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## Article

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# Estimating the impact of economic globalization on economic growth of Ghana: Wavelet coherence and ARDL analysis

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## ABSTRACT

Considering the importance of economic globalization in shaping Ghana's economic growth trajectory, examining the relationship between these two variables is crucial for policymakers to develop strategies aimed at maximizing the benefits of economic globalization and minimizing the challenges associated with it. Therefore, this study investigates the long-run and short-run effects of economic globalization on economic growth of Ghana. The autoregressive distributed lag (ARDL) is employed for the analysis. This paper further employs the Phillips-Ouliar's residual-based cointegration test and the continuous wavelet coherence test to examine the causality between economic growth and its determinants. The results from the ARDL model suggest that economic globalization has not promoted economic growth. Specifically, a 1% increase in economic globalization reduces economic growth by 1.80% and 3.90% in the short- and long run periods respectively at a 1% significance level. The results further reveal capital, government expenditure and labour as key determinants of economic growth. The wavelet causality test reveals a one-way causality from economic growth to economic globalization. Based on the findings, policy suggestions have been highlighted for stakeholders' consideration with the aim of enhancing economic growth of Ghana.

Source: Authors' compilation.

## 1. Introduction

Economic globalization – which refers to the interconnectedness among countries, particularly through trade of goods and services, financial resources (portfolio investment or foreign direct investment), international flow of labor, transfer of technology and knowledge across borders and various policies that facilitate these flows (Ahmed et al., 2021; Baidoo et al., 2023; Gygli et al., 2019; Quinn et al., 2011; Shangquan, 2000), – serves as an engine for economic growth globally. The economic growth effect of economic globalization is due to (i) the emergence of science and technology which has greatly lowers the cost of international trade and investment through improvement in transportation and communication, thus making it convenient to organize

and coordinate production, and (ii) multinational organizations expanding their frontiers into new markets and establishing network subsidiaries in other areas, especially, in manufacturing, service, and the financial sectors.

The dynamics of economic globalization has shaped the development agenda of nations around the world. Economic globalization facilitates economic growth, especially in developing countries through the access to intermediate and finished goods via trade, increase in the inflow of foreign direct investment (FDI), increase human capital development, enhanced productivity and efficiency through competition, technology transfer and innovation, access to external markets and capital (Kilicarslan & Dumrul, 2017; Yameogo et al., 2021). It is documented that open economies are likely to grow faster than closed economies (Grossman & Helpman, 1991). For example, trade facilitates the diffusion of knowledge and technology to enhance the production of

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**List of acronyms and meaning**

ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributed lag
CUSUM	Cumulative sum
CUSUMSQ	Cumulative sum of squares
CWT	Continuous Wavelet Transform
FDI	Foreign Direct Investment
GMM	Generalized Method of Moments
OECD	Organization for Economic Cooperation and Development
ODA	Official Development Assistance
AfCFTA	African Continental Free Trade Area
WC	Wavelet Coherence
WCS	Wavelet Coherence Spectrum
WT	Wavelet Transform
WPS	Wavelet Power Spectrum
DWT	Discrete Wavelet Transformation

goods and services and consequently, economic growth (Baidoo et al., 2022; Duodu & Baidoo, 2020; Egyir et al., 2020; Zahonogo, 2018). Nonetheless, studies such as Adesoye et al. (2015) and Yameogo et al. (2021) argued that developing countries have not benefited optimally from economic globalization in terms of economic growth compared to their developed counterparts. This is because developing countries rely on raw materials without any value addition, making their economies susceptible to global shocks. As indicated by Tetteh & Ntsiful (2023), this is evident in the current Russia-Ukraine war as the prices of wheat, fertilizer and oil have increased dramatically, causing uncontrollable inflation in most developing countries of which Ghana is no exception. In addition, economic globalization generates unhealthy competition which retards the expansion of local industries and consequently, harms economic growth (Kilicarslan & Dumrul, 2017).

Economic growth of Ghana for the past three decades has not been as expected (Duodu & Baidoo, 2022). However, after the recovery from the recessions in the 1980s, Ghana's economic growth started improving. In 2007, for instance, Ghana attained a middle-income status with gross domestic product (GDP) per capita of USD 1,000 and increased to USD 1,900 in 2013 (Aryeetey & Baah-Boateng, 2015). Average annual GDP growth rates of 5.36% and 6.68% were recorded from 2000 to 2009 and 2010–2018 respectively (Duodu & Baidoo, 2022). In 2022, the real GDP growth declined to 3.3% compared to the 5.4% recorded in 2021. This decline was attributed to factors, including macroeconomic instability, global financial tightening resulting from the Covid-19 pandemic, and the spillover effects of Russia-Ukraine war (African Development Bank, 2023). This low growth calls for actions from stakeholders to put measures in place to promote economic growth, and eventually, the welfare of the citizens. However, it is worth mentioning that these measures to be adopted and implemented need to be guided by empirical research like the present study. Considering the relatively slow growth over the years, Ghana has made some efforts and continue to do so in the areas of trade, and foreign direct investment in the hope of improving the macroeconomic performance (Nketiah et al., 2019; Sakyi et al., 2015). One significant effort is the signing of the African Continental Free Trade Area (AfCFTA) agreement in conjunction with other African countries. The motive for establishing AfCFTA is to promote trade (which is a key component of economic globalization) among African countries which Ghana is part.

Despite the unimpressive growth of the economy, economic globalization through the lens of international trade and financial flows (including foreign direct investment) in Ghana has been increasing in recent years. For instance, the average total trade (exports plus imports) was 69.5% of GDP from 2010 to 2019. In the year 2019, total trade in

goods was 43% of GDP (USD 29 billion) but reduced to 39.2% of GDP (USD26.8 billion) in 2020 due to the Covid-19 pandemic that interrupted global supply chain (Raga, 2022). Similarly, foreign direct investment (FDI) has increased in the last decade. For example, in 2012, FDI increased to about USD16 billion from USD2 billion in 2001. However, in 2020, the figure reduced by 52% due to the Covid-19 pandemic (Raga, 2022). To put it into perspective, according to the KOF globalization index, economic globalization (comprising financial and trade globalizations) increased from 27.6 in 1990 to 44.92 in 1994 and 50.42 in 2000. However, it declined to 39.63 in 2008 from 51.05 in 2003. In 2020, it increased to 49.02 (KOF Globalization index database - <https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html>). Other capital inflows such as remittances was 0.44, 10.13 and 5.80 (% of GDP) in 2009, 2015 and 2018, respectively (Duodu & Baidoo, 2022).

Considering the important role of economic globalization (trade and financial globalization) in economic growth, and also, the need to promote economic growth, it is imperative to empirically investigate the relationship between the two. A plethora of studies have investigated the relationship between the economic globalization and economic growth in Ghana and other developing countries (Adesoye et al., 2015; Akadir et al., 2020; Awad & Ragab, 2018; Coulibaly, 2023; De Matteis, 2004; Dinh Su & Phuc Nguyen, 2022; Duodu & Baidoo, 2022; Huchet-Bourdon et al., 2018; Kilicarslan & Dumrul, 2018; Kneller et al., 2008; Manu et al., 2020; Nguea et al., 2022; Nketiah et al., 2019; Ofoeda et al., 2022; Ofori & Figari, 2023; Olubiyi, 2014; Owusu, 2021; Sakyi et al., 2015; Sakyi & Egyir, 2017; Singh, 2010, 2011; Slesman et al., 2015; Thirlwall, 2000; Tinta et al., 2021; Zahonogo, 2018). However, studies on Ghana regarding the subject matter have focused on just trade or financial inflow such as FDI, remittances or ODA as measures of economic globalization (see Aperegdina, 2022; Duodu & Baidoo, 2022; Kulu et al., 2021; Nketiah et al., 2019; Sakyi et al., 2015; Udeagha & Ngepah, 2021; Yennu, 2018). Using indicators such as trade, FDI, ODA and remittance as measures of economic globalization becomes problematic in terms of policy implications considering the multifaceted nature of economic globalization. These variables do not provide a holistic measure of economic globalization because they do not capture the policy aspects of economic globalization, hence results obtained from such variables may impede wider scope of policy adoption and implementation. Furthermore, international trade and FDI in Ghana are influenced by factors such as trade regulations, investment restrictions, taxes, and international agreements, which are not captured by trade and FDI variables used in these past studies. Hence, using indicators like trade, FDI, and ODA has the potential of providing misleading results as far as economic globalization is concerned. Therefore, there is a need for further research to re-examine the consequences of economic globalization on economic growth of Ghana using a holistic measure that accounts for the multifaceted dimension of economic globalization. This is what this present paper seeks to achieve.

Studies on economic growth and economic globalization is equally important for the Ghanaian economy considering the unprecedented environmental changes, especially, in the contemporary era (see Akram et al., 2023; Adebayo & Alola, 2023; Jahanger et al., 2023; Liu et al., 2023). This has called for global effort through the COP26, which highlights the importance of International Corporation in addressing environmental issues. Ghana's pursuit of growth through economic globalization has led the extraction of natural resources and expansion of industrial activities, energy consumption, which could harm the environment. Understanding the link between economic globalization and economic growth in Ghana is essential as the interaction between the two has potential spillover effect on the environment, hence making this present study important.

Ghana, like many other developing countries, faces challenges as well as opportunities with regard to achieving sustained economic growth and benefiting from economic globalization. Studies in this area would be beneficial to policymakers on the subject matter. Within this

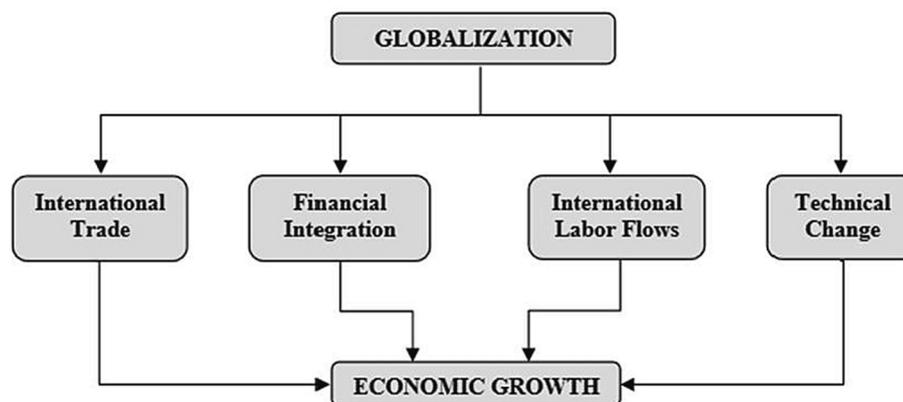


Fig. 1. Theoretical framework of the relationship between globalization and economic growth. Source: Adopted from Hossain et al. (2018).

context, this paper seeks to examine the impact of economic globalization on economic growth of Ghana. The study makes some contributions to economic globalization–economic growth literature. First, this current study employs a robust or broader measure of economic globalization (KOF economic globalization index) that accounts for both the flow of goods and services and financial resources and the policies that facilitate these flows. According to Gygli et al. (2019), this broader measure of economic globalization used in this present study account for geographical distribution of trade linkages and also provide quality-based measures which has the potential to reduce the volatilities and possible measurement errors in the flow of financial resources. To capture broader dimensions of financial flow, this index incorporated the sum of primary income payments and receipts as a share of GDP (Kilic, 2015), investment restrictions, and capital account openness, which the conventional priced-based measures such as FDI and ODA do not capture. Second, this paper employs the wavelet coherence technique that considers both time and frequency dimensions simultaneously to explore the co-movements and causality between economic globalization and economic growth which no past study, especially, on Ghana has considered. Third, this study employs the Phillips & Ouliaris (1990) residual-based cointegrations tests to examine the long-run relationship among the variables. This test is efficient in small sample sizes compared to other cointegration tests such as Engle & Granger (1987) cointegration test. Also, this test is robust in the presence of autocorrelation and potential heterogeneity in the residuals which is a common issue in conventional time series analysis. Fourth, this paper makes use of the Zivot & Andrews (2002) and Lee & Strazicich (2013) LM unit root tests which is able to determine possible structural break to examine the stationarity properties of the variables.

The remainder of the paper is structured as follows. The next section discusses the theoretical and empirical literature review, and this is followed by model specification and data description in section 3. Thereafter, the results and discussion is presented in the fourth section and the last section provides conclusions of the paper.

## 2. Theoretical and empirical literature review

This section presents the theoretical and empirical literature review that underpin this paper. Before discussing the theoretical underpinnings of this paper, Fig. 1 which shows the potential relationship between globalization and economic growth is presented.

Fig. 1 shows the theoretical connections between globalization and economic growth. Globalization could impact economic growth through four main channels as indicated by Hossain et al. (2018); the flow of goods and services, financial integration, international labour flows and technical change to facilitate production. For instance, financial integration may promote economic growth through capital allocation, enabling risk diversification, facilitating investment, and promoting

financial stability. Also, through international trade, countries could have access to larger markets, finished and semi-finished goods to increase production and consumption which in turn increase economic growth of countries.

Theoretically, the link between economic globalization and economic growth could be explained by the neoclassical and endogenous growth theories. The neoclassical growth model argues that a country may foster its growth by trading with other countries through competitive and absolute advantages. This implies that countries may generate revenue by trading, and hence, they can grow faster (Ricardo, 1817; Smith, 1776). The neoclassical growth theory also recognizes that economic globalization, characterized by increased international trade (trade globalization) and investment flows across country borders (financial globalization) could foster growth through competition, innovation and the efficient allocation of resources (Heimberger, 2022). It is also indicated that trade (component of economic globalization) has only short-term benefits (Baldwin, 1989). In the endogenous growth models, the impact of trade globalization is much straightforward as countries that open up grows faster, especially, the developing ones (Yanikkaya, 2003; Young, 1991), through technology spillovers and transfer of knowledge. In addition, financial flows such as FDI (component of financial globalization) may affect growth only if it enhances technological progress as indicated by the neoclassical growth theory (Iamsiraroj & Ulubaşoğlu, 2015). In addition, the endogenous growth theory indicates that FDI can influence growth directly by facilitating new technologies and capital accumulation and indirectly through improving infrastructure, human capital, institutions, and spillovers. Furthermore, financial globalization can assist the host nation in gaining access to new markets and source of funds for growth (Baldwin et al., 2005). However, the Structuralists posit that external capital inflow may crowd out domestic credit mobilization and may impede growth in the recipient country (Papanek, 1973). For example, Borensztein et al. (1998) argue that the productivity of external capital inflow is contingent on favorable factors in the host country such as human capital, and that the benefits are a consequence of distorted incentives. This shows that the theoretical predictions of financial globalization and growth is not clear-cut (Heimberger, 2022).

Studies have attempted to investigate the effect of economic globalization (trade and financial globalization) on economic growth using various sub-components of economic globalization such as trade openness (% of GDP), FDI, and remittances. For instance, Papanek (1973) investigated the role of financial flows (aid, foreign private investment and saving) on economic performance of less developed countries. Using cross-country regression, the author reported that saving and foreign inflows accounts for over a third of growth in these countries. Similarly, Borensztein et al. (1998) used data on financial inflows to 69 developing countries to probe the effects of FDI on economic growth. The results obtained support the notion that FDI is growth-enhancing through

technology transfer. Specifically, FDI had a positive impact on economic growth, after controlling for income, human capital development, parallel market premium for foreign exchange and government expenditure. However, the authors reported that the productivity of the financial inflows is contingent on human capital development of the recipient nation. Yanikkaya (2003) investigated trade openness and economic growth nexus in OECD and non-OECD countries. The author used annual data from 1970 to 1997 across 100 developed and developing countries. The results from the cross-country regression showed that trade benefits developing countries through scale of economies, technology transfer and competitive advantage. This results is support Wacziarg & Welch (2008) who reported that countries that open up to trade with other countries experienced an average growth of 1.5 percentage points higher than before liberalization. On the contrary, De Matteis (2004) documented that increasing international exposure had some adverse effects on growth. From a global perspective, Iamsiraroj & Ulubaşoğlu (2015) examined the impact of FDI on economic growth using 140 countries from 1970 to 2017. The author revealed that FDI significantly affects economic growth, but more pronounced in developing countries.

Sakyi & Egyir (2017) employed the system GMM to examine the impact of trade (measured by exports) and FDI on economic growth of 45 African countries from 1990 to 2014. The authors reported a positive relationship between trade and economic growth. The interaction of trade and FDI also had a significant positive relationship with economic growth supporting the Bhagwati hypothesis. Gözgor & Can (2017) investigated the causal link between economic globalization, export diversification and economic growth for 169 countries from 1970 to 2010 and reported a bidirectional causality between economic globalization and economic growth. Moreover, the authors reported a unidirectional causal link from export diversification to growth. Similarly, Huchet-Bourdon et al. (2018) showed that trade promotes growth using panel data from 169 countries. Gaies et al. (2019) examined how financial globalization and instability affect growth in 72 developing countries from 1972 to 2011, using the two-step system GMM. The results showed that financial globalization promotes economic growth. Ulucak (2019) explored the effects of KOF globalization indexes (economic, political, and social globalization) on economic in emerging economies from 1970 to 2014. The results revealed that economic and social globalization promoted growth while political globalization impacted growth negatively. Akadiriri et al. (2020) examined the causal relationship between trade, FDI and economic growth for 25 African countries for the period 1980 to 2018. The authors reported a bidirectional causality between trade, FDI and economic growth. Using panel vector autoregressive and the panel quantile regression technique, Manu et al. (2020) examined financial development-growth nexus from 1980 to 2017 for 33 African countries. The study also examined the causal link between trade, FDI and economic growth. The results showed that FDI and trade cause economic growth over the sample considered. Coulibaly (2023) used the Pooled Mean Group technique to examine the effect of trade on economic growth for 44 African countries over the period 1980 to 2017. It was revealed that trade enhances growth which support the assertion by Baidoo et al. (2023) that economic globalization (which captures trade) is good for growth. On the contrary, Chibalamula et al. (2023) revealed that trade is detrimental to economic growth in a panel of five African countries. In addition, the results from the random fixed effects estimation indicated that FDI is good for growth in these countries.

There have also been country-specific studies on other developing countries (see for instance, Olubiyi, 2014; Adesoye et al., 2015; Polat et al., 2015; Joshua et al., 2020; Owusu, 2021; Heimberger, 2022). For example, Olubiyi (2014) reported that imports and remittances cause economic growth in the short-run. The study further established a bidirectional causality between imports, exports, and GDP. Adesoye et al. (2015) also revealed that there is a positive relationship between FDI, trade openness and economic growth of Nigeria. Polat et al. (2015)

documented that trade openness influenced economic growth negatively for South Africa. Joshua et al. (2020) revealed there is positive relationship between trade globalization and economic globalization for Nigeria in the long run. Owusu (2021) also reported that there is a bidirectional causality between FDI and growth and a one-way causal relationship that runs from trade to economic growth. Heimberger (2022) also reported that globalization promoted growth.

There are some studies that have also focused specifically on Ghana. For instance, Sakyi et al. (2015) examined the dynamic relationship between FDI, trade and economic growth, utilizing data from 1970 to 2011. The results from the ARDL model revealed that the interaction of FDI and exports foster economic growth in Ghana. Mireku et al. (2017) employed the ARDL model to investigate trade openness and economic growth for the period 1970 to 2014. The results showed a positive relationship between trade openness and economic growth which is consistent with the study by Yennu (2018). In a related study, Nketiah et al. (2019) examined the relationship between FDI, trade openness and economic growth using the ordinary least squares estimation technique. The results showed that only trade had a significant effect on growth. Kulu et al. (2021) examined the impact of FDI on economic growth from the period 1995 to 2019. The results from the ARDL model revealed that FDI does not promote growth. However, the results turned significant and positive when interacted with institution. Similarly, Duodu & Baidoo (2022) investigated the impact of capital flow on economic growth, controlling for institutions for the period 1984 to 2018. The results from the ARDL revealed that remittances promote economic growth whereas external debt and FDI harm growth. The authors further reported that foreign aid does not have any significant implications on growth. Applying ARDL model to a dataset from the period 1990 to 2019, Apergedina (2022) reported that trade is detrimental to economic growth.

The empirical studies reviewed show that studies, especially, those on Ghana have used sub-components like trade, FDI, and remittances as measures of economic globalization in examining the relationship between economic globalization and economic growth. However, these indicators do not reveal the overall effect of economic globalization. This therefore impedes comprehensive policy design, adoption and implementation because such indicators or components do not capture the multifaceted dimension of economic globalization. For instance, trade openness measures only the flow of goods and services; it does not account for factors such as trade regulations, taxes, and tariffs. It is therefore imperative to use a broader measure of economic globalization for the investigation; this broadens the policy implications of the findings. This is what this present study seeks to do; using a broader measure of economic globalization which captures both the flow of goods and services, and financial resources as well as the policies that facilitate these flows. Doing this fills the gap created in the existing literature.

### 3. Model specification, methodology and data

This section outlines the methodological framework, data as well as the estimation strategies adopted for this study and it is divided into three parts. The first part presents the model specification. The second and third parts focus on estimation approach employed and data description respectively.

#### 3.1. Model specification

This study specifies equation (1) following the neoclassical Solow growth model which relates output to capital, labor and technology advancement as well as a study by Ehigiamusoe (2022). The model argues that long-run growth is a function of capital accumulation, labor and labor-enhancing technology that improves productivity (Solow, 1956).

$$Y_t = A_t K_t^{\alpha_1} L_t^{\alpha_2} \quad (1)$$

where  $Y, K, L$  and  $A$  represent output, capital, labor, technological progress, respectively,  $\alpha_1$  and  $\alpha_2$  are the elasticities of capital and labour respectively and  $t$  is the time element. Assuming that technological progress variable ( $A_t$ ) could be influenced by economic globalization ( $EGLO$ ),  $A_t$  can be re-specified as follows:

$$\Delta \ln Y_t = \vartheta_0 + \vartheta_1 \ln Y_{t-1} + \alpha_1 \ln K_{t-1} + \alpha_2 \ln L_{t-1} + \beta_1 \ln EGLO_{t-1} + \beta_2 \ln GE_{t-1} + \beta_3 \ln INF_{t-1} + \sum_{i=1}^p \vartheta_2 \ln Y_{t-i} + \sum_{i=1}^q \varphi_1 \ln K_{t-i} + \sum_{i=1}^r \varphi_2 \ln L_{t-i} + \sum_{i=1}^s \varphi_3 \ln EGLO_{t-i} + \sum_{i=1}^m \varphi_4 \ln GE_{t-i} + \sum_{i=1}^v \varphi_5 \ln INF_{t-i} + \varepsilon_t \tag{6}$$

$$A_t = EGLO_t \tag{2}$$

Substituting equation (2) into equation (1) yields equation (3).

$$Y_t = EGLO_t^\beta K_t^{\alpha_1} L_t^{\alpha_2} \tag{3}$$

where the variables are as already explained and  $\beta$  is the elasticity of economic globalization. Despite the traditional variables incorporated in the production function, studies (such as, [Ehigiamusoe, 2022](#)) have stressed the importance of government expenditure and inflation in economic growth in developing countries. Hence, this study incorporates government expenditure ( $GE$ ) and inflation ( $INF$ ) into the equation as specified in equation (4).

$$Y_t = EGLO_t^\beta K_t^{\alpha_1} L_t^{\alpha_2} GE_t^\delta INF_t^\theta \tag{4}$$

where the variables are as explained earlier,  $\delta$  and  $\theta$  are the elasticities of government expenditure and inflation, respectively. Taking logs of both sides to linearize the equation and introducing constant and error terms yields equation (5) for estimation.

$$\ln Y_t = \rho + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \beta \ln EGLO_t + \delta \ln GE_t + \theta \ln INF_t + \varepsilon_t \tag{5}$$

[

### 3.2. Estimation strategy

The main empirical model is the autoregressive distributed lag (ARDL) model, and the error correction model proposed by ([Pesaran et al., 2001a](#)). This model is chosen based on the following reasons. First, it can estimate the long- and short-run results regardless of the integration order among the variables in the study. Specifically, it provides reliable results even if one or more of the variables are stationary at levels  $[I(0)]$ , first-difference  $[I(1)]$  or mixed orders. Second, it is efficient in handling small sample size compared to other methods such as the ordinary least square ([Duodu & Baidoo, 2022](#)). The ARDL does not necessarily require prior testing of unit root, but the model is ineffective when one or more of the variables are stationary in second order  $[I(2)]$ . Hence, it is important to investigate the stationary properties of the variables. To this end, this paper employs the Augmented Dickey-Fuller [ADF], Phillips-Perron [PP], and Kwiatkowski-Phillips-Schmidt-Shin [KPSS] unit root tests. The null hypothesis of unit root is tested against the alternative of no unit root for the ADF and PP tests while for the KPSS test, the null hypothesis of no unit root (stationary) is tested against the alternative hypothesis of non-stationary series. However, [Zhang et al. \(2021\)](#) and [Tetteh & Baidoo \(2022\)](#) indicate that these conventional unit root tests are ineffective in the presence of structural breaks. To circumvent this shortfall, this present paper uses the [Zivot & Andrews \(2002\)](#) as well as [Lee & Strazicich \(2013\)](#), which accommodate stationarity features and structural breaks simultaneously.

After examining the stationary properties of the variables, the con-

ditional error correction model (ECM) is estimated. Afterwards, the ARDL formulation of equation (5), which produces both long-run and short-run estimates in a single equation as specified in equation (6) is estimated.

In equation (6),  $\vartheta_0$  and  $\Delta$  represent the constant term and the first difference operator, respectively,  $p, q, r, s, m$  and  $v$  are optimal lags for respective variables. Also,  $\vartheta_1, \alpha_1, \alpha_2, \beta_1, \beta_2$  and  $\beta_3$  are the long-run coefficients and  $\vartheta_2$  and  $\varphi_i$  ( $i = 1, 2, 3, 4, 5$ ) are the short-run parameters that measure the impact of the various independent variables on economic growth. In terms of a priori expectations, it is expected that capital and labor enhance economic growth based on the neoclassical growth model ([Ehigiamusoe, 2022](#)). Inflation is expected to reduce long-term economic growth since it deteriorates the real value of capital and investment and thereby reducing economic growth. Government expenditure is expected to influence economic growth positively following the Keynesian economics proposition regarding the role of government spending in an economy. Economic globalization is expected to promote economic growth as argued in the neoclassical growth theory, hence a positive relationship is anticipated.

To establish a long-term relationship among the variables, ([Pesaran et al., 2001b](#)) proposed and F-test for joint significance among the coefficients of the lagged values of all the variables as specified in equation (6). The null hypothesis of no long-run relationship [ $H_0: \vartheta_1 = \alpha_1 = \alpha_2 = \beta_1 \dots = \beta_3 = 0$ ] is tested against an alternative of long-run relationship [ $H_0: \vartheta_1 \neq \alpha_1 \neq \alpha_2 \neq \beta_1 \dots \neq \beta_3 \neq 0$ ]. The authors proposed two critical values, lower bound  $[I(0)]$  and upper bound  $[I(1)]$  based on F-test. The null hypothesis is rejected when the F-statistic exceeds the upper bound critical value. The decision becomes inconclusive when the F-statistic value falls between the upper and lower bound critical values. Furthermore, to ensure that estimated model is free from econometric problems, this paper performs normality and autocorrelation tests using Jarque-Bera and Breusch-Godfrey LM tests, respectively. The Ramsey reset, and the Breusch-Pagan-Godfrey tests are employed to check for possible functional form misspecification and heteroscedasticity, accordingly. Lastly, the plots of the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) are employed to determine the stability of the model used.

As noted by [Younger \(2016\)](#), macroeconomic variables in Ghana, especially, economic growth and economic globalization variables have undergone series of changes and shocks. This may cause possible serial correlation and heterogeneity in the residuals when testing for cointegration. To account for these dynamics, this paper employs the [Phillips & Ouliaris \(1990\)](#) residual-based cointegration test that accounts for serial correlation and potential heterogeneity problems among the variables. Also, the test included deterministic trends, such as constant and linear trend terms, in the cointegration analysis. This makes it more flexible and applicable to situations where such trends are present; which is particularly pertinent to time series variable. The test hinges on Augmented Dickey-Fuller (ADF) regression framework as follows:

$$\Delta y_t = \alpha + \beta t + \vartheta \Delta y_{t-1} + \sum_{i=1}^{p-1} \delta_i z_{t-i} + \varepsilon_t \tag{7}$$

where  $\Delta$  is the first difference operator.  $y_t, \beta, \alpha$ , and  $\delta_i$  are the dependent variable, coefficient of the time trend, constant term, and the coefficient of short-term dynamics, respectively.  $\varepsilon_t$  is the error term, which is nor-

**Table 1**  
Results for the descriptive statistics and correlation.

	lnY	lnEGLO	lnL	lnINF	lnGE	lnK
Mean	6.4865	3.7083	16.2484	2.873	2.2817	2.9007
Maximum	7.7330	3.9328	16.7594	4.0853	2.7284	3.3674
Minimum	5.535	3.318	15.7464	1.5821	1.9397	1.9281
Std. Dev	0.7722	0.1914	0.3245	0.6062	0.2205	0.3579
Skewness	0.4931	-0.7563	-0.0297	0.1003	0.1461	-0.8226
Kurtosis	1.5326	2.2399	1.6600	2.1841	2.0789	2.9365
J-B [p-value]	0.0898	0.1098	0.2499	0.5803	0.4869	0.1237
Observations	37	37	37	37	37	37
<b>Correlation</b>						
lnY	1.0000					
lnEGLO	0.3911	1.0000				
lnL	0.8710	0.7668	1.0000			
lnINF	-0.5693	-0.3167	-0.5500	1.0000		
lnGE	-0.5716	-0.0302	-0.4414	0.2652	1.0000	
lnK	0.2113	0.7234	0.5412	-0.0831	0.1366	1.0000

Note: Std, Dev denotes standard deviation; J-B represents Jarque Bera.  
Source: Authors' estimation

mally distributed with a constant variance and zero mean. There are two main test statistics; the  $Z_a$  and the  $Z_t$  test statistics, as expressed in equations (8) and (9).

$$ZT = \frac{\hat{\beta}}{se(\hat{\beta})} \tag{8}$$

$$ZA = \frac{\hat{\vartheta}}{se(\hat{\vartheta})} \tag{9}$$

where  $\hat{\beta}$  and  $\hat{\vartheta}$  are the estimated coefficient of the time trend and the lagged level term, accordingly and  $se()$  are their corresponding standard errors. The null hypothesis of no cointegration ( $\beta = 0$  or  $\vartheta = 0$ ) is tested against and alternative hypothesis of cointegration ( $\beta \neq 0$  or  $\vartheta \neq 0$ ). The test can be performed with no constant and trend, constant only or both constant and deterministic time trend and allows for multiple variables. The GAUSS 23 software is used for the estimation.

After the seminal work of Goupillaud et al. (1984) who pioneered the use of wavelet coherence analysis, the technique has been employed to analyze financial and economic data (Kumar et al., 2017; Zhang et al., 2021; Adebayo, 2022; Liu et al., 2023). The model is suitable for time series analysis since it can estimate correlation and causality at both time and frequency-domain simulations. In addition, the model accounts for structural correlation, which conventional time-domain causality models are not able to do so (Zhang et al., 2021).

A wavelet  $\phi_\nu, s(t)$  could be represented as real-valued function such that equation (10) is satisfied.

$$\phi_\nu, s(t) = \phi \frac{t - \nu}{\sqrt{s}} \tag{10}$$

where  $t, \nu$  and  $s$  represent the time, location, and scale. A wavelet has a mean of zero,  $\int_{-\infty}^{\infty} \phi(t)dt = 0$  and conventionally normalized to  $\int_0^{\infty} \phi^2(t)dt = 1$  (Kumar et al., 2017). In time series analysis, the model is reconstructed from its wavelet transform (WT) if it conforms to the following admissibility condition.

$$C_\phi = \int_0^{\infty} \frac{|\phi(f)|^2}{f} df < +\infty \tag{11}$$

here,  $\phi(f)$  is the Frontier transform of a given wavelet. There are two main classifications of the wavelet model. These are the continuous wavelet transform (CWT) and the discrete wavelet transform (DWT). The fundamental difference between the two is that the CWT estimates a given time series across all different frequencies while the DWT considers time series across dyadic scale such as 2, 4, 6, 8, 16 and so on. Hence, the DWT is limited because it requires that the time series should

be dyadic in length. Therefore, following Zhang et al. (2021), this study uses the CWT wavelet in the “mother” Mortlet wavelet family of wavelets. The model is specified in equation (12).

$$\phi(t) = \pi^{-\frac{1}{4}} e^{-i\omega_0 t} e^{\frac{t^2}{4}} \tag{12}$$

The wavelet transform (WT) of the time series,  $y_t$  using the Mortlet wavelets defined as a combination of series with a set of “daughter wavelets” generated by “mother wavelets” at different time translation,  $\tau$  and time scale,  $s$  can be written as follows:

$$w_y(\tau, s) = \int_{-\infty}^{\infty} y(t) \frac{1}{\sqrt{|s|}} \phi^* \left( \frac{t - \tau}{s} \right) dt \tag{13}$$

where  $*$  denotes the complex conjugate. The location of a daughter wavelet in the time domain is determined by localizing the time parameter,  $\tau$ , adjusted by the time increment of  $dt$ . The wavelet coverage of the series in the frequency domain is determined by the choice of the set of scales,  $s$ . From equation (13), the wavelet power spectrum (WPS) is constructed to capture the extent of volatility of the time series across different timescales as specified in equation (14).

$$WPS = |W_x(\tau, s)|^2 \tag{14}$$

where  $||^2$  is the square of the amplitude. In bi-variate framework, there are two main tools, namely, the wavelet coherence (WC) and the wavelet cross spectrum (WCS). In this case, the WC is analogous to correlation across different time scales while the WCS shows how the changes on one time series affects the other across different time scales. For example, the WC between two time series variables,  $X(t)$  and  $Z(t)$  is presented in equation (15).

$$R_{x,z}^2(\tau, s) = \frac{|S(s^{-1}w_{x,z}(\tau, s))|^2}{S(s^{-1}|w_x(\tau, s)|^2) \cdot S(s^{-1}|w_z(\tau, s)|^2)}, R^2 \in [0, 1] \tag{15}$$

where  $S$  is the smoothing parameter. On one hand, when  $R_{x,z}^2(\tau, s)$  reaches 1, it means that the time series indicators are correlated and that there is a causal relationship at a certain stage between them. On the other hand, when  $R_{x,z}^2(\tau, s)$  reaches 0, it means that the time series indicators are not correlated and that there is no evidence of causality. The WCS is specified in equation (16).

$$C_{x,z}(\gamma, \delta) = X^*(\gamma, \delta)Z(\gamma, \delta) \tag{16}$$

From equation (16),  $X^*(\gamma, \delta)$  and  $Z(\gamma, \delta)$  are the coefficients of the two time series variables. The absolute value of  $C_{x,z}$   $\{|C_{x,z}(\gamma, \delta)|^2 = |X^*(\gamma, \delta)Z(\gamma, \delta)|^2 = |X^*(\gamma, \delta)|^2|Z(\gamma, \delta)|^2\}$  is used for

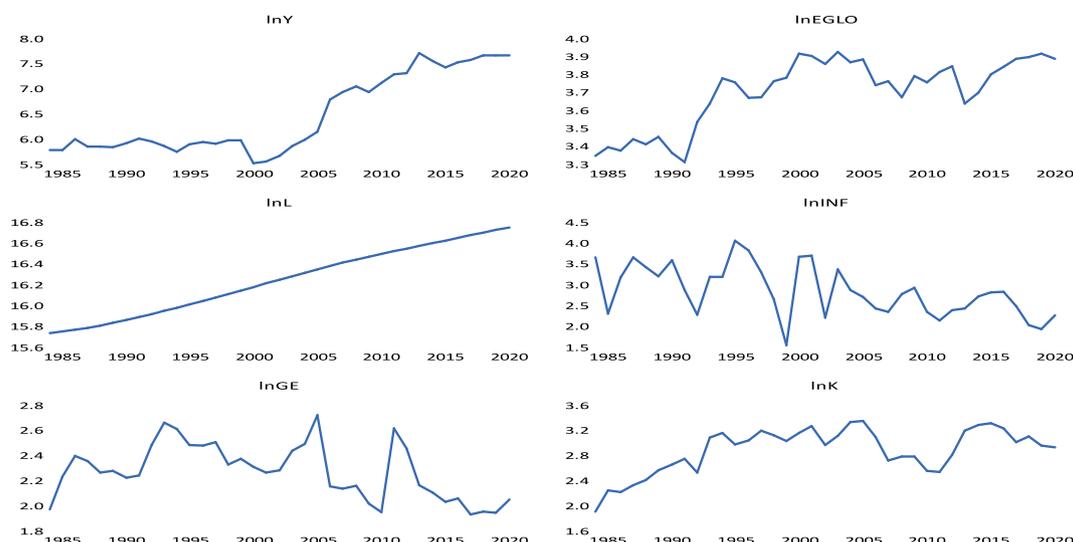


Fig. 2. Graphs of the variables. Source: Authors' construction.

visualization (in the case of complex wavelet) as Mortlet since  $C_{x,z}$  is complex in nature. In this study, the biwavelet package in RStudio 4.1 is used to estimate the model. For robustness purposes, the Toda & Yamamoto (1995) [T-Y] causality test is included in the analysis.

3.3. Data and variable descriptions

This paper uses annual data from 1984 to 2020. The variables considered are economic growth, economic globalization, labour force, capital, government expenditure and inflation. The starting period was chosen because the period marks many economic and social transformation policies in Ghana (Duodu & Baidoo, 2022). Economic growth is measured using GDP per capita (current US\$), while economic globalization index which encompasses both de-facto and de-jure measures of trade and financial globalization indexes is used as a measure of economic globalization. Specifically, the components of economic globalization in terms of actual flow of goods and services and financial resources are trade in goods and service, trade partner diversity, foreign direct investment, portfolio investment, international debt, international reserves, international income payments. The components in terms of the policies that facilitate these flows are trade regulations, trade taxes, tariffs, trade agreement, investment restrictions, capital account openness and international investment agreements. It is an index and the values range from 0 to 100, where large (small) values denote higher level (low level) of globalization. Labour force is measured using total population from 15 to 64 years due to unavailability of employment data for Ghana. With regard to capital and inflation, this study uses gross fixed capital formation (% GDP) and consumer price index (percentage), respectively. Government

expenditure is measured by general government consumption expenditure as a percentage of GDP. All the data is sourced from the World Bank's World Development Indicators (WDI) database, except the economic globalization index variable which is obtained from the KOF globalization database of the Swiss Economic Institute (Gygli et al., 2019).

4. Results and discussion

This section presents the empirical results of the paper. Specifically, the summary statistics, trends, stationarity properties and cointegration test, ARDL results and the wavelet causality tests results are presented and discussed.

4.1. Descriptive statistics

The summary of the descriptive statistics and correlation among the variables are reported in Table 1.

From Table 1, all the variables have positive averages. Particularly, economic growth, economic globalization, labour, inflation, government expenditure and capital recorded averages of 6.4865, 3.7083, 16.2484, 2.873, 2.2817, and 2.9007, respectively. The average for the economic globalization shows that, although the Ghana's integration with the global economy has intensified in recent year, it could still be improved. The low standard deviation shows that there is minimal dispersion among the variables around their respective means. In terms of distribution, the probability values of Jarque-Bera show that the variables are normally distributed, while the skewness indicates that economic globalization, labour and capital are skewed to the left and the

Table 2  
Unit root test results.

Variable	ADF test				P-P test			
	Levels		First difference		Levels		First difference	
	No Trend	Trend	No Trend	Trend	No Trend	Trend	No Trend	Trend
lnY	-0.0605	-1.6235	-5.2448***	-5.2496***	-0.1203	-1.6794	-5.2448***	-5.2510***
lnEGLO	-1.8571	-2.1499	-6.3020***	-6.2568***	-1.7593	-2.1494	-6.5596***	-6.7046***
lnL	1.0705	-3.4247**	-1.9874*	-2.1013*	4.9924	-7.1933***	-3.1468**	-1.5461**
lnINF	-0.6818	-5.1505***	-6.0733***	-5.9347***	-4.2574***	-6.1435***	-15.7205***	-17.5400***
lnGE	-2.9202*	-2.8838	-4.6103***	-4.0030***	-3.0034**	-3.8404**	-8.6242***	-10.0032***
lnK	-2.5120	-2.5995	-4.9126***	-5.1818***	-3.0757**	-2.5723	-5.7590***	-6.0267***

Note: \*\*\*, \*\*, and \* denote 1, 5, and 10 percent significance level respectively. Source: Authors' estimation

**Table 3**  
Phillips-Ouliaris (1990) and bound cointegration tests.

Phillips-Ouliaris (1990) test		Constant		Constant and Trend	
No constant or trend					
Test statistics	Decision	Test statistics	Decision	Test statistics	Decision
ZT	-13.184***	-2.928	Cannot reject the null hypothesis	-5.013*	Reject the null hypothesis
ZA	-33.639	-14.127	Cannot reject the null hypothesis	-30.09	Cannot reject the null hypothesis
<b>Bound test</b>		<b>Lower bound critical value</b>		<b>Upper bound critical value</b>	
Test statistics					
4.2520**		2.62		3.79	

Note:  $H_0$ : No cointegration,  $H_1$ : Cointegration; \*\*\*, \*\*, \* represent rejection of the null hypothesis of no long run relationship at 1%, 5% or 10% significance level respectively.

Source: Authors' estimation

**Table 4**  
Estimated long- and short run results.

Variable	Coefficient	Std. Error	Prob. Value
<b>Short Run Results</b>			
$\Delta \ln EGLO$	-1.7999	0.2602	0.0000
$\Delta \ln EGLO(-1)$	0.5275	0.2409	0.0385
$\Delta \ln L$	1.5698	0.4177	0.0010
$\Delta \ln INF$	-0.0185	0.0406	0.6532
$\Delta \ln GE$	0.2775	0.1348	0.0505
$\Delta \ln K$	-0.4347	0.1240	0.0018
ECM(-1)	-0.3449	0.1054	0.0032
R-squared	0.9887		
Adj. R-squared	0.9840		
DW-statistic	2.3386		
F-statistic	209.9487		
Prob. (F-statistic)	0.0000		
<b>Long Run Results</b>			
$\ln EGLO$	-3.8824	0.7560	0.0000
$\ln L$	4.5511	0.5339	0.0000
$\ln INF$	-0.0535	0.1219	0.6647
$\ln GE$	1.5318	0.6033	0.0180
$\ln K$	-0.3617	0.2665	0.1874
Constant	-55.2608	7.7389	0.0000

Note: std. error denotes standard error; prob. value denotes probability value (p-value); DW denotes Dabin-Watson

Source: Authors' estimation

remaining variables rightly skewed. The pair-wise correlation matrix (bottom part of Table 1) shows that inflation and government expenditure are negatively correlated with economic growth while economic globalization, labour, and capital are positively correlated to economic growth.

4.2. Unit root test

This section presents the results from the various unit root tests employed in this paper. Before ascertaining the unit root properties of the series, the graphical properties of the data are examined and reported in Fig. 2.

Fig. 2 reveals that generally, economic growth, labour force and economic globalization shows an upward trend while inflation, government expenditure and capital shows relatively random walk behavior. This shows that the series may not be stationary. Hence, the need to perform unit root tests to validate the stationarity properties of the variables as reported in Table 2.

The results in Table 2 show that, the variables are integrated in a mixed order; at levels  $I(0)$  and first difference  $I(1)$ . Specifically, the ADF test with trend shows that labor and inflation are stationary at levels while the PP test indicates that labour, inflation and government expenditure are stationary at first difference. The PP test with no trend shows that inflation, government expenditure and capital are stationary at levels. At first difference however, both tests unanimously confirm

that all the variables are stationary. It is important to note that these orthodox unit root tests are ineffective when there is potential structural breaks in the variables (see Fig. 1). Therefore, the Zivot & Andrews (2002) and Lee & Strazicich (2013) unit root tests with a structural break are estimated to authenticate the results in Table 2. As shown in Table 1A (see the Appendix) the variables are stationary in mixed orders of  $I(0)$  and  $I(1)$ , with structural breaks that underscore the various economic disturbances that has occurred over the years. For example, the structural break at 1986 is a result of the various structural adjustment programs implemented in the mid-1980s to restore economic growth after series of economic downturns (Younger, 2016). The unit root results shows that none of the variables is  $I(2)$ . Hence, the ARDL model is applicable.

4.3. Cointegration tests

The primary objective of this study is to examine the long-run relationship between economic growth and economic globalization in Ghana, therefore, it is important for the variables to be cointegrated. Hence, Phillips & Ouliaris (1990) residual-based cointegrations test is performed to examine the long-run relationship among the variables. Also, this paper performs the bounds cointegration test within the ARDL framework. The outcome is reported in Table 3.

The results reveal that the null hypothesis of no cointegration is rejected at 1 % and 10 % levels of significance for the Phillips-Ouliaris test with no constant or trend and constant and trend, respectively. This means that in the presence of the trending behaviours of the variables, there is a long-run relationship between economic growth and its determinants. Also, the bounds test is in harmony with the Phillips-Ouliaris test since the null hypothesis of no cointegration is rejected at a 5 % significance level (see the bottom panel of Table 3). Given the valid cointegration established, this paper proceeds with the estimation of the ARDL model.

4.4. ARDL results

The ARDL results are reported in Table 4 following the valid long run relationship among the variables.

Generally, the short-run and long-run results in Table 4 are not statistically different in terms of sign and significance. It is revealed that economic globalization, inflation, and capital harm economic growth (albeit insignificant for inflation) while labour force and government expenditure promote it. Specifically, a 1 % increase in economic globalization reduces economic growth by 1.7999 % and 3.8824 % in the short- and long run periods respectively at a 1 % significance level. This result indicates that Ghana has not benefited from economic globalization. This finding is plausible because economic globalization in most developing countries like Ghana may widen income inequality and increase the risk of economic crises through excessive fluctuations of capital investment and international trade, exposing Ghana's weak

**Table 5**  
Diagnostic test results.

Diagnostic test	Test statistic	Prob. value
Normality	0.5104	0.7748
Serial correlation	1.0823	0.3562
Heteroscedasticity	1.5243	0.1912
Functional form	0.2876	0.5969
CUSUM	Stable	
CUSUMSQ	Stable	

Source: Authors' estimation

financial institutions to external shocks. This is evident on how the global financial crises and other related crises jeopardized the Ghanaian economy and the African continent as a whole (Antwi-Asare et al., 2010; Yameogo et al., 2021; Tetteh & Ntsiful, 2023). Currently, the country is suffering uncontrollable inflation because it heavily relies on fertilizer and cereal imports from Russia and Ukraine due to the war. Also, Ghana interact with other countries by exporting raw materials and importing finished goods which exposes domestic industries to unhealthy competition, leading to potential de-industrialization and job losses. Within this context, Ackah et al. (2014) report that economic globalization in terms of FDI is detrimental to industrialization in Ghana through the manufacturing sector. Furthermore, this finding implies that Ghana is not benefiting fully from economic globalization probably due to compromise or inefficiencies in trade tariffs, taxes, agreement, regulations, investment restrictions and international investment agreements which are components of economic globalization. For instance, due to weak structures in the economy, some foreign firms (foreign direct investment) may be avoiding or under paying taxes and other incomes which in turn reduce government expenditure. Reduction in government expenditure has the potential to retard economic growth because government may not get the requisite funds to execute projects (such as road infrastructure, factories, schools and health facilities) that are earmarked to enhance economic growth. Also, the present finding does not conform to the orthodox economist's argument that economic globalization in the form of trade and FDI is good for economic growth (see Potrafke, 2015); it however conforms to heterodox views such as the Structuralists (Papanek, 1973) and the Stolper-Samuelson (Stolper & Samuelson, 1941) proposition that economic globalization is not always growth-enhancing phenomena. Furthermore, Borensztein et al. (1998) and Iamsiraroj & Ulubaşoğlu (2015) mentioned that the benefit of economic globalization is contingent on factors such as technological progress and human capital development in the host country, which is clearly not the case for Ghana as the country falls short of these catalysts of economic globalization. The present finding is consistent with studies such as Duodu & Baidoo (2022) on Ghana, Polat et al. (2015) on South Africa and Chibalamula et al. (2023) on developing countries including Ghana (though sub components of economic globalization are used) but contradicts the assertion by Baidoo et al. (2023) that economic globalization promotes economic growth.

With regard to the control variables, the results show that a 1 % increase in labour force, and government expenditure correspond to 1.5698 % (4.5511 %), and 0.2775 % (1.5318 %) in the short-run (long-run), respectively at 5 % level of significance. A 1 % increase in inflation and capital reduces economic growth by 0.0185 % (0.0535 %), and 0.4347 % (0.3617 %) in the short-run (long-run) respectively, although significant for only capital in the long-run. The outcome for labour is consistent with the endogenous growth models which argue that labour is an important factor as far as long run economic growth of countries is concerned. That of government expenditure is in line with the Keynesian economics – increase in government spending promote aggregate demand and eventually economic growth. The results with respect to capital could mean that there is misallocation of resources. That is, capital is not invested in productive sectors of the economy which has the potential to generate employment and investment opportunities which are pre-requisite for economic growth. Another plausible reason is that most foreign investors repatriate their returns to their countries leading minimal or detrimental effect on the Ghanaian economy where the investment takes place. This is consistent with the Structuralist hypothesis that capital investment may have negligible impact on the receiving country by crowding out domestic investment. Our result confirms the study by Duodu & Baidoo (2022) who report that capital does not enhance economic growth in the Ghanaian context.

4.4. Diagnostic and stability test

To ensure that the results in Table 4 are free from econometric problems, this study performs some diagnostic and stability tests and the results are reported in Table 5.

The results in Table 5 reveal that the result obtained is devoid of serial correlation, heteroscedasticity, and functional form misspecification as the null hypothesis for the Breusch-Godfrey LM test, Breusch-Pagan-Godfrey test, and the Ramsey RESET tests are rejected for all the tests. The normality test shows that the series are normally distributed. Also, for robustness check, the long-run output is cross-checked using the fully modified ordinary least squares (FMOLS) and the dynamic ordinary least squares (DOLS) (see Table 1B in the Appendix), and the results are not statistically different from what is obtained from the ARDL model. In addition, the CUSUM and CUSUMSQ plots (see Fig. 3) indicate that the model is stable as the plots lies between the 95 % confidence interval. Hence, the results in Table 4 is reliable for policy purposes.

4.5. Wavelet coherence test

To examine the causality among the variables, this study utilizes the wavelet coherence test which can detect causality and correlation at time and frequency domain simultaneously, which conventional time domain models cannot do so. In line with empirical studies such as Kirikkaleli (2020), the continuous wavelet coherence test is adopted.

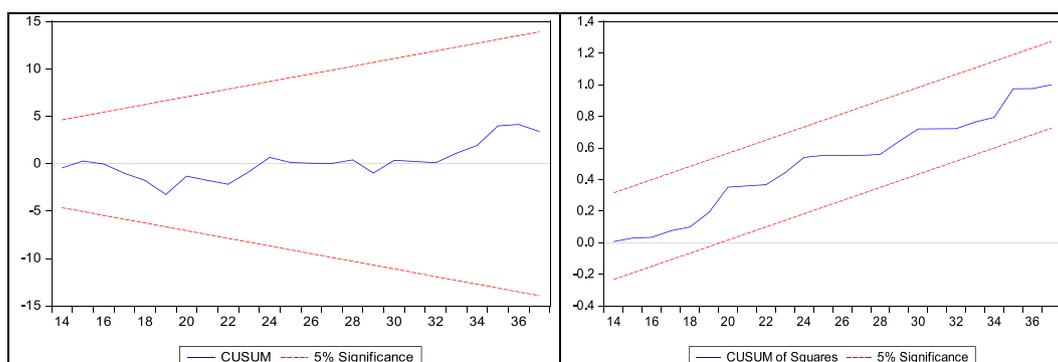


Fig. 3. Plots of cumulative sum and cumulative sum of squares. Source: Authors' construction.

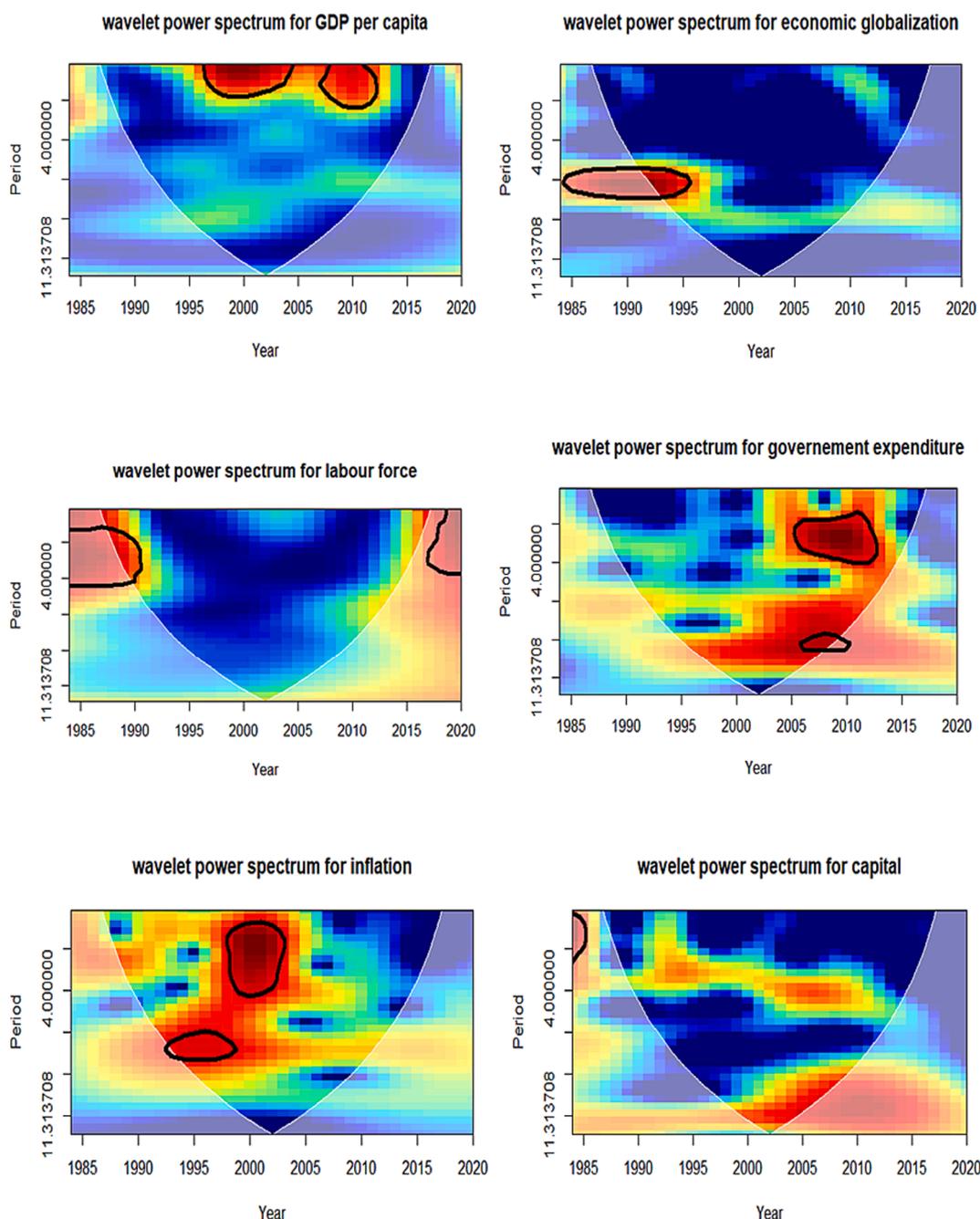


Fig. 4. Wavelet power spectrum for all the variables. Source: Authors' construction.

This has advantages over other family of wavelets such as the cross-wavelet analysis. The continuous wavelet coherence can detect both causality and correlation while the cross-wavelet just identifies regions with high common power. Also, the continuous wavelet coherence can detect both linear and non-linear relationships while the cross-wavelet may detect only linear relations. Before estimating the model, the power spectrum is estimated, and the result is presented in Fig. 4.

In Fig. 4, the scale of 11 periods is chosen automatically because of the relatively short sample size (1984–2020). The V-like shape represents the area below which the wavelet power is affected by shock or discontinuity and the thick black shape denotes the significant region at 5 % level determined by Monte Carlo experiment. The degree of volatility increases as the colour turns warmer (reddish). The figure shows that economic growth have high and significant volatility from 1996 to 2013 (indicated by the thick black shapes) in the short-run (period < 4).

This is plausible as these periods characterize the impact of the structural adjustment programs (SAP) implemented in the early 1980's as well as the 2012 energy crises that interrupted production. Similarly, economic globalization shows significant vulnerability from 1984 to 1997 (indicated by the thick black shape) in the medium-term (period between 4 and 8), which fall within the periods when Ghana open to the international market following the implementations of the SAPs. Furthermore, labour force, government expenditure, inflation and capital indicates significant fluctuations in the period 1984–1992 and 2017–2020, 2005–2012, 1992–2003, and 1984–1986, respectively (indicated by the thick black shapes in each graph).

To determine the causality among the dependent and independent variables, the continuous wavelet coherence test is estimated and the result is presented in Fig. 5. The cold (blue) colour means no causality while the warmer colour (reddish) and thick black shape denotes

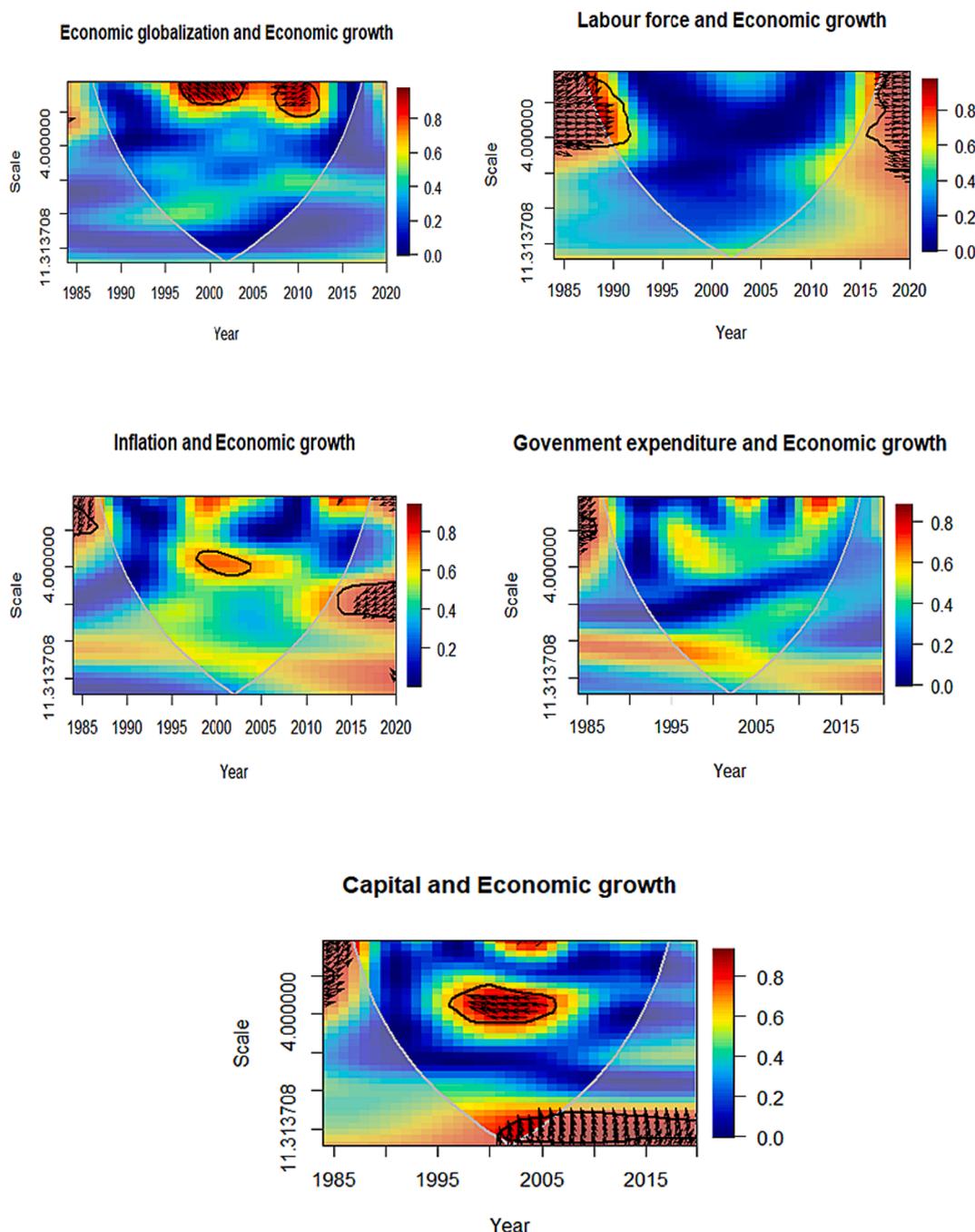


Fig. 5. Continuous wavelet coherence test between the independent and dependent variables. Source: Authors' construction.

significant correlation or causality among the variables. In the wavelet analysis, the direction of significant causality is indicated by the arrows surrounded by the thick black shape. The arrow pointing to the east (west) represents positive (negative) correlation. The arrows pointing to north, north-east or south-west indicate that the first variable Granger causes the second one whereas arrows pointing to south, south-east, or north-west imply that the second variable Granger causes the first one. In this paper, the first variable represents the various independent variables (economic globalization, labour, inflation, government expenditure and capital) and the second variable represents the dependent variable (economic growth) as they appear in the title on top of each graph in Fig. 5.

With regard to the economic globalization and economic growth graph, the arrows pointing to the north-west (in the thick black shape)

means that economic growth Granger causes economic globalization (from 1995 to 2002) and the arrows pointing to west (in the thick black shape) indicate a significant negative pairwise correlation between them which is consistent with the negative relationship revealed by the ARDL results in Table 4. Also, with respect to labour force and economic growth graph, the arrows pointing to north-east and south-east show a two-way significant causality between them (from 1984 to 1991 and 2017–2020). The arrows pointing towards east show a significant positive correlation among them. Regarding inflation and economic growth, the arrows pointing to south-west means that there is a one-way causality that runs from inflation to economic growth. The arrows pointing toward west direction also indicate a negative correlation among them. Similarly, government expenditure significantly Granger causes economic growth (in the 1980 s). Lastly, the arrows pointing to

**Table 1A**  
Lee & Strazicich (2013) and Zivot & Andrews (2002) unit root tests.

Lee & Strazicich (2013)		Break in level & trend		Break in level & trend		Break in level & trend		
	Break in level level		Break in level & trend		Break in level First-difference		Break in level & trend	
	Test stat	Break date	Test stat	Break date	Test stat	Break date	Test stat	Break date
lnY	0.495***	2004	0.065*	2004	0.061	1998	0.167	1986
lnEGLO	0.132	1991	0.063	2004	0.058	1986	0.065	1986
lnL	0.220**	1999	0.208***	2000	0.034	1986	0.013	1986
lnINF	0.035	1991	0.029	1996	0.028	1986	0.022	1986
lnGE	0.048	1990	0.04	1990	0.070	1986	0.096	1986
lnCAP	0.171*	2005	0.125***	2004	0.157	2006	0.193	1986
Zivot & Andrews (2002)								
lnY	-6.135***	2004	-4.550	1998	-27.301***	2006	-39.368***	2005
lnEGLO	-2.445	1993	-4.366	2004	-3.230	2006	-33.325***	2002
lnL	-2.117	1993	-4.198	2002	-3.916	1995	-13.496***	2004
lnINF	-5.308**	2002	-5.766***	2004	-8.456***	2004	-9.421***	1999
lnGE	-4.072	2006	-5.301**	1995	-13.755***	2005	-11.927***	2006
lnK	-2.972	2008	-4.430	2005	-4.042	2005	-7.622***	1995

Note: The null hypothesis ZA (LS) states that the variable is non-stationary (stationary); \*\* and \*\*\* denote that the null hypothesis of the unit root test is rejected at a 5% and 1% level respectively; The lag lengths are selected using AIC.

Source: Authors' construction.

the north and north-east from 2001 to 2020 and 1984–1987, respectively shows one-way causality from capital to economic growth in both long and short-run and there is a negative relationship among them in the medium-run (indicated by arrows pointing to the west). For consistency, The Toda-Yamamoto causality test is estimated (see Table 1C in the Appendix). Generally, the results from the Toda-Yamamoto causality test is not different from that of the continuous wavelet coherence test.

**5. Concluding remarks**

This current paper has investigated the long-run and short-run effect of economic globalization on economic growth of Ghana using the annual data from 1984 to 2020. By way of estimation, the ARDL model is employed. This paper also employs the Phillips-Ouliaris (1990) residual-based cointegration test that is suitable for small samples and the continuous wavelet coherence test to examine the causality between economic growth and its determinants. The traditional unit root tests as well as Lee & Strazicich (2013) and Zivot & Andrews (2002) tests that accounts for structural break are also employed to ascertain the stationarity properties of the variables. The unit root test results reveal that the variables have mixed orders of integration; at levels and first difference. The cointegration test results also confirm a valid long run relationship among the variables.

The results from the ARDL model suggest that economic globalization has not promoted economic growth; Ghana has not benefited adequately from economic globalization. Capital has also not promoted economic growth as expected. However, government expenditure and labour have promoted economic growth. The wavelet causality largely conforms to the ARDL results. The results from FMOLS and DOLS also confirm the robustness of the findings from the ARDL.

Based on the outcome of this paper, it is suggested that there is a need for the country to fully enforce the policies regarding flow of goods and services as well as financial resources (including foreign direct investment, and portfolio investment) which are the components of economic globalization. Any compromise on the policies such as trade regulations, trade taxes, tariffs, trade agreement, investment restrictions, and international investment agreements has the potential to reduce the revenue of the state and this will in turn harm economic growth as revealed by this paper. There is also a need to add value to the goods and services that are exported to other countries. Doing these will ensure that the country generates more income to undertake projects that have the potential to promote economic growth.

**Table 1B**  
DOLS and FMOLS results.

Variables	DOLS		FMOLS	
	Coefficient	Standard error	Coefficient	Standard error
lnEGLO	-2.3100***	0.7170	-2.7693***	0.4231
lnL	3.4301***	0.5694	3.6425***	0.2917
lnINF	0.0723	0.2016	0.0285	0.0848
lnGE	0.9634*	0.4604	0.1997	0.2577
lnK	-0.1452	0.3618	-0.3318*	0.1831
Constant	-41.3495***		-41.9908***	4.2500
R-squared	0.9857		0.9490	
Adjusted R-squared	0.9636		0.9405	

Note: \*\*\*, and \* represent significance level at 1%, and 10%, respectively.

**Table 1C**  
Toda-Yamamoto causality test.

Null hypothesis	Chi-square	p-value	Null hypothesis	Chi-square	p-value
lnEGLO → lnY	6.2051	0.0449	lnEGLO ← lnY	0.5153	0.7729
lnL → lnY	13.4597	0.001	lnL ← lnY	3.5079	0.1731
lnINF → lnY	7.8139	0.0201	lnINF ← lnY	5.6007	0.0608
lnGE → lnY	8.2608	0.0161	lnGE ← lnY	0.4131	0.8134
lnK → lnY	3.6346	0.1625	lnK ← lnY	2.5223	0.0283

Note: H<sub>0</sub>: No Granger causality; H<sub>1</sub>: Granger causality. ← and → show direction of causality. Maximum lags = 2.

**Author contributions**

STB, BT, EB, and REA have contributed equally to this paper at all stages: Conceptualization and writing the manuscripts, data curation, formal analysis and writing of the original drafts.

**Data Availability Statement**

The data that support the findings of this study are available from the corresponding author, [STB], upon request.

**CRedit authorship contribution statement**

**Samuel Tawiah Baidoo:** . **Bright Tetteh:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft,

Writing – review & editing. **Elliot Boateng**: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Raphael Edem Ayibor**: .

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix

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