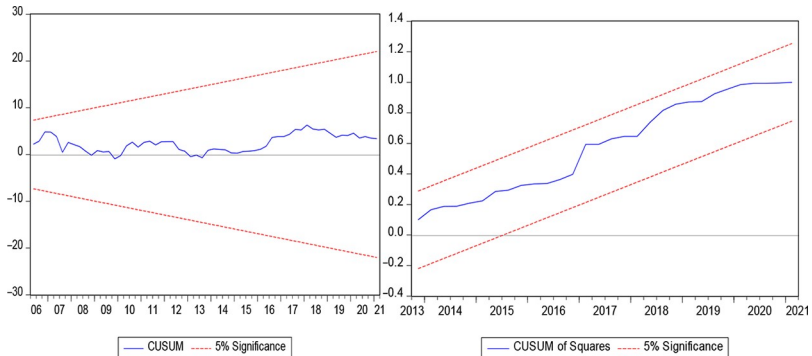


Figure A3. ARDL CUSUM and CUSUM square plots for Model 3
Source: Authors' work