RESEARCH

Tripartite relationship between FDI, trade openness and economic growth amidst global economic crisis in Nigeria: application of combined cointegration and augmented ARDL analysis

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Abstract

There is general consensuses among scholars on the importance of international trade and foreign direct investment as a main macroeconomic variables that drive economic growth of developing countries. However, the global economic crisis plays dominant role in determining the movement of these macroeconomic variables that can change the nomenclature of economic activities in relation with trade and FDI inflow. For this purpose, this study investigates the relationship between trade openness, FDI inflow and economic growth of Nigeria by accounting for the effects of global economic crisis of 2007–2008 and commodity crisis of 2016 using Bayer and Hanck (in J Time Ser Anal 34(1):83–95, 2013) approach to cointegration and augmented autoregressive distributed lag (AARDL) method on time series data from 1982 to 2018. The results provide evidence that (1) global economic crisis significantly dampens economic growth. (2) The negative interaction of total trade, FDI and global financial economic crisis is substantive enough to dampen the trade-growth and FDI-growth led relationship. (3) The negative interaction of FDI-inflow with global economic crisis is more pronounced and substantive in the long run than the short run. This study recommends for policy option positioned towards escalating specific fiscal measure that should provide a sound legislative rules and reductions in taxes for international investors; stimulus measures targeting measures to control public spending, which had previously fuelled economic expansion.

Keywords: Trade openness, FDI inflow, Economic crisis, ARDL, Bayer and Hanck, Nigeria

Introduction

In the wake of mid-2007 to Q1 2009, the world was taken by storm, when the sub-prime mortgage market in the United States plunged to an all-time low; indeed, the United States housing market bubble burst alongside excessive risk exposure of financial institutions catalyzed a severe glo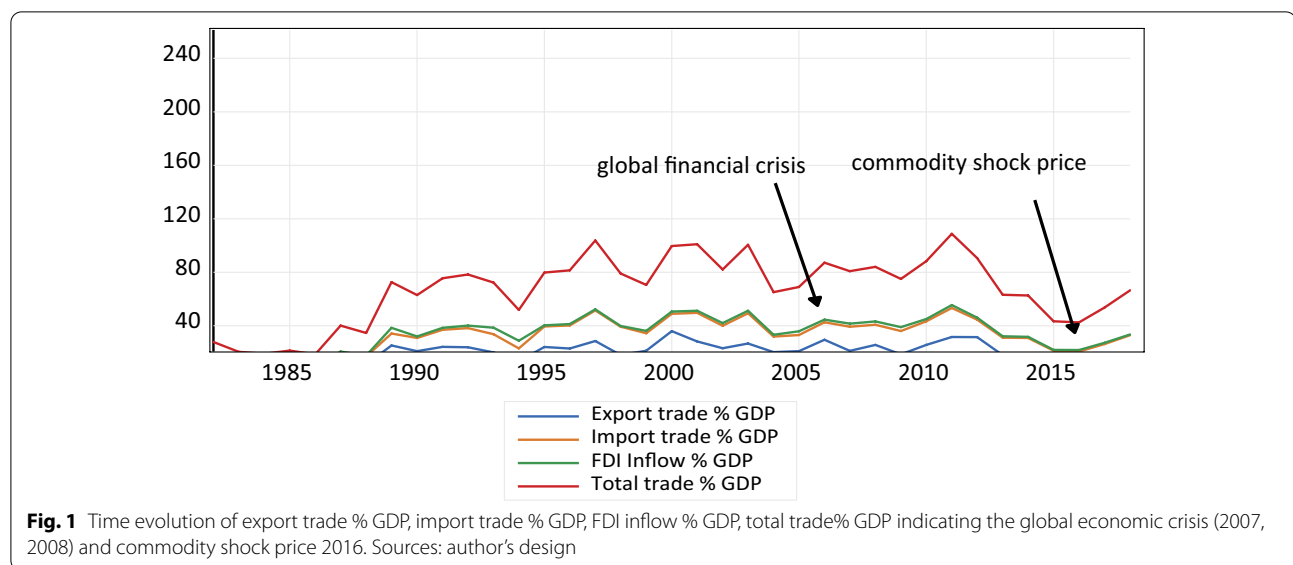bal economic and financial crisis spreading from the United States to the rest of the world through the auspices of inter-linkages in the global financial system.

Based on the above explanation, issues surrounding how economic crisis affects trade-led growth and foreign direct investment (FDI)-led growth have continued to dominate the research arena. The result of their research findings is still mixed and inconclusive. While some extant studies established that economic crisis generates a negative or distortionary effect on trade and FDI inflow in driving economic growth [1, 6, 17, 19, 34], some other scholars document that economic crisis has a significant

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Fig. 1 Time evolution of export trade % GDP, import trade % GDP, FDI inflow % GDP, total trade% GDP indicating the global economic crisis (2007, 2008) and commodity shock price 2016. Sources: author's design

direct effect on trade and FDI inflow in driving economic growth [18, 53, 64] (Ragab 2018). In the case of Nigeria, international trade is one of the channels pencilled to have paved the way for an economic crisis in the Nigerian economy. Figure 1 shows the increase in decomposed total trade (exports and imports % Gross domestic product (GDP)) and FDI inflow % GDP in recent years. The trend of these variables do not follow a definite pattern see (Fig. 1); it fluctuates upwards and downwards at its lowest point during the 2007–2008 global financial crisis and commodity price shock in 2016. This fluctuation of macroeconomic variables engineered by the global economic crisis may dampen the trade-led growth or FDI-led growth and subsequently escalate a distortionary effect that drains the positive effect of trade openness and FDI inflow on growth.

In all, the oscillation in trade (exports and imports % GDP) and FDI inflow % GDP signifies how the economic crisis driven by several economic agents impacts the Nigerian economy's integration vis-a-vis international trade, contributing to the failure of trade to generate economic growth in Nigeria.

FDI-growth nexus is well pronounced in academic literature theoretically and empirically in developing countries (see [20]). However, the scope of this research enlarges the discussion beyond the already established positive association between FDI-growth, especially in the Nigerian case, where economic growth is confused with a simultaneous increase in the world price of crude oil (see [8]). Specific to our scope is an extensive focus on foreign direct investment, trade and growth nexus in the global financial crisis and other types of crisis in the case of Nigeria. Narrowing literature down to Nigeria,

Egboro [27] argued in line positing that macroeconomic variables such as foreign portfolio investment (FPI) and foreign direct investment (FDI) are frontier recipients of the global shocks in the case of Nigeria, also making a case for multiplier effects translating into decreased economic activities. The notion of transmission of crisis through a macroeconomic variable to GDP is domiciled in the study of Bandara [9], where Bandara strongly posited that the main transmission conduit through which impact of financial crisis passed on to African economies is through FDI and exports, i.e. trade and financial flows, further strengthened by the stance of Macias et al. [50] stating that financial crisis affected developing economies primarily through the trade channel, hence the adoption of FDI and trade as the loci in our analysis. The choice of Nigeria hinges on its FDI's sensitivity to economic policy shifts, socio-political chaos, apex bank's policies and regulations, insecurity and economic downturns necessitating outflows and inflows depending on the scenario.

Trade-growth nexus is positive in line with theory and available empirical evidence in the case of Nigeria. However, exports are more pronounced in the literature than imports in Nigeria's case. More importantly, increased foreign trade spurs the diffusion of knowledge and technology from the import of superior-tech goods, enhancing internal domestic capacity leading to sustainable growth in the long-run. There is a controversy in the body of findings as to the study of Rassekh [68] and Dufrenot et al. [25] posits that lower-income countries benefit more from international trade as compared to higher-income economies. Were (2015) posited that trade exerts positive effects on economic growth in developed and developing countries; hence, the absence

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of consensus necessitates further empirical adventure. Exports as a trade component already established as a recipient of shocks in the face of crisis; hence, what is the state of trade-growth nexus in a middle-income economy (Nigeria) amidst the 2007 global financial crisis and the commodity oil price shock of 2016?

The argument above contributes to the novelty of the intending academic investigation on a topic that is yet to be considered by any author in the case of Nigeria. Papers associated with the tripartite relationship, as described in the introduction, is scarce in academic literature for Nigeria. However, attempts so far have focused on the FDI-financial crisis relationship as seen in Ucal et al. [74], Uctum and Uctum [75], Mahmoud [51], Broner et al. [13] and Stoddard and Noy [71]. Papers investigating the FDI-economic growth nexus in crisis periods are rare, and so far, only Dornean et al. [23], Jimborean and Kelber [38] concentrating on Central and Eastern European countries solely and Gaies et al. [33] focusing on developing countries. Our research extends beyond FDI-growth nexus amidst crisis as attempted by Dornean et al. [23], Jimborean and Kelber [38] and Gaies et al. [33], Del Prete and Federico [22] by bringing in trade to augment the state of discourse on the topic and enlarge the body of knowledge. Therefore, the purpose of this study is to investigate the FDI-trade-growth nexus amidst the 2007 global financial crisis and the 2016 commodity oil price shock in the case of Nigeria.

The uniqueness of this empirical adventure and its contribution to the knowledge repository is listed thus; (a) debut investigation on FDI-trade-growth nexus in aforementioned crisis periods, i.e. 2007−2008 global financial crisis and commodity price shock 2016 in the case of Nigeria. (b) filling the lacuna by adopting Bayer and Hanck co-integration and augmented Autoregressive distributed lag (ARDL) econometric techniques to test the research hypotheses. (c) incorporating relevant crisis periods in the case of Nigeria beyond the popularised global economic/financial crisis used by a multitude of authors in multi-jurisdictions in a bid to increase the generalisability of study findings. The rest of the paper is arranged in chronological order; Sect. 2 discusses the theoretical literature and empirical evidence on the specific thematic areas, Sect. 3, methodology and model specifications, and Sect. 4 discusses the empirical finding and discussion of results, Sect. 5 presents summary, conclusion and policy options.

Review of related literature
Theoretical literature
There is a battery of advantages attached to FDI inflows in engendering growth in host economies and well-advertised in available academic literature (see [5, 33, 78]). Theoretical standpoint as seen in Organisation for Economic Co-operation and Development (OECD) (2002) report reinforced in the study of Moura and Forte (2010) mentioned the several channels through which FDI engenders growth, namely; (a) transfer of new technologies and technical know-how (b) human resources (c) integration into the global economy (d) increased competition in host markets e) economic and political interference. The channels mentioned above are either transmitting positive effects or negative effects, reinforcing the failure of authors in the last decade due to their one-direction skewed perspective contributing to the lack of consensus on the FDI-growth debate. Some schools of thought opine that for growth to occur, human capital capable of absorbing technological and knowledge transfers must be readily available in line with De Mello [21], Ozturk [63] and Ford et al. [30].

Introducing business cycle theory to explain the nature and movement of FDI in the face of financial crisis or other economic crises is succinct. Broner et al. [13] document that gross capital flows are pro-cyclical in nature, justifying the submission of two states of nature; crisis and non-crisis periods. Pro-cyclical in this context relates to if any defined economic quantity increases during boom and decreases during economic downturns and financial crises. The inter-connectedness of countries through cross-border trade and financial flows doubles the likelihood of transmitting shocks from the originating country to other countries embedded in the global economic system. Bandara [9] posited that theories explaining the transmission of the financial crisis and other economic crises are numerous. However, they have broadly classified into two; theories that explain fundamental causes and theories linked to investor behaviour. Relating to our investigation, crisis periods covered encompasses theories from the dual classification provided by Bandara [9].

In line with Bandara [9] and Macias et al. [50], apart from financial linkages, trade linkages also serve as a channel through which crisis transmits from the originating country to other countries. A financial crisis transmitting through trade can bring about a reduction in income and a corresponding decline in demand for imports. In a global recession, world trade falls far more than world GDP, lending credence to the adoption of trade in our analysis, further cemented by the fact that trade is the engine for growth in most developing countries. Therefore, a collapse in global demand brought about by the crisis will reduce exports. Apart from being more prone to contractions in global demand and production shortfalls arising from the financial crisis, developing countries

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depend on healthy trade flows to maintain their balance of payments and fiscal balance accounts (see [32]).

Empirical review

FDI-growth nexus in the face of economic and financial crises

Our paper focuses direly on the state of the relationship between foreign direct investment, trade and economic growth in the face of economic and financial crises. Under this theme, we focus solely on empirical literature on the FDI-growth nexus amidst crises in different economic jurisdictions. However, despite the importance of the topic, only a few authors have made empirical entries in academic literature and are discussed thus;

Jimborean and Kelber [38] investigated the FDI-growth nexus amidst the 2007 global financial crisis and the 2011 euro area sovereign debt crisis in the case of Central and Eastern European countries relying on panel data two-step efficient GMM estimator and fixed-effect panel estimator. Findings revealed that the global financial crisis negatively impacted FDI inflows and GDP whilst the 2011 euro area crisis further worsened growth rates and net FDI inflows in the case of CEEC. Dornean et al. [23] adopted a simpler econometric method adopting growth and crisis as explanatory variables relegating FDI to the position of the dependent variable in the mission of investigating the FDI-growth nexus amidst financial crisis and relying on Least Squares regression as its econometric technique coupled with stipulated robustness checks. Dornean et al. [23] concurred with the findings of Jimborean and Kelber [38] in the case of Central and Eastern European countries stating that crisis possessed a negative impact on foreign direct investment, on the other hand, growth declined in 2009, 2010 but rose into positive in 2011 and normalised thereafter. The final empirical entry on the FDI-growth nexus amidst financial crisis was provided by Gaies et al. [33], taking a larger sample of 67 developing countries comprising lower and middle-income economies and adopting two-step system GMM and panel logit model as its econometric technique. The more robust study from the aforementioned lot provided fresh and distinct findings stated thus; In line with the findings of Dornean et al. [23] and Jimborean and Kelber [38], foreign direct investment retained its positive effect on growth in line with the a-priori expectations, on the other hand, foreign direct investment increases growth by reducing the recessionary effect of the crisis on growth up to a critical threshold, thereafter, the relationship turns negative. The merits of FDI accounts for the former, while the demerits of FDI accounts for the latter as opined by the scholarly trio.

Other authors such as Economou [26], Ucal et al. [74], Uctum and Uctum [75], Mahmoud [51], Broner et al. [13] and Ersoy and Erol [29] focused on foreign direct investment-crisis nexus.

Uctum and Uctum [75] led the pack of authors that focused solely on FDI-crisis nexus adopting the country-specific approach, which in this case is the Republic of Turkey. The scholarly duo focused solely on the comparison of the nexus amidst international and domestic crises (the Russian crisis of 1998 and the domestic banking crisis of 2000) and utilised the VAR econometric technique. Findings show that FDI reacts strongly to domestic crisis whilst foreign portfolio flows reacts more to global financial conditions. Economou [26] added flesh to available literature by investigating the Eurozone crisis's impact on FDI-inflows using a random-effects regression model. Findings reveal that the Eurozone crisis had a negative impact on foreign direct inflows in the case of Greece, Italy, Portugal and Spain. Ersoy and Erol [29] also towed the same line as Economou [26] in scrutinising the impact of the Eurozone crisis on foreign direct investment inflows. Ersoy and Erol [29] adopted the GMM econometric technique and fifteen EU countries as its sample. The scholarly duo concluded that regional crisis possesses a positive effect on FDI inflows, whereas global crisis reduces the inflow of foreign direct investment in the fifteen European countries investigated. The result is in sharp contrast with the finding of Economou [26], who also studied Southern European economies.

Examining studies covering a global perspective, Mahmoud [51] adopted panel data comprising 42 countries in investigating the nexus between bilateral FDI and financial crises using system GMM and spatial econometric techniques. Despite reaffirming the negativity recognised in literature of crisis affecting FDI inflows, Mahmoud [51] posited that the negative shock crisis transmits to FDI differs by type and causative factors. Ucal et al. [74] offered a twist by adopting a separate econometric method different from the studies mentioned above. Ucal et al. [74] adopted semiparametric Generalized Partial Linear Models and a larger sample comprising 148 countries than Mahmoud [51]. Findings revealed that FDI increases before the financial crisis and decreases after the financial crisis, in sharp contrast with the finding of Dornean et al. [23]. Another perspective to the debate is seen in the work of Broner et al. [13], blessed with a comparatively global sample as seen in Ucal et al. [74]. Broner et al. [13] offered insights about patterns obtainable pre-crisis and during crises; the scholarly quartet posited that during a crisis, foreigners

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withholds, causing a decline in inflows while domestic agents withhold too, causing a decline in outflows.

Trade-growth nexus amidst economic and financial crises

In line with the empirical affirmation provided by Bandara [9], Abiad et al. [1] and Macias et al. [50], trade is a certified channel through which crisis is transmitted into African economies and other developing economies. Under this theme, we intend to address salient studies that investigate trade-growth nexus amidst financial crises in developed and developing economies alongside authors that concentrated on trade-crisis nexus and authors that concentrated on trade-growth nexus alone.

Abiad et al. [1] sought to determine if past financial crises disrupted trade using a large set of data and an augmented gravity model of bilateral trade. Findings revealed that imports are the worst hit compared to exports in the case of a crisis country in the year of crisis, year after the crisis and further declines thereafter. On the other hand, exports decline a bit by a single digit in the year of crisis and return to normalcy subsequently. Ma and Cheng [49] investigated the effects of financial crises on international trade using the same methodology as Abiad et al. [1]. Findings are in line with Abiad et al. [1], but the scholarly duo specifies that the crisis's effect is solely dependent on external shock sources. The vulnerability of Sub-Saharan Africa to the financial crisis through the auspices of trade is addressed by the study of Berman and Martin [11] and also employing the same methodology adopted by Abiad et al. [1] and Ma and Cheng [49] and a large sample too. Findings reiterate that exports decline in the face of crisis, as seen in Abiad et al. [1] and Ma and Cheng [49]. Berman and Martin [11] also revealed that African exports are more vulnerable to economic and financial crises and specify explicitly that African countries dependent on trade finance are likely to be hit badly. Chor and Manova [19] consummated the finding of Berman and Martin [11] in their attempt to study the collapse of international trade flows during the GFC using the United States based data. The major findings show that exports in sectors opined to be financially vulnerable were sensitive to the cost of credit at the peak of the global financial crisis, thereby fingering credit as a channel through which crisis affects trade volumes. Macias et al. [50] also investigated the trade-crisis nexus using a sample of 83 developing countries and adopting the same methodology used in Abiad, et al. [1], Ma and Cheng [49] and Berman and Martin [11]. Results reiterate the stance of Berman and Martin [11] and Chor and Manova [19] regarding the role of trade finance in the existing debate; their opinion is fixated on the ability of trade finance to increase bilateral export flows in a majority of developing economies except for Latin America. Findings show that the global economic downturn reduces bilateral export flows in developing economies with reference to Latin America and Sub-Saharan Africa. Ronci [69] assessed the effect of constrained trade finance on trade flows in countries undergoing financial crises employing a battery of econometric techniques such as generalized least squares (GLS), instrumental variables (IV) both with fixed effects, and generalized method of moments (GMM). The results emanating from Ronci [69] study posits that a decline in trade financing associated with the domestic banking crisis is more devastating and can lead to substantial loss of trade.

Migrating from the bulk of studies on trade-crisis nexus, only one study addressed trade-growth nexus amidst crises according to available empirical literature; Pentecote and Rondeau (2015). Indeed, the scholarly duo took a special stance in investigating the degree to which a financial crash can hinder economic growth through the auspices of trade relationships adopting a panel data comprising twenty-six countries and Cerra-Saxena impulse response function approach as its econometric technique. After the simulation process, the scholarly duo deciphered that trade contributes to growth in a demand shock and dampens the negative effects of a banking crisis.

The last strand of academic literature focuses on the trade-growth nexus investigated across developed and developing economies. Nigerian-based studies on trade-growth nexus and others based on other countries across the African continent is reviewed thus; Khobai et al. [40] examined the existence of a long-run relationship between trade openness economic growth in Ghana & Nigeria using the traditional ARDL as its chosen econometric technique. Findings show that trade openness increases economic growth in the case of Ghana, while the reverse is the case in Nigeria. Nwadike et al. [57] also contributed to the theme mentioned above, employing traditional OLS as its econometric technique. Findings established that trade openness increases economic growth in the case of Nigeria. In the same vein, Lawal et al. [45] employed an autoregressive distributed lag (ARDL) model to investigate financial development, trade openness and economic growth relationship in Nigeria with data covering the 1981–2013 period. The scholarly quadruple discovered an inverse and significant relationship between trade openness and GDP in the long term and a direct association between them in the short-run. Also, a bi-directional linkage between trade openness and GDP was revealed. Similar documentation was seen in Keho [39], who adopted ARDL to analyse trade-growth association in Cote d'Ivoire. Using data spanning 1965–2014 and findings supported trade-led growth and showed that capital and trade openness directly

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influence GDP in short and long-run periods. At the same time, labour had an inverse and significant linkage with economic growth in the short-run only. Under the same research motive, Raghutla and Chittedi [67] found that import and export exerted a significant direct influence on growth and revealed the presence of growth-led export/import hypothesis in selected counties.

Ijirshar [35] conducted regional-based studies that adopted advanced econometric models such as the Pooled Mean Group and the Mean Group estimators. Findings show that trade openness increases the growth of ECOWAS member states in the long-run whereas the results are mixed in the short-run. Further supporting evidence is provided by the empirical attempt by Oloyede et al. [60], with full focus on ECOWAS and SADC and the adoption of Pooled OLS as its econometric technique. Findings show an insignificant relationship between growth and trade openness in ECOWAS and SADC countries. Brueckner and Lederman [15] examined the trade openness-growth nexus in the case of Sub-Saharan Africa using 2SLS and instrumental variable regression as its econometric technique. Findings show that trade openness increases economic growth in the short-run and long-run in the case of Nigeria. Dufrenot et al. [25] distinguishes itself by applying a superior methodology, i.e. quantile regression, different from the widely used GMM, OLS, Instrumental variables and GLS and a globally sufficient sample comprising 75 developing countries from Africa, Central & Latin America, Europe, Asia and the Middle East. The scholarly trio concludes that the effects of trade openness are stronger for low-growth countries both in the short-run and the long-run, evident by the reported elasticities of 1.6 for low-growth and 0.7 for high-growth countries, respectively.

Application of threshold is visibly present in Zahonogo [77] work adopting the pooled mean group econometric technique. Findings show that the presence of the Laffer Trade Curve, i.e. inverted U, informs readership that trade openness affects economic growth positively to a defined threshold above which trade effect on growth declines thereafter in the case of Sub-Saharan Africa. In Nigeria, to be precise, Olubiyi [61] explored the causal linkages between export, imports, remittances and GDP in a VECM framework using data covering 1980–2012. Findings showed that export enhances growth while import impedes growth in Nigeria, which established support for export-led growth assumption being potent.

Methods

Data sources and model building

The hypothesis tested in this present study is the tripartite relationship between trade openness, foreign direct investment inflow and economic crisis on economic growth in Nigeria. To give credence to the established hypothesis, we trend on the standard Cobb–Douglas production function. The Cobb–Douglas production function is adopted in this study as our frontier model with a distinct augmentation involving FDI inflows % of GDP, export and import % of GDP, FDI outflows % of GDP, economic crisis, real capital stock, domestic credit to private sector and trade openness % of GDP. Cobb–Douglas production function has been employed by various authors in investigating FDI-growth nexus as seen in Bandara [9], Ilgun et al. [36] and Makiela and Ouattarra [52]. The Cobb–Douglas production function was written in functional form by Philip Wicksteed but tested and developed against the statistical evidence provided by Charles Cobb and Paul Douglas. The Cobb–Douglas production function is expressed thus;

$$Q_t = A_t L_t^{\beta} K_t^{1-\beta} \quad 0 < \beta < 1 \tag{1}$$

In the above Eq. 1, Q is real economic output, K is capital stock, L is labor force, and A is technological progress. In line with previous statement, the production function is extended by assuming that technological progress is a function of trade openness, foreign direct investment inflow and the net-effect from the economic crisis. Thus, A is specified as follows:

$$A_t = \varnothing . trade_t^{\alpha} inflow_t^{\alpha} pcrd_t^{\tau} \tag{2}$$

Trade in the above equation stands for trade openness, *inflow* and crisis represent FDI inflow and economic crisis of 2007–2018, and commodity price shock of 2016, *pcrd* is other factor that may determine the level of technology, $\varnothing$ is the time invariant constant. Following extant studies, Eq. (2) is substituted in Eq. (1), as thus:

$$Q_t = \varnothing . trade_t^{\alpha} inflow_t^{\alpha} pcrd_t^{\tau} L_t^{\beta} K_t^{1-\beta} \tag{3}$$

Applying log to the above Eq. 3 the extended based-line model is given as thus;

$$lnQ_t = \theta_0 + \theta_1 lntrade_t + \theta_2 inflow_t \\ + \theta_3 lnk_t + \theta_4 lnl_t + \theta_5 lnpcrd_t + \varepsilon_t \tag{4}$$

Equation 4 addresses the first objective of this study which investigate the impact of trade openness and FDI inflow in Nigeria. The variables in the above equation are identified as thus: θ_0 is a constant term, lnQ_t is for real GDP, Real GDP is simply the macroeconomic measure for the yearly economic output of a country adjusted for price changes. Indeed, Real GDP is a sufficient measure of economic growth in our study, although, per capita GDP has been used tremendously in empirical literature, but our study pitch its tent in Real GDP to capture economic growth.

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The decomposition of trade openness into total trade (import and export), import trade and export trade is necessary to capture the individual effects on economic growth amidst the economic crisis. The adoption was further cemented in the case of Nigeria, posing as an import-dependent country with a high demand for a large variety of consumer goods and tech-related consumer goods and export-oriented in agriculture, gold and fossil fuels. Zahonogo [77] investigated the trade-growth nexus in Sub-Saharan Africa and adopted the logarithm of import and export in their robustness check as a follow-up to the main model estimated. lnimport and lnexport respectively should exert a positive impact on economic growth. *ln*import and *ln*export respectively should exert positive impact of economic growth. $lntrade_t$ is for total trade, Apart from FDI, OECD, in its 2011 Special Report titled "Science, Technology and Industry Scoreboard", posited that there is evidence of the impact of the economic crisis on international trade from 2008 to 2009 evident in the decrease of this ratio in OECD countries and BRICS countries within the same period. Another valid justification can arise from measuring the level of economic integration. The study of Gaies et al. [33] and Dornean et al. [23] utilized trade openness in their study on the FDI-growth nexus.

inflowis FDI inflow as a percentage of the GDP. This variable is worthy after its establishment as a recipient of global shocks from crisis or economic downturns, as established in the work of Egboro [27] and Bandara [9]. During the crisis, inflows and outflows occur simultaneously in some countries, while in others, it may occur in a one-way direction as pronounced in available academic literature. Nigeria is a practical example where FDI is highly sensitive to economic policy shifts necessitating outflows and inflows depending on the scenario.

lnl for labor force. This variable is an unchangeable component of the Cobb–Douglas production function and also contributes to output as posited in the study of Ilgun et al. [36] on FDI-growth nexus in the case of Turkey.

lnk is for real capital stock, Real capital stock generated from gross fixed capital formation: Capital accumulation has been tainted by many economists as a channel for engendering growth and vast number of scholars prefer to use gross fixed capital formation to that effect. Our study generates real capital stock from GFCF via perpetual inventory model computation to increase model uniqueness in comparison with past studies. Following extant study such [39, 62], the formula is given as thus:

$$K_t = K_{t-1}(1 - \delta) + I_t \tag{5}$$

Building on previous studies, K_t is defined as the current capital stock, whereas K_{t-1} indicates as the capital stock of the year prior to the current, with an annual rate of depreciation $\delta = 5\%$ used in this study. The initial level of capital stock is computed as:

$$K_0 = I_0/(g + \delta) \tag{6}$$

In which K_0 is the initial capital stock, I_0 is the initial capital investment, δ is previously defined, and g indicates the average growth rate of capital investment used to generate the initial capital stock over the period of the study.

$lnpcrd_t$ is for financial development indicator, Domestic credit to the private sector: Availability of finance engenders growth through multi-channels and in a bid not to fall prey to omitted variable bias, we included credit to the private sector, which has proved over the years to be a growth stimulator through manufacturing growth, reduction in the unemployment rate and a rise in the standard of living of citizens, hence its inclusion. The study of Aizenman et al. [4] employed domestic credit to the private sector in their analysis on Capital Flows and Economic Growth in the era of crisis. ε_t is the white noise error term. This study spans 1982 to 2018 and the data are sourced from the World Development Indicators, World Bank.

The second objective is to evaluate the effect of trade openness and FDI during economic crises in Nigeria by incorporating the interaction term between the economic crisis of 2007–2008 and the commodity price shock of 2016 as additional independent variables in the model. This allows us to test whether the total effect of FDI and trade openness on economic growth is a combined positive or negative during the crisis periods.

$$\begin{aligned} lnQ_t = {} & \theta_0 + \theta_1 lntrade_t + \theta_2 inflow_t + \theta_3 lnk_t \\ & + \theta_4 lnl_t + \theta_5 lnpcrd_t + \theta_6 crisis_t \\ & + \theta_7 lntrade_t * crisis_t + \theta_8 inflow_t \\ & * crisis_t + \varepsilon_t \end{aligned} \tag{7}$$

Crisis is the dummy variables indicator. We employ a single dummy variable to proxy crises that affected Nigeria throughout the timespan covered, namely; 2007–2008 global financial crisis and commodity oil price shock in 2016. We encompassed both events into one dummy variable; the crisis is the new dummy variable poised to capture both crises, so it takes the value of 1 for 2007–2009, 2016 and 0 for otherwise (see [23]). This method is distinct from the measures used in Jimborean and Kelber [38] and Brunnermeier [16], where quarterly data was employed.

In line with a-priori expectations, $\theta_1, \theta_2, \theta_3, \theta_4$ and θ_5 are expected to exert a positive impact on economic growth, an indication that trade openness and FDI inflow are the driving forces of economic growth in Nigeria. The signs

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of the interaction term coefficients evaluate if the interaction of economic crisis (financial crisis of 2007/2008 and the commodity price shock of 2016) on trade openness and FDI inflow enhances or distorts the impact of trade openness and FDI inflow on economic growth. A negative sign indicates that the economic crisis reduces the effect of trade openness and FDI inflow on economic growth and vice versa. Since the target variables are trade openness and FDI inflow, the total effect of trade openness on economic growth given the economic crisis is calculated as thus:[1]

Trending on similar studies [2, 3] the interpretation of the interaction terms is based on the following five possibilities:

1. If $\theta_7, \theta_8 = 0$ it shows that the interaction of economic crisis (financial crisis of 2007/2008 and the commodity price shock of 2016) with trade openness and FDI inflow have no significant impact on growth.
2. If $\theta_7, \theta_8 > 0$ it implies that of economic crisis (financial crisis of 2007/2008 and the commodity price shock of 2016) is a booster of trade and FDI inflow on growth.
3. If $\theta_7, \theta_8 < 0$, the overall impact of trade openness and FDI inflow on growth depends on the magnitude of the negative coefficient.
4. If the negative sign of θ_7, θ_8 outweighs the positive sign of θ_1, θ_2 then economic crisis (financial crisis of 2007/2008 and the commodity price shock of 2016) distorts the impact of trade openness and FDI inflow on economic growth.
5. If the negative sign of θ_7, θ_8 is less than the positive sign of θ_1, θ_2 it implies that the distortionary influence of economic crisis (financial crisis of 2007/2008 and the commodity price shock of 2016) is not sufficient to inhibit the positive effect of trade openness and FDI inflow on growth.

Estimation technique
Combined cointegration (Bayer and Hanck [10])
Different techniques have been adopted recently to ascertain the long-run stable state among variables considering the controversy surrounding the inconclusiveness in

the general acceptability of co-integration results [66]. To facilitate an improved power of the co-integration test, with the unique aspect of generating a joint test-statistic for the null of no-cointegration based on gloried traditional methods such Engle and Granger, Johansen, Peter Boswijk, and Banerjee tests, the new technique proposed by Bayer and Hanck [10] is adopted. The scholarly advantage of this technique over others is that it provides a platform to combine various individual co-integration test results; it also incorporates the computed significance level (p-value) of individual co-integration tests. In this study, Fisher's equation is as follows:

$$EG - JOH - BO - BDM = -2[\ln(P_{EG}) + (P_{JOH}) + (P_{BO}) + (P_{BDM})]$$ (8)

While the statistical rule follows as thus; the null hypothesis of no-cointegration is rejected on the premise of estimated Fisher statistics exceeding the critical values provided by Bayer and Hank [10]. The symbols P_{EG}, P_{JOH} ,P_{BO}, $andP_{BDM}$; are the *p*-values of the respective individual co-integration tests.

Augmented ARDL analysis
This study employs Augmented ARDL proposed by McNown et al. [54]; Sam et al. [70]; Pesaran et al. [60] and to investigate the long-run relationship between the variables in Eqs. 4 and 7. There are several advantages attributed to the Augmented ARDL analysis. Some of the salient features of AARDL are (i.) Inclusion of dummy variables to account for possible policy change or economic shock [54, 60]. (ii) a dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation (iii) different variables can be assigned multi-lag lengths as they enter the model (See [59]). The advantages over other techniques are as follows: (i.) the order of integration of variables is either 1(0), I(1) or a mix of both I(0) and I(1), the order of integration must not be greater than I(1). (ii.) the assumption of an I(1) dependent variable is unnecessary. (iii.) The three tests provide a clear conclusion on the cointegration status- overall F-test on lagged level variables, t-test on the lagged level of the dependent variable, and F-test on the lagged levels of the independent variable(s)). (iv.) The test is robust in the presence of a limited sample size and endogeneity [54].

The log-linear specification of Eq. 4 without the interaction is modelled using **Augmented** ARDL approach as given thus:

1

$$\frac{\partial lnQ}{\partial lntrade} = \theta_1 + \theta_7 crisis$$

Trending on similar case as above, the total effect of FDI inflow on economic growth given the economic crisis is computed as thus:

$$\frac{\partial lnQ}{\partial lninflow} = \theta_2 + \theta_8 crisis$$

$$
\begin{aligned}
\Delta lnQ_t = {} & \theta_0 + \theta_1 Q_{t-1} + \theta_2 lntrade_{t-1} \\
& + \theta_3 lnk_{t-1} + \theta_4 lnl_{t-1} + \theta_5 lnpcrd_{t-1} \\
& + \theta_6 crisis_t + \sum_{i=1}^{m} \delta_{1i} \Delta lnQ_{t-i} \\
& + \sum_{i=1}^{n} \delta_{2i} \Delta lntrade_{1t-i} + \sum_{i=1}^{q} \delta_{3i} \Delta lnk_{2t-i} \\
& + \sum_{i=1}^{p} \delta_{4i} \Delta lnl_{3t-i} + \sum_{i=1}^{d} \delta_{5i} \Delta lnpcrd_{4t-i} + \varepsilon_t
\end{aligned}
\tag{9}
$$

$$
\begin{aligned}
\Delta lnQ_t = {} & \theta_0 + \theta_1 Q_{t-1} + \theta_2 inflow_{t-1} \\
& + \theta_3 ink_{t-1} + \theta_4 lnl_{t-1} + \theta_5 lnpcrd_{t-1} \\
& + \theta_6 lncrisis_{t-1} + \sum_{i=1}^{m} \delta_{1i} \Delta lnQ_{t-1} \\
& + \sum_{i=1}^{n} \delta_{2i} \Delta lninflow_{1t-i} + \sum_{i=1}^{q} \delta_{3i} \Delta lnk_{2t-i} \\
& + \sum_{i=1}^{p} \delta_{4i} \Delta lnl_{3t-i} + \sum_{i=1}^{d} \delta_{5i} \Delta lnpcrd_{4t-i} + \varepsilon_t
\end{aligned}
\tag{10}
$$

crisis without natural log in Eqs. 9 & 10 is the dummy variable poised to capture both crises, so it takes the value of 1 for 2007–2009, 2016 and 0 for otherwise.

The log-linear specification of Eq. 7 with the interaction is modelled using AARDL approach as given thus

$$
\begin{aligned}
\Delta lnQ_t = {} & \theta_0 + \theta_1 Q_{t-1} + \theta_2 lntrade_{t-1} \\
& + \theta_3 lnk_{t-1} + \theta_4 lnl_{t-1} + \theta_5 lnpcrd_{t-1} \\
& + \theta_6 (lntrade * lncrisis)_t \\
& + \sum_{i=1}^{m} \delta_{1i} \Delta lnQ_{t-i} \\
& + \sum_{i=1}^{n} \delta_{2i} \Delta lntrade_{1t-i} \\
& + \sum_{i=1}^{q} \delta_{3i} \Delta lnk_{2t-i} \\
& + \sum_{i=1}^{p} \delta_{4i} \Delta lnl_{3t-i} \\
& + \sum_{i=1}^{d} \delta_{5i} \Delta lnpcrd_{4t-i} \\
& + \sum_{i=1}^{g} \delta_{6i} \Delta (trade * lncrisis)_{6t-i} + \varepsilon_t
\end{aligned}
\tag{11}
$$

Table 1 Descriptive statistics. Source: author's computation

Variables	Mean	Std. Dev	Skewness	Kurtosis	Observations
*ln*gdp	1749.84	443.588	0.6437	1.7800	37
*ln*trade	32.6365	12.5171	− 0.4201	2.2895	37
*ln*Export	19.5346	8.1193	− 0.1788	2.2072	37
*ln*import	13.1011	5.4185	− 0.0731	2.3946	37
*ln*inflow	1.6081	1.2421	1.6980	5.8906	37
*ln*K	1044.16	641.003	1.1206	4.4400	37
*ln*L	59.2968	2.3845	− 1.4266	3.8106	37
*ln*Pcrd	9.8366	4.3911	1.1581	3.6012	37

$$
\begin{aligned}
\Delta lnQ_t = {} & \theta_0 + \theta_1 Q_{t-1} + \theta_2 inflow_{t-1} \\
& + \theta_3 ink_{t-1} + \theta_4 lnl_{t-1} + \theta_5 lnpcrd_{t-1} \\
& + \theta_6 (inflow * lncrisis)_{t-1} \\
& + \sum_{i=1}^{m} \delta_{1i} \Delta lnQ_{t-i} \\
& + \sum_{i=1}^{n} \delta_{2i} \Delta lninflow_{1t-i} \\
& + \sum_{i=1}^{q} \delta_{3i} \Delta lnk_{2t-i} \\
& + \sum_{i=1}^{p} \delta_{4i} \Delta lnl_{3t-i} \\
& + \sum_{i=1}^{d} \delta_{5i} \Delta lnpcrd_{4t-i} \\
& + \sum_{i=1}^{v} \delta_{6i} \Delta (inflow * lncrisis)_{5t-i} + \varepsilon_t
\end{aligned}
\tag{12}
$$

The null hypothesis under this model is stated as thus

(i) F-test which tests the significance of the coefficients of all the lagged variables:

$H_O : \theta_1 = \theta_2 = ... = \theta_6 \text{are} = 0$

against $H_O : \theta_1 \neq \theta_2 \neq .. \neq \theta_6 are \neq 0$

(ii) t-test which tests the significance of the coefficients of the lagged level of the dependent variable:

$H_O : \theta_1 = 0$ against $H_O : \theta_1 \neq 0$

(iii) F*-test which tests the significance of the coefficients of all the lagged level of the independent variable: $H_O : \theta_2 = ... = \theta_6 \text{are} = 0$ against $H_O : \theta_2 \neq .. \neq \theta_6 are \neq 0$

The decision rule follows: The null hypotheses above must be rejected; otherwise, degenerate lagged of the

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Table 2 Lee and Strazicich [46] LM unit root test with two structural breaks, DF-GLS unit root test and correlation matrix

2A:	*Ln*gdp	*Ln*trade	*ln*Export	*ln*import	*ln*flow	*ln*k	Lnl	*ln*Pcrd
t-statistics (level)	− 4.7325[6]	− 6.5572[8]b	− 7.3533[6]b	− 4.7192[8]	− 5.1858[6]	− 4.1292[7]	47.367[7]a	− 6.7205[2]b
break date	1995, 2009	2002, 2012	2002, 2006	1995, 2007	1995, 2009	1995, 2005	1995, 2011	2005. 2012
First difference								
t-statistics	− 8.1944[6]b	7.2619[6]b	− 8.4183[8]b	− 6.9472[0]b	− 12.020[8]b	− 7.6633[1]b	− 51.546[6]a	− 7.3408[3]a
break date	1998, 2005	2003, 2012	2001. 2011	1992, 2001	1992, 1996	1992, 1996	1996, 2010	2004, 2009
2B:			DF-GLS test					
t-statistics(level)	− 0.5921[4]	− 1.9865[0]c	0.1632[1]	− 1.5711[0]	− 2.1239[0]b	− 1.0684[2]	− 0.8507[1]	− 0.8663[3]
First difference								
t-statistics	− 3.8868[3]a	− 2.4579[7]b	− 8.1743[0]a	− 4.2155[0]a	− 8.7659[0]a	− 3.4381[7]a	− 5.9637[0]a	− 4.8694[2]a
2C: Correlation Matrix								
*ln*gdp	1							
*ln*trade	0.2516	1						
*ln*Export	0.1533	0.969	1					
*ln*import	0.36	0.9314	0.8142	1				
*ln*inflow	− 0.0482	0.3415	0.3837	0.2457	1			
*ln*k	0.7494	− 0.1868	− 0.2579	− 0.072	− 0.3541	1		
*ln*l	− 0.7484	− 0.0319	0.074	− 0.163	0.1854	− 0.4808	1	

a, b and c indicate 1%, 5% and 10% level of significance [] is the maximum lag

independent variable case or degenerate lagged of the dependent variable case. Pesaran et al. [65] and Sam et al. [70] proposed two sets of asymptotic critical values: in the case of purely I(1) and purely I(0) regressors. The testing protocol is as follows: i.) implement the [65] F-test for the joint significance of the coefficients on the level (ii.) a t-test for the lagged dependent variables, a nonstandard distribution under the null hypothesis in the sense that no level relationship exists regardless of whether the regressors are I(0) or I(1). (iii.) following Pesaran et al. [65], McNown et al. [54], we introduce additional t-test or F-test on the lagged independent variables to mitigate the problem of degenerate case 1. (iv.) this study applied the upper and lower critical bounds to evaluate the null hypothesis of no co-integration among variables. Further, the following estimation protocols are implemented, (i) Compare the computed F-statistic from Eqs. (11 and 12) to the Pesaran et al. [65], Narayan (2005) and Sam et al. [70] critical bounds depending on the sample size, hence, the null hypothesis is rejected when the calculated F-statistics or t-statistics in absolute is greater than the upper critical bound, (ii) put in another form, we accepted null

hypothesis when it is less than the lower bound, (iii) F-statistics and t-statistics is inconclusive when the F-statistics or t-statistics calculated is between the lower and upper critical bounds consistent with extant studies, the error correction mechanism with interaction generated from Eqs. 9 and 10 is given as thus:

$$
\begin{aligned}
\Delta lnQ_t = 7\theta_0 + \psi_1 ecm_{t-1} &+ \sum_{i=1}^{m} \delta_{1i}\Delta lnQ_{t-i} \\
&+ \sum_{i=1}^{n} \delta_{2i}\Delta lntrade_{1t-i} \\
&+ \sum_{i=1}^{q} \delta_{3i}\Delta lnk_{2t-i} + \sum_{i=1}^{p} \delta_{4i}\Delta lnl_{3t-i} \\
&+ \sum_{i=1}^{d} \delta_{5i}\Delta lnpcrd_{4t-i} \\
&+ \sum_{i=1}^{v} \delta_{6i}\Delta lncrisi_{5t-i} + \varepsilon_{2t}
\end{aligned}
$$
$$(13)$$

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Table 3 Bayer and Hanck [10] cointegration

Estimated model	EG-JOH	EG-JOH-BO-BDM	EG-JOH	EG-JOH-BO-BDM	Cointegration
Specification					
1. F_rgdp (*ln*rgdp| *ln*intrade, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis)	18.9276a	26.8662a			YES
2. F_rgdp (*ln*rgdp| *ln*export,*ln*import, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis)			55.576a	166.1003a	YES
3. F_rgdp (*ln*rgdp| *ln*inflow, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis)	15.7071b	35.9855a			YES
4. F_rgdp (*ln*rgdp| *ln*intrade, *ln*k, *ln*l *ln*Pcrd, *ln*(trade*crisis)	55.7115a	62.2535a			YES
5. F_rgdp (*ln*rgdp| *ln*export, *ln*k, *ln*l, *ln*Pcrd, *ln*(export*crisis)	19.1609a	21.6699a			YES
6. F_rgdp (*ln*rgdp| *ln*import, *ln*k, *ln*l, *ln*Pcrd, *ln*(import*crisis)	17.3731a	21.3358a			YES
7. F_rgdp (*ln*rgdp| *ln*inflow, *ln*k, *ln*l, *ln*Pcrd, *ln*(inflow*crisis)	18.2767a	41.7489a			YES
5% critical value	10.419	19.888	10.352	19.761	

a, b and c indicate 1%, 5% and 10% level of significance

Table 4 Augmented ARDL bound test cointegration. Source: author's computation

AARDL bounds cointegration test results	F-statistic	t-statistic	F*-statistic
Specifications, all k = 5. Model k = 6 N = 37			
1. F_rgdp (*ln*rgdp| *ln*intrade, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis): ARDL (2,2,2,2,2,1)	4.771b	− 3.977c	5.9141b
2. F_rgdp (*ln*rgdp| *ln*export, *ln*import, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis): ARDL (2,2,2,2,2,1,1)	8.5313a	− 6.706c	9.7613b
3. F_rgdp (*ln*rgdp| *ln*inflow, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis): ARDL (2,2,2,2,1,1)	3.890c	− 3.657c	4.071c
4. F_rgdp (*ln*rgdp| *ln*trade, *ln*k, *ln*l, *ln*Pcrd, *ln*crisis*trade): ARDL (2,2,2,0,2,1)	5.795a	− 4.043c	6.668c
5. F_rgdp (*ln*rgdp| *ln*export, *ln*k, *ln*l, *ln*Pcrd, crisis, *ln*crisis*export): ARDL (2,2,2,2,1,1)	5.744a	− 3.842c	6.672a
6. F_rgdp (*ln*rgdp| *ln*ixport, *ln*k, *ln*l, *ln*Pcrd, crisis, *ln*crisis*import): ARDL (2,2,1,2,0,1)	4.066b	− 3.234c	3.541c
7. F_rgdp (*ln*rgdp| *ln*inflow, *ln*k, *ln*l, *ln*Pcrd, crisis, *ln*crisis*inflow): ARDL (2,2,2,2.1,1)	4.399b	− 3.9634b	3.991b
Remark	Cointegtration		
The model selection ARDL is based on Akaike info criterion (AIC)			

a,b, & c indicate significance at 1, 5 & 10%

Source of critical value: Pesaran etal. (2001) Appendix: Case I &V unrestricted intercept and no trend, Narayan(2005), Appendix: Case III unrestricted intercept and no trend Sam et al.(2019) Appendix: Case III unrestricted intercept and no trend

$$\Delta lnQ_t = \theta_0 + \psi_2 ecm_{t-1} + \sum_{i=1}^{m} \delta_{1i}\Delta lnQ_{t-i}$$
$$+ \sum_{i=1}^{n} \delta_{2i}\Delta lninflow_{1t-i}$$
$$+ \sum_{i=1}^{q} \delta_{3i}\Delta lnk_{2t-i}$$
$$+ \sum_{i=1}^{p} \delta_{4i}\Delta lnl_{3t-i}$$
$$+ \sum_{i=1}^{d} \delta_{5i}\Delta lnpcrd_{4t-i}$$
$$+ \sum_{i=1}^{v} \delta_{6i}\Delta lncrisis_{5t-i} + \varepsilon_{2t} \tag{14}$$

While the error correction mechanism with interaction generated from Eqs. 11 and 12 is given as thus

$$\Delta lnQ_t = 7\theta_0 + \psi_3 ecm_{t-1} + \sum_{i=1}^{m} \delta_{1i}\Delta lnQ_{t-i}$$
$$+ \sum_{i=1}^{n} \delta_{2i}\Delta lntrade_{1t-i}$$
$$+ \sum_{i=1}^{q} \delta_{3i}\Delta lnk_{2t-i} + \sum_{i=1}^{p} \delta_{4i}\Delta lnl_{3t-i}$$
$$+ \sum_{i=1}^{d} \delta_{5i}\Delta lnpcrd_{4t-i}$$
$$+ \sum_{i=1}^{v} \delta_{6i}\Delta(lntrade * lncrisis)_{5t-i} + \varepsilon_{2t} \tag{15}$$

Table 5 Diagnostic test. Source: author's computation

Diagnostic test	Spec 1		Spec 2		Spec 3		Spec 4		Spec 5		Spec 6		Spec 7	
Durbin–Watson stat	2.6319		2.5244		2.00387		2.0934		2.1804		2.0851		2.2167	
Jarque–Bera normality test	0.5286	[0.7677]	0.751	[0.6869]	2.0348	[0.3615]	2.0348	[0.3615]	2.5607	[0.2779]	4.9303	[0.8499]	7.5692	[0.1034]
BG serial correlation LM test	8.1523	[0.0170]	4.2948	[0.1168]	6.9903	[0.3550]	14.161	[0.0885]	0.6415	[0.7256]	0.334	[0.0845]	0.8465	[0.6549]
Heteroskedasticity test: ARCH	17.493	[0.2308]	6.189	[0.9974]	4.8624	[0.9378]	17.278	[0.7478]	11.606	[0.6379]	12.288	[0.5042]	48,255	[0.9393]
Ramsey RESET test	0.4703	[0.5016]	1.0474	[0.3248]	1.7286	[0.2179]	0.8471	[0.6106]	1.0185	[0.3255]	1.2268	[0.2812]	0.8997	[0.3532]
CUSUM & CUSUMSQ	Stable		Stable		Stable		Stable		Stable		Stable		Stable	

4.2 Co-integration result

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$$\Delta lnQ_t = 7\theta_0 + \psi_4 ecm_{t-1} + \sum_{i=1}^{m} \delta_{1i} \Delta lnQ_{t-i}$$

$$+ \sum_{i=1}^{n} \delta_{2i} \Delta lninflow_{1t-i} + \sum_{i=1}^{q} \delta_{3i} \Delta lnk_{2t-i}$$

$$+ \sum_{i=1}^{p} \delta_{4i} \Delta lnl_{3t-i} + \sum_{i=1}^{d} \delta_{5i} \Delta lnpcrd_{4t-i}$$

$$+ \sum_{i=1}^{v} \delta_{6i} \Delta \ln(inflow * crisis)_{5t-i} + \varepsilon_{2t}$$

$$(16)$$

The coefficient for the error correction term is given as $\psi_1, \ldots, \psi_4$. Consistent with extant studies, we expect these coefficient to negative and statistically significant to confirm that the short run disequilibrium is converged to the long run position on a certain speed of adjustment.

Results and discussion

Preliminary investigation

Table 1 provides descriptive statistics of our variables used in the study. It can be observed that log of real GDP per capita has the highest average level of 1749.84 followed by log of capital stock (lnK) with mean value of 1044.16 and then log of labour and log of total trade with the average values of 59.2968 and 32.6365, respectively. As for the standard deviation, the result indicates that lnK has the highest value followed by lngdp.

Stationary test and correlation result

To determine the stationarity state of the variables used in this study, we estimated Lee and Strazicich [46] Lagrange multiplier unit root test that considers possible multiple structural breaks in the data. The result from Table 2A suggests that Lntrade, lnPcrd, lnExport, and Lnl are stationary at a level. At the same time, other variables are stationary at the first difference while accounting for structural breaks in all the series. Accordingly, the test suggests structural breaks in the Lngdp series in 1995 and 2009. This means that Nigeria observed significant policy shocks in Lngdp following the economic and financial crisis and the various economic policies that started the transition leading to capital flight to bank recapitalization. Tables 2B using the modified ADF unit root test in the likes of DF-GLS test as proposed by Elliott et al. (1996) shows a similar results indicating that all variables are I(0) or I(1), and

none of the variables in the model is I(2); hence, Augmented ARDL can be used to model the log-linear empirical specification in Eqs. (4 & 7), respectively.

Considering Table 2C, high correlation coefficients of 0.84, 0.97, 0.93 and 0.81 were seen between lnpcrd and lngdp, lnexport and lntrade, lnimport and lntrade, lnimport and lnexport, respectively. The coefficient of correlation between lmgdp and lntrade, lnexport, lnimport, lnK and lnPcrd are positive, implying a rise in lntrade, lnexport, lnimport, lnK, and lnPcrd will raise GDP. Also, the high positive correlation between credit to the private sector (lnpcrd) and economic growth is theoretically expected. It implies that financial development is a key driver of growth. On the other hand, there is a negative correlation between lnL and GDP and lninflow and GDP. All other correlation coefficients reveal values less than 0.8, which shows that those variables are not linearly dependent.

Table 3 presents the Bayer and Hanck [10] co-integration test, showing that the Fisher statistic for EG-JOH and EG-JOH-BO-BDM is] greater than the 5% critical values of 10.419 19.888 for spec. 1, 3–7 and spec. 2 for 10.352 19.761, respectively. On this note, the null hypothesis is rejected and concludes that the variables under consideration are cointegrated. Table 4 indicates the Augmented ARDL bounds test for co-integration, which explains the long-run relationship among the dependent and the independent variables for all seven specifications and equations of our models. The overall F-test on lagged level variables, t-test on the lagged level of the dependent variable, and F-test on the lagged levels of the independent variable have the highest critical values across specifications. The results revealed that the test is significant and are more than the upper critical values I(1) at 1%, 5% and 10% significant, respectively. This further suggests the existence of co-integration between the dependent and explanatory variables in Nigeria because the null hypothesis of no co-integration between the variables was rejected. In Table 5, the diagnostic tests of (for heteroscedasticity test), (Breush-Godfrey LM for serial correlation test), and JB (Jarque–Bera for normality test) revealed insignificant probability values- implying that the models were homoscedastic, not serially correlated and normally distributed. Also, the long-run stability test of CUSUM and CUSUMSQ test statistics to the recursive residuals as prescribed by Brown et al. (1975) shows evidence of stability over the selected period (see Figs. 2, 3, 4, 5, 6, 7 and 8 in Appendix 1).

Long-and short-run coefficients

This section provides findings from the long and short-run estimates that fill gaps in the literature on the tripartite relationship between trade openness, FDI inflow, economic crisis and economic growth in Nigeria, substantiating the fact on whether trade openness and FDI inflow individually enhance economic growth or if their interaction term with economic crisis changes or enhances their impact on growth. The analysis starts by alternating the models with the economic crisis and their interactions with trade openness-export and import and FDI inflow as shown in Table 6.

Specification [1] [2] and [3] relate to the analysis for the direct impact of trade openness, FDI inflow and crisis on economic growth. In contrast, specifications [4] and [7] relate to the interaction with economic crisis. The study incorporates export and import as a proxy for the decomposed total trade in specification [5] and [6] as an additional variable corresponding to robustness checks for specification [4]. The interpretation for the respective specifications [1] [2] and [3] in Table 6 are therefore taken in turns.

In Table 6, Specification 1, total trade is a statistically significant positive predictor of economic growth in the long and short-run at the 5% level, suggesting an elastic association. This result is consistent in line with Keho [39], suggesting that trade openness directly influences economic growth both in the short and long-run in the case of Cote d' Ivoire. However, for the case of Nigeria, Omoke and Opuala-Charles [62] found that trade openness is positive but statistically insignificant. Our finding differs from Omoke and Opuala-Charles [62] submission because they considered the moderating role of institutional quality on trade-growth nexus, while the present investigated the role of economic crisis on the tripartite relationship between key variables. When assessing other variables, the capital coefficient is statistically positive and significant at the 1% level. From the coefficient, a 1% increase in capital translates into about 0.0785% increase in economic growth. While labour, credit to private sector crisis are statistically insignificant. The short-run estimates show that the coefficient of labour and capital is negative and statistically significant at 5% level with a 1% increase in both variables to generate a 0.0885% and 0.6730% decrease in economic growth in Nigeria, at the same time credit to the private sector (control variable) and crisis is significantly reducing economic growth to the turn of 0.0125% and 0.0229% in the long-and short-run.

Decomposing total trade into imports of goods and services (% of GDP) and exports of goods and services (% of GDP) for robustness check in specification 2, surprisingly, the long-run contribution of import and export trade on economic growth in Nigeria showed mixed results. From the coefficients, the export trade is positive and statistically significant at a 1% level, with a 1% increase in export escalating to about a 0.0744% rise in economic growth. This finding agrees with the submission of Olubiyi [61], which concludes that the expansion of the Nigerian economy is focused on the export-led growth hypothesis and in contrast to what Malefane and Odhiambo (2019) reported for Lesotho. Import trade is statistically insignificant in the long-run; crisis exerts negative and statistically significant in predicting economic growth.

Although positive, domestic credit to the private sector generates a 0.0536% insignificant increase in economic growth. Export trade is statistically insignificant at level coefficient in the short-run, while import trade at lag 1 is positive and statistically significant at 10% level. This implies import-led growth in the short-run. This condition conforms to the findings of Raghutla and Chittedi [67], where the study observed that import-led growth hypothesis model in the case of Russia under the auspices of the topic "Is there an export- or import-led growth in emerging countries? A case of BRICS countries". Labour and capital are simultaneously negative and statistically significant at 10% and 5% level, respectively. With their respective coefficients, a 1% decrease in both variables generates a 0.0587% and 0.5165% increase in economic growth in Nigeria, ceteris paribus. Domestic credit to the private sector has an insignificant effect, while crisis significantly affects economic growth. Intuitively, the overall effect of these insignificant contributions of domestic credit to the private sector could be attributed to the low economic activities during the global economic crisis, and possibly Nigeria entered a recessionary regime during the economic crisis.

On the inclusion of FDI inflow in specification 3, the coefficient is statistically significant in both the long and short-run. The signs of the coefficients are in pari-passu with the theoretical underpinnings and extant studies. Another scholarly evidence emanates from the fact that credit to the private sector, capital and labour are positive and statistically insignificant in exerting influence on economic growth. Collectively, the findings are not surprising considering the assertion by Alfaro et al. [5], Ozturk [63], De Mello [21], Ozturk [63] and Ford et al. [30],

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where the study posited that only countries with well-developed financial markets experience long-run growth from FDI; and capable of using human capital to absorb technological and knowledge transfers in crisis and slow economic growth. The impact of capital and labour are statistically significant in the short-run at the 1% level. While capital contributes a positive impact on economic growth, labour contributes a negative impact on economic growth. Jointly, a 1% increase/decrease in capital and labour will generate a 0.1044% increase and 0.7741% decrease in economic growth. Crisis is significant in the short-run. Lastly, the respective ECM (− 1) of Specifications 1, 2 & 3 show similar results across the board. For example, Spec. 1 (− 0.2143), spec. 2 (− 0.2213), and Spec. 3 (− 0.1709) respectively. These coefficients are negative and significant at a 1% level, implying that the short-run disequilibrium will converge back to the established long-run relationship between the average of 17.09% and 22.13%.

Moving towards the novelty of this study, specifications [4], [5], [6] and [7] are analysed in turn, debuting the investigation on FDI-trade-growth nexus between the 2007–2008 global financial crisis and commodity price shock 2016 in the case of Nigeria. Equation 13 was extended by including an interaction term to mimic the contribution of the economic crisis in the trade-growth nexus in Nigeria. In Specification 4, the coefficient of trade openness is positive and statistically significant at a 5% level, implying that, all things being equal, a 1% increase in trade will escalate 0.2297% and 0.0779% increase in growth in both long and short-run, respectively. The coefficients of the interaction terms, which indicate whether economic crisis distorts or improves trade, is negative across all specifications [4] to [7] for economic growth. For specification [4], the magnitude of the negative coefficient determines the influence of the economic crisis. For example, the differential effect of − 0.1824 (that is 0.2297–0.4121) in the long-run and − 0.0491(that is 0.0368–0.0859) in the short-run offers the total effect of trade openness on growth given economic crisis, which shows that the negative interaction is substantive enough to dampen the positive impact of trade on economic growth. These findings agree with the extant studies' assertions on trade openness, highlighting that growth in the low-income economies could translate to negative growth during the shock transmission in the face of economic crisis.

Specification 5 & 6 replicates specification 4 using the decomposed version of total trade (imports of goods and services (% of GDP) and exports of goods and services (% of GDP) for robustness check. In spec. 5, the coefficient of the interaction term ln crisis*exp and Δln crisis*exp in the short-run are negative, and the long-run is positive and statistically significant at 1% level, suggesting that the negative long-run effects and short-run effect of export on economic growth in Nigeria decrease within the period of the global financial crisis. The net effects are 0.0436 for the long-run and − 0.0216 for the short-run, suggesting that the immediate effect of economic crisis is more pronounced in the short-run than the long-run impact given that 0.0436 > − 0.0216. These are significant contributions to the body of knowledge as it corroborates growth-enhancing export in the long-run. These findings validate the empirical submission to the country-time and sector-time fixed effects model of Del Prete and Federico [22], showing evidence of a negative impact of financial shocks on exports, leading to economies' vulnerability. In specification 6, the coefficient of import trade is positive and significant in the long-run and short-run, thus, inducing growth by an average of 0.525% and 0.0329%, respectively. The ln crisis*imp and Δln crisis*imp interaction are negative for the long and short-run with the coefficient − 0.1330 & − 0.1137, respectively. It concludes that the global economic crisis is sufficient to dampen the positive implication of import through the net effect of − 0.0999 & − 0.0808 (see Table 6). In comparison with the study of Bandara [9] posits that theories of transmission channels (through import) between the global financial crisis and economic growth holds for Nigeria. By intuition, import trade forms the baseline through which global financial crisis can weaken economic growth.

In specification 7, the coefficient of the interaction term (long and short-run) ln crisis*fdi & Δln crisis*fdi are negative and statistically significant at 1% level, suggesting the negative long and short-run effects of FDI inflow on economic growth in Nigeria decreases during the global financial crisis. The ln crisis*fdi and Δln crisis*fdi interaction is negative for long and short-run − 0.1030 & − 0.1137, respectively. However, the net effect shows a mixed result totally; for instance, the differential effect of − 0.0105 in the long-run and 0.0018 in the short-run explain the total effect of FDI inflow on growth given the global economic crisis, which shows that the negative

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Table 6 Long-and short-run coefficients, and their differential effects. Source: author's computation

Variable	Spec. 1		Spec 2		Spec 3		Spec 4		Spec 5		Spec 6		Spec 7	
	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics
Long run result														
C	0.6039	0.0869	1.0158c	1.9403	0.9318	1.3523	− 0.4054	0.0695	2.2584	1.2405	− 0.2037a	4.8473	0.3756	1.1935
ln trade	0.0427b	2.6526					0.2297b	2.7427						
ln export			0.0744	0.5899					0.2036a	3.8262				
ln import			− 0.0341	− 1.0095							0.0525b	3.5868		
ln inflow	0.0785a	4.0962			0.0026b	2.4638							0.1033b	2.6419
ln k	− 0.1154	− 1.9137	0.0717a	5.541	0.2755	0.733	0.3849a	4.0875	0.3093a	5.9669	0.0825a	5.5088	0.2730b	2.0209
ln l	0.001	1.3874	− 0.345	− 0.8645	0.7832	0.6958	1.1716	1.0637	− 0.1286	− 0.5208	0.479	1.1552	1.0911	0.8552
ln pcrd	− 0.0125b	− 2.9216	0.0536	1.1072	0.1099	0.9277	0.1034	1.1931	0.0393	1.139	0.256	1.101	0.1242	0.1685
Crisis			− 0.0115a	− 4.4236	− 0.0528a	− 3.691								
ln crisis*trade							− 0.4121b	− 2.6753						
ln crisis*export									− 0.1598b	− 2.7479				
ln crisis*import											− 0.1331b	2.1535		
ln crisis*inflow													− 0.0138a	3.5268
Short run result														
Δln (gdp(−1))	0.4766a	4.2911	0.3265b	2.5564	0.3939a	3.5603	0.4470a	4.2605	0.4164a	4.2219	0.3924b	2.5344	0.3980b	2.0148
Δln trade	0.0251b	3.0637					0.0779b	2.0284						
Δln (trade(−1))	0.033b	4.1637					0.0368c	1.9836						
Δln (export)			0.0294	0.0382					0.0038b	2.0448				
Δln (export(−1))			0.0178c	1.758					0.0069c	1.9263				
Δln import			0.0511	0.0142							0.0238b	2.0256		
Δln (import(−1))			0.0302c	2.0795							0.0329c	0.3584		
Δln fdi					0.0234b	2.6468							0.1137b	2.2611
Δln fdi (−1)					0.0278b	2.361							0.0161b	2.0021
Δln k	− 0.0219b	− 3.3217	− 0.1279b	− 2.2427	0.076b	2.0735			− 0.0742	− 0.0767	− 0.2676	− 0.0486	− 0.0757	− 0.0742
Δln (k(−1))	− 0.0885b	− 3.1031	− 0.0587c	2.0664	0.1044a	4.3246			− 0.0722b	− 2.9329			0.1050a	3.6576
Δln l	− 0.0878b	− 2.7829	− 0.0397b	− 3.3021	− 0.1058b	− 2.0084	0.0150b	2.2075	0.0371b	2.6681	0.0658b	2.5701	0.0073b	2.1085
Δln (l(−1))	− 0.6730b	− 3.3217	− 0.5165b	2.0121	− 0.7741a	− 4.4931	− 0.7508a	− 4.0163	− 0.6403b	− 2.948	− 0.5988c	− 1.9514	− 0.7829a	3.3509
Δln (pcrd)	− 0.0434	− 0.3217	− 0.0315	− 0.0376	− 0.0119	− 0.161	− 0.0513	− 0.0426	− 0.0622c	− 1.9655			− 0.0091	− 1.7427
Δln (pcrd(−1)	0.0546	0.0394					0.0508	0.6534					0.0089	0.0526
Δln crisis*trade	− 0.0229b	− 2.2429	− 0.0129b	− 2.0106	− 0.009	− 0.0122	− 0.0859a	− 3.5062						
Δln crisis*export									− 0.0285a	− 3.3047				
Δln crisis*import											− 0.1137b	2.7581		
Δln crisis*inflow													− 0.0024a	− 4.7962

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Table 6 (continued)

Variable	Spec. 1		Spec 2		Spec 3		Spec 4		Spec 5		Spec 6		Spec 7	
	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics	Coeff	t-statistics
ecm(− 1)	− 0.2143a	− 4.8686	− 0.2213a	− 11.1038	− 0.1709b	− 4.1939	− 0.2084b	− 3.7785	− 0.2681a	− 4.2681	− 0.2037a	− 10.7315	− 0.1769b	− 4.0999
Differential effects														
Long run														
Crisis*trade							− 0.1824							
Crisis*export									0.0436					
Crisis*import											− 0.0999			
Crisis*inflow													− 0.0105	
Short run														
Crisis*trade							− 0.0491							
Crisis*export									− 0.0216					
Crisis*import											− 0.0808			
Crisis*inflow													0.0018	

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interaction in the long-run is substantive enough to dampen the positive impact of FDI inflow on economic growth. In contrast, the positive differential or total effect implies that the global financial crisis is insufficient to dampen the short-run positive effect.

It concludes that the global economic crisis is sufficient to dampen the positive implication of import through the net effect of -0.0999 & -0.0808 (see Table 6). Conversely, investment inflows into Nigeria during the global crisis are weakened, creating economic conditions such as poor-absorptive capacities of economic agents and poor industrial infrastructures that could negatively impact growth. Indeed, this could be a case of the FDI inflow contributing to unsustainable consumption and diversion of economic resources through the global economic crisis. In all, there is a mixed level of impact led-relationship between capital, labour and domestic credit to the private sector on economic growth, which could be attributed to recessionary episodes, low-absorption capability, and poor structure associated with the Nigerian economic system in recent time. Lastly, the respective ECM (-1) of specifications 4, 5, 6 & 7 show similar results across the board. For example, Spec. 4 (-0.2084), spec. 5 (-0.2681), Spec. 6 (-0.207) and 7 (-0.1769) respectively. These coefficients are negative and significant at a 1% level, implying that the short-run disequilibrium will converge back to the established long-run relationship between the average of 17.39% and 26.81%.

Conclusion and policy implication

This study examined (a) the FDI-trade-growth nexus in aforementioned economic crisis covering the periods i.e. 2007–2008 global financial crisis and commodity price shock 2016 in the case of Nigeria. (b) filled the lacuna in the previous studies by adopting Bayer and Hanck co-integration and augmented ARDL econometric techniques to test research hypothesis. (c) Incorporated relevant crisis periods in the case of Nigeria beyond the popularised global economic/financial crisis used by a multitude of authors in multi-jurisdictions, in a bid to increase the generalisability of study findings (d). Indicators of trade openness used in the study were total trade (including exports and imports), import trade, and export trade. Using Augmented ARDL, this study provides evidence of a long-run association among the data set. The estimates suggest (1) global economic crisis significantly dampens economic growth. (2) The negative interaction of total trade, FDI a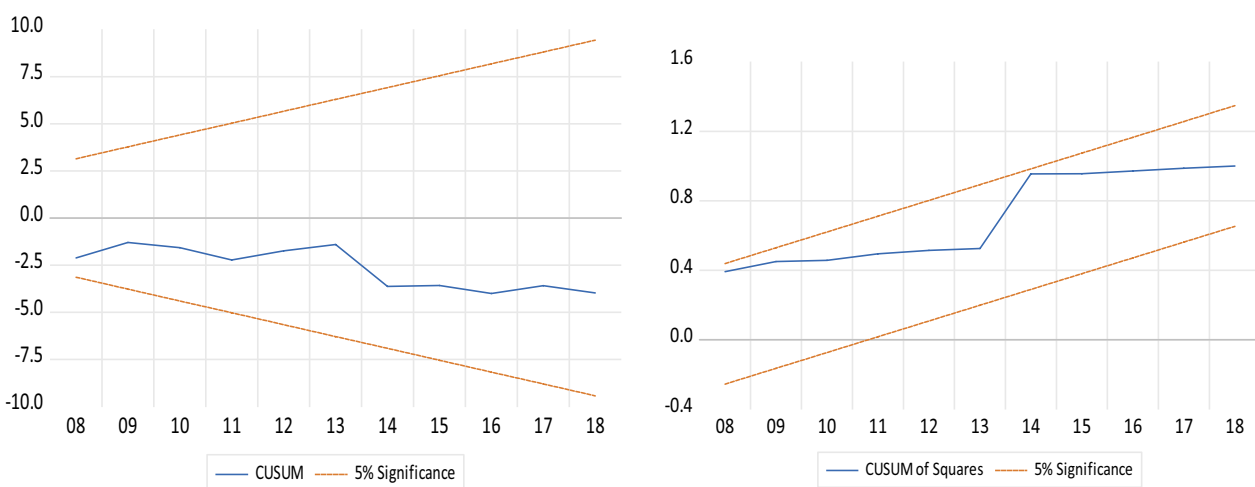nd global financial economic crisis is substantive enough to dampen the trade-growth and FDI-growth led relationship. (3) The negative interaction of FDI-inflow with global economic crisis is more pronounced and substantive in the long run than the short run. Scholars, stakeholders and policy makers are therefore advised to take into account specific fiscal measures that should provide a sound legislative rules and reductions in taxes for international investors. Also attempt by the government should be positioned towards escalating the stimulus measures that stimulated the economy, they might obliged to return to austerity measures to control public spending, which had previously fuelled economic expansion. Another suitable policy option points to an immediate total seizure in undesirable policy announcements by the Apex bank and the central government inimical to investors' largesse sustainability in the Nigerian economy. All these contributes to the short-term trajectory of FDI in Nigeria and the refusal of foreign investors to commit long-term in non-oil sectors and sectors with enormous capacity capable of engendering growth through the auspices of domestic sustainability. The FG should provide stable environment on all frontiers in a bid to romance investors to commit long-term investment in Nigeria which enables stable growth and kills speculation that fuels occurrence of business cycles. In all, this masterpiece contributes to repository since extant studies that determined causal nexus between trade openness, FDI inflow and economic growth neglected the economic crisis in the case on Nigeria. Future research should reconsider the effect of the economic crisis on asymmetric or non-linear effect of trade openness, FDI inflow on economic growth.
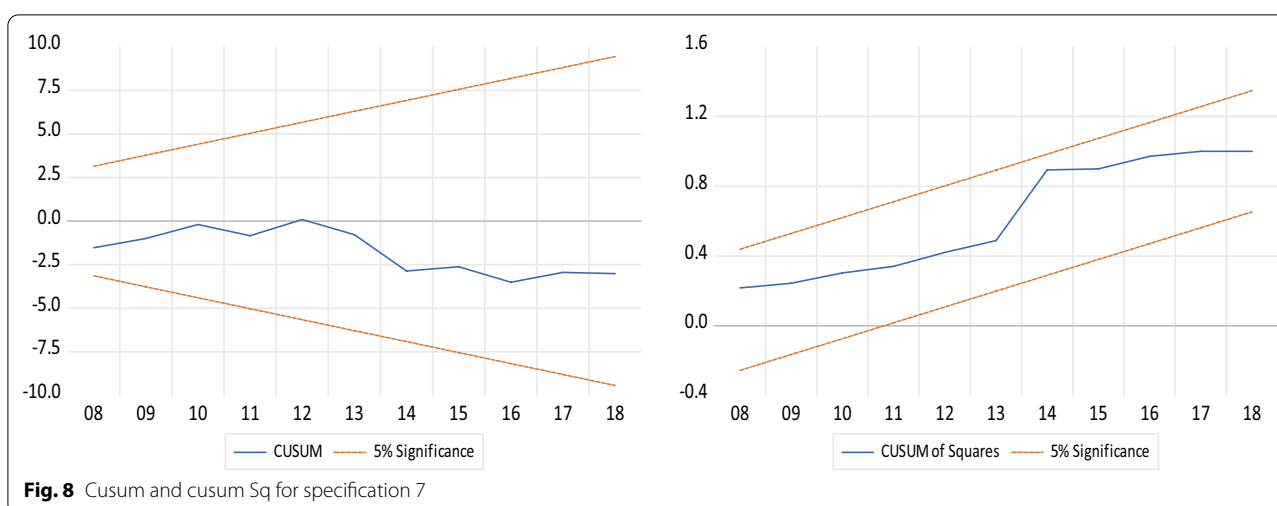
Government must wade in to create buffers and stimulants in crisis periods to decrease the dampening effect of trade and crisis on economic growth in Nigeria. Furthermore, government should redirect its attention from import-dependency to export-led growth through the auspices of increased domestic capacity across manufacturing, industrialisation, technology and agriculture. This is expected in pursuance of increasing government revenue, reducing effect of shocks emanating from global and local economic crisis and increasing domestic capacity which leads to the creation of jobs and hike in the standard of living.

Appendix 1

See Figs. 2, 3, 4, 5, 6, 7, 8.

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Fig. 2 Cusum and cusum Sq for specification 1

Fig. 3 Cusum and cusum Sq for specification 2

Fig. 4 Cusum and cusum Sq for specification 3

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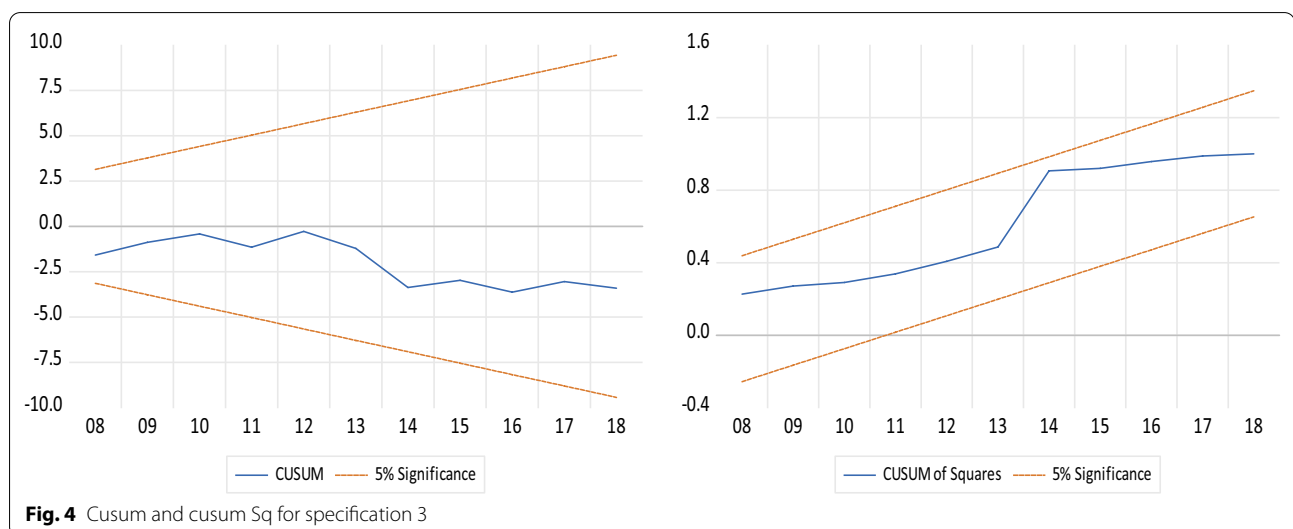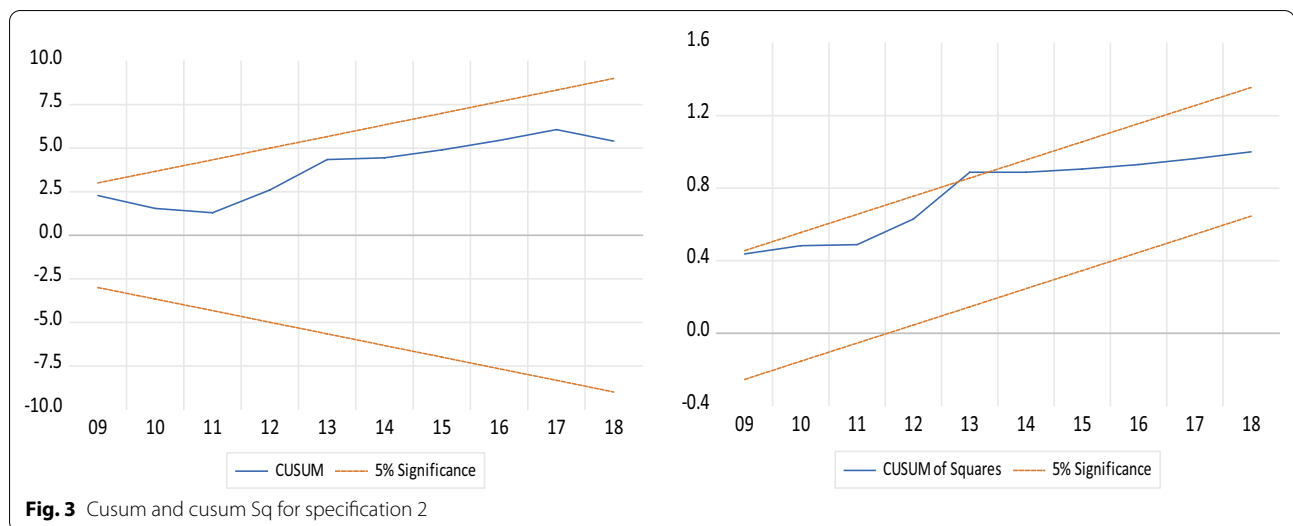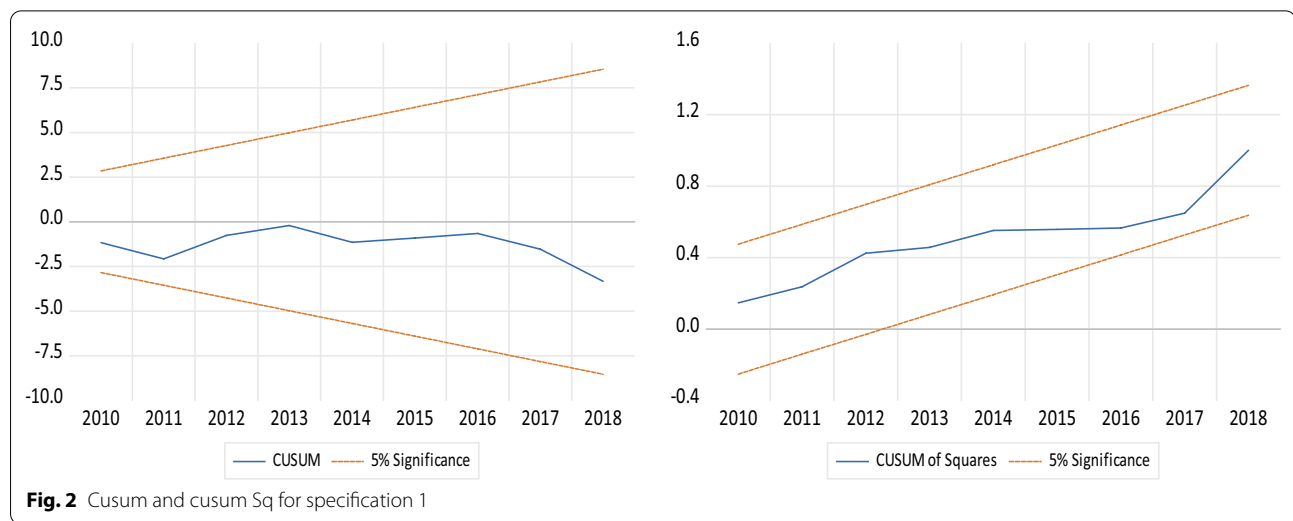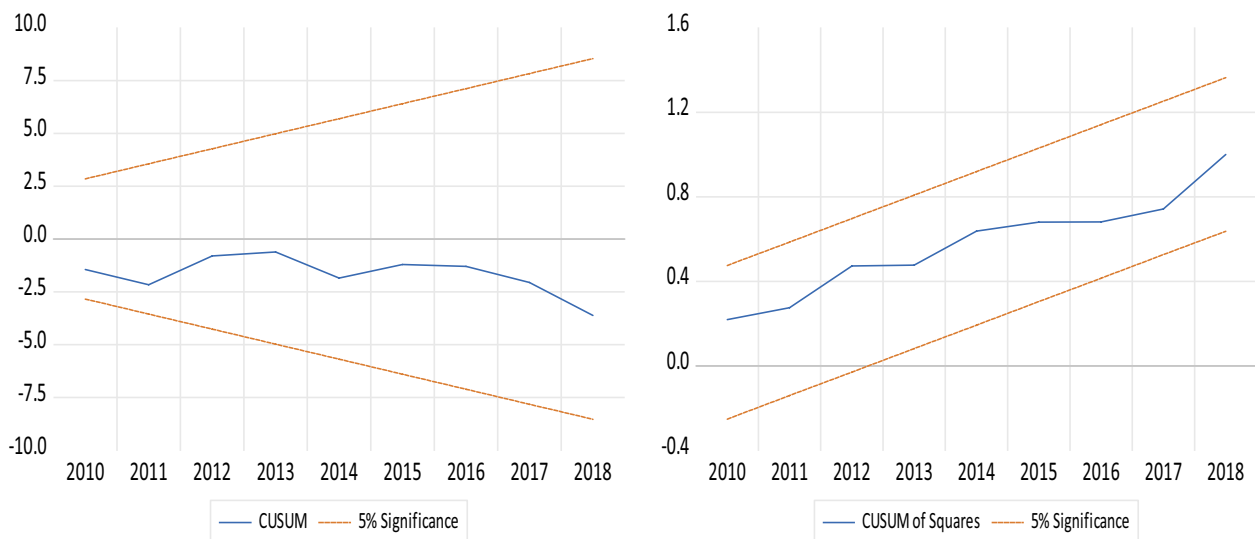
Fig. 5 Cusum and cusum Sq for specification 4
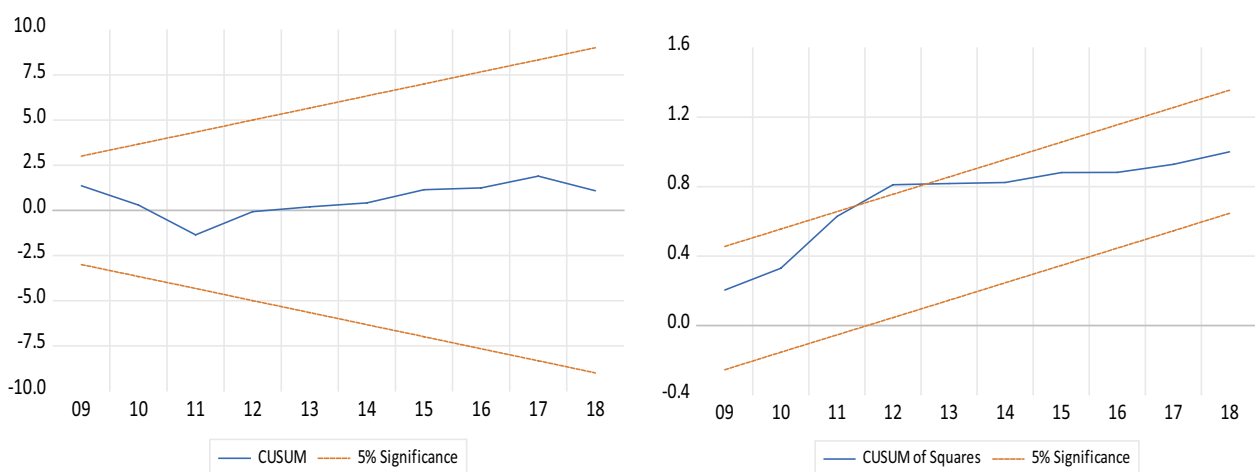
Fig. 6 Cusum and cusum Sq for specification 5

Fig. 7 Cusum and cusum Sq for specification 6

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Fig. 8 Cusum and cusum Sq for specification 7

Availability of data and materials
Yes, available on request.

Declarations

Ethics approval and consent to participate
Note applicable.

Consent for publication
Note applicable.

Competing interests
On behalf of all authors, the corresponding author states that there is no conflict of interest.

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