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Socio-economic, environmental and institutional sustainability and economic growth within BRICS: What are the best policy options?

By

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A thesis submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy in Economics

Supervisor: Prof. Josue Mbonigaba

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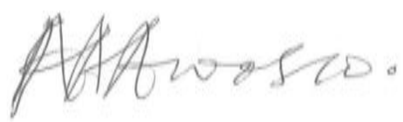
While the sections detailing each paper contain a statement of contribution by co-authors, this serves as a general declaration that the work of all papers included here is the original work of the candidate, Mr. Awolusi Olawumi Dele. Prof. Josue Mbonigaba has contributed to this thesis in his supervisory role by providing overall guidance to the coherence of this body of work. His contributions have been advisory in nature; the writing of the work in its entirety was done by the candidate. In submitting papers for consideration for publication, Mr. Awolusi Olawumi Dele has been the primary and corresponding author.



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ABSTRACT

Due to diverse socio-economic, environmental, institutional characteristics and different levels of industrial development, a major problem in BRICS (Brazil, Russia, India, China, and South Africa) countries is how bloc member countries can work together to advance the goals of economic growth without compromising individual member countries aspirations to sustainability. For BRICS cooperation to bring about improved welfare in individual countries, economic growth in the bloc needs to be conducive to sustainability in individual countries. Otherwise, policies need to be enacted to ensure sustainability in the bloc. The formulation of policy options would require extensive knowledge of how economic growth relates to identified sustainability variables. Consequently, the overall objective of this thesis is: To examine the effect of economic growth on socio-economic, institutional, and environmental sustainability within the BRICS as well as compare evidence on relationships between economic growth and sustainable developments within the BRICS bloc.

To accomplish the stated objective, the thesis used various non-linear and linear estimators that are robust to both small sample size bias and cross-sectional dependence errors, contrary to most literature on the topic. The overall argument of the thesis was supported by four different pieces of analysis, each contained in a publishable paper.

The first article (chapter 3) titled "Socio-economic sustainability and economic growth in BRICS: relationships and policy options" investigates the influence of economic growth on socio-economic sustainability in BRICS to observe possible patterns in this bloc. The paper uses Pesaran et al. (2001) autoregressive distributed lag (ARDL) co-integration technique, as well as, Toda and Yamamoto (1995) granger non-causality approach in a two-variable vector autoregression model. In this paper, the results established the existence of co-integrating vectors and short-run causal relationships, which run either unidirectionally or bidirectionally in all the variables. Our study, therefore, concluded that the long-run equilibrium relationships between economic growth and socio-economic sustainability in BRICS vary from one country to another, but were largely insignificant in the models of Russia and China during the study period. This conclusion is tacit support for the Kuznets hypothesis in both China and Russia. The study concluded that a common policy option was not possible and that for the block to pursue its economic prosperity goals without compromising individual countries' needs for socio-economic sustainability, varied radical policy options were inevitable in Brazil, India, and South Africa. These include radical law reforms and independent organisations; population growth control, speedy poverty alleviation and basic education; market development; and creation of societal culture to promote socio-economic sustainability.

Article 2, titled "Economic growth and institutional sustainability nexus within BRICS: Relationships and policy options" in Chapter 4 of the thesis examines the influence of economic growth on institutional sustainability within BRICS. The paper adopted a panel data co-integration analysis and Hausman specification test. As a robustness check, the study launched the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimations at individual and panel levels over the study period. The study concluded that the effect of economic growth on institutional fitness within BRICS, though significant and positive, was limited and varied. Specifically, the study observed that China performed well among the five countries. Consequently, this study posited a more radical policy mix to enhance institutional sustainability in the three (Brazil, India, and South Africa) less developed countries in the bloc. The policies could focus more on developing radical institutional strategies; superior growth induced domestic investment, financial developments, and circular economic model.

Article 3 in Chapter 5 of the thesis, titled “Economic growth and environmental sustainability within BRICS countries: A comparative analysis " focused on the influence of economic growth on environmental sustainability within BRICS. Due to the probable cross-sectional dependency errors, the estimates via the autoregressive distributed lag (ARDL) were supported by cross-sectional autoregressive distributed lag (CS-ARDL). The results confirm that economic growth and environmental sustainability are co-integrated at the panel level. Specifically, the study concluded that GDP growth exhibits a significant negative impact on C02 emissions in the short-run but reversed in the long-run, tacit support for the Environmental Kuznets Curve (EKC) hypothesis as supported by both the neoclassical and the new growth theories. The study, therefore, recommended policies to improve green economic growth, the nature of technology usage, energy consumption, and institutional fitness to achieve healthy environmental sustainability in BRICS.

Article 4, Chapter 6, titled Economic growth and sustainable developments within the BRICS, MINT and G-7 countries: A comparative panel data analysis focused on the effect of economic growth on sustainable developments within the BRICS, MINT and G-7 countries, in an attempt to compare evidence, since differing levels of industrial development might mean different concerns about sustainability issues. The estimates via the autoregressive distributed lag (ARDL) were supported by cross-sectional autoregressive distributed lag (CS-ARDL) and cross-sectional distributed lag (CS-DL). The results confirm that economic growth increases the level of sustainable developments in all BRICS countries in the short-run, but constitutes a drag on sustainable development in the BRICS sub-sample 1 (Brazil, India and South Africa) countries in the long-run. Consequently, this study recommended a more radical policy mix to reduce the negative impact of economic growth on the level of sustainable development in Brazil, India, and South Africa. These policies should take the form of focused, sustainable development strategies and energy policies, the creation of a new economy, and improved education.

Overall, the validation of the Kuznets hypothesis in the relationship between economic growth and socio-economic sustainability in the BRICS bloc, as attested by the empirical validation of a probable EKC argument, depicted the necessity for a more radical sustainability policy mix by in three vulnerable countries (Brazil, India and South Africa). When compared with the two more advanced countries (China and Russia) for the more desired goal of sustainable economic growth to be realized, the outcomes were different. To the best of our knowledge, this is the first comprehensive study to analyses the effect of economic growth on sustainability to devise possible policy options that would take care of priority needs of individual countries (or subgroup of countries) in aspects of socio-economic, environmental and institutional sustainability in the BRICS bloc. Again, contrary to the practice in the literature, the study corrected for cross-sectional dependence. The study also addressed endogeneity issues in both linear and non-linear frameworks. Our results conform to all robustness checks, including temporal and spatial changes. The novelty of this thesis also rests on the provision of novel cross-validation of estimation techniques, as well as the construction of socio-economic, institutional fitness, financial development, and sustainable development indices that are robust to small sample bias and cross-sectional dependence issues.

DEDICATIONS

In loving memory of my late Father, Chief Michael Idowu Awolusi

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LIST OF ABBREVIATIONS

ADF: Augmented Dicky Fuller,

ARDL: Autoregressive Distributed Lag

BRICS: Brazil, Russia, India, China, and South Africa

CS: Cross-Section Dependence

CS-ARDL: Cross-Sectionally Autoregressive Distributed Lag

CS-DL: Cross-Sectionally Distributed Lag

DL: Distributed-Lag

DOLS: Dynamic Ordinary Least Squares

FDI: Foreign Direct Investment

FMOLS: Fully Modified Ordinary Least Squares

GMM: Generalised Method of Moments

GDP: Gross Domestic Product

KPSS: Kwiatkowski-Phillips-Schmidt-Shin

PC: Principal Components

POLS: Pooled ordinary least square

PP: Phillips-Perron

SDGs: Sustainable Development Goals

TFP: Total Factor Productivity

VECM: Vector error-correction Modelling

CHAPTER 1

NATURE AND SCOPE OF STUDY

1.0 Introduction

This chapter presents the background, research problem, and purpose of the study. It also includes the following sections: research questions, hypotheses, significance of the study, research philosophy, methods and methodology, and structure of the thesis.

1.1 Background of the Study

BRICS (Brazil, Russia, India, China, and South Africa) is a group of countries with a vast landmass and population. BRICS are so strategic in the present global economy based on its original goal of creating a world order that is democratic, equitable, and multi-polar (Hickel & Kallis, 2020; World Bank Group, 2018). The collaboration of all BRICS countries is, therefore, majorly aimed at achieving infrastructural developments, sustainable economic growth, and increased international trade (Agrawal, 2015; Awan, 2013; Menon, 2017). However, these countries are diverse in terms of socio-economic status, institutional capacity, and environmental protection needs. Also, these countries have varying levels of development. For example, countries like Russia and China are on the verge of transiting from developing countries' status to developed status, and others such as Brazil, India, and South Africa still considered as emerging countries. By developed status, it simply means that countries like Russia and China are gradually moving to more advanced economies in terms of infrastructure and higher standards of living. In contrast, others such as Brazil, India, and South Africa are considered as emerging countries because they are presently developing light manufacturing bases, as well as supplying components or natural resources to other more advanced manufacturing nations (Akadiri et al., 2019).

This situation means that BRICS countries might not have similar aspirations to socio-economic, institutional, and environmental sustainability while pursuing economic growth (Ogasawara, 2018; Hofkes, 2017; Santana et al., 2014; Fakoya, 2013). Again, it is essential to state that economic growth might have varied deleterious impacts on sustainability variables of interest for each of BRICS countries. This problem calls for the need to have extensive knowledge of how economic growth relates to sustainability variables in individual countries, vis-à-vis in the bloc so that it is possible to identify growth policy options for a particular country or subgroup of countries that could be proposed to sustain economic growth in the bloc (Younsi

& Bechtini, 2018; Bilgili., Kocak & Bulut, 2016). BRICS bloc is a cohesive and largely homogeneous based on the fact that they all satisfy the criteria set by Standard and Poor (Mosteanu, 2019). These criteria include the following: huge growth potential, low-to-mid per capita income; high market volatility; commodity and currency swings, as well as the brisk pace of economic growth (Omar & Inaba, 2020; Mosteanu, 2019; Younsi & Bechtini, 2018).

It is also important to note that sustainability and growth policies often require careful execution (Mikulewicz & Taylor, 2020; Spangenberg, 2010). Difficulty in formulating growth policies stems from the fact that economic growth and sustainability policies are usually at the opposite side of the spectrum, and growth policies are often structurally anti-sustainable (Spangenberg, 2010). Consequently, this is capable of pushing both ends of the inequality towards the wrong direction, hence the need to always establish a potentially sustainable growth/ development trajectory (Zha et al., 2019; Santana et al., 2014; Fakoya, 2013). The focus of this thesis is, therefore, to provide the evidence in this respect to propose policy options. The evidence was presented in four papers. The first paper investigated the effect of economic growth on socioeconomic sustainability in the BRICS countries as a way of proposing policy options for reducing socioeconomic inequalities in the bloc. The second paper analysed the impact of economic growth on institutional sustainability vis-à-vis individual countries with the aim of promoting the declining institutional fitness in the bloc. The third paper examined the effect of economic growth on environmental sustainability within the BRICS countries to correct the increasing environmental degradation in the bloc. The last paper assessed the influence of economic growth on sustainable development within the BRICS (and sub-samples in the group) and other blocs of developing and developed countries. The question of interest in the last paper was whether the evidence in groups of countries as per the level of development displayed similar patterns as the evidence in the group of other emerging countries (MINT) and developed countries (G-7). This analysis was based on the assumption that differing levels of industrial development might mean different concerns about sustainability issues.

1.2 BRICS and its diversity

BRICS is a block of the countries where striking a balance between sustainability and economic growth is problematic and requires careful policy options design. A balance between sustainability and economic growth is desirable due to the usual trade-off between increasing economic growth today and growth in aggregate demand, which may lead to future environmental problems and depletion of resources (Mikulewicz & Taylor, 2020). A sustained increase in economic growth is, therefore, expected to be carefully balanced to avoid generating economic problems for future generations (Ahenkan & Osei-Kojo, 2014; Amigun et al., 2011). Therefore, sustainable economic growth involves types of economic and institutional growth that enhance and protect social equity and the natural environment (Ogasawara, 2018; Hamilton, 2015).

Furthermore, BRICS is a disparate group of countries that came into existence in 2010 with member countries ranging from low-to middle-income emerging economies to fast-growing emerging economies. Hence, a comparative analysis of sustainability while trying to achieve the desired economic growth in individual countries is needed (Onuonga, 2020). This analysis is based on the premise that a comparative analysis of the growth profile of and sustainability in these countries would shed some light on policy options that would promote sustainability in the bloc. Again, this study focused on the BRICS bloc since the impact of economic growth on sustainability variables in the past three decades tends to be highly debated in the literature (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). Besides, many of the BRICS countries like China, Russia, and India are often accused of not respecting the global climate change programmes in their quest for sustainable economic growth (Jamel & Maktouf, 2017). Furthermore, different levels of development in the bloc with some countries like China on the verge of becoming a developed country portends whether policy options can be informed by evidence in other emerging markets (MINT) and developed (G-7), as these groups of countries have comparable groups in BRICS, notably the group of Brazil, India and South Africa and the group of China and Russia. This analysis was based on the premise that it was comparatively easy to predict the growth profile or sustainability dimensions of BRICS countries when the bloc shares the same or similar evidence with other emerging markets (MINT) and developed (G-7) (Bese & Kalayci, 2019).

The abbreviation BRIC was coined in 2001 by Jim (Goldman Sachs analyst) to represent a group of four countries, namely Brazil, Russia, India, and China. These countries are deemed to be at a comparable phase of freshly advanced economic growth (Goldman Sachs, 2001). However, BRIC was later expanded to include South Africa in 2010 and became BRICS (Brazil, Russia, India, China, and South Africa) (Javeria et al., 2017). Specifically, BRICS as an idea was coined at a Foreign Ministerial meeting of Brazil, Russia, China, and India in Newyork in September 2006; but the official name, BRIC, came into being at the 2009 conference in Yekaterinburg, Russia (Azevedo et al., 2018). BRICS occupy over 25 percent of the livable surface of the earth altogether, with about forty (40) percent of the total population (Hickel & Kallis, 2020; RSA, 2013). The collaboration of all BRICS countries is aimed at achieving infrastructural development, sustainable economic growth, and increased consumption and international trade (Agrawal, 2015; Awan, 2013; Menon, 2017). BRICS countries are all newly emerging and developing countries that form one of the most captivating groups of economies established to achieve some stated goals (Sesay., Yulin, & Wang, 2018; Tsaurai, 2017). The BRICS countries had a joint nominal GDP of US$ 16.039 trillion as of 2016; this is about 20% of the total gross world product (ISSA, 2017; Tsaurai, 2017; Behera & Mishra, 2016; Santana, Rebelatto, Périco, & Mariano, 2014).

However, the most critical question to answer is, why was BRICS formed? The original goal of BRICS was to create a world order that is democratic, equitable, and multi-polar (United Nations, 2013). Specifically, given the recent geopolitical conditions around the world, BRICS was formed due to the following two major reasons: to challenge United States' supremacy in the global trade by creating an alternative to the World Bank and International Monetary Fund, and most importantly, to provide self-managed and self-owned organisations to execute economic and developmental agendas in member countries without any reliance on existing foreign agencies (Alzoubi et al., 2020; Javeria., Ashok, & Vishal, 2017).

The above reasons for the formation of BRICS were further enhanced as a result of the recent establishment of the BRICS Bank and development institution, which is specifically targeted towards the attainment of the above plans and objectives of BRICS **(**World Bank Group, 2018 Agrawal, 2015**).** The BRICS Bank aims to be one of the most important organisations alongside the World Bank and IMF **(**World Bank Group, 2018; Agrawal, 2015**).** To this extent, the BRICS have made huge investments on many projects, with a special focus on electricity and energy infrastructures in the past decade (World Bank Group, 2018). The joint bank (New Development Bank-NDB) is also positioned to give supplementary funds for investment purposes in member states and other developing economies (Sesay., Yulin, & Wang, 2018; Azevedo et al., 2018). The bank was borne out of the consistent failure of the advanced economies to honour the pledge of making money available to all developing countries for this decades-long need for foreign direct investment and long-term capital for infrastructure development (World Bank Group, 2018; Pereira et al., 2018). Again, promises made at the 2010 summit by all G20 leaders to create a high-level panel for the desired infrastructure development in all developing countries have not yielded the desired results (Azevedo et al., 2018). BRICS countries were seriously concerned and disappointed at the slow pace of changes in the structures of both the International Monetary Fund and World Bank; hence, the NDB is positioned to facilitate a southern substitute to the existing traditional forms and sources of global development finance (World Bank Group, 2018; Menon, 2017). However, this southern substitute role of the NDB has been questioned by many studies (Bond, 2016, 2014). Specifically, Bond (2016) posits the inability of the NDB to work differently to the World Bank, IMF and other multilateral development banks due to the following: division-prone BRICS where different agendas now proliferate, unsatisfying incrementalism that is largely fuelled by Donald Trump's uncontested appointment of David Malpass as World Bank president in 2019 (Mikulewicz & Taylor, 2020; Onuonga, 2020). Although other scholars see macroeconomic trends as the likely decisive factor, Bond and Garcia (2015) still maintains that the BRICS are no alternative, but created within Western-centric capitalism (Bond, 2016; Bond and Garcia 2015)

However, BRICS goals have expanded in recent years, with many of its goals similar to the present MINT and G-7 goals, as well as the United Nations Sustainable Development Goals (SDGs). Specifically, the following are the notable expanded goals of BRICS: promoting an equitable international financial development, organisations and creating a new world order (Similar to Goals 16 and 17 of United Nations SDGs); other important socio-economic and environmental goals are: sustainable economic growth of members (Similar to Goal 7 of United Nations SDGs); poverty reduction through promotion of healthy living and well-being (Similar to Goal 3 of United Nations SDGs), equitable quality education (Similar to Goal 4 of United Nations SDGs), social inclusion, inclusive growth and reduction in income inequality (Similar to Goals 1 and 2 of United Nations SDGs); institutional development and trade promotion among the BRICS countries (Similar to Goals 4 and 7 of United Nations SDGs); combating climate change and its impacts (Similar to Goal 13 of United Nations SDGs); and avoiding the destruction of the natural environment, as well as, the development of technologies that are environmentally friendly (Similar to Goal 7 of United Nations SDGs) (Sesay et al., 2018; ISSA, 2017; UNCSD, 2012). It is also important to add that all the above goals require growth in individual countries.

However, promotion of sustainable economic growth of members (Similar to Goal 7 of United Nations SDGs), which is mainly dependent on the three anchorages of sustainability (socio-economic, institutional and environmental) is the most important goal of all BRICS members (Sesay et al. 2018; ISSA, 2017). Although, there is always a trade-off between increasing economic growth today, and growth in the future, a sustained increase in economic growth is expected to be maintained without generating other noteworthy economic problems for future generations (Ahenkan & Osei-Kojo, 2014; Amigun et al., 2011). This is on the premise that today's rapid economic growth may create environmental problems and deplete resources (like depletion of oil and global warming) for future generations (Akadiri et al., 2019), mainly due to an increase in aggregate demand (like consumer spending). Consequently, sustained growth must increase the output level to counter any probable increase in aggregate demand. Hence, the major focus of this study is on the three sustainability dimensions, as defined in the definition of sustainable economic growth/ developments (Ogasawara, 2018; Hofkes, 2017; Hamilton, 2015).

1.3 Background to the problem

Sustainable economic growth is anchored on the integration of three sustainability dimensions, namely, socio-economic sustainability, institutional sustainability, and environmental sustainability (Younsi & Bechtini, 2018; Santana et al., 2014; Fakoya, 2013). When any of these dimensions are not adequately contemplated in the growth initiatives, any growth reached would be lacking in terms of balanced wellbeing. For example, growth built on corruption because of failing institutions would be unsustainable as it would lead to inequalities and environmental degradation.

These linkages can be understood by assessing the association between economic growth and sustainability variables. For example, the existence of a positive correlation between economic growth and sustainable development/ sustainability dimensions has been adjudged as a veritable source of powerful growth and sustainable development strategies (Zha et al., 2019; Cuthill, 2010). That notwithstanding, after three decades of growth, the sustainability of economic growth in the BRICS countries has been documented as a major problem given the diverse nature of socio-economic, institutional and environmental characteristics in the group, especially, as some members of the group change status from emerging economies to developed economies (Younsi & Bechtini, 2018; Javeria et al., 2017). Besides, the varying levels of industrial development in the bloc also threaten the achievement of the above goals (Azevedo., Sartori, & Campos, 2018). Development, alternatively known as sustainable development, as used here, which may or may not include economic growth (according to Zha et al., 2019 and Daly & Cobb, 1990), emphasises the unfolding of human potential or qualitative improvement in human well-being, as discussed by the ecological economist, Herman Daly (Menon, 2017; Daly & Cobb, 1990). Therefore, understanding the knowledge of how economic growth would affect the socio-economic, environmental, and institutional sustainability of individual BRICS countries is important in solving this problem (Menon, 2017). This understanding can empirically be achieved by comparing the nexus between sustainability dimensions with economic growth across countries, making up BRICS to observe coherence or contrast in results. Comparing sustainability dimensions with economic growth across various socio-economic, institutional and environmental characteristics in these countries (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017) is important as it would provide evidence that could serve as a basis for alternative policy options.

Since sustainable economic growth is anchored on the integration of the three sustainability dimensions (socio-economic sustainability, institutional sustainability, and environmental sustainability dimensions/ objectives), sustainability in this study is treated as the goals or endpoints of a process called sustainable development (Hofkes, 2017). Sustainable economies are, therefore, considered to be economies that have reached sustainability through this process of sustainable development. Moreover, despite many empirical studies on economic growth and sustainability dimensions, continuous evaluation of the process of economic change has been highlighted as an essential precondition to improving economic growth in both developed and developing economies (Mosteanu, 2019; North, 2005). Pereira et al. (2018) observe that we all live in a world that is characterised by dynamic economic change, while the theories we use to understand the present world are still mostly static, with little emphasis on the role of institutions and government (Pereira et al., 2018; Hayek, 1973). Consequently, Błazejowski et al. (2019) posit that the tools we use to control and understand the present world are insufficient to deal with the issues (North, 2005).

Given the diversity in the BRICS bloc, each country making up the block might have a different priority in formulating sustainability and growth policies. To solve the problem, the BRICS countries would require policies that are relevant to the critical socio-economic, environmental, and institutional issues. In particular, the issues pertinent to development imperatives of more vulnerable partners in the group (like South Africa), so that any growth path adopted can be supported by socio-economic, environmental and institutional sustainability of all BRICS countries, even as some are in transitions to advanced economic status (Azevedo et al., 2018). This is, however, a dilemma as countries will likely embrace policies that are more relevant to their circumstances. It is therefore posited that the problem of possible diversity in interest among BRICS can be resolved by finding growth policy options within the bloc that would allow socio-economic, institutional, and environmental sustainability within the bloc. This study, therefore, focused on BRICS economies due to the unseemly sustainability of the past three decades of economic growth.

1.4 Summary of the Research problem and Thesis argument

Due to diversity in terms of socio-economic, environmental, and institutional characteristics and the fact that different levels of industrial development might mean different concerns about sustainability issues, a major problem in BRICS countries is how bloc member countries can work together to advance the goals of economic growth without compromising individual member countries aspirations to sustainability. For cooperation to bring about improved welfare in individual countries, economic growth in the bloc needs to be conducive to sustainability in individual countries; otherwise, policies need to be enacted to ensure sustainability in the bloc. A plausible rationale is that goal of economic growth might not be realised if member countries are concerned with issues of sustainability to a different extent and would require bloc members to strike a compromise on how aspirations of members could be achieved by adjusting operating policies. This compromise would require extensive knowledge of how economic growth relates to identified sustainability variables to suggest policy options.

A major problem with the sustainability of economic growth in the BRICS countries has to do with the increasing level of socio-economic inequality (Menon, 2017; Agrawal, 2015).

Consequently, this is a significant threat towards the BRICS goal of achieving sustainable economic growth for members (Similar to Goal 7 of United Nations SDGs) (Sesay et al. 2018; ISSA, 2017). Many studies also observed that BRICS countries are largely different, both in terms of values and goals and resource support to the vulnerable segment of the society (Younsi & Bechtini, 2018; Javeria et al., 2017).

Besides, inefficient institutional development is another problem (Menon, 2017; Agrawal, 2015). Lack of stronger institutions in some countries is a threat to the attainment of sustainability, as well as the overall goal of achieving sustainable economic growth for members (Similar to Goal 7 of United Nations SDGs), as well as other similar specific goals like institutional development and trade promotion among the BRICS countries (Similar to Goals 4 and 7 of United Nations SDGs) (Sesay et al. 2018; ISSA, 2017). Justifying the problem, many empirical studies (Błazejowski et al., 2019; Franck-Dominique, 2008) also observe that BRICS countries are largely different in terms of institutional support and development; while some BRICS countries are oblivious of democratic governments, others have embraced it (Behera & Mishra, 2016). Specifically, many recent studies (Younsi & Bechtini, 2018; Javeria et al., 2017) also attributed the present threats to the sustainability of economic growth in the BRICS countries to poor and inefficient government institutions to support the growth process. Although many of the studies agreed that any positive relationships between economic growth and institutional sustainability in a homogeneous bloc could serve as powerful policy strategies, especially for developing countries, many of the studies still fail to address any probable reverse causality, endogeneity, and cross-sectional dependence issues (Cashin, Mohaddes & Raissi, 2017; Breitenbach, Tipoy & Zerihun, 2017). There is a need to address these issues properly to be able to advise policymakers with certainty.

Again, environmental degradation in BRICS countries is also seen as another threat to the attainment of sustainability, an important component of the overall goal of achieving sustainable economic growth for members (Similar to Goal 7 of United Nations SDGs) (Sesay et al. 2018; ISSA, 2017). The issue that arises from the environment has been partly attributed to the inability of BRICS countries to have an existing treaty on how to reduce emissions, despite their major contributions to the increasing greenhouse gas (GHG) emissions (Menon, 2017; Behera & Mishra, 2016). Justifying this problem, climate change was acknowledged, at the 2013 fifth BRICS meeting in Durban, as one of the major threats towards achieving the goal of sustainable economic growth (Javeria et al., 2017). Again, many studies have examined the influence of economic growth on environmental pollution degradation using linear estimators like GMM of Arellano and Bond (1991) (Menon, 2017; Behera & Mishra, 2016). Unfortunately, there has been limited empirical work on the nexus between economic growth and environmental degradation in a non-linear framework. Again, as growth regression is a concern, there is also a need to address endogeneity, reverse causality, and cross-sectional dependence issues, especially in a bloc of homogeneous countries like BRICS.

Another problem that might arise is that any evidence from BRICS analysis might not be strong enough since it would only come from one context. Analysing BRICS as one set of countries might be blurred by contextual factors specific to the organisation and any proposed policy might not be guided by strong linkage evidence. All the development and policy directions in BRICS will be understood if the sustainability of economic growth in BRICS is discussed about evidence in other blocks of countries with comparable and different development levels. MINT and G7 would serve in this respect as best countries (Mosteanu, 2019; Polasky et al., 2019). Consequently, formulating an appropriate policy mix will require an understanding of the connections between the level of sustainable development and economic growth as some countries in BRICS graduate from emerging economies to developed economies. This diversity means that while some members could be pursuing economic growth, others might be interested in other aspects. Hence, economic growth needs to be compatible with all sustainability dimensions to an acceptable level in each policy for the bloc to cooperate on relevant policy.

The above problems would not arise if there is knowledge of how economic growth would affect the socio-economic, environmental, and institutional sustainability of individual countries. In case it affects the sustainability of individual countries differently, then countries can adopt different sustainable growth policies, and if it does not, all the BRICS countries can adopt the same sustainability and growth policies. Again, this diversity implies that each member may pursue different priorities. The questions here are whether sustainable growth policy formulated at the block level would work or whether there would be alternative policies to take into account the diversity in terms of growth profiles, socio-economic, institutional, and environmental characteristics as well as the level of development in BRICS countries. The problem is, therefore, a problem of growth policy options that would result in sustainability along socio-economic, institutional, and socio-economic dimensions making justice to every member whether such options should be adopted per subgroup of countries based on comparable characteristics or the developmental level. The main advantage of such growth policy options is that BRICS's vulnerable subgroups (like Brazil, India and South Africa) will have the opportunity of encouraging investment in domains that would complement BRICS other goals to create future domestic capability and interregional comparative advantage (Bartniczak & Raszkowski, 2019; Ahenkan & Osei-Kojo, 2014). This strategic advantage is coined smart specialisation, and it has the capacity of spreading quickly within the sub-group with its objectives of smart, sustainable and inclusive growth along socio-economic, institutional, and socio-economic dimensions (Mikulewicz & Taylor, 2020; Onuonga, 2020). Again, the issues raised by successful smart specialisation go far beyond the discussion in the BRICS context (Onuonga, 2020). This type of specialisation is on the premise that many countries, within MINT and G-7 countries are now taking an interest in' smart specialisation' another veritable way of leading their countries out of the recent financial and economic crisis (Bartniczak & Raszkowski, 2019; Ahenkan & Osei-Kojo, 2014; Amigun et al., 2011).

Strategically, the overall argument and the problem under investigation is that, for the beneficial cooperation of BRICS countries, economic growth needs to relate favourably to sustainability in individual countries. Specifically, for beneficial cooperation in BRICS and as argued in each of the four papers (developed in this study): 1) economic growth needs to reduce socio-economic inequalities in individual countries (Paper 1); 2) economic growth needs to reduce environmental degradation in individual countries (Paper 2); 3) economic growth must lead to intuitional fitness in the bloc (Paper 3), and 4) economic growth needs to influence sustainability variables regardless of the level of development (Paper 4).

1.5 Aim and Objectives of the Study

The aim and objectives of the four papers for this study are as follows:

1. Paper 1 seeks to assess the sustainability of economic growth by investigating the effect of economic growth on socio-economic inequalities within the BRICS countries to observe possible patterns in this bloc. This objective is achieved via a Pesaran et al. (2001) autoregressive distributed lag (ARDL) co-integration technique, as well as, Toda and Yamamoto (1995) granger non-causality approach in a two-variable vector autoregression model.

2. Paper 2 seeks to assess the sustainability of economic growth by investigating the effect of economic growth on institutional fitness within the BRICS bloc vis-à-vis individual countries. This objective was achieved via panel data co-integration analysis and the Hausman specification test.
3. Paper 3 seeks to assess the sustainability of economic growth by determining its relationship with environmental degradation in the BRICS bloc vis-à-vis individual countries. The aim of the paper is achieved via the Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) and Auto-Regressive Distributed Lag (ARDL) methodologies.
4. Paper 4 seeks to analyse the influence of economic growth on sustainable development within the BRICS, MINT, and G-7 countries in an attempt to compare evidence since differing levels of industrial development might mean different concerns about sustainability issues. This objective is achieved via the Auto Regressive Distributed Lag (ARDL) and supported by Cross-Sectional Distributed Lag (CS-DL) and Cross-Sectional Autoregressive Distributed Lag (CS-ARDL).

1.6 Research Questions

The central research question can be formulated as follows: What growth policy options are implied by the relationship between sustainability (viewed from various dimensions) and economic growth to be fair to individual circumstances in BRICS?

Hence, the formulation of policies would require finding answers to the following specific questions:

1) How does economic growth relate to socio-economic sustainability in each country in BRICS?
2) How is economic growth related to institutional sustainability in the bloc vis-à-vis each country in BRICS?
3) How does economic growth relate to environmental sustainability in the bloc vis-à-vis each country in BRICS?
4) Is the effect of the differences in the level of sustainable development in individual countries as related to economic growth in BRICS irrelevant to the contextual realities of the Block, vis-à-vis MINT, and G-7 economies?

Again, these questions were answered by detailed analyses. Each question was analysed in each paper. The evidence from the papers guided our proposed policy options that, if implemented, can lead BRICS to pursue growth in a manner that brings about sustainability to every member making up the block.

1.7 Statement of Hypotheses

Based on the above research objectives and questions, as well as the various kinds of literature, the central hypothesis of the study is as follows:

Hypothesis: The problem of possible diversity in interest among BRICS can be resolved by finding growth policy options within the bloc that would allow socio-economic, institutional and environmental sustainability within the bloc

Nonetheless, the following specific hypotheses were contrived from the central hypothesis:

Hypothesis 1: $H0_1$: There is no significant influence of economic growth on socio-economic sustainability in individual BRICS countries.

Hypothesis 2: $H0_2$: There is no significant effect of economic growth on institutional sustainability in the group vis-à-vis individual BRICS countries.

Hypothesis 3: $H0_3$: There is no significant influence of economic growth on environmental sustainability in the group vis-à-vis individual BRICS countries.

Hypothesis 4: $H0_4$: There is no significant difference in the level of sustainable development in individual countries as related to economic growth in BRICS vis-à-vis MINT and G-7 economies.

In line with the overall argument of the thesis, the sub-hypothesis underlying the four papers are based on the following arguments in the literature (Mosteanu, 2019; Polasky et al., 2019; Zha et al., 2019), as expressed in each of the four papers:

1) That sustainable economic growth has the potential to reduce socio-economic inequalities in individual BRICS countries (Paper 1);

2) That sustainable economic growth arising from the cooperations has the potential of reducing environmental degradation in individual BRICS countries (Paper 2);

3) That sustainable economic growth resulting from the cooperations could lead to institutional fitness in the bloc (Paper 3); and

4) That sustainable economic growth arising from beneficial cooperation within the BRICS countries could lead to favourable sustainability variables regardless of the level of development in each of the countries (Paper 4).

Again, based on gaps in previous literature **(**Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014; Pelinescu, 2015), the above specific hypotheses were premised on the fact that economic growth will be sustainable in BRICS countries if:

1. it results in reduced social inequalities in the individual countries;
2. it strengthens institutions in individual BRICS countries;
3. it results in comparable environmental impact in the individual countries; and
4. Sustainability is robust to changes in the status of some countries from emerging economies to developed economies.

1.8 Focus and Significance of the Study

1.8.1 Focus of the Study

The rationale and focus of this thesis are that the growth goals of the bloc might not be realised if member countries are concerned with different issues of sustainability. It would be ideal to require the bloc members to strike a compromise on how aspirations of members could be achieved by adjusting operating policies. This compromise would require extensive knowledge of how economic growth relates to identified sustainability variables to suggest policy options. This search of extensive knowledge in this respect is the focus of the thesis, which seeks to present and discuss evidence in this respect through research papers.

Specifically, the four research objectives/questions were answered by the detailed analysis, with each objective/ question being analysed within a paper as follows:

(1.) To compare evidence on the effect of economic growth on socio-economic sustainability measured in terms of socio-economic inequality in individual BRICS countries. Consequently, article one (1) seeks to understand the influence of economic growth on socio-economic sustainability (proxied by socio-economic sustainability) in the BRICS countries**,** via multivariate co-integration analysis. Specifically, in the first research paper, the thesis discusses the evidence of how economic growth in BRICS influences socio-economic sustainability in individual countries. Analysis of the long and short term influences of economic growth on socio-economic inequalities was contextualised based on the notion that the higher the influence of economic growth on this variable, the more the economic growth is unsustainable. The analysis seeks to find whether the policy for a specific country in the bloc could be formulated to allow countries that would suffer the sustainability effect of economic growth to apply policies that could relieve them from this situation. The paper has been submitted for publication, and it is under review by the International Journal of Services, Economics, and Management (IJSEM). The long-run equilibrium relationships were established via Pesaran et al. (2001) autoregressive distributed lag (ARDL) co-integration technique, as well as, Toda and Yamamoto (1995) granger non-causality approach in a two-variable vector autoregression model (Menon, 2017; Aregbesola, 2014).

(2.) To compare evidence on the effect of economic growth on institutional sustainability (measured as institutional fitness) in the bloc vis-à-vis individual BRICS countries. Consequently, Article 2 estimated the nexus between economic growth and institutional fitness (a proxy for institutional sustainability) within the BRICS countries based on a data set from 1990 to 2017. Specifically, in the second paper, the thesis presents and discusses the evidence on how economic growth in BRICS affects institutional sustainability in individual countries. The study conducted a panel regression analysis and a panel data integration analysis to investigate the effect of growth on institutions. The analysis seeks to find whether the policy for the group could be formulated to allow countries that would suffer the sustainability effect on the economy to apply policies that could relieve them from this situation. The paper has been submitted for publication and is under review by the *International Journal of Education Economics and Development.* After testing for Unit Root, the Hausman specification test was assessed to know which effect (both the fixed and random effects estimates) is more significant. Again, to check for probable cross-sectional dependence errors, as well as, the capacity to generalise our panel results, the study conducted a cross-sectional dependence test and a panel data co-integration analysis, via Pedroni's (1999) panel co-integration test on each panel data set of the BRICS bloc. As a robustness check, the study launched FMOLS and DOLS estimations at individual and panel levels over the study period.

(3.) To compare evidence on the effect of economic growth on environmental sustainability measured in terms of environmental degradation (C02 emissions). Consequently, Article 3 estimated the nexus between environmental sustainability and economic growth within the BRICS countries using data sets from 1990 to 2017. Specifically, in the third paper, the thesis presents and discusses the evidence on how economic growth in BRICS affects the environment in individual countries. Again, environmental degradation was measured using a proxy measure called CO2 emissions. The analysis seeks to find whether the policy for the bloc could be formulated to allow countries that would suffer the environmental effect on the economy to apply policies that could relieve them from this situation. The study used autoregressive distributed lag to carry out the analyses. The paper has been submitted for publication, and it is under review by the *International Journal of Green Economics.* Specifically, after deploying the Pesaran cross-section dependence test, the study tested for unit roots via the Pesaran Augmented Dickey-Fuller test. Again, due to the probable cross-sectional dependency errors, the estimates via the Auto Regressive Distributed Lag (ARDL) were supported by Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) estimates over the period 1990-2017 (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). Contrary to most literature in the field, the study addressed endogeneity, reverse causality, and cross-sectional dependence issues.

(4) Lastly, to compare evidence on the nexus between economic growth and the levels of sustainable developments within the BRICS block vis-a-vis MINT and G-7 countries. Consequently, Article 4 estimated the nexus between economic growth and the levels of sustainable developments within the BRICS block vis-a-vis MINT and G-7 countries using a panel dataset from 1990 to 2017. The study analysed the connection between the level of sustainable development and economic growth as some countries in BRICS graduate from emerging economies to developed economies. Specifically, in the fourth paper, the thesis presents the evidence on how economic growth relates to sustainability variables highlighted above in different levels of development in BRICS. The study divided the five BRICS countries to two sub-samples of three (sub-sample 1: Brazil, India and South Africa) and two (sub-sample 2: Russia and China) countries each, based on the pace of development as affirmed by previous studies (Bindi, 2018; Nkoro & Uko, 2016). The study provides a series of robustness checks, including temporal and spatial changes. The pattern of these results, as compared to the patterns in the emerging markets and developed countries to see whether the linkages are robust using a panel data set. The paper was submitted and is under review by the *International Journal of Sustainable Development*. It is within this context that a comparative evaluation of the effect of economic

growth and sustainability dimensions on the levels of sustainable development in the BRICS, MINT (Mexico, Indonesia, Nigeria, and Turkey) and G-7 (Canada, France, Germany, Great Britain, Italy, Japan, and the United States) countries is seen as a precondition for the much desired sustainable economic growth within the BRICS countries (Javeria et al., 2017; Agrawal, 2015). Again, due to the likely cross-sectionally dependent errors in a dynamic heterogeneous panel data, to test the nexus between economic growth, sustainability (all) dimensions and the levels of sustainable developments within the BRICS bloc vis-a-vis MINT and G-7, a CS-DL, ARDL, and CS-ARDL models were used as the estimation techniques (Lombardi et al., 2017). Most significantly, the adopted estimation techniques addressed endogeneity, reverse causality, and cross-sectional dependence issues.

1.8.2 Significance of the Study

A major significance of the present study is the adoption of various linear and non-linear estimators that are robust to both small sample size bias and cross-sectional dependence issues. Specifically, contrary to most literature on the topic, the study corrected for cross-sectional dependence, as well as addressed endogeneity issues in both linear and non-linear frameworks. Attesting to this is the fact that all results conform to all robustness checks, including temporal and spatial changes. Again, the novelty of this thesis is partly the construction of socio-economic, institutional fitness, financial development, and sustainable development indices that are robust to small sample bias and cross-sectional dependence issues.

In a deviation from previous studies that used singular measure of institutional fitness, part of the novelty of this study is the development of an aggregated composite index of institutional fitness based on the dictates of institutional economics (theory), by looking at risk assessment factors of all the BRICS countries over time, as identified by (1) Euromoney country risk survey, (2) Corruption perception index-CPI (Transparency International), (3) World Bank decomposed governance indices; and (4) the top three global rating agencies - Fitch Ratings Inc, Standard & Poor's Financial Services LLC (S&P) and Moody's Investors Service. Our findings also validated the theoretical framework (Menon, 2017; Carnoy, 2006).

Also, previous studies have paid little consideration to address a comparative study on the influence of economic growth on sustainability variables within many developing and developed blocs, like the BRICS, MINT, and G-7 economies (Alzoubi et al., 2020; Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014; Pelinescu, 2015). This lack of focus on within-bloc analysis is problematic considering the important part that a comparative analysis of these variables (reduction in socio-economic inequality, institutional fitness, environmental protection, and sustainable development) can play in attaining improved sustainable economic growth and development for many developing economies (Onisanwa, 2014; Ogasawara, 2018; De La Fuente & Domenéch, 2006). Supporting this view, many studies observe that it is in this realm that paucity in the literature exists (Azevedo et al., 2018; Santana et al., 2014; Fakoya, 2013).

Again, this study differs from previous studies, since socio-economic and institutional variables may be inter-related, and previous studies did not consider this connection (Akinola & Bokana, 2017; Eggoh., Houeninvo & Sossou, 2015). The output of this study is useful to policymakers in the BRICS countries not only in estimating the achievement of many BRICS goals but also serves as a double-edged tool for monitoring the progress towards the attainment of the United Nations SDGs by the rear 2030, particularly, the goal of promoting sustainable economic growth of members (Similar to Goal 7 of United Nations SDGs) (World Bank Group, 2018).

1.9 Methodology and Data Sources

The primary purpose of the section is to present a justification for the research design and describe the philosophical assumptions that underpin the study (Błazejowski et al., 2019; Creswell, 2014).

1.9.1 Research Paradigm

The methodology is one of the three elements of a paradigm that researchers either implicitly or explicitly work within (Mosteanu, 2019; Polasky et al., 2019; Shebaya, 2011; Walter, 2006). The other elements of a paradigm include ontology and epistemology (Creswell, 2014). Precisely, the overall conceptual framework within which a scholar may work is referred to as paradigm, which is the basic worldview or belief system that guides the candidate (Ac et al., 2018; Awan, 2013). On the other hand, ontology is reality, while the term epistemology can be regarded as the connection between that reality and the researcher. However, the methodology can be regarded as the techniques used by scholars to discover that reality (Bryman & Bell, 2011; Bryman, 2012).

Although research methodology is an integral part of conducting an empirical study, however, we adopted quantitative methodology since this thesis was done in the form of four major articles that addressed specific research objectives, questions, and hypotheses (Creswell, 2009; Creswell, 2014).

1.9.2 Research design and its appropriateness

The study adopted a time-series design (quantitative research design) via various time-series data of five BRICS countries from 1990 to 2017. The relationships among all variables were analysed via various estimation techniques (Lee and Tan, 2006). The models for the study were adopted from past theoretical and empirical studies (Menon, 2017; Akinola & Bokana, 2017; Lee & Tan, 2006). The research design allowed us to navigate from well-stated philosophical assumptions to meticulous methods of collecting data, as well as data analysis (Creswell, 2009; Bryman and Bell, 2011). Since long and short-run relationships are popularly assessed in most empirical literature via co-integration and for most panel data analysis, this study adopted the most popular co-integration approach called the autoregressive distributed lag (ARDL) model in many of the four articles making up the Thesis (Lombardi et al., 2017). However, one major problem in many panel equations is the possibility of correlated errors across countries, which may lead to inconsistent estimates (Breitenbach et al., 2017). Hence, it is always good to test for the likely presence of cross-sectional dependence problem since some of the BRICS countries (like China and India) are from the same geographical region. Besides, due to probable similar economic structures, shocks may be transmitted between countries (Chudik et al., 2015; Nkoro & Uko, 2016; Breitenbach et al., 2017). This approach is usually termed a cross-sectionally autoregressive distributed lag (CS-ARDL) model. Similarly, Lombardi et al. (2017) and Chudik et al. (2015) observed that the same method adopted in the CS-ARDL approach, by augmenting our regression with cross-sectional averages could also be adopted in the straight estimation of our equations. This alternative approach is commonly referred to as cross-section augmented DL (CS-DL). Both approaches were majorly adopted in this study to provide robust comparable estimates in this study (Bindi, 2018; Lombardi et al., 2017; Chudik et al., 2015; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017). However, since a research design forms a critical connection between theory and arguments that inform the research study to the empirical data that are collected and analysed, the adopted research design is deemed appropriate because our focus is on measurement (of concepts, variables, and building relationships), establishing causality, generalisations of our findings, replicability (Bryman, 2012; Shebaya, 2011; Creswell (2014). Lastly, a time-series design (quantitative research design) can easily facilitate the comparison of groups, like the BRICS countries, and to provide insight into a breadth of experiences (Lombardi et al., 2017).

1.9.3 Research Philosophy

Positivism, constructivism, critical theory, and realism are the four philosophical assumptions guiding the four paradigms of science (Mosteanu, 2019; Polasky et al., 2019; Bryman & Bell, 2011). According to Creswell (2014), worldview is the overall philosophical inclination about the world and research stance that one brings to a study that may be directly or indirectly influenced by discipline or experience (Creswell, 2014). Underlying the four paradigms is the question of how knowledge is created (Bryman, 2012; Creswell, 2009).

Positivism posits that knowledge is generalised statistically to a given population through a statistical examination of observations about the reality that is readily accessible (Bryman, 2012; Creswell, 2009; Creswell, 2014). Secondly, realism as a paradigm, believes that a finding can be extended through the analytical generalisation that shows the nexus between research findings and theories (Bese & Kalayci, 2019; Shebaya, 2011; Walter, 2006). Hence, the goal of realism, as a paradigm is to generalise to theoretical propositions only rather than populations (Shebaya, 2011). In the other two paradigms of constructivism (constructivism is connected to qualitative study) and critical theory, the reality is perception. Hence, the notion of generalising one research finding based on perception to another theory about reality, cannot be done (Creswell, 2014; Hasan, 2011). Consequently, this study embraced positivism based on an economist's philosophical worldviews of mostly embracing quantitative, rather than qualitative or mixed methods approach (Błazejowski et al., 2019; Creswell, 2014; Hasan, 2011). Again, the study adopted a positivist research thinking based on a philosophical stance of the natural science in which scholars worked with observable social reality (Tsaurai, 2019; Krauss, 2005).

As differentiated from constructivism and the critical theory paradigm, this study adopted a positivist stance based on the core assumption of an objective view of the world in which the researcher remains neutral and maintains an unbiased view of the research variables (Creswell, 2014; Hasan, 2011). However, the study specifically adopted positivist research thinking to represent new thinking and challenge the traditional notion of the existence of absolute truth of knowledge (Kraus, 2005).

Specifically, this study is based on a deterministic philosophy, where causes are deemed to determine outcomes or effects (Creswell, 2014). Consequently, this study was mostly aimed at ssassessing the effect of independent variables (economic growth) on dependent variables, namely socio-economic sustainability, environmental sustainability, institutional sustainability, as well as, sustainable development in the BRICS countries. This aim was in line with similar stated research questions and hypotheses, intending to ultimately draw upon few theoretical frameworks from the social sciences (Błazejowski et al., 2019; Mosteanu, 2019; Polasky et al., 2019; Creswell, 2014).

1.9.4 Methods and Data sources

Although the level of homogeneity or heterogeneity in the BRICS bloc is debatable in the literature (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Chudik et al., 2015; Lombardi et al., 2017; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017), this study adopted the Pesaran cross-section dependence test in most of the papers, despite the econometric analysis of a panel data of five countries (N=5) from 1990 to 2017 (T=28). This analysis was based on the premise that the Pesaran cross-section dependence test is capable of being applied to small sample properties, despite its usual application to many unbalanced and balanced panels with unit-root, large T and N, and heterogeneous panels (Chudik et al., 2015; Lombardi et al., 2017). The same assumption of large T and N also works for the adopted ARDL and CS-ARDL models (Pesaran, 2004). Most of the adopted methodologies are expected to treat the likely endogeneity of the regressors (Strittmatter & Sunde, 2011; Licumba., Dzator & Zhang, 2016; El-Wassal, 2012). The study provided lucid descriptions and derivation of the various methodologies and models in each of the papers. Time-series data of the five BRICS countries, from 1990 to 2017, were mostly utilised in this study. The data were sourced from various sources, with the bulk coming from World Bank Databases (the World Development Indicators-

WDI), International Monetary Fund, Transparency International Database, and International Financial Statistics and data files.

1.9.5 Reliability and validity of the study

Similar to previous studies (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017), this study tested for validity and reliability of data sets by ascertaining conformity with few diagnostics tests and assumptions of multiple regression, with sustainable development variables as dependent variables, economic growth as an independent variable, while holding other variables (FIN, INQ, Health, EXR, INF, TO, CO_2, HCAP, POP) as control variables. First, we ran the script to test for normality of our dependent variable (log of sustainable development) and obtained a skewness and kurtosis of -0.092 and -0.688 with all satisfying the criteria for a normal distribution (between -1.0 and +1.0) (Adelakun, 2011; Adelowokan, 2012; Agrawal, 2015; Akinola & Bokana, 2017). The same goes for other independent and control variables. Secondly, we ran various scripts to test linearity assumptions between (1) dependent variable and independent variables, (2) dependent variable, and our control variables. For the linearity test between the log of sustainable development and economic growth variables, we obtained statistically significant values ($r= 0.520$, $p<0.001$), meaning a linear relationship exists between these variables (Adelakun, 2011; Akinola & Bokana, 2017). Moreover, our test for homogeneity of variance assumption via the Levene test showed that the probability associated with the test (0.678) was $p=0.418$, greater than the 0.01 level of significance required to test the assumption (Agrawal, 2015; Akinola & Bokana, 2017). Hence, the null hypothesis of equal variances was not rejected (Adelakun, 2011; Akinola & Bokana, 2017). Finally, all major diagnostics tests: collinearity diagnostics for testing multicollinearity, casewise diagnostics to identify outliers and Durbin-Watson statistics to test for serial correlation showed a minimum/ maximum standardised residuals of -2.812 (fell in the acceptable range of +- 3.0), Durbin-Watson statistic of 1.923 (which falls within the acceptable range since the residuals are not correlated at a statistics approximately 2) (Adelakun, 2011; Adelowokan, 2012; Agrawal, 2015).

1.9.6 Ethical Consideration for the Study

Research ethics were an integral part of this study, and the researcher ensured careful consideration of all the respective ethical considerations. Although our study made use of purely secondary data, a formal application to ethical clearance/ conduct research was made to the University of KwaZulu-Natal's (UKZN) ethics committee. Via the Research Information Gateway (RIG) system on the 16th of July, 2019, and the Exemption from ethics Review letter, with a protocol Reference Number: 00002657, was granted on the 14th October, 2019 (Appendix 6B) to forge ahead with the methodology designed for the study. After collecting data, the integrity of the collected raw data is expected to be protected by the researcher, by not tampering or manipulating the raw data. Raw data must be kept for the period stipulated by the ethics committee of UKZN. Subsequently, the stored data is expected to be destroyed after the required period (usually five years). This study acknowledged all sources of information by following the Harvard referencing style as required by the School of Management, IT, and Governance. We also reported results based on the analysis and research findings without altering data to suit a certain perception (Agrawal, 2015).

1.10 Organisation of the Thesis

The thesis is organised as follows:

Chapter 1 has provided the nature and scope of the thesis.

Chapter 2 provides a comprehensive review of the literature and highlights the contribution of the literature.

Chapter 3 assesses the relationship between economic growth and socio-economic sustainability in BRICS. The chapter contains the paper "Socio-economic sustainability and economic growth in BRICS: relationships and policy options," as submitted to the *International Journal of Services, Economics, and Management (IJSEM).*

Chapter 4: assesses the relationship between economic growth and institutional sustainability in BRICS. The chapter contains the paper "Economic growth and Institutional Sustainability Nexus within the BRICS Countries: relationships and policy options, "as submitted to the *International Journal of Education Economics and Development.*

Chapter 5 assesses the relationship between economic growth and environmental sustainability in BRICS. The chapter contains the paper "Economic growth and environmental sustainability within BRICS countries: a comparative analysis," as submitted to the *International Journal of Green Economics.*

Chapter 6 analyses the effect of economic growth on sustainable development within the BRICS, MINT, and G-7 countries in an attempt to compare evidence since differing levels of industrial development might mean different concerns about sustainability issues. The chapter contains the paper "Economic growth and Sustainable Developments within the BRICS, MINT and G-7 Countries: A Comparative Panel Data Analysis," as submitted in the *International Journal of Sustainable Development*.

Chapter 7 provides conclusions and policy recommendations. It summarises the thesis and provides policy options. The chapter also highlights the various implications and contributions of the thesis, as well as limitations and suggestions for further studies.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter covers the review, critique, developments of concepts, theories, and the empirical work linking economic growth and sustainability.

2.1 Conceptual Framework

A conceptual framework is a premeditated concept that is deliberately adopted for investigating expected relationships between variables based on existing models and theories (Błazejowski et al., 2019; Mosteanu, 2019; Hamilton, 2015; Carnoy et al., 2012). However, much of the existing literature does not agree on the conceptual framework and constructs that should be used to explain the relationships between sustainability and economic growth (Ogasawara, 2018; Menon, 2017). That notwithstanding, the conceptual framework for this study is based on the nexus between socio-economic sustainability, environmental sustainability, institutional sustainability, and economic growth in the BRICS countries (Mesagan et al., 2019; Menon, 2017; Agarwal & Khan, 2011). The reasons why existing models of economic growth and sustainability are inadequate for actual changes in the level of growth and sustainability in the BRICS countries could be found in the approach towards understanding the relevant concepts, namely, “sustainability,” “socio-economic sustainability,” “environmental sustainability,” “institutional sustainability” and "sustainable development," hence, a need for an accurate understanding of the various concepts.

Sustainable growth and development are possibly seen as two of the most puzzling policy concepts ever contrived (Spangenberg, 2004; WCED, 1987). That notwithstanding, the Brundtland Report (WCED, 1987) defined sustainable growth as a growth that meets the needs of the present-day without jeopardising the capacity of future generations to meet their own needs (Polasky et al., 2019; Spangenberg, 2004). Consequently, the Brundtland Report identified three important problem areas that the concept is to address, to include, socio-economic sustainability, institutional sustainability, and environmental sustainability (WCED, 1987; Younsi & Bechtini, 2018; Spangenberg, 2004). Hence, our conceptualisation of sustainable economic growth as an active optimisation process of three dimensions: socio-economic, institutional, and environmental. On the other hand, "sustainability" means putting scientific, technical, economic, social, and ecological resources to ensure the maintenance of equilibrium state for some giving space and time (Younsi & Bechtini, 2018; Spangenberg, 2004). Hence, **"**socio-economic sustainability" is defined as maintaining a stable level of social contacts, training, social security, education, income, communication and participation (known as core microelements/ level of socio-economic sustainability), as well as, steady circulation of assets and income (known as the core macro perspective of socio-economic sustainability) for some time and in space (Younsi & Bechtini, 2018; Ogasawara, 2018; Spangenberg, 2004). Additionally, "institutional sustainability" is defined as maintaining a stable level of institutional functioning, civil society empowerment, gender equity, knowledge formation and accountability (known as core institutional objectives), as well as, steady inter-linkages between institutions, socio-economic and environmental developments for some time and in space (Tekabe, 2018; Spangenberg, 2004). Lastly, "environmental sustainability" is described as maintaining normative targets of present environmental problems like resource depletion or pollution (known as short term perspective), as well as, the imperative of a general reduction in the entire throughput of physical resources in the economy (longer-term perspective) for some time and in space (Younsi & Bechtini, 2018; Spangenberg, 2004). Hence, environmental sustainability is the maintenance of economic capital (Ogasawara, 2018).

2.2 Methodological review of ARDL, CS-ARDL, and CS-DL

Due to probable cross-sectional dependence issues, one of the unique contributions of this study was the adoption of various linear and non-linear estimators that are robust to both cross-sectional dependence and small sample size bias. This approach is based on the premise that some of the BRICS countries like China and India are from the same geographical region. Besides, due to probable similar economic structures, shocks may be transmitted between the BRICS countries (Chudik et al., 2015; Nkoro & Uko, 2016). Consequently, the thesis utilised ARDL, CS-ARDL, and CS-DL in most of our contrived papers. Hence, the need to briefly derive the above-mentioned estimators:

Long-run relationships are popularly assessed in most empirical literature via cointegration, and for most panel data analysis, the most popular cointegration approach is the autoregressive distributed lag (ARDL) model (Lombardi et al., 2017). ARDL was first postulated by Pesaran and Smith (1995). For example, using Chudik et al.'s (2015) approach and assuming that the joint dynamics are determined by a VAR(1) model, to establish a long-run relationship between sustainability and economic growth in the BRICS bloc, the innovations et^y and et^x are deemed to be correlated, which will result in a contemporaneous correlation between sustainable development (y^t) and economic growth (x^t) (Bindi, 2018; Lombardi et al., 2017). Hence, endogeneity would be a major issue in any OLS regression performed to establish these relationships (Cashin et al., 2017; Nkoro & Uko, 2016).

However, we can decompose our innovations in Equation 1.1 into two components and spell out their orthogonal component (Chudik et al., 2015; 2016):

$e_t^y = E(e_t^y / e_t^y) + u_t = \omega e_t^x + u_t$………………………………………………………….. Equation 1.1

in the above equation $\omega = cov(e_t^y, e_t^x)/var(e_t^x)$.

According to Lombardi et al. (2017) and Chudik et al. (2015), by simple substitution method, we can derive our simple ARDL specification in Equation 1.2.

$Y_t = \varphi y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t$……………………………………………………………. equation (1.2)

Again in the above simple ARDL Equation 1.2, $\varphi = \phi_{11} - \omega\phi_{21}$, $\beta_0 = \omega$, and $\beta_1 = \phi_{12} - \omega\phi_{22.}$

Consequently, our simple ARDL specification in Equation 1.2, as derived from a VAR model can simply estimate an OLS without endogeneity problem, since our ut is deemed orthogonal to our xt while its lags are done by construction (Lombardi et al., 2017; Chudik et al., 2015).

Lombardi et al. (2017) observed that any OLS estimated by Equation 1.2 will yield consistent estimates, whether the variables are I(1) or I(0). Consequently, Chudik et al. (2015) and Cashin et al. (2017) reconstructed the simple ARDL Equation 1.2 in the cointegrating form to produce Equation 1.3:

$Y_t = \theta x_t + \alpha(L)\,\Delta x_t + \tilde{u}_t$………………………………………………………….. Equation 1.3

From Equation 1.3, $\tilde{u}_t = \varphi(L)^{-1} u_{t.}$

Although the long-run coefficient $\theta = (\beta_0 + \beta_1)/(1 - \varphi)$ in Equation 1.3 can be estimated explicitly, where our dependent variable (sustainability- y^t) and economic growth (x_t) are I(1), then, Equation 1.3 would establish a cointegrating relationship with $(1, -\theta)'$ (Bindi, 2018; Lombardi et al., 2017). Note that $(1, -\theta)'$ represents a cointegrating vector.

An alternative estimation approach, known as distributed-lag (DL), is a direct estimation of Equation 1.3, by truncating the α(L) (lag polynomial) at a satisfactorily high level (Bindi, 2018; Lombardi et al., 2017; Chudik et al., 2015). One advantage of the DL approach is that the estimates yields significantly lower uncertainty, particularly with a small sample size (Nkoro & Uko, 2016).

However, using Equations 1.2 and 1.3, a generic ARDL(p,q) model for our panel can be shown in Equation 1.4, where i=the country index:

$$y_{i,t} = \sum_{k=1}^{p} \varphi_{i,k} y_{i,t-k} + \sum_{l=0}^{q} \beta'_{i,l} x_{i,t-1} + u_{i,t} \quad \text{Equation 1.4}$$

However, the cointegrating form for Equation 1.4 can be depicted in Equation 1.5:

$$y_{i,t} = \theta_i x_{i,t} + \alpha'_i(L)\Delta x_{it} + \tilde{u}_{i,t} \quad \text{Equation 1.5}$$

That notwithstanding, one major problem in our panel Equation 1.4 is the possibility of correlated errors across countries, which may lead to inconsistent estimates (Breitenbach et al., 2017). Hence, it is always good to test for the likely presence of cross-sectional dependence problem since some of the BRICS countries (like China and India) are from the same geographical region, besides due to probable similar economic structures, shocks may be transmitted between countries (Chudik et al., 2015; Nkoro & Uko, 2016; Breitenbach et al., 2017).

However, this problem can be solved by postulating common unobserved factor errors (Nkoro & Uko, 2016). Consequently, Lombardi et al. (2017) and Chudik et al. (2015) postulate that the best way to solve this problem is to augment Equation 1.4 with cross-sectional averages of both the dependent (sustainability) and explanatory variable (economic growth), and also their lags (a proxy for unobserved common factors) (Bindi, 2018; Lombardi et al., 2017). This approach is usually termed a cross-sectional autoregressive distributed lag (CS-ARDL) model. Similarly, Lombardi et al. (2017) and Chudik et al. (2015) observed that the same method adopted in the CS-ARDL approach, by augmenting regression with cross-sectional averages could also be adopted in direct estimation of Equation 1.5. This alternative approach is commonly referred to as cross-section augmented DL (CS-DL). Both approaches were adopted in this study to provide robust comparable estimates in this study (Bindi, 2018; Lombardi et al., 2017; Chudik et al., 2015; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017).

2.3 Theoretical Framework and Sustainability Model Development

"Sustainability" and "economic growth" analysis usually involve solving complex diagnostic problems, owing to its focus on long-run processes, that notwithstanding, a mix of varied sustainability theories and models can help in addressing these complexities over time (Polasky et al., 2019; Menon, 2017). Since many models of sustainability and economic growth mostly focus on evolutionary or social processes, natural process description, and technology, this study does not posit one best modelling approach, rather a several models that are capable of providing diverse, and largely corresponding insights for use (Younsi & Bechtini, 2018; Javeria et al., 2017). This study's modeling is, however, built on the premise by many economists that "sustainability" and "sustainable economic growth" ought to revolve around the maintenance of justifiable equity (optimal allocation) between generations (externality-welfare-theory). However, other economists believe that the goal of "sustainable economic growth" and "sustainability" is achieved by placing restrictions on a country's physical scale (Gur, 2015).

From the modelling perspective, there are various interpretations of "sustainability," namely discounted utilitarianism (also denotes the present discounted value of utility), intergenerational equity (non-decreasing welfare), weak sustainability (maintaining total capital), strong sustainability (all capital is independently maintained in biological/physical terms), stationary state (maintained economic and population stocks), ecological stability and resilience (stability, resilience and biotic diversity) (Bilgili et al., 2016; Spangenberg, 2004). However, various models for the present study fall within weak sustainability and ecological stability and resilience (Younsi & Bechtini, 2018; Bilgili et al., 2016; Spangenberg, 2004). The adoption of weak sustainability models is based on the premise that models based on weak sustainability often allowed changes between natural and man-made capital, with emphasis on the same opportunities for future and present generations (Hediger, 2000). Moreover, one of the adopted growth models (neoclassical models) also fit this perspective since the standard methodology is based on implied utility patterns over time (Zha et al., 2019; Spangenberg, 2001).

Consequent to the above, this study posits that a single theoretical standpoint cannot satisfactorily elucidate the effect of economic growth on sustainability dimensions (Mahe, 2005). Besides, previous studies (Zha et al., 2019; Hofkes, 2017; Hamilton, 2015; Cuthill, 2010) also indicate that existing theories do not sufficiently explain the nexus between sustainability and economic growth, and they have called for either the extension of existing theories or the development of new theories to explain this phenomenon (Gur, 2015; Mankiw et al., 1992). Furthermore, a theoretical framework can be based on more than one theory (Riley, 2012). Consequently, the theoretical framework for this study is built majorly on the four most common theories of sustainability and economic growth-determinants nexus, namely, neoclassical growth theory, modified endogenous growth theory, institutional fitness theory, and new theory of economic growth (Pistorius, 2004; Wilhelms, 1998).

2.3.1 The Neoclassical Growth Theory

Many studies have severally put forward the positive linkages between sustainable economic growth and sustainable development (sustainability), as well as, the notion of "limits" on socio-economic-environmental sustainability activities that would spur sustainable development (ecologist notion of limits to growth) (Zha et al., 2019; Hofkes, 2017; Menon, 2017; Hamilton, 2015; Gur, 2015; Fan & Zheng, 2013).

Specifically, Franck-Dominique’s (2008) study posited that issues arising from increasing environmental degradation and uneven wealth distribution throughout the world have often questioned the objective of continued growth in the past three decades (Hofkes, 2017; Menon, 2017). Although sustainable development (sustainability) was seen as an offshoot of the various critiques of growth proposed by the neoclassical corpus theorists, Solow’s model, as somewhat modified, is still the main neoclassical theory’s response to the lingering debates on sustainable development (Zha et al., 2019; Santana et al., 2014; Fakoya, 2013). D'Alessandro et al. (2010) believe that the basic conventional theoretical framework of sustainability started with the publication of Solow (1974), Dasgupta and Heal (1974), and Stiglitz (1974) in the same special issue of *Review of Economic Studies.* The three articles developed neoclassical growth models with technical progress as an exogenous variable, along with labour, capital, and a non-renewable resource in the same production function (D'Alessandro et al., 2010). Specifically, Solow (1974) posits the feasibility of constant consumption as long as a composite stock of man-made and natural capital is kept constant. This model, however, resulted in the formulation of Hartwick's rule, which states that "investment of present exhaustible resource returns in reproducible capital depends on constant consumption per capita (Hartwick, 1977, p. 974).

Neoclassical economists maintained that the main objective of any sustainable development should always consider the need to maintain steady and high economic well-being (such as socio-economic, institutional and environmental sustainability) over time in the society, as well as, an extension of same economic well-being to future generations (Menon, 2017; Hamilton, 2015; Franck-Dominique, 2008). Hence, Neoclassical economists defined sustainability as the "non-decline," well-being of individuals over time, probably measured by the level of individual consumption, income, and utility (Gur, 2015; Fan & Zheng, 2013; Franck-Dominique, 2008).

With a high savings rates in capital stocks and production capacity (like knowledge, amenities, education and training, skills, and natural resources) over time, sustainability could be achieved (Zha et al., 2019). Hence, "natural capital" was considered by the neoclassical theorists' as a particular form of capital. However, neoclassical theorists insist on "substitutability" (that increase in generated capital by societies should compensate for any decrease in "natural capital") between these different forms of capital in an attempt to ensure a steady, productive capacity and well-being over time (Hofkes, 2017; Menon, 2017; Franck-Dominique, 2008). Consequently, Solow's "medium of exchange" over time, whereby the present generation consumes more "natural capital" but, in exchange for more stock of output capacity (knowledge, amenities, and skills) to future generations (Franck-Dominique, 2008).

Again, the neoclassical economists' hypothesised that the value of the different forms of substituted capitals should be determined by the price system, thus bringing back into the market sphere what was outside it in the first place by taking cognisance of pollutants and natural resources; an approach labelled by economists as "internalisation of externalities" in the conceptualisation of "weak" sustainability (Mosteanu, 2019; Hofkes, 2017). Subsequently, the neoclassical theory posits that the quest for economic growth is in the interest of future environmental protection (Błazejowski et al., 2019); a notion that was supported by Grossman and Krueger (1993, 1995) studies, termed the "inverted U-shaped curve" or the "Environmental Kuznets Curve (Błazejowski et al., 2019; Mosteanu, 2019; Menon, 2017). The neoclassical growth theory can be used to explain the problem of diversity in the level of sustainability in the BRICS countries, which is probably because many BRICS countries pursue their interests that are counter-productive to the interests of other members and therefore against the common interest of the bloc (Javeria et al., 2017; World Bank Group, 2018). Specifically, the neoclassical theory views growth as arising from strategic accretion of factors of production and the growth in total factor productivity (Pistorius, 2004). The neoclassical growth theory assumed that growth is automatic, cost-free and inevitable, as well as, the fact that growth is bound to continue in the future at the same rate with the past ("the trend") since the incoming generations are expected to be richer and better equipped to afford the cost of repairing the present environmental damages (Javeria et al., 2017; Ayres et al., 2007). The theory also conditioned the attainment of sustainability and economic growth on the bargaining power of the host nation. It also conditioned it on the willingness to provide sustainability induced policies and infrastructures relative to the availability of labour, capital, and technology (Onuonga, 2020; Bese & Kalayci, 2019; Fedderke & Romm, 2005). Also, since the level of income and rate of interest are the main determinants of the savings rate in any society, interest rates must be positive to encourage people to save (Meagher & Lindell, 2013). This understanding is based on the proposition that uncertainties and risks in the future will generally compel citizens to prefer present income to the future (Amigun et al., 2011; Webersik & Wilson, 2009).

Consequently, many studies (Zha et al., 2019; Hofkes, 2017; Santana et al., 2014; Fakoya, 2013) advised that any sustainable growth induced policies should consider the three arms of sustainability, namely, socio-economic equity, institutional development, and environmental protection (Javeria et al., 2017). Again, the sustainability path can be established by incorporating sustainability in a typical neoclassical growth model. Hence, the study's modelling of "socio-economic sustainability" in the BRICS countries is feasible with the incorporation of "sustainability" as a pre-condition to economic and welfare changes (Menon, 2017; Agrawal, 2015; Gur, 2015).

Other studies (Hofkes, 2017; Hamilton, 2015; Pearce et al., 2014; Fan & Zheng, 2013; Omer, 2008; Diesendorf, 2000) also attributed the present threats to the sustainability of the past three decades of economic growth in the BRICS countries to poor and inefficient sustainability strategies to support the growth process (Hamilton, 2015; Azevedo et al., 2018). For example, despite recent improvements in South Africa's democratic consolidation and the rule of law, there still exist growing social disparities, poor policy implementation in terms of social investments, environmental protection, institutional development, education, and labour market (Menon, 2017; Omer, 2008). Brazil seems to be the most hopeful of all the BRICS countries, in terms of improved policy implementations and governance. However, the country remains affected by poor infrastructure and high levels of social inequality (World Bank Group, 2018; Pereira et al., 2018). Essentially, any association with common goals may not work if there are potential conflicts of interest among members and this is better described in the case of BRICS where structures are likely to make policy on economic growth detrimental to the various sustainability dimensions (Błazejowski et al., 2019; Cuthill, 2010).

Also, previous studies believe that, although there is no doubt that economic growth is a driving force for sustainability in a group of countries, like the BRICS, it is not as clear whether the levels of economic growth that can realistically be achieved will be sufficient to reduce socio-economic inequalities and environmental degradation in many BRICS countries (Azevedo., Sartori, & Campos, 2018; Santana et al., 2014; Fakoya, 2013). Furthermore, Selden and Song (1994) and Grossman and Krueger (1991) posits that, after a particular level of economic growth at the initial stages, the GDP per capita often leads to gradual pollution, but reverses at a later phase (Jamel & Maktouf, 2017). This concept is termed the environmental Kuznets curve (EKC) hypothesis. Consequently, the EKC has been used to elucidate the causal relationship between economic growth and environmental pollution since the 1990s (Hofkes, 2017; Hamilton, 2015).

Also, the influence of economic growth on sustainability in the BRICS countries can be demonstrated by the Kuznets hypothesis, which posits for an increase in income disparities arising from the first phase of economic growth, while the same economic growth in a later phase, given redistribution mechanisms, tends to contribute to the attainment of an egalitarian pattern of income distribution in a welfare state (Fan & Zheng, 2013; Omer, 2008). Specifically, Błazejowski et al. (2019) and Spangenberg (2004), maintained that given the fact that a certain minimum level of economic growth may be a necessary pre-condition for sustainability, it might not be adequate to guarantee the attainment of all sustainability dimensions, hence, a suggestion for the consideration of other variables like health, education, financial development, and trade.

2.3.2 Institutional Economics and Institutional Fitness Theory

Many studies observe that both the imperfect and perfect markets still cannot adequately explain improvement and the link between economic growth and sustainability (Ogasawara, 2018; Hofkes, 2017). Thus, Wilhelms (1998) posited the integrative school as the only solution. The institutional fitness theory, as suggested by Wilhelms (1998), formed an important part of estimating the influence of economic growth on sustainability.

Moreover, Wilhelms (1998) also observed that while the dependency school embraces the structuralist and neo-Marxist theories on the one hand. On the other hand, the modernisation school is rooted in both imperfect and perfect market methods (Nosheen et al., 2019). This contrast is based on the proposition that modernization theory studies largely deals with the development of societies and the process of social evolution (social modernization) (Tsaurai, 2019). The main level of analysis, therefore, focuses on the macrocosmic studies of modernization. This focus was based on the manifest processes and empirical trajectories of the modernization of BRICS economies where individual buyers and sellers can influence prices and production (Mikulewicz & Taylor, 2020).

Thus, this study is entrenched in the integrative school, as advanced through the institution fitness theory. The adoption of institutional fitness theory, in this study, is a veritable means of accounting for the array of heterogeneous variables that are usually involved in the sustainable economic growth process. These variables give more significance to institutions (Meso level) over the entire economy (macro-variables) and firms (micro-variables) (Ogasawara, 2018; Wilhelms, 1998).

The link between economic growth and sustainability can be further explained by the institutional fitness theory, which suggests that the sustainability of economic growth is determined more by institutional variables (Anyanwu and Yameogo, 2015). The presupposition is that government policies should be executed within a sound institutional framework for the country to achieve the desired improvements in sustainable economic growth (Wilhelms, 1998). Consequently, national institutions like education, markets, socio-cultural systems, and government, must be active and efficient in the process of transmitting various government policies to tangible derivatives. This enhanced capacity of institutions is termed institutional fitness (Ogasawara, 2018; Wilhelms, 1998).

Supporting the above linkages between economic growth and sustainability, many recent studies (Younsi & Bechtini, 2018; Hofkes, 2017; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) also attributed the present threats to sustainable economic growth in the BRICS countries to inefficient government institutions. Specifically, Javeria et al. (2017) and Agrawal (2015) assert that attaining sustainability, a veritable ingredient of sustaining the past three decades of economic growth and development in the BRICS countries might be a mirage without a proper nexus between economic growth and sound government institutional/ governance variables. Consequently, many of the studies (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) opined that more future research should focus on understanding the nexus between economic growth and institutional/ governance variables. Consequently, to investigate the influence of economic growth on institutional sustainability in the BRICS countries, in the quest to achieve sustainable economic growth (based on the dictates of institutional economics), this study developed its composite index of institutional fitness. This development was done by looking at risk factors of countries over time, as identified by the top three global rating agencies: Standard & Poor's Financial Services LLC (S&P), Moody's Investors Service, and Fitch Ratings Inc., as well as, Euromoney country risk survey. The consideration of risk factors by rating agency was done on the premise that countries with greater risks are less fit, more prone to ‘sickness,’ and hence can experience low or unsustainable economic growth.

However, the above is based on the following presumptions: first, many studies often criticise the notion that corruption is caused simply by failing institutions (Tsaurai, 2019). In many corrupt countries, those who are corrupt use the 'institutions' to perpetuate their corruption practices (Phong, 2019). Corruption may also arise because of weak resolves of those corrupt people involved. That is greed, which may have been caused by other externalities. Then again, observations have shown that corruption continued to occur unabated even when the country's economy has improved (Alzoubi et al., 2020). Additionally, in many developing countries, corruption often starts in small ways, then grows more significant, especially when no adverse reactions from superiors are forthcoming or worse, of course, if those supervisors themselves begin to get involved as well (Jamel & Maktouf, 2017).

2.3.3 The New Growth Theory

The new growth theory posits that the sustainability of economic growth in most developing economies (like the BRICS countries) is largely dependent on their capacity to adopt and implement innovations and technological developments from advanced countries (Ozturk, 2007). Hence, the new growth theory is important in our analysis of sustainability in the BRICS countries due to its regard for technology as being endogenous to the economy (Jamel & Maktouf, 2017). The new growth theories, therefore, strategically positioned many BRICS countries in a way to better catch-up with developed countries given the presence of abundant labour stocks with the required skills to either develop or adopt new foreign sustainability policies (Phong, 2019; Hamilton, 2015; Grossman & Helpman, 1990).

Based on Rostow's (1980) study on situations for sustainable growth in the long term, a study by Kuznets subsequently became the foundation for further progress in many studies on sustainable economic growth (Jamel & Maktouf, 2017). Subsequenlty, Grossman, and Krueger (1991) and Selden and Song (1994) demonstrated that, after a certain threshold of economic growth at the initial stages, the GDP per capita often leads to gradual pollution, but reverses at a later phase (Jamel & Maktouf, 2017). This phenomenon is termed the environmental Kuznets curve (EKC) hypothesis, and the EKC has been used to elucidate the causal relationship between GDP and pollution since the 1990s (Hofkes, 2017; Hamilton, 2015).

Many empirical studies observed that economic growth is correlated with an initial augmentation in environmental degradation (Fan & Zheng, 2013; Omer, 2008; Tahvonen & Kuuluvainen, 1993; Friedl and Getzner, 2003). While previous studies were worthwhile to analyse economic growth, they did not describe how wealth is produced, used, and distributed (quality of economic growth). Thus, many of the studies are less helpful in assessing the sustainability of a certain level of economic growth in a bloc with similar policies (Spangenberg, 2001; Valentin & Spangenberg, 2000).

The empirical research in the BRICS countries in this thesis investigates the reduced-form or partial empirical relationships between economic growth and sustainability dimensions via testing hypotheses, using empirical data based on temporal or cross-section samples (Azevedo et al., 2018).

2.3.4 The Modified Endogenous Growth Theory

The endogenous theory posits an improvement in economic growth through sustainable environmental practices, knowledge transfers, and capital formation (Madsen, 2007; Blomstrom et al., 1996). The theory, however, cautioned on the need to augment knowledge level through labour training and acquisition of new skills (De-Mello, 1996). Moreover, the significance of diffusion in technology, socio-economic equity, and innovation as a veritable tool in improving growth in developing countries was also advanced (Madsen, 2007). The modified endogenous growth theory, therefore, further strengthened the contributions of human capital, health, institutions, and educational development toward the attainment of sustainable economic growth (Zha et al., 2019; Cuthill, 2010; Felipe, 1997; Grossman & Helpman, 1990). Unfortunately, the inability of many developing countries to adhere to the dictates of both endogenous and modified endogenous growth theories has been partly attributed to the imbalances in the levels and pace of economic growth and development in many developing countries (Mosteanu, 2019; Hofkes, 2017; Omer, 2008).

Consequently, the contrast in the level of development among BRICS countries partly motivated our study's interest in analysing conditions for sustainability, as well as in maintaining these conditions for the highest possible period (Jamel & Maktouf, 2017; Fan & Zheng, 2013; Omer, 2008). The requirement of such analysis predetermined using the mathematic modelling of economic growth (Younsi & Bechtini, 2018). Besides, the two sides in the definition of “sustainable development” refer to the long-run mutual dependence of environmental quality and resource availability, as well as economic growth, hence, any sustainability analysis cannot be complete without growth derivatives (Spangenberg, 2004). Furthermore, regarding the blurred segment of the socio-economic dimension of sustainability in the Brundtland Report (WCED, 1987), the criterion mentioned most frequently is the maintenance of a consistent level of the growth of capital stock (Mosteanu, 2019; Younsi & Bechtini, 2018; Spangenberg, 2004), as well as a steady and non-inflationary economic growth(Mosteanu, 2019; Younsi & Bechtini, 2018; Spangenberg, 2004). Consequently, formulating an appropriate policy mix will require understanding the connections between economic growth and sustainability as some countries in

BRICS graduate from emerging economies to developed economies (Menon, 2017; Aregbesola, 2014; Daly & Cobb, 1990). Hence, the modified endogenous growth theory can assist in explaining the connections between the level of development, economic growth, and sustainability in the BRICS countries.

Supporting this perspective, many recent studies (Fan & Zheng, 2013; Omer, 2008; Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) attributed the present threats to sustainability, in the BRICS countries to inefficient growth and sustainable development strategies to support the growth process. Many scholars also believe that uneven economic growth in the last decade is also contributing to the uneven levels of developments and the goal of achieving sustainable economic growth for all BRICS members (Azevedo., Sartori, & Campos, 2018; World Bank Group, 2018; Menon, 2017). Consequently, the central hypothesis of the study is investigated through the development of research papers focusing on the interplay between economic growth and sustainability dimensions.

2.4 Empirical reviews on sustainability-economic growth nexus

Sustainability is a relatively new concept/ phenomenon; hence, there are a limited number of studies on the relationship between economic growth and sustainability. Most of the pioneer studies came from the United States (Solow, 1974; Dasgupta & Heal, 1974; Stiglitz, 1974; Smulders, 1995). Besides, most of the empirical studies on the nexus between economic growth and sustainability (or its dimensions) have been largely concentrated on developed countries (Grossman and Krueger, 1993; Beckerman, 1992; D'Alessandro et al., 2010; Perrings and Ansuategi, 2000; Ayres et al., 2007; Gaspar et al., 2017; Sorrell, 2010; Islam et al., 2004; Spangenberg, 2010), global (Błazejowski et al., 2019; Stern et al., 1996) and few isolated "emerging" countries in Asia and the Middle East, with China forming the greatest bulk of the empirical studies (Zha et al., 2019; Błazejowski et al., 2019; Huang & Ulanowicz, 2014; Esseghir and Khouni, 2014; Greyson, 2007; Stern et al., 1996).

Therefore, the unseemly neglect of developing countries and a group of strategic bloc countries has been positioned as a veritable gap worthy of investigating by many studies in recent times (Zha et al., 2019; Hofkes, 2017; Menon, 2017; Hamilton, 2015). Again, many empirical works on sustainability-economic growth nexus are often seen as confusing and contradictory, probably due to the use of singular measure and estimation technique (Zha et al., 2019; Hofkes, 2017; Islam et al., 2004). Consequently, a comparative validation of estimation techniques and robustness checks has been seen as probable alternatives (Zha et al., 2019; Hofkes, 2017).

That notwithstanding, active studies on sustainability and sustainable development started in the early 1970s. Beckerman's (1972:336) work seems to have pioneered the sustainability and sustainable development debates in the literature. Wilfred Beckerman's (a neoclassical theorist) work was a trenchant critique of the Meadow's report of 1972, supporting the notion that the pursuit of economic growth can protect the environment in the long run (Santana et al., 2014; Fakoya, 2013). Beckerman (1972) buttressed his arguments on the reduction in SO2 pollution in many states in American despite continued growth. This statement was said to be a major recognition and linkage to the neoclassical theory of economic growth after decades of debates on economic dynamics of the price system and tacit support for "ecological economics" (Zha et al., 2019; Franck-Dominique, 2008). Beckerman's (1972) proposition was generalised after twenty years. This generalisation was based on the publication of Grossman and Krueger's (1993, 1995) articles. Hence, Grossman and Krueger's (1993) study seems to be the first work to provide empirical support to Beckerman's proposition, by assessing the nexus between economic growth and sustainability dimensions (Menon, 2017; Hamilton, 2015).

Furthermore, the endogenous growth theory only entered the sustainability debate in the 1990s. Specifically, Smulders (1995) advised that exponential growth can only be environmentally sustainable via a process of knowledge accumulation, which is seen as the engine of economic growth (Madsen, 2007; Spangenberg, 2004). The linkage between economic growth and knowledge accumulation was based on the premise that environmental variables can only exist and remain constant (Smulders, 1999, p. 615). Unfortunately, the relevance of Smulders's (1999) framework propositions to policymaking has been doubted because its optimality and feasibility often requires large numbers of extreme hypotheses (Bovenberg and Smulders, 1995).

2.4.1 Sustainability and Economic Growth in Developed Countries

Grossman and Krueger's (1993) study seems to be the first empirical work in the United States of America on the nexus between economic growth and sustainability dimensions (Menon, 2017;

Hamilton, 2015). This was based on the neoclassical theorist’s position that the quest for economic growth is in the interest of future environmental protection (Błazejowski et al., 2019); a notion that was supported by Grossman and Krueger’s (1993, 1995) studies, termed the “inverted U-shaped curve” or the “Environmental Kuznets Curve (Błazejowski et al., 2019; Mosteanu, 2019; Menon, 2017). Again, based on Rostow (1960) study on situations for sustainable growth in the long term, Grossman and Krueger’s (1991) work subsequently became the foundation for further progress in many studies on the nexus between economic growth and sustainability (Jamel & Maktouf, 2017).

Specifically, Grossman and Krueger (1991) and Selden and Song (1994) demonstrate that, after a certain threshold of economic growth at the initial stages, the GDP per capita often leads to gradual pollution, but reverses at a later phase (Jamel & Maktouf, 2017). This relationship is captured in what is termed the environmental Kuznets curve (EKC) hypothesis. Consequently, the EKC has been used to elucidate the causal relationship between GDP and various sustainability dimensions since the 1990s (Hofkes, 2017; Hamilton, 2015). However, one major shortcoming of Grossman and Krueger's (1995) work is the inability to generalise the relationship described by EKC since it was based on certain pollutants that have local and short-term impacts. This shortcoming explains varying results on the EKC hypothesis in recent literature (Zha et al., 2019; Hofkes, 2017; Menon, 2017). For example, the results are different in studies based on household waste generation, which increases with per capita income and physical resources (Hofkes, 2017; Menon, 2017). Other critiques also maintained that, if at all any relationship, the relationships may not be systematic (Błazejowski et al., 2019; Mosteanu, 2019). Many therefore observed that most of the acclaimed “inverted-U” relationships might be due to public policies or probably that the highest polluting industries have been moved to other countries or regions (Błazejowski et al., 2019; Mosteanu, 2019). Although many studies have investigated the environmental Kuznets curve (EKC) hypothesis (Fan & Zhen, 2013; Hediger, 2000; Pearce & Atkinson, 1993; Spangenberg, 2001; Valentin & Spangenberg, 2000), empirical findings demonstrated mixed results justifying additional studies to clarify this hypothesis (Jamel & Maktouf, 2017; Spangenberg, 2004). Consequently, this study was partly an attempt to test the EKC hypothesis within the BRICS countries, by testing various forms of environmental sustainability-economic growth relationships, ranging from quadratic (representing the EKC), monotonically increasing and decreasing linear relationship as well as a cubic polynomial (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; De Bruyn et al., 1998).

Aside from previous empirical studies focusing on the EKC hypothesis, other notable studies in the realms of "ecological economics" in advanced countries are Hediger (2000), Valentin and Spangenberg (2000), Spangenberg (2004), and Jamel & Maktouf (2017). It is interesting to know that many of the above studies support the various assumptions of ecological economics and are mostly based on neoclassical and endogenous theories (Błazejowski et al., 2019; Franck-Dominique, 2008). Specifically, many of the articles share the neoclassical theorist’s position that the quest for economic growth is in the interest of future environmental protection. They also support positive linkages between sustainable economic growth and sustainability, as well as, the notion of “limits” on socio-economic-environmental sustainability (Zha et al., 2019; Hofkes, 2017; Menon, 2017; Hamilton, 2015; Gur, 2015; Fan & Zheng, 2013).

Interestingly, many other articles in many advanced countries in Europe seem to deviate from this trajectory. Notable are the works of Stern et al. (1996), Błazejowski et al. (2019), Gaspar et al. (2017), D’Alessandro et al. (2010), Perrings and Ansuategi (2000) and Ayres et al. (2007).

An earlier study by Stern et al. (1996) critiques the environmental Kuznets curve (EKC), particularly the assumption of EKC of no feedback from environment quality to production possibilities. The study also advances the possibility that trade does not have any effect on environmental degradation (sustainability) but posits an (EKC) inverted U-shape nexus between environmental degradation (sustainability) and income per capita (economic growth). This critique means that economic growth will ultimately reduce the economic activities on the environment (sustainability).

Again, while identifying other econometric problems with the EKC estimates, Stern et al.'s (1996) study further questioned the logic behind the EKC that further development (economic growth) will reduce environmental degradation (improve sustainability) based on the assumption of a normally distributed world per capita income, a fact that is contestable in the literature (Bartelmus, 2013). Consequently, Stern et al. (1996) simulated combined EKC estimates from the literature with economic growth forecasts of selected countries by the World Bank. This simulation was done in an attempt to derive the overall global impact. Unfortunately, findings suggest increasing emissions of SO_2 (decreasing sustainability) within the prospect of the Bank's 2025 predictions.

D'Alessandro et al. (2010) study was a stylised dynamic model in the field of renewable energy that depicts the imperatives of investment in smooth technological progress. To show the possible transition in energy via investing in renewable sources of energy, the study adopted a simple dynamic model to test the relationships between economic growth and (sustainability) energy in European countries. However, based on Solow's (1974) position on the feasibility of constant consumption as long as a composite stock of man-made and natural capital is kept constant and the potential energy shortage, the study took into consideration the necessity of investing in smooth technical change via renewables (D'Alessandro et al., 2010). This argument was similar to a study by Tsur and Zemel (2003, 2005). The study established a positive link between economic growth and the acceleration of exhaustible resource depletion time. The study concluded that sustained positive growth in GDP due to fossil fuels engendered an increase in income for R&D in renewable energy, while on the other hand, accelerated the exhaustible resource depletion time (D'Alessandro et al., 2010). Consequently, the study highlighted the danger of accelerated economic growth and subsequently opined that policies should discourage consumption growth, stimulate investment in alternative energy sources, and target low growth rates to facilitate economic sustainability.

Specifically, Solow (1974) posits the feasibility of constant consumption as long as a composite stock of human-made and natural capital is kept constant. This feasibility resulted in the formulation of Hartwick's rule, which states that "investment of present exhaustible resource returns in reproducible capital depends on constant consumption per capita" (Hickel & Kallis, 2020; Hartwick, 1977, p. 974). However, the endogenous growth theory only entered the sustainability debate in the 1990s. Specifically, Smulders (1995) advised that exponential growth can only be environmentally sustainable via a fully delinked process of knowledge accumulation, which is seen as the engine of economic growth more than physical quantities (Madsen, 2007; Spangenberg, 2004). This thinking was based on the premise that environmental variables can only exist and remain constant in a balanced economic growth path with constant positive economic variables (Smulders, 1999, p. 615). Unfortunately, the policy relevance of Smulders's (1999) framework propositions has been doubted because its optimality and feasibility often requires large numbers of extreme hypotheses (Bovenberg and Smulders, 1995). Perrings and

Ansuategi's (2000) study contradicts the Brundtland Report (WCED, 1987). The Brundtland Report (WCED, 1987) maintained that the main threats to the environmental sustainability of development in both developing countries and developed countries are the poverty-driven depletion of environmental resources and consumption-driven pollution. Perrings and Ansuategi's (2000) study on the empirical relationship between economic growth and sustainability observes that although a few indicators of water quality and local air are initially worsened by economic growth, they later improve as *per capita* incomes increases in the long term. The paper, therefore, argues that the important question should not be the impact of economic growth on environmental sustainability, but whether the impact of economic growth threatens the long-run resilience of the ecological systems on which economic growth depends. This argument was based on the premise that any loss of environmental resilience will imply the environmental unsustainability of the economic growth, and that this should be the primary focus of strategies for sustainable development (Perrings and Ansuategi, 2000).

Ayres et al. (2007) differ from many studies. This paper examines the role continued growth on the sustainability of energy utilisation in many European economies. While attesting to the importance of reducing greenhouse gas (GHG) emissions, the paper identified potential means of increasing energy efficiency and usage for continued long term growth and global sustainability. The study, therefore, proposed improved regulations rather than "radical new technologies" in the energy sector. While contradicting the prevailing policy stance in Europe, the paper observed that the introduced carbon tax, as a way of increasing energy costs to promote sustainability, maybe ineffective under present market structures and may negatively impact both growth and sustainability. Ayres et al.’s (2007) work proposed simultaneous strategies of reducing GHG emissions and boosting sustained technology-driven growth. The study is also aimed at challenging the neoclassical growth theory that assumed that growth is automatic, cost-free, and inevitable. The neoclassical theory also assumed that growth is bound to continue in the future at the same rate as the past ("the trend") since the incoming generations are expected to be richer and better equipped to afford the cost of repairing the present environmental damages (Javeria et al., 2017; Ayres et al., 2007).

Gaspar et al. (2017)’s main focus was on establishing the nexus between energy consumption-economic growth / sustainable development nexus using a panel of annual data sets of 20 European countries from 1995–2014. While proposing the Index of Sustainable Economic

Welfare (ISEW) as a better measure of sustainable development (rather than GDP), the findings of the study are relying on traditional GDP (economic growth) rather than on the Index of Sustainable Economic Welfare (ISEW). Specifically, the study observed a new negative feedback hypothesis for ISEW (the alternative measure of SD) but maintained a conservative hypothesis for the nexus between economic growth and energy consumption (sustainability). The study, therefore, concluded that policies focused on GDP (economic growth) might find it difficult to improve the much-desired influence on sustainable development. The study, therefore, argued that there could be wrong interpretations of the economic growth approach (using GDP) by policymakers in their quest for the much desired increased sustainable development. Other related empirical studies in European countries could be found in the literature (Moşteanu and AlGhaddaf, 2019; Zhang et al., 2018; Cadarso et al., 2016; Robaina-Alves et al., 2016; Hapenciuc & Neamtu, 2016; Katircioglu et al., 2014; Hall et al., 2013; Becken, 2011; Chiu & Chang, 2009; Dawson et al., 2010; Perch-Nielsen et al., 2010; Levinson, 2009).

2.4.2 Sustainability and economic growth in developing countries

Many of the empirical studies on the nexus between economic growth and sustainability (or its dimensions) in developing countries have been concentrated mainly on a large isolated "emerging" countries in Asia and the Middle East, with China forming the greatest bulk of the empirical studies (Zha et al., 2019; Błazejowski et al., 2019; Huang & Ulanowicz, 2014; Esseghir and Khouni, 2014; Greyson, 2007; Stern et al., 1996). There have been few studies in Africa, and most of the studies concentrated on establishing the influence of economic growth on the environment (Mikulewicz & Taylor, 2020; Onuonga, 2020; Akadiri et al., 2019; Bese & Kalayci, 2019; Tsaurai, 2019).

Based on a production model and Westerlund ECM (Error Correction Model), Esseghir and Khouni (2014) examined the relationship between economic growth and sustainability (energy consumption) using a panel data set of 38 UFM (Union for the Mediterranean) countries from 1980-to-2010. The study observed bidirectional sustainability (*energy)–growth* panel causality in both the short and long-run. Hence, sustainable development, based on energy saving and promotion policies, is seen as the right strategy, energy-saving and promotion policies are priorities. Mosteanu's (2019) study, similar to our present study in BRICS, was aimed at balancing the level of inequalities in development in the territory of European and GCC Countries due to diversities in changing economic conditions (economic growth). Given the diversity of geographical and economic conditions, the study was an exploratory (qualitative) research on the relationships between economic growth and development challenges in Europe and the Middle East. The study concluded that the influence of economic growth on sustainability (Sustainable development) could be significantly improved if economic policies are properly aligned with regional development objectives, via the promotion of artificial intelligence and new industrial technologies (New theory of growth) (Moșteanu and AlGhaddaf, 2019). Hence, it advocated for a balanced, harmonious, and sustainable development in line with the reduction of inequalities in internal regional (Moşteanu, 2019b).

In addition to its robustness to lower data sets, DEA can better measure multiple inputs and outputs, as well as, technical change by considering substitution effect (Zha et al., 2019; Liu et al., 2011; Liu et al., 2010). The study observed that the impact of growth on sustainability (tourism CO2 emissions) varied from one region or province to another. Specifically, the study posits that the scale effect of economic growth (in tourism) was the highest (largest) factor impacting sustainability (CO2 emissions growth). Other notable contributors to the increasing CO2 emissions are technical efficiency change (negligible positive effect) and attractive resources. However, energy index and technical changes played a dominant role in reducing CO2 emissions growth (sustainability) (Liu et al., 2011; Liu et al., 2010). The main recommendation of the study was the decoupling (or weakening) of (sustainability) CO2 emissions growth from economic growth, which is capable of reducing the negative impact of economic growth on increasing CO2 emissions. Unfortunately, the decoupling of CO2 emissions from economic growth is enormously challenging since it may alternate from negative and weak decoupling (Liu et al., 2017; Meng et al., 2016).

The role of technical change and changes in technical efficiency can be reduced by promoting technical progress through the introduction of more advanced energy-saving technologies (e.g., advanced energy-efficient facilities and low-emission vehicles), increasing investment in technological development, and strengthening institutional innovation and management innovation. For example, the tourism transportation sector can constantly replace old transport systems by using high energy-efficient transport modes (e.g., public buses and hybrid electric vehicles), which will help to reduce tourism CO2 emissions (Zha et al., 2019). Measures such as decreasing the proportion of fossil energy consumption by increasing the use of renewable energy sources (e.g., wind, solar, and geothermal energy) will be beneficial for restricting the growth of CO2 emissions (Wang & Zhou, 2018).

In terms of the input factors, the study observed that it is necessary to optimise the factor allocation structure for most provincial tourism sectors (Zha et al., 2019). For example, readjusting the allocation structure of these inputs and deliberately reducing some tourism projects with high energy consumption and emissions may be effective ways to reduce tourism CO2 emissions in China. Again, strengthening training and enhancing the quality of practitioners, optimising investment structure and reducing capital redundancy, and exploiting and utilising tourism resources rationally will also help to minimise the effects of these inputs on increasing CO2 emissions (Zha et al., 2019; Wang, 2018; Liu et al., 2017).

Reacting to the intractable negative impact of economic growth on sustainability in China, Greyson (2007) advocated for an incremental reduction in wastes and its impact based on the practices of precycling, recycling insurance, and circular economic policy. According to Greyson (2007), 'precycling insurance' is based on the philosophy that decision-making on sustainability ought to be led by the market rather than by educational campaigns or prescriptive regulation (Wang, 2018; Wang & Zhou, 2018). Furthermore, to quantify economic growth and (sustainability) sustainable development of Beijing via ecological network analysis (ENA), Huang and Ulanowicz (2014) study assessed the links between economic growth and sustainable development (Sustainability) based on 11 input-output (I-O) tables of Beijing's economic system from 1985 to 2010. Although the study observed a positive relationship between exponential economic growth and sustainable development, the impact was insignificant and merely fluctuated within a small range. The study recommended that to improve sustainable development, system ascendency should be increased through strengthening those pathways with positive contributions or weakening those with negative effects (Huang and Ulanowicz, 2014). The novelty of the study is the distinction between economic growth and economic development. Aside from contriving separate meanings of economic growth and development, the combined action of growth and development was quantified with a single index, a position that is always echoed in the literature (Liu et al., 2017; Meng et al., 2016). For other Chinese related work in literature, see Wang et al., 2017; Wang & Feng, 2017; Xu et al., 2014; Zha, 2016; Zha et al., 2017; Zhang & Choi, 2013; Zuo, 2011; Wu & Flynn, 2010; Li, 2010; Liu et al., 2011; Liu et al., 2010.

Many studies, mostly in China, looked at the beneficial role of decoupling sustainability from economic growth (see Aoki-Suzuki, 2016; Andreoni & Galmarini, 2012; Jorgenson & Clark, 2012; Wang et al., 2013; Wang, 2013; Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013). Using rescaled range analysis, Zhang et al.'s (2016) study examined the impact of economic growth on sustainability dimensions (impact decoupling and resource decoupling). Resource decoupling was measured via energy and water, while impact decoupling was proxied by $S0_2$, wastewater, and CO2 (Zhang et al., 2016; Aoki-Suzuki, 2016; Andreoni & Galmarini, 2012). The study was premised on sustainability goals of decoupling economic growth from environmental degradation (impact decoupling) and resource consumption (resource decoupling) (Zhang et al., 2016; Gu et al., 2014; Zhang et al., 2011). The study recommended stringent policy measures on wastewater discharge standard and water-saving targets, the level of water recycling both in industrial, agricultural, and households if China desires to prevent the falling trend in sustainability (decoupling performance).

However, contrary to the assumption of decoupling sustainability (as echoed by many studies in China)from economic growth in much empirical literature, Sorrell's (2010) study challenged the conventional theory and raised major concerns due to probable less expected improvements from any potential process of decoupling carbon emissions from economic growth (Zhang et al., 2016; Gu et al., 2014). Sorrell's (2010) contrary arguments were based on five propositions: 1) the rebound effects could limit any potential decoupling; 2) the improved contribution of energy consumption to productivity; 3) complimenting improved efficiency with an ethic of sufficiency; 4) incompatibility of sustainability with increasing economic growth in advanced countries; 5) and negative influence of a zero-growth economy with reserves in the banking system (Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013). All his propositions were deemed to run counter to conventional wisdom underlying major climate policies and orthodox theory deserving further detailed and critical investigation (Ichinose et al., 2015; Chen et al., 2014). The study, therefore, concluded by proposing the following policy options: green fiscal reform, efficiency standards that is progressive, probable caps on resource use and emissions, low carbon technologies, flexible or reduced working arrangements/ hours, income redistribution and so on (Mikulewicz & Taylor, 2020; Sorrell, 2010; Bartelmus, 1999). However, the study cautioned about the failure of the above policy options if any of the structural factors of continued economic growth are not properly addressed (Sorrell, 2010).

Few studies based on Africa are also noted in the literature. Mikulewicz & Taylor's (2020) study subjected the new climate-resilient development dialogue to serious inquiry based on the theoretical lens of post-politics, by cautioning the depoliticising of African climate change agenda as an external threat to the level of development on the continent. A similar econometrical study by Onuonga (2020) examines the long-run relationship among environmental quality variables, financial development, and economic growth in Kenya for the period 1970-2019. Estimates based on the autoregressive distributed lag bounds test depicts a long-run relationship among the variables. Specifically, the long-run estimates suggest that increases in financial development lagged CO2, population growth, trade openness, and energy consumption significantly reduces environmental quality in Kenya (Onuonga, 2020). However, while acknowledging the significant influence of natural resources on environmental quality, the study generally establishes the presence of the EKC hypothesis between CO2 and financial development, but decline the long-run Environmental Kuznets curve hypothesis between CO2 and economic growth in Kenya during the study period. Lastly, the study supports the neutrality hypothesis between financial development and economic growth in Kenya (Onuonga, 2020).

A similar study by Akadiri et al. (2019) offered a new perspective by employing the Autoregressive Distributive Lag model and Toda-Yamamoto procedure for testing Granger causality. The study assessed the influence of kg oil equivalent per capita energy usage and real output per capita level towards environmental quality or degradation in South Africa using a time series data from 1973 to 2014. Estimated results revealed the significant role of energy usage and per capita real output level towards environmental degradation or quality in South Africa during the study period (Akadiri et al., 2019). Also, the study showed a unidirectional causality running from environmental quality to real income per capita of energy consumed. The study, therefore, recommended policies from the perspective of economic performance, environmental sustainability, and energy saving in the long-run (Akadiri et al., 2019).

2.4.3 Sustainability and Economic Growth in BRICS Bloc

Since the pioneer studies on sustainability-economic growth nexus in the United States (Solow, 1974; Dasgupta & Heal, 1974; Stiglitz, 1974; Smulders, 1995) and subsequent empirical studies in developed countries (like Grossman and Krueger, 1993; Beckerman, 1992; D'Alessandro et al., 2010; Perrings and Ansuategi, 2000; Ayres et al., 2007; Gaspar et al., 2017; Sorrell, 2010; Islam et al., 2004; Spangenberg, 2010), as well as, few isolated "emerging" countries in Asia and the Middle East (see Zha et al., 2019; Błazejowski et al., 2019; Huang & Ulanowicz, 2014; Esseghir and Khouni, 2014; Greyson, 2007; Stern et al., 1996), there seem to be scanty studies concentrating on the nexus in the BRICS bloc, or similar blocs of developing countries (Zha et al., 2019; Hofkes, 2017). Two prominent studies in the BRICS bloc are Santana et al. (2014) and Fakoya (2013).

Based on the probable impact of economic growth on both social and environmental sustainability in the BRICS countries, Santana et al. (2014) study aimed at evaluating the performance of BRICS countries in the context of sustainable development. The specific objective of the study was to assess to the influence of technological innovation and productive resources on sustainable development. The objective was achieved via carefully selected econometric tools and data envelopment analytical methods on each of the sustainability dimensions in an attempt to create a comparative environmental, social, and economic efficiency ranking for all BRICS countries. The results of the study observed that Brazil had the highest economic efficiency average, followed by South Africa, China, Russia, and India in the BRICS bloc. The DEA environmental application also positioned China as having the lowest environmental efficiency (average of 21%), when compared with South Africa (99%), Brazil (90%), India (81%), and Russia (78%), respectively. Lastly, results from the DEA social application depict Brazil as having the highest average social efficiency, followed by Russia (89%), South Africa (76%), China (56%), and India (49%), respectively. The study out-rightly positioned Brazil amongst the BRICS countries with the highest capacity to transform GDP growth into a more humane production mode, environmental attention, and income distribution (Santana et al., 2014). However, the study cautioned on the interpretations of the main findings, since the DEA analytical technique for relative efficiency merely compares Brazil with other BRICS countries. Again, institutional sustainability was lacking in this sustainability debate (Santana et al., 2014).

Fakoya's (2013) study seems to be among one of the bold warnings on the BRICS's strategy of continuous growth. The study was premised on the fact that any further growth may end up causing more harm than good in terms of sustainable development and sustainability. The study was a review of selected quoted companies on the Johannesburg stock exchange mainly to analyse the impact of the newly introduced King III sustainability reporting initiative on the environmental sustainability performance of the selected companies in south African's quest for sustainable economic growth. The study was based on the premise that BRICS countries prioritized the adoption of conventional business approaches (mostly to increase shareholders' returns) to enhance economic growth and development, as well as the fact that the adoption of the traditional approach of business may be in fundamental conflict with sustainable development and sustainability practices. Hence, the probable contributions of increasing economic growth within the BRICS nations to environmental degradation in the bloc and the consequential threats to sustainable development and sustainability principles in the long-term (Onuonga, 2020; Fakoya, 2013); although, the study mainly provided a review of current sustainable development and sustainability agenda for South Africa alone, through the lens of its King III code on sustainability reporting initiatives. The study concluded by advocating for an unambiguous standard of sustainability reporting that is capable of engendering better comparison between and within companies, and most significantly, a sustainability reporting standard that integrates the goal of economic growth with sustainable development and sustainability practices (Fakoya, 2013). Unfortunately, the study, however, acknowledged its limitation to environmental-related impact, at the expense of other important aspects of sustainability, like socioeconomic and institutional impacts of companies.

Similar to Fakoya’s (2013) study, few other studies on the nexus between economic growth and socio-economic inequality were mostly “stand-alone” study on one of the BRICS countries (Ang, 2010). Specific examples of these “stand-alone” studies are Ang’s (2010) study on the relationships between economic growth, finance and (socio-economic) inequality in India; Bittencourt’s (2010) work, also on the relationships among economic growth, (socio-economic) inequality and financial development in Brazil from 1985 to 1999; Giri and Sehrawat’s (2015) on income inequality and financial development in India using ARDL approach; Hye’s (2011) work on the effect of economic growth on financial development in India; and Odhiambo's (2010) ARDL study on the relationships between economic growth and socio-economic inequality and finance-investment in South Africa. (For more related studies on the nexus between economic growth and socio-economic inequality/ financial developments in developing countries see Bahmani & Zhang, 2015; Clarke et al., 2013; Daisaku et al., 2014; Hye, 2011; Kappel, 2010;

Kim & Lin, 2011; Nikoloski, 2013; Batuo et al., 2010). Although many of these studies obtained contradictory results, however, several of the studies were unanimous in confirming a long-run cointegration nexus between economic growth and both financial development and income inequality (socio-economic inequality), while some supported (significant negative effect) both the environmental/ financial Kuznets hypothesis of an inverted U-shaped relationship (Giri & Sehrawat, 2015; Bittencourt, 2010; Clarke et al., 2013).

Also, studies by Younsi and Bechtini (2018), Menon (2017), and Javeria et al. (2017) were recent studies on the relationships between economic growth and sustainability dimensions. Specifically, Younsi and Bechtini's (2018) study aimed at establishing the nexus between economic growth, income inequality (socio-economic inequality) and financial development for the BRICS countries based on an annual panel data from 1995-2015. Estimates from Pedroni panel cointegration, as well as, the Kao residual panel cointegration tests confirm a long-run cointegration association between economic growth and both income inequality (socio-economic inequality) and financial development in the BRICS countries. While estimates from fixed effects results posit the positive and significant influence of economic growth on income (socio-economic) inequality, the coefficient of its squared term depicts a significant negative impact. Additionally, the contrived financial development index in Younsi and Bechtini (2018) established a statistically positive significant influence on income (socio-economic) inequality, while estimates based on its squared term observed a statistically significant effect of financial developments on income (socio-economic) inequality.

Younsi and Bechtini's (2018) study implied critical support for the Kuznets financial hypothesis in the BRICS countries during the study period. Kuznets' financial hypothesis depicts an inverted U-shaped relationship between economic growth, inequality, and financial sector development (Alzoubi et al., 2020; Agnello and Sousa, 2012). The Kuznets hypothesis simply posits for an increase in socioeconomic disparities arising from the first phase of economic growth, while the same economic growth in a later phase, given redistribution mechanisms, tends to contribute to the attainment of an egalitarian pattern of the income distribution (Fan & Zheng, 2013; Omer, 2008; Spangenberg, 2004).

Lastly, findings from the Granger causality test depict a unidirectional causality from financial developments to income (socio-economic) inequality, but there was no reversed causal relationship between income inequality and economic growth. Consequently, Younsi and

Bechtini (2018) proposed mixed policy options aimed at reducing (socio-economic) inequality in the BRICS bloc through improvements in taxation and financial system policies.

Javeria et al.'s (2017) study on BRICS also aimed at establishing an empirical relationship among sustainability (CO_2 emissions), energy consumption, and economic growth using an annual panel data set from 1991 to 2011. Based on a contrived double log function, estimates from the preferred random effects established a positive relationship between economic growth and Sustainability (energy consumption and C02 emissions), depicting increasing levels of CO_2 emissions due to economic growth. The study recommended more environmentally friendly policies on environmental sustainability in the long-term to achieve the much-desired sustainability goals (sustainable economic growth and sustainable development) in the BRICS bloc (Javeria et al., 2017). However, due to small data sets and restrictive conceptualisation, the study advised on the necessity to improve on these limitations by undertaking extensive variables to establish the impact of economic growth on sustainability (environment) in the bloc (similar to gaps identified by Cuma & Akan, 2014 and Ugur & Sari, 2003).

Also, while emphasising the role of economic growth on socio-economic redistribution in many developing economies, Menon's (2017) study assessed the impact of economic growth on sustainability via a Compound Annual Growth Rate (CAGR) estimates of a ten-year data set, from 2006-2007 to 2015-2016. Findings established negative trends in the estimates for China and South Africa. Consequently, the study recommended that the two countries, China and South Africa, should concentrate on enacting policies to reduce inflation via proper monitoring of monetary control and domestic products (Menon, 2017). It is important to state that the unseemly neglects of developing countries and groups of a strategic bloc of countries, as questioned by recent studies, necessitated this present study.

While there have been some studies previously that looked at the economic growth, the aspect of sustainability has not been analysed sufficiently. Consequently, a comparative analysis on the influence of the recent economic growth on environmental degradation within the major contributing countries, like BRICS countries will enhance government policies on climate change, especially on lower carbon emissions (Sesay., Yulin, & Wang, 2018; Azevedo et al., 2018; World Bank Group, 2018; Agrawal, 2015). Besides, previous studies often emphasised the need for empirical research to investigate specific reduced-form or partial empirical relationships between economic growth and environmental stress or quality/degradation ("environmental sustainability"), via testing hypotheses, using empirical data based on temporal or cross-section samples of the BRICS countries (Azevedo et al., 2018; Agrawal, 2015). Hence, this study centrally hypothesises that: "the problem of possible diversity among BRICS can be resolved by finding growth policy options within the bloc that would allow socio-economic, institutional and environmental sustainability within the block, as well as improved sustainable development."

2.5 Gaps in Literature

To cover all the linkages between economic growth and sustainability dimensions, this thesis has been positioned to fill any gaps identified in the literature:

1. Understanding the knowledge of how economic growth would affect the socio-economic sustainability of individual countries in BRICS is important in solving the different levels of socio-economic inequalities within the BRICS countries (Menon, 2017; Gur, 2015). This evidence can be done by comparing the nexus between socio-economic sustainability with economic growth across countries, making up BRICS to observe coherence or contrast in results. Comparing socioeconomic sustainability dimensions with economic growth across various socioeconomic characteristics in these countries (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017) is important as it would provide evidence that could serve as a basis for alternative policy options, a gap in literature positioned by previous studies (Agrawal, 2015; Menon, 2017; Agarwal & Khan, 2011). Although empirical studies on the economic growth-socio-economic sustainability nexus are on the increase, most have mainly focused on a single country (Tekabe, 2018; Onisanwa, 2014; Akintunde & Satope, 2013; Adelowokan, 2012; Bakare & Olubokun, 2011), developed (Ogasawara, 2018) and emerging economies analysis (Kurt, 2015; Barro, 2013). The practice of pooling developed or emerging and developing countries together in analysing the influence of economic growth on socio-economic inequality is also common in many studies (Weil, 2013; Barro, 2013; Strittmatter & Sunde, 2011). According to Ogasawara (2018), there seem to be few studies concentrating on a comparative study on the influence of economic growth on socio-economic inequality/ sustainability within a group of developing/ developed economies like BRICS (Tekabe, 2018; Tendetnik., Clayton, & Cathcart, 2018).

2. Although there have been many empirical studies on economic growth-institution nexus continuously evaluating the process of economic change has been seen as an essential

precondition to improving economic growth and development (Błazejowski et al., 2019; North, 2005). Again, we all live in a world that is characterised by dynamic economic change, while the theories we use to understand the present world are still largely static, with little emphasis on the role of institutions and government (Pereira., Ferraz., Araujo & Machado-Taylor, 2018; North, 2005; Hayek, 1973).

Another important theoretical contribution of the study would be the validation of the institutional fitness theory; a gap raised in previous literature is the role of economic growth in achieving institutional fitness (sustainability) in vast developing economies, like BRICS (Sesay et al. 2018; Ogasawara, 2018; Anyanwu and Yameogo, 2015). This focus is based on the premise that both the imperfect and perfect markets still find it difficult to adequately explain or predict the influence of economic growth on institutional developments in many developing countries (Sesay et al. 2018; Ogasawara, 2018; Wilhelms, 1998). The adoption of institutional fitness theory, in this study, is also a veritable means of accounting for the array of heterogeneous variables that are usually involved in the economic growth process, by giving more significance to institutions (Meso level), over both the entire economy (macro-variables) and firms (micro-variables) (Ogasawara, 2018; Wilhelms, 1998).

In a deviation from previous studies that used singular measure of institutional fitness, part of the novelty of this study is the development of an aggregated composite index of institutional fitness based on the dictates of institutional economics (theory), by looking at risk assessment factors of all the BRICS countries over time, as identified by (1) Euromoney country risk survey, (2) Corruption Perception Index-CPI (Transparency International), (3) World Bank decomposed governance indices; and (4) the top three global rating agencies - Standard & Poor's Financial Services LLC (S&P), Fitch Ratings Inc and Moody's Investors Service (Menon, 2017; Carnoy, 2006).

3. Although manystudies have investigated the environmental Kuznets curve (EKC) hypothesis (Fan & Zhen, 2013; Hediger, 2000; Pearce & Atkinson, 1993; Spangenberg, 2001; Valentin & Spangenberg, 2004), allempirical findings, have yieldedmixed results. This situation motivates the undertaking of additional studies (Jamel & Maktouf, 2017; Javeria et al., 2017; Spangenberg, 2004). In an attempt to fill the gap in the literature, Javeria et al. (2017: 58) recommended that future studies utilise "extensive variables to estimate the impacts of economic growth on the environment in BRICS." The present study is expected to offer new empirical

proof concerning the economic growth-environmental sustainability nexus in the quest toward attaining sustainable economic growth in the BRICS countries. In the literature, only a few studies seem to have examined these relationships (Pereira et al., 2018; Menon, 2017; Agrawal, 2015).

Another significance of the present study is the adoption of various linear and non-linear estimators that are robust to both small sample size bias and cross-sectional dependence. Specifically, contrary to most literature on the topic, the study is capable of correcting any probable cross-sectional dependence, as well as, address endogeneity issues in both linear and non-linear frameworks (Pereira et al., 2018; Menon, 2017).

4. Previous studies have paid very little consideration to address a comparative study on the influence of economic growth on sustainable development using a panel analysis within many developing and developed blocs, like the BRICS, MINT, and G-7 economies (Azevedo et al., 2018; Menon, 2017). This lack of focus on comparative studies of developing bloc is problematic considering the important benefits of a comparative study to many developing countries in their quest toward improved policy options on sustainable growth and development (Onisanwa, 2014; De La Fuente & Domenéch, 2006). Consequently, many studies opined the desirability of future studies that exclusively focused on a comparative analysis of BRICS countries, with either a developing or developed bloc countries, as it is in this realm that a paucity in the literature exists (Azevedo et al., 2018; Eggoh et al., 2015).

Most importantly, the output of such studies will be useful to policymakers in the BRICS countries not only in estimating the achievement of many BRICS goals but could also serve as a "double-edged" tool for monitoring BRICS's progress towards the attainment of the United Nations SDGs by the year 2030 (Agrawal, 2015; Awan, 2013). Lastly, an increase in GDP per capita or GDP are often used to represent economic growth (Al-mulali et al., 2014; Shahbaz et al., 2013; Wang et al., 2013; Welle-Strand et al., 2012; Bowen et al., 2012; Sharma, 2010). While in many instances, the same indicators (increases in GDP per capita or GDP) are also used to depicts economic development (Hudson et al., 2013; Zanin & Marra, 2012; Schumacher & Strobl, 2011; Colantonio et al., 2010), sometimes development is construed as being different from a mere growth (Stefan, 2012). Unfortunately, fuzzy relationships still exist to date. However, due to the blurred line between growth and developments, Huang and Ulanowicz

(2014) posit the quantification of growth and development as a necessary prerequisite to any treatment of sustainable development. Hence, many studies often advocate for the quantification of a singular measure of sustainable development (Mosteanu, 2019; Polasky et al., 2019; Zha et al., 2019; Cuthill, 2010; Franck-Dominique, 2008). Aside from contriving separate meanings of economic growth and sustainable development, the combined action of economic growth and sustainable development in the BRICS bloc can be quantified with a single index that is robust to cross-sectional biases and small sample size.

CHAPTER 3

SOCIO-ECONOMIC SUSTAINABILITY AND ECONOMIC GROWTH IN BRICS COUNTRIES: RELATIONSHIPS AND POLICY OPTIONS

3.1 Declaration

The work in this paper is my original work, as the .D.Ph.D. candidate - Mr. Awolusi Olawumi Dele. Prof. Josue Mbonigaba, in serving as a supervisor, has contributed by providing overall guidance to the coherence of this body of work. His contributions have been advisory. I did the writing of the paper in its entirety. In submitting this paper for consideration for publication, I (Mr. Awolusi Olawumi Dele), as the .D.Ph.D. candidate, was the primary and corresponding author.

3.2 Contribution of the Paper to Literature

This paper investigated the influence of economic growth on socio-economic inequality within the BRICS countries from 1990 to 2017. The long-run equilibrium relationships were established via Pesaran et al.'s (2001) autoregressive distributed lag (ARDL) cointegration technique, as well as, Toda and Yamamoto's (1995) granger non-causality approach in a two-variable vector autoregression model. The existence of co-integrating vectors, as well as short-run unidirectionally and bidirectionally associations, were established in all variables for the selected BRICS countries. The study, therefore, concluded that the long-run equilibrium relationships between economic growth and socio-economic sustainability in the BRICS countries vary from one country to another, but were largely insignificant in the models of Russia and China during the study period. This finding tacit support for the Kuznets hypothesis in both China and Russia. Also, the present study found that somewhat varied policy options are inevitable in the bloc.

This study provides a tool to understand the sustainability of BRICS and achievement of its goals and also to aid sustainability and growth policy options, which is the main essence of establishing the relationships between socio-economic objectives and economic growth in the BRICS countries (Hofkes, 2017; Hamilton, 2015; Fan & Zheng, 2013; Spangenberg, 2004). Consequently, to the best of the researcher's knowledge, no study has investigated comprehensibly (along with multiple determinants) the sustainability of growth policy options within BRICS to propose sustainability and growth policy options and building evidence by establishing the relationship between socio-economic sustainability and economic growth in each BRICS country. Again, this study has been able to provide new empirical evidence concerning the relationships among socio-economic sustainability and economic growth in the BRICS countries (Pereira et al., 2018; Menon, 2017; Gur, 2015; Agrawal, 2015). The novelty of the present study is the construction of a composite socio-economic sustainability index, as well as the provision of novel cross-validation of estimation techniques and robustness checks in response to many gaps in the literature.

3.3 Paper as submitted to the International Journal of Services, Economics, and Management (IJSEM)

ABSTRACT

This paper assesses the influence of economic growth on socio-economic sustainability in the BRICS countries, using a yearly dataset from 1990 to 2017. The long-run equilibrium relationships were established via Pesaran et al.'s (2001) autoregressive distributed lag (ARDL) cointegration technique, as well as, Toda and Yamamoto's (1995) granger non-causality approach in a two-variable vector autoregression model. The outcome of the estimated causality test detected both unidirectionally and bidirectionally causal effects in the short-run for all the variables. Our study, therefore, concluded that the long-run equilibrium relationships between economic growth and socio-economic sustainability in the BRICS countries vary from one country to another, but were largely insignificant in the models of Russia and China during the study period. This is tacit support for the Kuznets hypothesis in both China and Russia. Also, the present study found that somewhat varied policy options are inevitable in the Bloc. Consequently, to improve socio-economic sustainability in the BRICS bloc, the policy implications and recommendations are straight forward: the radical legal basis for the transition from natural resource export, as well as, sweeping regulation for the sustainable usage of natural resources protection, strict penalties on violations of environment-related laws and policies to enhance general country-wide support. Also, there may be an urgent need to define the active role of non-governmental organization and other independent institutions in improving socioeconomic sustainability at both local and national levels. The novelty of the present study is the construction of a composite socio-economic sustainability index, as well as the provision of novel cross-validation of estimation techniques and robustness checks in response to many gaps in the literature.

Keywords: Socio-economic sustainability, economic growth, Autoregressive Distributed Lag Cointegration Test, Toda-Yamamoto Causality Test, BRICS Countries

Introduction

A major problem with the BRICS's goal of achieving sustainable economic growth for members is the increasing level of socio-economic inequality in the bloc (Hickel & Kallis, 2020; Younsi & Bechtini, 2018). Therefore, understanding the knowledge of how economic growth would affect the socio-economic sustainability of individual countries is essential in solving this problem. The main inquiry is, therefore, on how to produce evidence that would inform policy options for the socioeconomic sustainability in BRICS (Mikulewicz & Taylor, 2020; Mosteanu, 2019).

Sustainability simply means putting scientific, technical, economic, social, and ecological resources to ensure the maintenance of equilibrium state for some in space and time (Younsi & Bechtini, 2018; Spangenberg, 2004). However, since socio-economic sustainability (such as income inequality, gender inequality, racial or ethnic inequality, age inequality, and inequalities in health) is broader than income inequality and poverty, hence a broader measure of socioeconomic sustainability is recommended in the literature (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). This recommendation is made on the premise that socioeconomic sustainability is defined over the entire population, and does not only focus on the poor. Consequently, this study defines socio-economic sustainability as the ability of individual BRICS countries to change to improve the level of labour force participation, balanced employment, social security, as well as, steady circulation of assets and income under an unpredictable and disruptive economic growth condition that they are now facing (Younsi & Bechtini, 2018; Ogasawara, 2018; Spangenberg, 2004). The above definition is founded on the notion of gradual improvements in the level of socio-economic sustainability with corresponding economic growths within individual BRICS countries. Accordingly, this study is focused on achieving sustainable economic growth that is aimed at reducing socio-economic inequality in the BRICS bloc.

Analysis of BRICS bloc is motivated by the fact that in these countries, there is need to grow respective economies but then this might not work for all countries to satisfy other socio-economic issues (Polasky et al., 2019; Zha et al., 2019; Younsi & Bechtini, 2018). One of these issues is socio-economic inequalities, our proxy for socio-economic sustainability; hence the terms are being interchangeably used in this paper. The basic presumption is that, while some countries in the BRICS bloc may be more preoccupied with the issues of socio-economic sustainability, others may enact pure growth chasing strategies, which might hurt some social aspects in some countries (Ogasawara, 2018; Hofkes, 2017; Hamilton, 2015). These conflicts might ultimately compromise good cooperation within the bloc and, therefore, may need policy adjustment. These conflicts can be understood by assessing the association between economic growth and socio-economic sustainability variables (Cashin., Mohaddes & Raissi, 2017; Nkoro

& Uko, 2016; Breitenbach., Tipoy & Zerihun, 2017). The focus of this paper is bring evidence to this effect.

Over the past few decades, the interaction of economic growth and socio-economic sustainability has been a subject of interest among academics and policymakers. Previous studies have documented mixed results. Since economic growth provides an impact on the fluctuation in the level of socio-economic sustainability (Younsi & Bechtini, 2018; Javeria et al., 2017), this instability condition builds uncertainty towards the attainment of sustainable economic growth in many developing, "emerging," and developed countries (Cuthill, 2010). Hence, the interactions between economic growth and socio-economic sustainability variables have been projected as a veritable line of discussion by academics and policymakers (Hussin., Muhammad., Abu & Awang, 2012**;** Jamel & Maktouf, 2017; Agrawal, 2015).

After many years of its existence, the sustainability of economic growth in the BRICS (Brazil, Russia, India, China, and South Africa) countries has been documented as a major problem given the diverse nature of socio-economic characteristics in the group, especially, as some members of the group change status from emerging economies to developed economies (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015). Therefore, understanding the knowledge of how economic growth would affect the socio-economic sustainability of individual countries is important in solving this problem (Menon, 2017; Gur, 2015). This understanding can be empirically brought about by comparing the nexus between socio-economic inequality with economic growth across countries, making up BRICS to observe coherence or contrast in results.

Again, BRICS is one of the countries where striking a balance between socio-economic sustainability and economic growth is problematic and requires careful policy options design. BRICS brings together countries with different levels of socioeconomic status. Some countries have higher incomes in terms of GDP per capita than others. BRICS is a disparate group of countries that came into existence in 2010 (with member countries ranging from low-to middle-income emerging economies, as well as fast-growing emerging countries). H Hence, a comparative analysis of socioeconomic sustainability while trying to achieve the desired economic growth in individual countries is needed. BRIC was coined in 2001 by Jim O'Neill (Goldman Sachs analyst) to represent a group of four countries, namely Brazil, Russia, India, and China. These countries are deemed to be at a comparable phase of freshly advanced economic growth (Goldman Sachs, 2001). However, forming a political organisation, BRIC was later expanded to include South Africa in 2010 and now referred to as BRICS (Brazil, Russia, India, China, and South Africa) (Javeria et al., 2017). BRICS countries occupy over 25 percent of the livable surface of the earth altogether, with about 40 percent of the world's population (World Bank Group, 2018; RSA, 2013). The collaboration of all BRICS countries is aimed at achieving infrastructural development, sustainable economic growth, increased consumption, and international trade (Agrawal, 2015; Awan, 2013; Menon, 2017). The present paper, therefore, recognises the disparate economic, social well-being, ideological, and cultural statuses of the BRICS member countries. Consequently, analyzing BRICS's socio-economic sustainability profile is justified on the ground that these countries are homogenous since they all passed the criteria set by Standard and Poor to be classified as emerging economies (Breitenbach., Tipoy, & Zerihun, 2017). These criteria include the following: huge growth potential, low-to-mid per capita income; high market volatility; commodity and currency swings as well as the brisk pace of economic growth (Omar & Inaba, 2020; Mosteanu, 2019; Younsi & Bechtini, 2018).

Problem Orientation

The different levels of socio-economic sustainability majorly threaten the achievement of the above goals within the BRICS countries (Azevedo., Sartori & Campos, 2018; Hochestler, 2014). These problems in the BRICS countries would require that countries adopt policies that are relevant to the key socio-economic issues, in particular, the issues relevant to development imperatives of more vulnerable partners in the group (like South Africa) so that growth path adopted is embraced by socio-economic development of all countries (Azevedo et al., 2018; Gur, 2015). The adoption of the policies is, however, a dilemma as countries will likely embrace policies that are more relevant to their circumstances. It is therefore hypothesised that the problem of possible diversity in interest among BRICS can be resolved by finding policy options within the block that would encourage socio-economic sustainability within the block.

Specifically, many studies observed that BRICS countries are largely different, both in terms of values and goals and resources support to the vulnerable segment of the society (Menon, 2017; Agrawal, 2015; UNCSD, 2012). The problem of diversity in the distribution of social goods among BRICS countries is also because many BRICS countries pursue their interests that are counter-productive to the interests of other members and therefore against the common interest of the bloc (Javeria et al., 2017; World Bank Group, 2018; Agrawal, 2015; ISSA, 2017). Supporting this problem, many recent studies (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) also attributed the present threats to sustainable economic growth in the BRICS countries to poor and inefficient social developmental strategies to support the growth process. For example, despite recent improvements in South Africa's democratic consolidation and the rule of law, there still exist growing social disparities and poverty, poor policy implementation in terms of education and labour market (Menon, 2017; Agrawal, 2015; Gur, 2015). Brazil seems to be the most hopeful of all the BRICS countries, in terms of improved policy implementations and governance; however, the country remains affected by poor infrastructure and high levels of social inequality (World Bank Group, 2018; Pereira et al., 2018). However, the above problems would not arise if there was knowledge of how economic growth would affect the socio-economic sustainability of individual countries. In case it affects the sustainability of individual countries differently, then countries can adopt differential growth policies, and if it is not, all the BRICS countries can adopt the same growth policies.

Consequently, the main objective of this study is to estimate the impact of economic growth on socioeconomic sustainability in the BRICS countries**,** using a yearly dataset from 1990 to 2017. Moreover, despite many empirical studies on economic growth and socio-economic sustainability, continuous evaluating the process of economic change has been seen as an important precondition to improving economic growth and social welfare in both developing and developed economies (Onuonga, 2020; North, 2005). Consequently, this study is focused on BRICS economies due to the unseemly sustainability of the past three decades of economic growth (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). The importance of the study also lies on the sustainability of economic growth being accorded the importance in the vision 2030 Sustainable Development Goals (SDGs) of the United Nations.

Research question

The question in this study is whether sustainable economic growth policy formulated at the bloc level would work or whether there would be alternative policies giving the diversities in terms of growth profiles and socio-economic characteristics in BRICS countries. The problem is, therefore, a problem of growth policy options that would result in sustainability along socio-economic dimensions making justice to every member whether such options should be adopted in individual countries based on comparable characteristics or the basis of developmental level. Consequently, the central research question can be formulated as follows: What growth policy options are implied by the relationship between socio-economic sustainability and economic growth to be fair to individual countries' circumstances in BRICS? The remaining sections of the paper are as follows: Section 2 is the review of related theories and empirical studies. Section 3 depicts the adopted methodology. Section 4 presents the results and discussion of findings. Lastly, Section 5 is the conclusion, policy implication, and recommendations of the study.

Review of Related Literature

Conceptual, theoretical Framework and Sustainability Model Development

Any meaningful research that contributes to knowledge should be supported by a sound conceptual and theoretical framework (Younsi & Bechtini, 2018; Javeria et al., 2017; Hussin et al., 2012; Bryman, 2012). Specifically, Bryman (2012) maintains that theory forms the backcloth and justification for the research being carried out. This means that theory forms the framework on which a research problem can be understood, and the research findings can be interpreted. A conceptual framework is, therefore, an argumentative concept that is deliberately adopted for investigating expected relationships between variables based on existing models and theories (Hamilton, 2015; Carnoy et al., 2012). Hence, the conceptual framework for this study is based on the nexus between socio-economic sustainability and economic growth in the BRICS countries (Menon, 2017; Agarwal & Khan, 2011). However, much of the existing literature does not agree on the conceptual framework and constructs that should be used to explain the relationships between socio-economic sustainability and economic growth (Ogasawara, 2018; Menon, 2017). The reasons why existing models are inadequate in explaining the actual changes in the level of economic growth and socio-economic sustainability in the BRICS countries could be found in the approach towards understanding the relevant concepts.

"socio-economic sustainability" and "economic growth" analysis usually involve solving complex diagnostic problems, owing to its focus on long-run processes, a mix of varied sustainability theories and models can help in addressing these complexities over time (Menon, 2017). However, since many models on the above relationships usually focus on evolutionary or social processes, natural process description, and technology, this study does not postulate the best modelling approach, but an array of models that are capable of providing diverse, and mostly corresponding insights (Younsi & Bechtini, 2018; Javeria et al., 2017). While "socio-economic sustainability" revolves around the maintenance of justifiable equity between generations (optimal allocation/externality-welfare- theory), other economists believe that the goal of reducing "socio-economic inequality" is achieved by placing restrictions on a country's physical scale (Gur, 2015).

Consequently, from the modelling perspective, there are various interpretations of "socio-economic sustainability. These interpretations include "discounted utilitarianism," "intergenerational equity (non-decreasing welfare)," "weak sustainability," strong sustainability (all capital are independently maintained in biological/physical terms), "stationary state" (maintained economic and population stocks), and "ecological stability and resilience" (stability, resilience and biotic diversity) (Bilgili et al., 2016; Spangenberg, 2004). However, various models for the present study fall within weak sustainability, as well as in ecological stability and resilience (Younsi & Bechtini, 2018; Bilgili et al., 2016; Spangenberg, 2004). The reliance on these two interpretations is because models based on weak sustainability often permit substitution between human-made and natural capital, with emphasis on equal opportunities for future and present generations (Hediger, 2000; Spangenberg, 2001).

The present study, therefore, posits that a single theoretical standpoint cannot satisfactorily elucidate the effect of economic growth on socio-economic sustainability dimensions (Mahe, 2005). Again, previous studies (Hofkes, 2017; Hamilton, 2015) also called for either the extension of existing theories or the development of new theories to explain this phenomenon (Gur, 2015; Mankiw et al., 1992). Besides, a theoretical framework can be based on more than one theory (Riley, 2012). Consequently, the theoretical framework for this study is built majorly on the two (the classical theory of economic growth and the neoclassical growth theory) most common theories of socio-economic inequality and economic growth-determinants nexus (Pistorius, 2004; Wilhelms, 1998).

Although the traditional convergence model framework was the first macro-economic analysis of growth (Ozturk, 2007; De Mello, 1996; Carnoy, 2006); the inability of the model in explaining wealth and social disparities between nations necessitated the search for the initial circumstances that might define the long-term theme towards convergence in many economies (Anyanwu, 2012; Carnoy, 2006). The inability of the traditional convergence model in explaining wealth and social disparities between nations was further argued by Mankiw, Romer, and Weil (1992), who did so by using Solow's aggregated production function of a stationary state in physical and human capital, concerning their level of wealth (saving), social inclusion, demographic growth and educational development (De Mello, 1996; Carnoy, 2006). Barro (1990) also posits the positive relationships between a country's initial social and human capital (health and education) developments and economic growth, given a certain level of wealth accumulation and distribution (Pelinescu, 2015; Mahe, 2005). Consequently, macro-economic convergence is believed to be highly dependent on the initial level of education, income distribution, and well-being of the population (De Mello, 1996; Carnoy, 2006). Unfortunately, the classical theory regards productivity of labour to be an exogenous factor, which often fails to reflect the valuable influence of social equity and education on the possible growth in productivity, hence, the need for its extension (Pistorius, 2004).

The Neoclassical Growth Theory Vs. Socio-economic sustainability and Economic Growth

Under the neoclassical growth theory, growth commonly arises from strategic accretion of factors of production and the growth in total factor productivity (TFP) (Zha et al., 2019; Cuthill, 2010; Felipe, 1997). That notwithstanding, the above two derivatives also depend on the host country's bargaining power in providing the supporting socio-economic policies and infrastructural development (Onuonga, 2020; Fedderke & Romm, 2005). The neoclassical growth theory, therefore, strengthened the contributions of social justice and human capital development to the growth debate. It also observed the importance of socio-economic equity and strategic accumulation of factors of production (total factor productivity) in creating sustainable economic growth (Zha et al., 2019; Cuthill, 2010; Felipe, 1997). The theory also conditioned the attainment of improved socio-economic sustainability and economic growth on the bargaining power of the host nation and the willingness to provide the supporting institutional and socio-economic development policies (Fedderke & Romm, 2005).

Also, socioeconomic inequality can be improved through the sharing of management skills' integration and knowledge in the host country (Frenkel et al., 2004). Likewise, government investment in learning, innovation, and research and development may also engender productivity spillover for the host economy (Temple, 1999). Furthermore, the neoclassical growth theory also posits an improvement in output level due to increased health consciousness and education, via the strategic addition to labour skills, increased labour capacity, as well as, increased worker capacity to innovate using both old and new technologies (Ozturk, 2007; Carnoy, 2006). Consequently, the neoclassical growth theory can be used to explain the problem of diversity in the level of socio-economic inequality in the BRICS countries, which is probably because many BRICS countries pursue their interests that are counter-productive to the interests of other members and therefore against the common interest of the bloc (Javeria et al., 2017; World Bank Group, 2018).

Again, socio-economic inequality path can be established by incorporating inequalities in a typical neoclassical growth model; hence, the study's modelling of "socio-economic sustainability" in the BRICS countries is feasible with the incorporation of "sustainability" as a condition, on the stock of environmental resources or more generally on welfare changes (Menon, 2017; Agrawal, 2015; Gur, 2015).

Supporting this theory, many recent studies (Hofkes, 2017; Hamilton, 2015; Pearce et al., 2014; Fan & Zheng, 2013; Omer, 2008; Diesendorf, 2000) attributed the present threats to sustaining the past three decades of economic growth in the BRICS countries to poor and inefficient social developmental strategies to support the growth process (Hamilton, 2015; Azevedo et al., 2018). Also, many of the studies in the developing seem to be based on "stand-alone" countries like China and India. UUnfortunately, very few studies seem to have focused on the BRICS bloc.

Specific examples of these "stand-alone" studies are Ang's (2010) on the relationships between economic growth, finance and inequality in India; Bittencourt's (2010) work, also on the relationships between economic growth, financial development and inequality in Brazil from 1985 to 1999; Giri and Sehrawat's (2015) on financial development and income inequality in India using ARDL approach; Hye's (2011) work on the effect of economic growth on financial development in India; and Odhiambo's (2010) ARDL studyon the relationships between economic growth and socio-economic sustainability and finance-investment in South Africa.

Besides, many empirical works on the socio-economic sustainability-economic growth nexus are often seen as confusing and contradictory, probably due to varied measures and estimation techniques (Menon, 2017; Agrawal, 2015; Gur, 2015; Spangenberg, 2004). Although many of these studies obtained contradictory results, however, many of the studies confirmed a long-run cointegration relationship between economic growth and both financial development and income inequality (Giri & Sehrawat, 2015; Bittencourt, 2010; Clarke et al., 2013). That notwithstanding, studies by Younsi and Bechtini (2018), Menon (2017), and Javeria et al. (2017) were recent studies on the relationships between economic growth and socio-economic sustainability.

Specifically, Younsi and Bechtini's (2018) study examined the causal relationship between economic growth, financial development, and income inequality for the BRICS countries using annual panel data covering the period 1995-2015. Estimates from Pedroni panel cointegration, as well as, the Kao residual panel cointegration tests confirm a long-run cointegration relationship between economic growth and both financial development and income inequality in the BRICS countries. While estimates from fixed effects results posit the positive and significant influence of economic growth on income inequality, the coefficient of its squared term depicts a significant negative effect. Additionally, the contrived financial development index in Younsi and Bechtini (2018) established a statistically positive significant influence on income inequality, while estimates based on its squared term observed a statistically significant effect of financial developments on income inequality, hence, critical support for the financial Kuznets hypothesis in the BRICS countries during the study period.

Also, while emphasising the role of economic growth on socio-economic redistribution in many developing economies, Menon's (2017) study assessed the impact of economic growth on income inequality via a Compound Annual Growth Rate (CAGR) estimates of a ten-year data set from 2006-2007 to 2015-2016. Findings established negative trends in the estimates for China and South Africa. Consequently, the study recommended that the two countries (China and South Africa) should concentrate on enacting policies to reduce inflation via proper monitoring of monetary control and domestic products (Menon, 2017). That notwithstanding, previous studies believe that, although there is no doubt that economic growth is a driving force for socio-economic sustainability in a group of countries, like the BRICS, it is not as clear whether the levels of economic growth that can realistically be achieved will be sufficient to reduce inequalities in BRICS countries (Azevedo, Sartori & Campos, 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Spangenberg, 2004).

There is always an expectation of a trade-off between increasing economic growth today, and socioeconomic inequality (Ahenkan & Osei-Kojo, 2014; Amigun et al., 2011). This expectation is on the principle that today's rapid economic growth may create socioeconomic inequality due to corruption and failing institutions in the distribution of income. An increase in demand also can lead to disparities Ifthe output does not increase, any extra demand will push up the price level and will often lead to corruption and failing institutions (Tsaurai, 2019). In many developing countries, socioeconomic inequality is often compounded by the weak legal and judicial system, as well as a lack of enforcement of court orders (Fan & Zheng, 2013). Then there seems to be a common discriminatory application of anti-corruption requirements in many developing countries that do not exempt BRICS countries either (Phong, 2019). However, contrary to the above negative presumptions of the nexus between economic growth and inequality, many studies have argued that in some corrupt countries, there would be evidence that in fact, corruption will lead to reduced inequalities for a larger part of the community albeit not all (Alzoubi et al., 2020; Menon, 2017; Agrawal, 2015; Gur, 2015).

Furthermore, the influence of economic growth on socioeconomic sustainability in the BRICS countries can also be demonstrated by the Kuznets hypothesis; which simply posit for an increase in income disparities arising from the first phase of economic growth, while the same economic growth in a later period, given redistribution mechanisms, tends to contribute to the attainment of an egalitarian pattern of income distribution in a welfare state (Fan & Zheng, 2013; Omer, 2008). Spangenberg (2004) argues that the fact that a certain level of economic growth is a pre-condition for improving socio-economic sustainability, it might not be adequate to guarantee the attainment of the much desired socio-economic sustainability. In this situation, other studies have suggested consideringdifferent variables like health, education, financial development, and trade (Alzoubi et al., 2020; Menon, 2017).

Based on the above research objectives and questions, as well as, the various kinds of literature, the central hypothesis of the study is stated thus: "the problem of possible diversity in interest among BRICS can be resolved by finding economic growth policy options within the block that would improve socio-economic sustainability within the block." Nonetheless, the following specific hypothesis was contrived: **Hypothesis 1:** $H0_1$: there is no significant influence of economic growth on socio-economic sustainability in individual BRICS countries. Again, based on gaps in previous literature **(**Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014; Pelinescu, 2015), the above specific hypothesis was premised on the fact that economic growth will be sustainable in BRICS countries if it results in improved social inequalities in the individual countries (Younsi & Bechtini, 2018; Javeria et al., 2017; Hussin et al., 2012).

Methodology

Time-series data of the five BRICS countries, from 1990 to 2017, were utilised in this study. The long-run equilibrium relationships between economic growth and socio-economic sustainability (proxied by socio-economic inequality) were established via Pesaran et al.'s (2001) autoregressive distributed lag (ARDL) co-integration technique, as well as, Toda and Yamamoto's (1995) granger non-causality approach in a two-variable vector autoregression model within individual BRICS economies. Consequently, the following steps were followed in the estimation process:

Unit Root Test: A unit root test is usually conducted to identify non-stationarity, that is, the presence of unit-roots. The unit root test was performed via the Augmented Dickey-Fuller (ADF) Test, Phillips-Perron (PP) Test, and KPSS-Kwiatkowski-Phillips-Schmidt-Shin Test at various differenced series (Alzoubi et al., 2020; Phillips & Perron, 1988). In the ADF hypothesis, both null hypothesis (Ho: Model has a Unit Root) and an alternative hypothesis (H_1: Model has no Unit Root) were tested. The testing is based on the notion that if the critical value is greater than the computed result, then the null hypothesis rejects, signifying the absence of unit roots (Maktouf, 2017). Similarly, in the PP test, the null hypothesis (Ho: Model has a Unit Root) is rejected if the critical value (in absolute value) than the computed result (Hussin et al., 2012). Alternatively, *KPSS*-Kwiatkowski-Phillips-Schmidt-Shin Test merely hypothesises a null hypothesis that the model is stationary (Ho: Model is stationary) and an alternative hypothesis (H_1: Model is not stationary).

Pesaran cross-section dependence (CD) test:

The present study tested for cross-sectional dependence errors between socio-economic sustainability and economic growth via the Pesaran CD test (Strittmatter & Sunde, 2011). This was done after a robust and possible absence of arbitrary serial correlation or time-varying variances results (Breitenbach et al., 2017).

Cointegration Tests: After establishing the stationarity of our variables, the study tested the extent of co-integration (long-run equilibrium relationship) between socio-economic sustainability and economic growth. Based on one single equation and the possibility of adopting different optimal lags, this study adopts the autoregressive distributed lag (ARDL) co-integration technique developed by Pesaran et al. (2001). ARDL technique is also applicable to series that are not integrated with the same order. HHowever, none of the series should be I(2) (Pesaran et al., 2001).

Given the following unrestricted error correction model:

$\Delta Y_t = \beta_0 + \sum_{i=1}^{p} \beta_{i,} \Delta Y_{t-1} + \sum_{j=0}^{q} yj \Delta X_{t-j} + \phi_1 Y_{t-1} + \phi_2 X_{t-1} + u_t$ ………………………equation (2.1)

Where Y is the dependent variable, X is the independent variable. Δ denotes the first difference operator, and u_t is the error term (Dritsaki, 2017). Similar to previous studies (Dritsaki, 2017; Hussin et al., 2012), the estimated ARDL (p,q) approach (where p and q are order lags on Y_t and X_1 variables) involved the following stages: (1) using the minimum values on Schwarz (SBC), Hannan-Quinn (HQC), Akaike Information Criterion (AIC) criteria, the maximum values for lags p and q of the unrestricted error correction model was selected; (2) assumption of serially independent errors in selecting the maximum number lags; however, if errors in equation 1 are independent, then the necessity for continuous testing of the ARDL dynamic stability using the unit circle; (3) estimation of bounds test on equation (1) based on F distribution with a null hypothesis of no cointegration (H_0:$\varphi_1 = \varphi_2 = 0$) and alternative hypothesis of cointegration (H_1:$\varphi_1 \neq \varphi_2 \neq 0$); (4) establishment of cointegration from the bounds test should lead to the estimation of probable long-run relationship of our series on equation (2.2), as well as, restricted error correction model based on equation (2.3)

$Y_t = \alpha_0 + \alpha_1 x_1 + u_t$ ………………………………………………….………………equation (2.2)

$\Delta Y_t = \beta_0 + \sum_{i=1}^{p} \beta_{i,} \Delta Y_{t-1} + \sum_{j=0}^{q} yj \Delta X_{t-j} + ƀ Z_{t-1} + u_t$ …………………………………equation (2.3)

Z_t in equation (2.3) represents the error term produced by equation (2.3) (Hussin et al., 2012; Asteriou & Hall, 2007).

Error Correction Model (ECM) Stability Test

Since any probable dynamic restricted error correction model from equation (2.3) may not necessarily imply stable coefficients, Pesaran et al. (2001) suggested the adoption of ECM stability test. This test is popularly known as a cumulative sum (CUSUM) and cumulative square sum (CUSUMSQ) (Maktouf, 2017). After that, the causality direction was established using Toda and Yamamoto's (1995) granger non-causality approach in a two-variable vector autoregression model. The short and long-term granger causal relationships could be observed through the Wald test (F statistics) and error correction term (ECT-1). This observation helped in identifying the existence and nature of the causality relationship between the variables Younsi & Bechtini, 2018; Javeria et al., 2017). However, the present study adopted Toda and Yamamoto's (1995) granger non-causality approach since Granger testing is cumbersome and may give spurious regressions (Maktouf, 2017). Also, the VECM model provides long-term relationships, as well as, short-term dynamics of the endogenous variables, which we expect to converge to their co-integrated relations in the long run (Lee and Tan, 2006). Specifically, VECM shows the attainment of long-term equilibrium, as well as the rate of change in the short term to achieve equilibrium (Akinola & Bokana, 2017). That notwithstanding, Toda and Yamamoto's (1995) granger non-causality approach is often regarded as an 'advanced Granger testing' developed from the modified Wald test (MWald), as well as, Seemingly Unrelated Regression models (SUR models).

Toda –Yamamoto causality analysis:

Toda and Yamamoto's (1995) granger non-causality approach is based on the augmented VAR estimated model ($k+d_{max}$) where d_{max} is the maximum integrated order of the VAR model, and k is the first VAR model's optimal time lag (Breitenbach et al., 2017; Maktouf, 2017). Consequently, the Toda and Yamamoto approach involves the following steps: the establishment of integration order for each series; creation of a VAR model; defining the direction of VAR model (k) from the lag length and final prediction error (FPE) based on selected criteria (such as AIC, SC, HQ criteria); Check the correctness of VAR ($k+d_{max}$) (adjusted VAR model); cointegration testing based on Johansen or Pesaran et al. (2001) methodologies; Granger causality test for non-causality; and lastly, checking for cointegration on VAR model

(Breitenbach et al., 2017; Maktouf, 2017; Toda and Yamamoto, 1995). The resulting VAR (p + d_{max}) model is expressed in Equations (2.4) and (2.5):

$$Y_t = \alpha_0 + \sum_{i=1}^{k} \beta_{1i} Y_{t-1} + \sum_{j=k+1}^{dmax} \alpha_{1j} Y_{t-j} + \sum_{j=1}^{k} \phi_{1j} X_{t-j} + \sum_{j=k+1}^{dmax} \delta_{1j} X_{t-j} + u_{1t} \text{……………equation (2.4)}$$

$$X_t = \alpha_1 + \sum_{i=1}^{p} \beta_{2i} Y_{t-1} + \sum_{j=k+1}^{dmax} \alpha_{2j} Y_{t-j} + \sum_{j=1}^{p} \phi_{2j} X_{t-j} + \sum_{j=k+1}^{dmax} \delta_{2j} X_{t-j} + u_{2t} \text{…………equation (2.5)}$$

Where u_{1t} and u_{2t} are the VAR error terms, and d_{max} is the maximum order of integration (Toda and Yamamoto, 1995). Therefore, in equation (2.4), Granger causality between X (economic growth) and Y (socio-economic sustainability) will be detected, provided that $\beta_{1i} \neq 0$ for every i. Similarly, in Equation (2.5), Granger causality between X (economic growth) and Y (socio-economic sustainability) will be detected, if $\beta_{2i} \neq 0$ for every I (Breitenbach et al., 2017; Maktouf, 2017). Finally, according to Toda and Yamamoto's (1995) procedure, rejection of the null hypothesis simply implies the existence of granger causality between X (economic growth) and Y (socio-economic sustainability) (in both directions), while any reciprocal rejection would indicate a bilateral causal relationship between the analyzed variables (Hussin et al., 2012; Toda and Yamamoto, 1995).

Construction of the composite socio-economic sustainability index

Since socio-economic sustainability is broader than income inequality and poverty, hence a broader measure of socio-economic sustainability is recommended in the literature (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). This recommendation is because socio-economic sustainability is defined over the entire population, and does not only focus on the poor. Consequently, the study applied the principal component technique on the five important proxies of socio-economic sustainability. These proxies are Gini coefficient-income inequality, Atkinson index, Ratio of female to male labour force participation rate in percentage, Unemployment, and refugee population by country or territory of origin. Using the above proxies a composite socio-economic sustainability index was constructed (see Appendix 2A). This index was subsequently used in our analyses. Specifically, the construction of the composite socio-economic sustainability index for all the countries was done by applying principal component analysis (PCA) on our five measures of socio-economic sustainability (Younsi & Bechtini, 2018). The

PCA, as a multivariate statistical technique, is usually used for analysing the inter-correlation by linking several quantitative variables (Younsi & Bechtini, 2018). For each dataset with '*p'* quantitative variables, we can evaluate at most *p* principal components (PC) by descending order of the eigenvalues, with each '*p'* representing a linear combination of the original variables, and the coefficients equal to the eigenvectors of the correlation covariance matrix (Younsi & Bechtini, 2018). The results of the constructed composite socio-economic sustainability index for the five BRICS countries, as depicted in Appendix 2A, shows the PC analysis for Brazil, Russia, India, China, and South Africa with the highest first PC explains about 58.13%, 57.34%, 60.42%, 64.69%, and 70.93% of the standardised variance in each of the countries, respectively; hence, were selected to compute the socio-economic sustainability index (Younsi & Bechtini, 2018). This was based on the premise that the first PC is a linear combination of the whole five measures of socio-economic sustainability index with the respective weights represented by the first eigenvector (Younsi & Bechtini, 2018). Consequently, 78.34%, 78.52%, 39.67%, 41.45% and 32.15% individual contributions for each of the GCII; AI, RFMLF, UNEMP, and RPOP respectively were further used to construct the socio-economic sustainability index for Brazil after rescaling to the standardised variance of the first PC (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; De Bruyn et al., 1998). Again, the same interpretations of results were seen to be true for the other four countries in our analysis (Russia, India, China, and South Africa). In the present study, GDP represents real per capita GDP (a proxy for economic growth). Other important variables in our robustness check analysis include the following: HEALTH stands for total government expenditure on health (a proxy for health development), and EDU is the weighted average of government expenditure in primary and secondary and tertiary education (a proxy for educational development). Again, INST is institutional fitness, as represented by aggregations of economic, political, and institutional indexes (Adelowokan, 2012). FIN represents financial development, TO is trade openness, C02 is environmental pollution, and EC represents Energy consumption. The various measures of constructs are shown in Appendix 2E.

Results and Discussion of Findings

Unit Root Test

The Augmented Dickey-Fuller (ADF) test was conducted for unit roots in both the first difference and levels for all the BRICS countries. The results of this analysis are reported in

Appendix 2B1. In Appendix 2B1, the numbers within parentheses for the ADF statistics column depicts the lag length of the dependent variable used to obtain white noise residuals, and the lag lengths were selected using AIC (Akaike, 1974). Similar to our ADF results, the PP test was also conducted for unit roots in both the first difference and levels for all the BRICS countries, and the results are reported in Appendix 2B1. Lastly, the KPSS-Kwiatkowski-Phillips-Schmidt-Shin Test (as shown in the last two columns of Appendix 2B1) for all the BRICS countries was also conducted in the levels and first difference (Lee & Tan, 2006). Similarly, in Appendix 2B1, the numbers within brackets for the PP and KPSS statistics represent the bandwidth selected based on Newey and West (1994) method using Bartlett Kernel (Breitenbach et al., 2017; Maktouf, 2017). However, the study observes different integration order in all the series for the BRICS countries. Socio-economic sustainability series are integrated order null I(0) while economic growth (GDP) series are integrated in first order I(1). Consequently, the study examined the long-run relationship for each pair of series via the Pesaran et al. (2001) ARDL approach (Maktouf, 2017).

Pesaran cross-section dependence (CD) test:

The results of our Pesaran CD test (Appendix 2B2) on socio-economic sustainability (ln_INQ) refute the presence of cross-sectional dependence in the dependent variable since the test accepts the H0 of cross-section independence (at the 1% level of significance). Fortunately, this is an indication that our variables do not possess a high degree of cross-sectional heterogeneity (Maktouf, 2017). The absence of cross-sectional dependence in the dependent variable, however, justifies the adoption of GMM and POLs during the study’s robustness checks, since all these may assume a large degree of homogeneity (Breitenbach et al., 2017).

Cointegration Tests Results:

After establishing the stationarity of our variables, we proceeded to test the extent of co-integration (long-run equilibrium relationship) between socio-economic sustainability and economic growth. However, since our series is not integrated in the same order, while none of the series is I(2), the study adopted the ARDL (p,q) approach (Pesaran et al., 2001). The results are depicted in Appendix 2C1. The results of the maximum values for p and q lags based on the Schwarz Information Criterion (SIC), FPE, AIC, HQC, and likelihood ratio (LR) criteria are presented in Appendix 2C1. Specifically, the maximum time lag is 1 for Brazil, India, and South Africa, and 3 for Russia and China (Maktouf, 2017).

4.4 Results of Error Correction Model (ECM) Stability Test

Further analysis of the order of optimal lags (p, q) (Table not shown) also shows that ARDL (1,0) is the most suitable for Brazil, India, and South Africa, while ARDL (1,2) is the most suitable for Russia and China. Also, based on the maximum lag number, the LM test (error independence) established first order for Brazil, India, and South Africa and third-order for Russia and China (Zha et al., 2019). This result simply depicts that errors are not autocorrelated in any of the examined models. Consequently, the test of the dynamic stability of our models was performed based on the unit circle (figure not shown). Analysis of the unit circle also supports our findings since none of the reverse roots on equation (2.1) is outside the unit cycle. Hence, our models can be characterized as dynamically stable in the five BRICS countries (Maktouf, 2017).

In the ARDL bounds testing for co-integration, the study tested if φ1 and φ2 parameters in our equation (2.1) are null on our estimated models (Pesaran et al., 2001). Appendix 2C2 depicts that the value of F-statistic for Brazil, Russia, and China is higher than the upper limit of Pesaran et al. tables for 10% level of significance ((Pesaran et al., 2001). Based on equation (2.1), estimates of the unrestricted error correction model for all the BRICS countries in Appendix 2C3 clearly shows sufficient and acceptable results for both statistic and diagnostic tests. Therefore we estimated the long-run results from the unrestricted error correction model {-(GDP/INQ)} for all the five countries as follows: Brazil (0.0051/0.025=0.20), Russia (0.0020/0.069=0.028), India (0.0021/0.011=0.19), China (0.0019/0.071=0.026), and South Africa (0.0020/0.010=0.21). Thus, we can say that an increase in economic growth by 1% will bring about an increase in socio-economic sustainability rates by 0.20% in Brazil, by 0.03% in Russia, by 0.19% in India, by 0.03% in China, and by 0.21% in South Africa. Subsequently, this instability is corrected every year between long and short-run (ECM_{t-1}) socio-economic sustainability rates by 0.017% for Brazil, by 0.023% for Russia, by 0.019% for India, by 0.017% for China and by 0.022% for South Africa. This implies that fiscal policies in the BRICS countries could be aimed at improving socio-economic sustainability through short term sustainability rates which are often affected by expected growth rates (Younsi and Bechtini, 2018).

Table 2.1: Estimation of the long and short-run relationship

Dependent variable = INQ_t								
Estimated long-run coefficients								
Brazil			**Russia**			**India**		
Variable	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**
Const.	4.735	24.22	Const.	5.477	35.87	Const.	3.674	31.23
GDP_t	0.175	1.537	GDP_t	-0.265	-2.023	GDP_t	0.764	2.435
R2	0.556			0.498			0.431	
F-stat	0.748			11.6751			.785	
D-W	1.111			1.145			1.073	
Diagnostic	**χ2**	**P**	**Diagnostic**	**χ2**	**P**	**Diagnostic**	**χ2**	**P**
Normal	4.46 (2)	0.234		6.65 (2)	0.067		6.43 (2)	0.035
Serial	8.22 (1)	0.018		7.11 (1)	0.019		11.2 (1)	0.003
ARCH	5.76 (1)	0.013		9.66 (1)	0.008		11.5 (1)	0.001
Dependent variable = ΔINQ_t								
Restricted error correction model (short-run ECM)								
Brazil			**Russia**			**India**		
Variable	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**
Const.	−0.023	−1.96	Const.	−0.035	−1.648	Const.	−0.031	−2.011
ΔINQ_{t-1}	0.345	5.543	ΔINQ_{t-1}	-0.344	4.875	ΔINQ_{t-1}	0.074	1.955
ΔGDP_t	0.0103	1.435	ΔGDP_t	-0.047	1.793	ΔGDP_t	0.0473	1.893
ΔGDP_{t-1}	0.036		ΔGDP_{t-1}	-0.034			0.913	
ΔGDP_{t-2}	0.062		ΔGDP_{t-2}	-0.049			1.783	
ECM_{t-1}	−0.017	−3.564	ECM_{t-1}	−0.023	−2.023	ECM_{t-1}	−0.019	−1.976
R2	0.423		R2	0.487		R2	0.423	
F-stat	6.346		F-stat	10.127		F-stat	3.534	
D-W	1.989		D-W	1.998		D-W	2.121	
Diagnostic	**χ2**	**P**	**Diagnostic**	**χ2**	**P**	**Diagnostic**	**χ2**	**P**
Normal	1.88 (2)	0.523	Normal	2.89 (2)	0.324	Normal	1.42 (2)	0.637
Serial	1.67 (1)	0.426	Serial	1.63 (1)	0.322	Serial	5.12 (1)	0.023
ARCH	0.68 (1)	0.983	ARCH	1.14 (1)	0.312	ARCH	0.13 (1)	0.812
Dependent variable = INQ_t								
Estimated long-run coefficients								
China			**South Africa**					
Variable	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**			
Const.	4.782	45.23	Const.	5.367	42.23			
GDP_t	-0.187	-1.673	GDP_t	0.043	2.763			
R2	0.401			0.432				
F-stat	0.356			0.735				
D-W	1.673			1.536				
Diagnostic	**χ2**	**P**	**Diagnostic**	**χ2**	**P**			
Normal	4.46 (2)	0.219		4.56 (2)	0.067			
Serial	6.15 (1)	0.023		5.23 (1)	0.023			
ARCH	5.14 (1)	0.025		8.34 (1)	0.016			
Dependent variable = ΔINQ_t								
Restricted error correction model (short-run ECM)								
China			**South Africa**					
Variable	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**			
Const.	−0.342	−1.76	Const.	−0.113	−1.699			
ΔINQ_{t-1}	0.463	6.423	ΔINQ_{t-1}	0.325	4.637			
ΔGDP_t	-0.021	-1.675	ΔGDP_t	0.026	1.786			
ΔGDP_{t-1}	-0.033		ΔGDP_{t-1}	0.021				
ΔGDP_{t-2}	-0.061		ΔGDP_{t-2}	0.047				
ECM_{t-1}	−0.017	−1.234	ECM_{t-1}	−0.022	−1.726			
R2	0.426		R2	0.425				
F-stat	11.324		F-stat	4.627				
D-W	2.024		D-W	1.987				
Diagnostic	**χ2**	**P**	**Diagnostic**	**χ2**	**P**			
Normal	1.56 (2)	0.524	Normal	1.95 (2)	0.324			
Serial	1.18 (1)	0.423	Serial	1.49 (1)	0.324			
ARCH	0.11 (1)	0.735	ARCH	1.12 (1)	0.302			

Note: Δ Denotes the first difference operator; ***,** and * show significant at 1%, 5% and 10% levels respectively.; χ2 Serial for LM serial correlation test; χ2 Normal is for normality test, χ2 ARCH for autoregressive conditional heteroskedasticity, ( ) is the order of diagnostic tests

Next, we estimated the long and short-run relationships in series on equation (2.2) and (2.3). The results are shown in Table 2.1. From table 2.1, the study observes mixed results in both statistic and diagnostic tests for all the BRICS countries. Specifically, although the parameter of economic growth is smaller than one and positive in the estimates of Brazil, India, and South Africa, the same parameter is smaller than one but negative in the estimates of Russia and China. The results, therefore, depicts the severity of economic growth to increase socio-economic growth in Brazil, India, and South Africa during the study period. Additionally, the Results of the F bound test (Appendix 2C2) show the insignificant influence of economic growth on socio-economic sustainability in Russia (10.02) and China (11.16).

However, we observed positive and significant influence of economic growth on socioeconomic sustainability in Brazil (3.99*), India (6.071**), and South Africa (5.123**). However, based on equation (2.3), the statistically significant and negative estimates from ECMt−1 in all the BRICS countries confirmed the long-run equilibrium relationship among the variables during the study period.

Results of Toda –Yamamoto no-causality analysis:

Generally, the establishment of any long-run equilibrium relationships cannot be used to determine the direction of economic growth and socio-economic sustainability for all the five BRICS countries, hence, the adoption of Toda –Yamamoto causality analysis (Zha et al., 2019). Estimation of Toda –Yamamoto causality analysis was based on a lag length selection was based on sequentially modified LR test statistic at a 5% level of significance (Maktouf, 2017). EViews 9.0 was used for all computations. Based on Equation (2.4) and (2.5), the results of Toda and Yamamoto causality seems to suggest a positive relationship and effect of economic growth on socio-economic sustainability in Brazil, India, and South Africa, whereas negative and insignificant influences observed in Russia and China. On the other hand, socio-economic sustainability influences economic growth only in South Africa. Our estimates, therefore, justify the capability of our construed models to predict future socio-economic sustainability in the BRICS bloc (Breitenbach et al., 2017).

Table 2.2: Toda and Yamamoto no-causality test results

Excluded	Lag (k)	Lag (k+d_{max})	Chi-square	Prob.	Direction of causality
Brazil					
Dependent variable: INQ					
GDP	1	1+1	196.18**	0.033	GDP → INQ
Dependent variable: GDP					
INQ	1	1+1	2.85	0.513	INQ # GDP
Russia					
Dependent variable: INQ					
GDP	1	1+1	-2.453	-0.446	GDP # INQ
Dependent variable: GDP					
INQ	1	1+1	-1.627	-0.324	INQ # GDP
India					
Dependent variable: INQ					
GDP	1	1+1	262.44*	0.000	GDP → INQ
Dependent variable: GDP					
INQ	1	1+1	6.42	0.345	INQ # GDP
China					
Dependent variable: INQ					
GDP	1	1+1	-1.612	-0.446	GDP # INQ
Dependent variable: GDP					
INQ	1	1+1	-3.45	-0.346	INQ # GDP
South Africa					
Dependent variable: INQ					
GDP	1	1+1	189.34*	0.001	GDP → INQ
Dependent variable: GDP					
INQ	1	1+1	235.23*	0.000	INQ → GDP

Note INQ= Socio-economic inequality; GDP= Economic growth; FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion. * and ** denotes 1% and 5% significance level, respectively. →Denotes one-way causality, # denotes not causality.

Discussion of Findings

In our models for Brazil, India, and South Africa, economic growth seems to contribute to the declining level of socio-economic sustainability in the three countries during the study period.

Specifically, estimates from both the co-integration test and Toda and Yamamoto causality seem to suggest a positive and declining effect of economic growth on socio-economic sustainability in Brazil, India, and South Africa, whereas negative and insignificant influences observed in Russia and China.

Similar to previous studies (Younsi & Bechtini, 2018; Spangenberg, 2004), the estimates of the study showed a cointegrated relationship and also that socio-economic sustainability and economic growth move in parallel in the models of Brazil, India and South Africa in the long-run. Also, due to the strong unidirectional causal relationships between economic growth and socio-economic sustainability in South Africa, many studies posit that poor institutional fitness, education, financial development, and energy consumption may have altered the influence of economic growth in the country over the years (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017). The unidirectional causality between economic growth and socio-economic sustainability in South Africa differs from previous studies on BRICS countries (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017). Specifically, Younsi and Bechtini's (2018) study assessed the relationships between economic growth and socio-economic inequality in BRICS countries using annual panel data covering the period 1995-2015. The study also confirmed a long-run cointegration relationship between economic growth and income inequality in the BRICS countries. While estimates from fixed effects results posit the positive and significant influence of economic growth on income inequality, the coefficient of its squared term depicts a significant negative effect, similar to what the present study observed in Brazil, India, and South Africa estimates. However, unlike our estimates from South Africa's models, there was no reversed causal relationship between income inequality and economic growth in Younsi and Bechtini's (2018) study. Younsi and Bechtini's (2018) study, therefore, recommended mixed policy options aimed at reducing inequality in BRICS bloc through improvements in taxation and financial system policies (Younsi and Bechtini, 2018; Menon, 2017).

The present study also observed an insignificant influence of economic growth on socio-economic sustainability in the Russian and Chinese models. These estimated results, therefore, depict tacit support for the Kuznets hypothesis. Kuznets hypothesis posits for an increase in income disparities arising from the first phase of economic growth, while the same economic growth in a later phase, given redistribution mechanisms, tends to contribute to the attainment of an egalitarian pattern of income distribution in a welfare state (Alzoubi et al., 2020; Omer, 2008; Spangenberg, 2004). Surprisingly, this result is somewhat different from previous results in the BRICS region (Younsi and Bechtini, 2018; Menon, 2017; Javeria et al., 2017; Jamel & Maktouf, 2017). While emphasising the role of economic growth on socio-economic redistribution in many developing economies, Menon's (2017) study established negative trends in the estimates for South Africa but differed based on our improved estimates for Russia and China. Consequently, South Africa should concentrate on enacting policies to reduce inflation via proper monitoring of monetary control and domestic products (Menon, 2017).

Robustness checks

Firstly, we conducted a spatial robustness test by dividing the five BRICS countries to two sub-samples of three (sub-sample 1: Brazil, India and South Africa) and two (sub-sample 2:

Russia and China) countries each, based on the pace of industrial development as affirmed by previous studies (Bindi, 2018; Nkoro & Uko, 2016). We then re-estimated our ARDL and F bounds test (Wald Test) for socioeconomic sustainability and economic growth. The results are shown in Appendix 2D1. Based on a comparative analysis of estimates from the F bounds test (Wald test) (Appendix 2C2) and the one illustrated in Appendix 2D1 (the two sub-samples), there are negligible differences (Bindi, 2018; Westerlund, 2007). Specifically, in the F bounds test (Wald test) estimates (Appendix 2D1), all the variables' signs are still the same in both the first and second sub-sample estimates. Consequently, similarities in the magnitudes and variables' signs (significant at 1 and 5 percent levels) are a perfect attestation to the robustness of our main findings (Nkoro & Uko, 2016; Westerlund, 2007). In short, similar to our main findings, estimates of the robustness checks also posits that the parameter of economic growth is smaller than one and positive in the estimates of Brazil, India, and South Africa, the same parameter is also smaller than one but negative in the estimates of Russia and China. This depicts the severity of economic growth to increase socioeconomic growth in Brazil, India, and South Africa during the study period. Most importantly, the results of the F bound test (Appendix 2C1) show the insignificant influence of economic growth on socio-economic sustainability in Russia (11.33) and China (12.22).

Our second robustness check was to consider the inclusion of additional variables, such as Institutional fitness (INST), Total government expenditure on Health (HEALTH), Total Trade (TO) (% of GDP), CO2 emissions ($C0_2$)(in metric tons per capita), Energy consumption (EC) (in kilotons), Financial Development (FIN), exchange rate volatility (EXR) and inflation risk (INF), and then re-estimated Equation 2.3. Based on a comparative analysis of our new estimated ARDL (Appendix 2C3) and the initial ARDL estimates (table 2.1), there are negligible differences in magnitude and variables' signs of GDP in all the BRICS countries (Javeria et al., 2017). In short, the results of our re-estimated ARDL models are concordant with the main finding of this study, which simply posits that the long-run equilibrium relationships between economic growth and socio-economic sustainability in the BRICS countries vary from one country to another, but were largely insignificant in the models of Russia and China during the study period.

Secondly, similar to a methodology by Blundell and Bond (1998) and Arellano and Bond (1991), we estimated our GMM and pooled ordinary least square (POLS) (Akinola & Bokana, 2017; Menon, 2017; Blundell and Bond, 1998; Arellano and Bond, 1991). A typical result for Brazil is depicted in Appendix 2D2. We selected two specific diagnostic tests, Hansen test, and second-order autocorrelation AR (2) test, to test for any probable over-identifying restrictions and serial correlations of the error terms, respectively. Estimates of the GMM and POLS largely attested to the robustness of our main preferred results in all the BRICS countries due to the unchanged signs and level of significance. Again, the results of both the GMM and POLS in the new samples (with additional regressors) are similar to the main finding of this study, which concluded that the long-run equilibrium relationships between economic growth and socio-economic sustainability in the BRICS countries vary from one country to another, but were largely insignificant in the models of Russia and China during the study period. Specifically, in our GMM results, the Hansen test for over-identification indicates the acceptance of the null hypothesis, while the AR (2) test estimate also indicates the presence of a second-order serial correlation in our mode (Menon, 2017). Hence, a validation of our instruments and seemly uncorrelated with the error term (Akinola & Bokana, 2017). It is also a perfect attestation to the robustness of our main findings (Hickel & Kallis, 2020; Nkoro & Uko, 2016).

Conclusion, policy Implication and Recommendations

Conclusion

This paper examined the influence of economic growth on socio-economic sustainability within the BRICS countries from 1990 to 2017. The paper utilizes Pesaran et al. (2001) cointegration as well as the Granger no-causality methodology developed by Toda and Yamamoto (1995) as estimation techniques. Our results confirmed the existence of co-integrating vectors in all the models of all the selected BRICS countries. Specifically, estimates from all the BRICS countries exhibit long-run equilibrium relationship with each other, however, while the models of Brazil, India and South Africa did the adjustment in the short-run via one established channels, variables in the models of Russia and China exhibit the same adjustment via three identified channels. However, since the presence of cointegrating vectors in any system merely assumed the existence and/or nonexistence of causality, this, however, often failed to specify the route of causality among the systems (Hickel & Kallis, 2020). Consequently, the direction of causality was therefore established via Toda–Yamamoto causality analysis. The outcome of the estimated causality test detected both unidirectionally and bidirectionally causal effects in the short-run for all the variables. Our study, therefore, concluded that the long-run equilibrium relationships between economic growth and socio-economic sustainability in the BRICS countries vary from one country to another, but were largely insignificant in the models of Russia and China during the study period. Also, the present study found that a common policy option may not be beneficial and that for the block to pursue its economic prosperity goals without compromising individual countries' needs for socio-economic sustainability, varied policy options were inevitable.

Furthermore, the insignificant influence of economic growth on socio-economic sustainability in the estimates from Russian and Chinese models could be seen as tacit support for the Kuznets hypothesis. The Kuznets hypothesis simply posits for an increase in income disparities arising from the first phase of economic growth, while the same economic growth in a later phase, given redistribution mechanisms, tends to contribute to the attainment of an egalitarian pattern of the income distribution (Fan & Zheng, 2013; Omer, 2008; Spangenberg, 2004). Lastly, our study also observed a unidirectional causality between economic growth and socio-economic sustainability in South Africa. This interesting result, however, differs from previous studies in the same bloc (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017).

Policy Implication and recommendations

General Implication and recommendations

To improve socio-economic sustainability and also to positively improve economic growth in the BRIC countries, effort should be geared towards the promotion of enhanced social programmes, integration of existing policies, and creation of societal culture. This is based on the notion that an increase in economic growth by 1% will bring about an increase in socio-economic sustainability rates by 0.20% in Brazil, by 0.03% in Russia, by 0.19% in India, by 0.03% in China, and by 0.21% in South Africa. Subsequently, this instability is corrected every year between long and short-run socio-economic sustainability rates by 0.017% for Brazil, by 0.023% for Russia, by 0.019% for India, by 0.017% for China and by 0.022% for South Africa. This implies that fiscal policies in the BRICS countries could be aimed at improving socio-economic sustainability through short term inequality rates, which are often affected by expected growth rates (Younsi and Bechtini, 2018; Maktouf, 2017).

Additionally, based on the output of our findings, if economic growth is likely to decline socio-economic sustainability in the BRICS countries, then various policies to improve socio-economic sustainability could become necessary. Specifically, efforts should be made to improve the main causes of inequalities, like energy usage, institutional fitness, and financial development in the Bloc. Strategic adoption of a focused liberalization and financial openness policies to attract higher R&D-related foreign direct investment that is capable of reducing the increasing socio-economic inequality in BRICS countries is a necessity. It is through establishing the balance among socio-economic sustainability, financial development, and economic growth that sustainable and equitable growth can be achieved by all BRICS countries (Menon, 2017). Lastly, general policies should focus more on radical law reforms and the creation of independent organisations to assist poor people; population growth control, speedy poverty alleviation and basic education; market development. Overall, the impact of the aforementioned recommendations will be beneficial to policymakers in all the BRICS countries not only in estimating the achievement of many BRICS goals but also will serve as a "double-edged" tool for monitoring the BRICS' progress towards the attainment of the United Nations SDGs by the year 2030 (World Bank Group, 2018 Agrawal, 2015; Awan, 2013).

Policy Implication and recommendations for Brazil, India and South Africa

Our findings have shown that socio-economic sustainability has not been adequately supported, while there are variations in the impact of economic growth on socio-economic sustainability within the BRICS bloc. Consequently, this study posits a more radical policy mix to reduce the negative impact of economic growth on socio-economic sustainability, especially in the three most affected countries (namely Brazil, India, and South Africa).

Improving socio-economic sustainability in Brazil, India, and South Africa can be achieved through radical legal basis for the transition from natural resource export, as well as sweeping regulation for the sustainable usage of natural resources protection, strict penalties on violations of environment-related laws and general country-wide support in the three countries. Also, there may be an urgent need to define the active role of NGOs and other independent institutions in improving socio-economic sustainability at both local and national levels.

Specifically, in South Africa, adequate Corporate Social Responsibility (CSR) guidelines should be implemented as a veritable way of encouraging corporations to monitor their contributions to socio-economic sustainability at both local and national levels. Special enforcement mechanisms, such as "Green Scorpions," should be adequately empowered by the coordinating ministry (Ministry of Environment and Tourism) to step-up their monitoring, assessment, and enforcement roles. There is also a need to have a national standard for reporting CSR by corporations and civil society organisations (CSOs).

Also, the declining trends in socio-economic sustainability in Brazil, India, and South Africa require a radical policy mix on population growth control, inclusive and basic education for all citizens, as well as swift poverty alleviation programmes. There is an urgent need for improved transparency and participation of media organisations in this regard. The establishment and promotion of nationwide social standard and corporate social responsibility guidelines will also go a long way in improving the increasing level of socioeconomic sustainability in the three countries. Specifically, the three countries should prioritise the radical provision of social security and services to assist the poor. Specifically, in South Africa, this could be achieved via an improved implementation of the present accelerated growth strategy to encourage public redistribution of resources and investment in critical infrastructures. On education, content-related coordination for education policy should be encouraged by designing programmes that are capable of integrating learning methods and materials on socioeconomic sustainability into an agreed percentage of all classroom curricula in all post-secondary schools in the three countries.

This study acknowledges the fact that economic growth alone cannot solve the declining socio-economic sustainability in Brazil, India, and South Africa. Hence, radical strategic policies should be formulated to demand better social standards from multinational companies operating in these countries. Specifically, to reduce income inequalities in Brazil, national government policies must shift from the present dominance of the "industrialist paradigm," which tends to prioritise mainly the economic dimension of sustainability. There is also an urgent need to invigorate the present income transfer programme, as well as transparent land reform, to increase the present level of disposable income needed by the poor and disadvantaged citizens in Brazil. Similar to the successful regional policies in Russia, Brazil may need to focus more on the creation of protected areas, indigenous people's settlements, as well as special economic zones.

In India, there is a need for an objective and transparent poverty alleviation programme to improve the declining socio-economic sustainability during the study period. Unfortunately, due to the limited capacity of the government to mobilise resources needed to accelerate the level of development, there is an urgent need to increase the level of cooperation with the organised private sector via Public-Private Partnerships initiatives. To assist the poor and improve the declining socio-economic sustainability in Brazil, India, and South Africa, there is an urgent need to reinvigorate reconstruction and development programmes. For example, to improve the declining level of socio-economic sustainability in South Africa, the Reconstruction and Development Programme (RDP) should be reinvigorated based on a long term framework that is efficient and coherent in addressing targeted socio-economic sustainability issues. There is also a need to prioritize the concept of nation-building, basic human needs, peace and security, and people-driven growth processes in many Reconstruction and Development Programme (RDP) initiatives. Furthermore, to improve the declining level of socio-economic sustainability in Brazil, India, and South Africa countries, the government will have to create a societal culture that is favourable to socioeconomic sustainability in each country. However, to achieve this noble objective, the government institution must work harmoniously with both civil society and business sectors. The creation of a societal culture that is favourable to socio-economic sustainability can also be created through local level's promotion of best practices, increase in consumers' demand for sustainable clean services and products, transparent corporate reporting, as well as, required political will on the part of the government to provide the necessary funding, institutional support, and other incentives.

Policy Implication and recommendations for Russia and China

Despite the giant stride recorded by China and Russia in improving socio-economic sustainability over the study period, this study is unmindful of the necessity to improve the current challenges in the area of unemployment, uneven distribution of political and financial power, as well as, regional disparities, especially in China. The present study is, therefore, of the opinion that it is only through even development strategies and viable interactions between the private sector, general public, and government that can engender the formulation of transparent and equitable policies needed for the much desired sustainable economic growth in the BRICS bloc. On the social dimension, the more advanced group in the bloc (China and Russia) could also emulate Germany's "greying society" strategy of decoupling economic growth from socio-economic sustainability and environmental pollution due to the probable increase in average age and decrease in size. Also, China and Russia should move further by integrating socio-economic inequality interventions into their export/ trade policies. Most importantly, BRICS countries must understand that economic growth might not necessarily result in socio-economic sustainability; rather, it may lead to an unprecedented decline in socio-economic sustainability, financial, institutional, and market risks (Younsi & Bechtini, 2018; Javeria et al., 2017).

Managerial and Theoretical Contributions/ Implications

By investigating the short and long-run equilibrium relationships, as well as, the direction of Granger causality among socio-economic sustainability and economic growth variables have both managerial/ societal and theoretical implications/ contributions. First, the study provides a tool to understand the imperative of improving socio-economic sustainability in the BRICS countries and the achievement of its goals (Sesay et al. 2018; Agrawal, 2015; Awan, 2013). In line with a recent gap positioned in the literature and also to aid socio-economic sustainability and economic growth policy options, the main essence of establishing the relationships between socio-economic sustainability objectives and economic growth in the BRICS countries is to derive socio-economic criteria for economic growth to be sustainable (Hofkes, 2017; Hamilton, 2015; Fan & Zheng, 2013; Spangenberg, 2004). Consequently, to the best of the researcher's knowledge, no study has investigated the sustainability of growth policy options comprehensibly within BRICS to propose socio-economic sustainability and growth policy options.

Moreover, due to the strategic importance of BRICS countries in enhancing global economic growth and improving socio-economic sustainability, the paucity of studies on a trending issue, like the nexus between economic growth and socio-economic sustainability, in the bloc has been described as a major concern in the literature (Younsi & Bechtini, 2018). Consequently, the present study has been able to provide new empirical evidence concerning the aforementioned relationships. Additionally, in a deviation from previous studies that used singular measure of socio-economic sustainability, part of the novelty of this paper was the development of an aggregated composite index of socio-economic sustainability from several socio-economic sustainability variables that have been used in the literature.

Constructing the index comprising variables depicting various dimensions of socio-economic sustainability was crucial as a single index might not give a strong measure of socio-economic sustainability in the bloc, as well as its capacity to correct past contradictory results in the literature (Javeria et al., 2017). To the best of the researcher's knowledge, there has not been any study using an index while investigating socio-economic sustainability in the BRICS bloc. Also, many empirical works on socio-economic sustainability-economic growth nexus are often seen as confusing and contradictory, probably due to the use of singular measure and estimation method (Zha et al., 2019; Hofkes, 2017; Hamilton, 2015; Fan & Zheng, 2013; Spangenberg, 2010). Consequently, this study provides novel cross-validation of estimation techniques and robustness checks in response to many gaps in literature (Zha et al., 2019; Hofkes, 2017).

Limitations and Suggestions for Further Studies

The first limitation, akin to most empirical studies on socio-economic sustainability-economic growth relationships using cross-country data from many developing countries, is the probable presence of periods and country-specific omitted variables (Azevedo et al., 2018; Menon, 2017). This is usually due to poor data collection by relevant government agencies (World Bank Group, 2018; Pereira et al., 2018). Secondly, another "inevitable" flaw in many regression results are the constructs/specifications used to measure our variables, as well as endogeneity concerns (Anyanwu, 2012; Hailu, 2010). This is based on the premise that most of the explanatory variables may probably be jointly endogenous with socio-economic sustainability (Agrawal, 2015). This may lead to biases from simultaneous or reverse causation, since each of the socio-economic sustainability determinants may cause higher inequalities as opposed to the opposite (Younsi & Bechtini, 2018). However, the adopted estimation techniques in the present study are a deliberate attempt to address any potential endogeneity (El-Wassal, 2012). Lastly, it is also important to know that short-run changes in socio-economic sustainability often require fiscal policy changes. However, future studies must emphasise that long-run socio-economic sustainability should also support other important basic determinants (such as financial and health development, institutions, natural resource endowment) apart from economic growth.

CHAPTER 4

ECONOMIC GROWTH AND INSTITUTIONAL SUSTAINABILITY NEXUS WITHIN THE BRICS COUNTRIES: RELATIONSHIPS AND POLICY OPTIONS

4.1 Declaration

The work in this paper is my original work, as the Ph.D. candidate - Mr. Awolusi Olawumi Dele. Professor Josue Mbonigaba, in serving as a supervisor, has contributed in terms of his supervisory role by providing overall guidance to the coherence of this body of work. His contributions have been advisory. I did the writing of the paper in its entirety. In submitting this paper for consideration for publication, I (Mr. Awolusi Olawumi Dele), as the Ph.D. candidate, was the primary and corresponding author.

4.2 Contribution of the Paper to Literature

This study analyses the effect of economic growth on institutional sustainability within the BRICS countries using a panel dataset from 1990 to 2017. The main focus of paper 2 was on deriving policy options that would emanate from the linkage between economic growth and institutional sustainability. After testing for panel Unit Root, the study estimates via the system-Generalised Method of Moments (GMM) were, however, supported by the Hausman specification test. Again, to check for probable cross-sectional dependence errors, as well as the capacity to generalise our panel results, the study conducted a cross-sectional dependence test and a Panel Data Co-integration Analysis, via PEDRONI'S Panel co-integration test on the panel data set of the BRICS bloc. The results confirm that economic growth and institutional fitness are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships. Consequently, findings suggest that the influence of economic growth on institutional fitness within the BRICS countries, though significant, was limited and varied. The study, therefore, cautioned on the capacity of economic growth to diminish institutional fitness in Brazil, India, and South Africa countries. Our results are robust to all the robustness checks, including temporal and spatial changes.

One major contribution of this study was the provision of institutional sustainability indexes that are robust to small sample size bias, as well as probable cross-sectional dependence (Younsi

& Bechtini, 2018). To the best of the researcher's knowledge, there seems not to be any study that has investigated these issues comprehensibly in sustainable development literature. Moreover, using different estimation techniques is another way of controlling for the likely homogeneity or heterogeneity that may exist between the BRICS countries (Menon, 2017; Gur, 2015). Many previous empirical studies often assume homogeneous intercepts and slopes of countries with the same economic characteristics (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; Menon, 2017; Gur, 2015).

Again, in line with a recent gap positioned in literature and also to aid sustainability and growth policy options, the main essence of establishing the relationships between institutional sustainability objectives and economic growth in the BRICS countries was to derive institutional criteria for economic growth to be sustainable (Hofkes, 2017; Hamilton, 2015; Fan & Zheng, 2013; Spangenberg, 2004). Consequently, to the best of the researcher's knowledge, no study has investigated comprehensibly the institutional sustainability of growth policy options within BRICS to propose sustainability and growth policy options and building evidence by establishing these relationships.

Again, in a deviation from previous studies that used a singular measure of institutional fitness, part of the main contributions of this paper was the development of an aggregated composite index of institutional fitness based on the dictates of institutional economics. Specifically, the present study looked at risk assessment factors of all the BRICS countries over time, as identified by the Euromoney Country Risk Survey, Corruption Perception Index-CPI, World Bank decomposed governance indices, as well as the top three global rating agencies (Moody's Investors Service, Standard & Poor's Financial Services LLC (S&P) and Fitch Ratings Inc.)

Another important contribution of the study was the validation of the institutional fitness theory; a gap raised in previous literature is the role of economic growth in achieving institutional fitness (sustainability) in vast developing economies, like BRICS (Sesay et al., 2018; Ogasawara, 2018; Anyanwu and Yameogo, 2015). This is based on the premise that both the imperfect and perfect markets still find it difficult to adequately explain or predict the influence of economic growth on institutional developments in many developing countries (Sesay et al., 2018; Ogasawara, 2018; Wilhelms, 1998). The adoption of institutional fitness theory, in this study, is a veritable means of accounting for the array of heterogeneous variables that are usually involved in the economic growth process, by giving more significance to institutions (Meso level), over both the entire economy (macro-variables) and firms (micro-variables) (Ogasawara, 2018; Wilhelms, 1998).

4.3 Paper as submitted to the *African Journal of Economic and Management Studies*

ABSTRACT

After three decades of economic growth, inefficient and poor institutional development is still a major problem in the BRICS (Brazil, Russia, India, China, and South Africa) countries. This is a threat to the attainment of institutional sustainability in the BRICS bloc. However, understanding the knowledge of how economic growth would affect the institutional sustainability of individual countries is important in solving this problem. This study analyses the effect of economic growth on institutional sustainability within the BRICS countries using a panel dataset from 1990 to 2017. After testing for panel Unit Root, the study estimates via the Hausman specification test was supported by the system-Generalised Method of Moments (GMM). The study conducted a cross-sectional dependence test and a Panel Data Co-integration Analysis, via PEDRONI'S Panel co-integration test. Our results are robust to all the robustness checks, including temporal and spatial changes. The results confirm that economic growth and institutional fitness are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships. Consequently, findings suggest that the influence of economic growth on institutional fitness within the BRICS countries, though significant, was limited and varied. Specifically, evidence from our study cautioned on the capacity of economic growth to diminish institutional fitness in Brazil, India, and South Africa; consequently, this study posits for a more radical policy mix to enhance institutional sustainability in the three (Brazil, India and South Africa) countries. The recommended policy mix include superior growth induced domestic investment and financial developments, via radical interaction between the marketplace and extractive communities or regular contact between credit institutions and producers, to promote FDI that will increase the value of traditional knowledge, technology, capacity building, social organization, aggregation of value, collection and quality of life. Also, radical institutional development (fitness) could be enhanced in the three countries (Brazil, India, and South Africa) by strengthening the role of non-governmental organisations (NGOs). Contrary to previous studies, the novelty of this study is partly the construction of institutional fitness indexes that are robust to cross-sectional dependence and small sample bias.

Introduction

Although sustainable economic growth is anchored on the integration of the three dimensions of sustainability, namely, socio-economic, institutional, and environmental, this paper focuses on one dimension, institutional sustainability in BRICS (Hickel & Kallis, 2020; Younsi & Bechtini, 2018). This focus responds to the literature requesting for a critical analysis of the nexus between economic growth and institutional developments in many developing and emerging countries due to the probable diverse nature of institutional and economic characteristics when compared with developed countries (Ogasawara, 2018; Pelinescu, 2015; Fosu, 2018; Adelakun, 2011; Aregbesola, 2014). Again, the importance of sustainable economic growth is also accorded considerable preference in the vision 2030 SDGs of the United Nations (Eggoh, Houeninvo & Sossou, 2015). After three decades of economic growth, inefficient and poor institutional development in BRICS (Brazil, Russia, India, China, and South Africa) has been documented as a major problem given the diverse nature of institutional and economic characteristics in this group of countries (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015). Therefore, the understanding of how economic growth would affect the institutional sustainability of individual countries is important in solving this problem (Menon, 2017; Gur, 2015).

BRIC is an abbreviation that was coined in 2001 by Jim O'Neill (Goldman Sachs analyst) to represent a group of five countries, namely Brazil, Russia, India, and China. These countries were deemed to be at a comparable phase of of development (Goldman Sachs, 2001). The group was later expanded to include South Africa and is now referred to as BRICS (UNDP, 2014). BRICS countries occupy over 25 percent of the livable surface of the earth altogether, with about 40 percent of the total world's population (Mikulewicz & Taylor, 2020; World Bank Group, 2018). The collaboration of BRICS is aimed at achieving infrastructural development, sustainable economic growth, increased consumption, and international trade (Agrawal, 2015; Awan, 2013; Menon, 2017). ,

The BRICS countries had a combined nominal Gross Domestic Product (GDP) of US$ 16.039 trillion as at 2016; this is comparable to about 20% of the total gross world product (ISSA, 2017; Tsaurai, 2017; Behera & Mishra, 2016; Santana, Rebelatto, Périco & Mariano, 2014). Specifically, ,BRICS are all newly industrialised and developing countries that have demonstrated to be one of the most captivating economic groups established to achieve some stated goals, chiefly, sustainable economic growth of member countries (Sesay, Yulin, & Wang, 2018; Tsaurai, 2017).

However, to achieve sustainable economic growth in the BRICS countries, efforts must be geared toward making legitimate social progress and economic growth, as well as, improving environmental protection (Sesay et al. 2018; World Bank Group, 2018). Likewise, for sustainable economic growth to be beneficial, it must be inclusive and capable of protecting the most vulnerable and poorest, as well as, protecting the natural endowments; strengthen institutions and governance (Menon, 2017; Agarwal & Khan, 2011; Gur, 2015; UNCSD, 2012). Again, since a complete theory of economic growth is expected to integrate the three strands of economic change (stock of human knowledge, quantity and quality of human capital, and institutional fitness), many studies have advocated for the development of an aggregated composite index of institutional fitness based on the dictates of institutional economics, by looking at risk assessment factors of countries over time (Zha et al., 2019; Cuthill, 2010; Franck-Dominique, 2008).

Problem Statement

Diversity in institutional characteristics in BRICS countries might arise in a conflict of interest in adopting common economic growth policy as economic growth in this bloc arising from common policies might lead to different adverse effects on individual countries (World Bank Group, 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014).

Specifically, inefficient and poor institutional development has been documented as a major problem in the BRICS countries, given the diverse nature of institutional and economic characteristics in the group (Menon, 2017; Agrawal, 2015). This is a threat to the attainment of the overall goal of sustainable economic growth for members (Similar to Goal 7 of United Nations SDGs), as well as, other specific goals, like institutional development and trade promotion among the BRICS countries (Similar to Goals 4 and 7 of the United Nations' SDGs) (Sesay et al., 2018; ISSA, 2017).

BRICS countries are largely different in terms of institutional supports and development (Mosteanu, 2019; UNCSD, 2012). While some BRICS countries are ignorant of democracy, others have embraced it (Behera & Mishra, 2016). While China and Russia are permanent members of the United Nations Security Council, others are not (Sesay et al., 2018; Behera & Mishra, 2016).

Supporting this problem, many recent studies (Alzoubi et al., 2020; Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) also attributed the present threats to sustainable economic growth in the BRICS countries to poor and inefficient government institutions to support the growth process. Specifically, Javeria et al. (2017) and Agrawal (2015) assert that sustainable economic growth and development in the BRICS countries might be a mirage without a proper nexus between economic growth and government institutional/governance variables like regulatory quality, the rule of law, control of corruption and political stability. Consequently, many of the studies opined that more future research should focus on understanding the nexus between economic growth and institutional/ governance variables (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015).

The poor level of institutional development in India also prompted many scholars to reinforce the urgent need for the Indian government to reinforce the effectiveness of public institutions and governance to combat widespread corruption (Menon, 2017; Agrawal, 2015; Gur, 2015). Also, ease of doing business is declining in all BRICS countries, mainly due to poor institutional development (Błazejowski et al., 2019; Mosteanu, 2019).

Apart from Russia (placed number 35), other BRICS countries were ranked outside the top 70 in the Doing Business 2018 ranking (Azevedo et al., 2018; World Bank Group, 2018; Menon, 2017**).** Therefore, there is an urgent need to prioritise institutional development strategies aimed at achieving sustainable economic growth in BRICS countries (Aregbesola, 2014; Adelakun, 2011).

Fortunately, the above problem would not arise if there is knowledge of how economic growth would affect institutional sustainability in the BRICS bloc vis-à-vis individual countries. Consequently, this study is aimed at assessing the relationships between institutional fitness and economic growth as a precondition for economic growth to be sustainable in the BRICS countries (Younsi & Bechtini, 2018; Spangenberg, 2004). Accordingly, this study's main focus was on achieving sustainable economic growth in all BRICS countries, in their quest toward achieving some self-determined goals, similar to the year 2030 Sustainable Development Goals (SDGs) of the United Nations (United Nations, 2013; UNCSD, 2012).

Also, assessing the relationships between economic growth and institutional fitness has been described as an absolute precondition to deriving various institutional fitness criteria for economic growth to be sustainable in the BRICS countries (Younsi & Bechtini, 2018; Spangenberg, 2004). Besides, previous studies have also demonstrated the possibility and need to reconcile institutional fitness and economic growth to aid policy formulation, hence, based on the sustainability scenarios' core action zones for policymaking (Javeria et al., 2017; Agrawal, 2015; Spangenberg, 2004). These will naturally serve as yardsticks for assessing the impact of key policy proposals at an early stage (Javeria et al., 2017; Agrawal, 2015; Spangenberg, 2004).

Sustainable economic growth is therefore conceptualised based on the United Nations description of sustainable development, as a growth that is capable of meeting the present needs without jeopardising the needs of future generations (Sesay et al., 2018; ISSA, 2017; Hochestler, 2014; United Nations, 2013; UNCSD, 2012).

Results from this study will be beneficial to all the BRICS countries, as well as many developing countries in the formulation of their institutional and growth policies. It will also help policy-makers, practitioners, and scholars in developing an objective framework for investigating the interplay between economic growth and institutional fitness within the BRICS bloc (Anyanwu and Yameogo, 2015; Wilhelms, 1998).

Moreover, a cross-national comparison of all BRICS countries given institutions/ governance also reveals that primary products and manufacturing induced economic growth alone cannot advance sustainable development (World Bank Group, 2018). Consequently, there is an increasing need for key policy reforms in institution /governance structures (Pereira, Ferraz, Araujo & Machado-Taylor, 2018; Gur, 2015).

A recent World Bank Group's (2018) global economic prospects also positioned functioning education and health systems, stable and competent institutions, and a dependable judicial and social system as the required panacea toward achieving stable and sustainable growth in all BRICS countries. Given the above, the formation and implementation of reforms and policies in curbing this declining trend have been growing concerns to policymakers (Azevedo, Sartori & Campos, 2018; Agrawal, 2015; Carnoy, Loyalka, Androushchak & Proudnikova, 2012).

Moreover, a coordinated policy-making is important in directing all BRICS countries towards sustainable economic growth. Section two of this paper is the literature review; section three details the adopted methodology; section four includes the analysis of the various data collected and results and discussion of findings, while section five presents the conclusion and implications of the study.

Review of Related Literature

Any meaningful research that contributes to knowledge should be supported by a conceptual/ theoretical framework. Bryman (2012) maintains that theory forms the backcloth and justification for the research being carried out. This means that theory forms the framework on which a research problem can be understood, and the research findings can be interpreted.

Conceptual Framework

A conceptual framework is an argumentative concept that is deliberately adopted for investigating expected relationships between variables based on existing models and theories (Hamilton, 2015; Carnoy et al., 2012). However, much of the existing literature does not agree on the conceptual framework and constructs that should be used to explain the relationships between institutional fitness (sustainability) and economic growth (Ogasawara, 2018; Menon, 2017). That notwithstanding, the conceptual framework for this study is based on the nexus between institutional sustainability and economic growth in the BRICS countries (Menon, 2017; Agarwal & Khan, 2011).

By "sustainability," the study implies putting scientific, technical, economic, social, and ecological resources to ensure the maintenance of equilibrium state for some giving space and time (Younsi & Bechtini, 2018; Spangenberg, 2004). Hence, “institutional sustainability” is defined as maintaining a stable level of institutional functioning, civil society empowerment, gender equity, knowledge formation and accountability (known as core institutional objectives), as well as, steady inter-linkages between institutions, socio-economic and environmental developments for some time and in space (Tekabe, 2018; Spangenberg, 2004). Unfortunately, there is no generally acceptable measures/ indicators of institutions, that notwithstanding, notable measures of institutions are the Corruption Perception Index (CPI), Country Policy and Institutional Assessment (CPIA) and the World Bank decomposed governance indices (Menon, 2017; Agarwal & Khan, 2011).

Specifically, the World Bank decomposed governance indices are made up of six variables, namely, the rule of law, political stability, voice and accountability, control of corruption, government effectiveness, and regulatory quality. This is one of the most commonly used indicators of institutional development in literature because of its careful construction and relative acceptability (Menon, 2017; Agrawal, 2015; Agarwal & Khan, 2011). The indices range between -2.5 (weakest institutional development) to 2.5 (strongest institutional development). Also, four institutions Fitness variables, based on a study by Wilhelms (1998), are education, government, markets, and socio-culture (Ogasawara, 2018; Pelinescu, 2015; Wilhelms, 1998).

The extent of a country's receptivity to diverse socio-cultural and business modes will largely depend on its citizenry's exposure to foreign cultures, educational attainment, and global integration (De-Mello, 1997). Likewise, educational fitness contrives an environment conducive for technology and innovation, information processing, research, and development (Pelinescu, 2015; Wilhelms, 1998). Markets, as the economic and financial indicators of institutional fitness, postulates that any open and competitive markets with protective regulations tend to draw more economic growth than markets exposed to directive government regulations (Pelinescu, 2015; Wilhelms, 1998). Government, as the last form of institutions, signifies the significant task of political capital (Alzoubi et al., 2020). It is widely believed that government openness to institutional capacity enhancement will engender more prosperity and sustainable growth (Aregbesola, 2014; Ahmad & Schroeder, 2003).

However, in a deviation from developed to developing economies by focusing on the role of institutions, this study is rooted in the work of Douglass North (1920–2015). This is a deviation from the usual focus of the 'New Institutional Economics (NIE)' (North, 2005). Moreover, Wilhelms (1998) also observed that while the dependency school embraces the structuralist and neo-Marxist theories, on the other hand, the modernisation school is rooted in both imperfect and perfect market methods. Thus, this study is entrenched in the integrative school, as advanced through the institution fitness theory.

Consequently, to investigate a comparative analysis of the relationship between institutional variables and economic growth in the BRICS countries, based on the dictates of institutional economics, this study developed and adopted its composite index of institutional fitness, by looking at risk assessment factors of countries over time, as identified by the top three global rating agencies: Fitch Ratings Inc., Standard & Poor's Financial Services LLC (S&P) and Moody's Investors Service, as well as, Euromoney country risk survey, World Bank decomposed governance indices and the Corruption Perception Index (CPI). This is based on the premise that countries with greater risks are less fit, more prone to 'sickness,' and hence can experience low economic growth. The various risk assessment could be linked to the four levels of rules defined by the 'new' institutional economist: embeddedness (social theory), institutional environment (economies of property right / positive political theory), governance (transaction cost economics), and resource allocation and employment (neoclassical economics/ agency theory) (Hayek, 1973; North, 2005). Our conceptualisation of institutional fitness is therefore justified since many powerful analytical tools of economic growth are well suited for studying static situations; however, only static and mechanistic analysis is not adequate to understand the ever-changing environmental challenges looming ahead (Ostrom and Basurto, 2011). Ostrom and Basurto (2011) also observe that any attempt to understand the evolutionary process of economic growth and the role of institutional development should analyse the institutional change in any quest for sustainable economic growth in the BRICS countries (Ogasawara, 2018). This is based on the premise that economic growth often reacts differently to the absence or presence of different institutions (Zha et al., 2019; Ostrom and Basurto, 2011).

Theoretical Framework and Institutional Sustainability Model Development

Institutional "sustainability" and "economic growth" analysis usually involves solving complex diagnostic problems, owing to its focus on long-run processes, that notwithstanding, a mix of varied institutional sustainability theories and models can help in addressing these complexities over time (Menon, 2017). Hence, from the modelling perspective, the adopted models for the present study fall within weak sustainability and ecological stability and resilience (Younsi & Bechtini, 2018; Bilgili et al., 2016; Spangenberg, 2004). This is based on the premise that models based on weak sustainability often permit substitution between man-made and natural capital, with emphasis on equal opportunities for future and present generations (Hediger, 2000). Again, since a single theoretical standpoint cannot satisfactorily elucidate the effect of economic growth on institutional sustainability dimension, this study is anchored on institutional fitness and human capital theories (Pistorius, 2004; Wilhelms, 1998). According to Aregbesola (2014), individual's decisions on training and education are usually based on the desire to improve their productivity in the workplace. Consequently, the human capital theory suggests an improvement in the rate of adoption and implementation of new technologies by any organisation due to the level of the skilled and educated workforce if the desired sustainable economic growth is to be achieved (Mosteanu, 2019; Adelakun, 2011).

In addition to recognising employee experience, skills, and knowledge as important assets with the potential to generate economic rent, the human capital theory also assesses human resources through gains in productivity (Ahmad & Schroeder, 2003). Again, while drawing on a behavioural psychology-perspective, Ahmad and Schroeder (2003) also emphasised the strategic facet of human capital practices and the consequential increase in competitive advantage in many developing nations. Consequently, the four human capital indices suggested by Pelinescu (2015) are likely to improve such unique characteristics in human capital development and competitive advantage within the BRICS countries.

Institutional Fitness Theory and Empirical Review

The imperfect market approach, like the internalisation theory, the theory of the firm, and industrial organisation theory posits that growth-induced institutional development and FDI usually occur in oligopolies (Agarwal and Khan, 2011; Ozturk, 2007). Nonetheless, many studies observe that both the imperfect and perfect markets still cannot adequately explain the improvement in economic growth (Ogasawara, 2018; Hofkes, 2017). Thus, Wilhelms (1998) positioned the integrative school as the only solution. Hence, the institutional fitness theory, as suggested by Wilhelms (1998), could form an important part of estimating the influence of economic growth on institutional sustainability within the BRICS countries.

Wilhelms (1998) also observed that while the dependency school embraces the structuralist and neo-Marxist theories, on the other hand, the modernisation school is rooted in both imperfect and perfect market methods. Thus, this study is entrenched in the integrative school, as advanced through the institution fitness theory. Again, similar to this study is Pelinescu's (2015) strategic tripod of the modernisation schools, dependency schools, and the integrative schools. According to Adelakun (2011), this strategic tripod is a veritable way of integrating the two traditional schools (the modernisation schools and dependency) of development thinking into the integrative schools (Ogasawara, 2018; Menon, 2017; Pelinescu, 2015). Most dependency theories (like the neo-Marxist and structuralist theories) posit the main source of poor economic growth and underdevelopment in many developing countries due mainly from the exploitation (either through multinational corporations or international trade) by the industrialised countries (Bese & Kalayci, 2019; Pelinescu, 2015; Aregbesola, 2014). Unfortunately, the solution to poor economic growth and institutional development (in many developing countries) offered by the dependency theorists (for example restricting international trade and investment) contradicts the recent pursuit of better economic growth via institutional development by many developing countries (Anyanwu and Yameogo, 2015; Adelakun, 2011; Wilhelms, 1998). Consequently, dependency theories are deemed not to be the desired state doctrine (Ogasawara, 2018; Menon, 2017). On the other hand, the perfect market theories, and many modernisation school's theories arise from the perfect competition, and free trade assumptions also positioned institutional development as a catalyst and prerequisite for any desired sustainable economic growth in many developing countries (Aregbesola, 2014; UNCTAD, 2015). This was the offshoot of the big bang theories and structural adjustment norms, conversing for full privatisation in Eastern Europe and the transformation of political and economic structures to reduce poverty and the declining impact of institutions in many developing countries (Mosteanu, 2019; UNDP, 2014; Wilhelms, 1998).

Specifically, industrial organisation theory observes that many organisations choose a suitable location for their various investments based on its comparative advantage after making provision for "friction" due to poor institutions, trade barriers and transportation costs (Anyanwu, 2012). Nonetheless, many studies observe that both the imperfect and perfect markets still cannot adequately explain the improvement in economic growth (Eslamloueyan & Jafari, 2019; Kandil, 2009). Thus, Wilhelms (1998) positioned the integrative school as the only solution. Hence, the institutional fitness theory, as suggested by Wilhelms (1998), formed an important part of the theoretical framework in this study. The adoption of institutional fitness theory, in this study, is a veritable means of accounting for the array of heterogeneous variables that are usually involved in the economic growth process, by giving more significance to institutions (Meso level), over both the entire economy (macro-variables) and firms (micro-variables) (Onuonga, 2020; Wilhelms, 1998).

The institutional fitness theory suggests that improvements in economic growth is determined and sustained more by institutional variables (Anyanwu and Yameogo, 2015). Consequently, many studies observed that fitness must be founded on a country's ability to recognise and utilise the existing opportunities to achieve sustainable growth (Aregbesola, 2014; De-Mello, 1996).

Previous empirical studies on the relationships between institutional sustainability (fitness) and economic growth have been mixed and contradictory in both developed and developing countries, or bloc of developing countries (Eslamloueyan & Jafari, 2019; Kandil, 2009; Younsi & Bechtini, 2018; Constantine & Khemraj, 2019; Wanjuu & Le Roux, 2017; Effiong, 2016; Ang, 2013). The varied findings have been traced to the different measures of constructs and estimation techniques being adopted (Constantine & Khemraj, 2019; Wanjuu & Le Roux, 2017). Consequently, Younsi and Bechtini (2018) and Ang (2013) view the adoption of validations via multiple estimators and robustness checks as a probable way of reducing previous contradictory studies (Azevedo et al., 2018; Wanjuu & Le Roux, 2017).

Specifically, Kandil's (2009) study on the determinants of institutional quality observed a significant positive relationship between institutional quality and economic growth (measured by increase real GDP growth) across the Middle East and North Africa (MENA) countries. The study provides empirical support on the underlying roots of institutional quality. The study, therefore, advised policymakers to address shortcomings in their institutional development processes, based on the premise that any improvement in institutional quality will re-distribute the benefits of economic growth in the MENA region. The study is distinct from earlier literature on the nexus between growth and institutions, based on its focus on oil-producing region and analysis of micro-foundations in the transmission channel between economic growth and institutional development (Kandil, 2009).

Similarly, Eslamloueyan and Jafari's (2019) study also assessed the nexus between economic growth and institutional development, based on the notion that better growth and institutions could enhance the marginal product of capital and speed of adjustment in East Asia. The study is an extension of the traditional neoclassical theory to capture any probable deviation in current institutional quality from the ideal level. Subsequently, the study estimated a dynamic panel data model via GMM. The study, therefore, observed a positive relationship between institutional quality and economic growth in the selected East Asian countries during the study period. The study, therefore, concluded that countries with better institutional quality in the region are less exposed to the adverse influence of any structural or financial crises (Eslamloueyan & Jafari, 2019; Kandil, 2009). However, few other studies differ from the above positive relationships (Constantine & Khemraj, 2019; Wanjuu & Le Roux, 2017; Effiong, 2016; Ang, 2013).

For example, Wanjuu & Le Roux's (2017) study also examined the cause and effect relationships between institutions and economic growth in the Economic Community of West African States (ECOWAS), using co-integration regression and vector error correction models as estimation techniques. Findings suggest an insignificant relationship between economic institutions and economic growth in ECOWAS during the studied period. On the contrary, all variables, except trade openness, stimulated economic growth (Wanjuu & Le Roux, 2017). The study, therefore, recommended more stringent policies aimed at fostering private investments, economic and social infrastructural facilities, and adequate security, as well as curbing corruption in the region.

Similarly, Effiong’s (2016) study examined the relationships between institutions, financial development, and economic growth via a panel of 21 Sub-Saharan African countries from 1986-2010, using standard growth regression as the estimation technique. Findings observe an insignificant relationship between economic growth and institutional quality in the selected Sub-Saharan African countries during the study period. However, the study observed a significant positive relationship between financial developments and institutional quality. While advocating for a radical policy mix to spur institutions and growth in the region, the study recommended an improvement in both monetary and fiscal policies that will engender institutional fitness and sustainable growth in the region.

However, since the emphasis is placed on the association between economic growth and institutional fitness in the BRICS countries, this study is concentrated on country determinants, rather than firm or industry determinants of institutional fitness (Pelinescu, 2015; Wilhelms, 1998). This is based on the premise that firm and industry factors are less important when country-related factors are already inhibiting institutional developments in the BRICS bloc (Ogasawara, 2018).

Hence, the study centrally hypothesised that: **“**Economic growth will be sustainable in BRICS countries if it is sustainable in individual countries in the block and it remains sustainable as some countries change status from emerging economies to developed economies." However, based on the above conceptual and theoretical background, the specific hypothesis is stated thus: Hypothesis: H1: economic growth will be sustainable if it strengthens institutions in individual BRICS countries.

Methodology

Based on the proposition that “economic growth will be sustainable if it strengthens institutions in individual countries,” this hypothesis was tested using models of institutional fitness and how it links to economic growth. Hence, the adopted methodology sought to analyse the influence of economic growth on institutional fitness within the BRICS countries using a data set from 1990 to 2017. Although, the level of homogeneity or heterogeneity in the BRICS bloc is debatable in the literature (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Chudik et al., 2015; Lombardi et al., 2017; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017), that notwithstanding we adopted the Pesaran cross-section dependence test in this paper, despite our econometric analysis of a panel data of five countries (N=5) from 1990 to 2017 (T=28). This is on the premise that the Pesaran cross-section dependence test is capable of being applied to small sample properties, despite its usual application to many unbalanced and balanced panels with unit-root, large T and N, and heterogeneous panels (Chudik et al., 2015; Lombardi et al., 2017).

Econometric Model

Based on a framework from Akinola and Bokana (2017), the econometric model in this study is akin to the basic production function. Consequently, to examine the nexus between institutional fitness (a proxy for institutional sustainability) and economic growth, the Cobb-Douglas Production Function is also expanded (Akinola & Bokana, 2017; Oladipo, 2008).

Therefore, given the regression specification in Equation 3.1:

$G_{it} = \beta_0 + \lambda\varepsilon_{i,t-1} + \beta_1 X_{it} + \mu_i + \varepsilon_{it}$ ……………………………………………………...........................…Equation 3.1

Where G_{it} depicts the logarithm of institutional fitness, X_{it} denotes some numbers of relevant independent variables, μ_i is the time-invariant country-specific effects, and $\varepsilon_{i,t}$ is the error term.

According to El-Wassal (2012), by relaxing the strict exogeneity assumption, Equation 3.1 can be translated to equation 3.2 to remove the country-specific effect:

$G_{it} - G_{it-1} = \eta(G_{it-1} - G_{it-2}) + \beta(X_{it} + X_{it-1}) + (\varepsilon_{it} + \varepsilon_{it-1})$……………………….……………………Equation 3.2

Based on this method, Equation 3.2 automatically controls for the association between $\varepsilon_{it} - \varepsilon_{it-1}$ (new error term) and $G_{it-1} - G_{it-2}$ (lagged dependent variable).

Therefore, using the Bundell-Blond approach (El-Wassal, 2012) and its basic assumptions, in addition to the introduction of some vector (X^1) of some controls perceived to affect institutional fitness, the resultant model for this study is shown in Equation 3.3:

$(\text{INSTFIT})_{it} = \alpha o + \alpha 1(\text{INSTFIT})_{it-1} + \alpha_2 GDP_{it} + \alpha_3 GDP^2_{it} + \alpha_4 X^1_{it} + \mu_i + \varepsilon_{i,t}$………..…….Equation 3.4

Where: INSTFIT represents our institutional fitness variable (Aggregations of economic, political, and institutional indexes as a proxy for institutional fitness). GDP is proxied by real per capita GDP; X^1 is the control variables (exchange rate volatility, inflation risk, FDI, domestic investment, and financial development); $\alpha 0$ is an intercept; μ_i is country-specific effects; and $\varepsilon_{i,t}$ represents the error term.

However, due to the problem (failure to account for endogeneity issues like measurement error, omitted variable bias and reverse causality) inherent in the ordinary least squire (OLS), the regression equation was estimated using a Generalised Method of Moments (GMM) model by using the log of Institutional fitness variable for each of the BRICS countries as an external instrument (Aggarwal et al., 2006). GDP^2 in the control variables, Private sector credit (a proxy for Financial Development), and gross fixed capital formation (a proxy for domestic investment) were measured as a ratio of GDP (Agrawal, 2015; Awan, 2013).

Defining the Dependent and Explanatory variables

The outcome variable in this study is the Institutional fitness variable (Aggregations of economic, political, and institutional indexes as a proxy for institutional fitness). Hence, institutional sustainability and institutional fitness are interchangeably used in this study. Although there are no generally acceptable measures/ indicators of institutions (Menon, 2017; Agrawal, 2015; Agarwal & Khan, 2011), consequently, based on the dictates of institutional economics, this study developed and adopted its own aggregated composite index of institutional fitness, by looking at risk assessment factors of countries over time, as identified by the top three global rating agencies (Moody's Investors Service, Standard & Poor's Financial Services LLC (S&P) and Fitch Ratings Inc.), Euromoney country risk survey, World Bank decomposed governance indices and Corruption Perception Index-CPI (Transparency International).

Specifically, the construction of the composite institutional fitness index for all the countries was done by applying principal component analysis (PCA) on the four measures of institutions, namely, sovereign bond, investment risk, governance, and corruption (Younsi & Bechtini, 2018). The PCA, as a multivariate statistical technique, is usually used for analysing the inter-correlation by linking several quantitative variables (Younsi & Bechtini, 2018). Consequently, for each dataset with '*p'* quantitative variables, we can evaluate at most *p* principal components (PC) by descending order of the eigenvalues, with each '*p'* representing a linear combination of the original variables, and the coefficients equal to the eigenvectors of the correlation covariance matrix (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). While all three global rating agencies mainly issue credit ratings for the debt of public and private companies and sovereign states, on the other hand, Euromoney country risk survey majorly evaluates the investment risk of a country (economic and political risks).

Although there are slight variations in the subscripts used by the top three global rating agencies (Moody, S&P, and Fitch), ratings are based on long term sovereign credit rating, ranging from Prime “AAA” to In default “D.” Consequently, average sovereign bond ratings for each countries grades are graduated on a scale of 100 percent from in default-“D” to Prime “AAA” (Agrawal, 2015; Pelinescu, 2015).

Euromoney country risk survey is graded on a scale of 100 percent by assigning a weighting to both qualitative expert opinion (political risk-30%, economic projections/ performance-30%, and structural assessment-10%) and quantitative values (debt indicators-10%, credit ratings-10%, and access to bank capital market/ finance-10%). The Corruption Perceptions Index (CPI) is a composite indicator used to measure perceptions of corruption in the public sector in different countries around the world, while the World Bank decomposed governance indices (range from -0.25-weakest institutional development- to 2.5 –strongest institutional development) measure six important variables; namely, voice and accountability, government effectiveness, control of corruption, political stability, the rule of law, and regulatory quality (Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015). Consequently, the study posits that countries with greater risks are less fit, more prone to ‘sickness,’ and hence can experience low economic growth.

However, to reduce the problem of aggregation issue, we contrived three aggregations, namely, economic index, political index, and institutional index (corruption) (Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015). Again, to also facilitate the use of the GMM, log values of the variables were used (Agrawal & Khan, 2011). All the variables, measures, and sources are depicted in Appendix 3B.

The results of the constructed composite institutional fitness index for the five BRICS countries, as depicted in Appendix 3A, show the PC analysis for Brazil with the highest first PC explains about 47.07% of the standardised variance in the country; hence, was selected to compute the institutional fitness index for Brazil (Younsi & Bechtini, 2018). Consequently, 71.09%, 69.08%, 37.25%, 41.99%, 42.54% and 25.63% individual contributions for each of the MIS, S&P, FR, ECRS, WDGI, and CPI, respectively, were further used to construct the institutional fitness index for Brazil after rescaling to the standardised variance of the first PC (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; De Bruyn et al., 1998). Again, the same interpretations of results were seen to be true for the other four countries in our analysis (Russia, India, China, and South Africa).

Again, at different stages of the estimation process, various diagnostic tests were performed to control for sensitivity, as well as reliability (Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015). Since the results were robust and also lacked any arbitrary serial correlation (David., Bloom, & Canning, 2008; Strittmatter & Sunde, 2011; Licumba., Dzator & Zhang, 2016), then we proceeded with the following estimation steps: (1) a Panel Unit Root Test, (2) the Pesaran cross-section dependence test and PEDRONI'S Panel cointegration test, (3) the Hausman specification tests, and (4) Robustness checks and test for country-specific effects.

To determine the robustness of our results, first, we adopted the pooled ordinary least square (POLS) and the Generalised Method of Moments (GMM) estimation techniques (Younsi & Bechtini, 2018). Additionally, in other to further determine the robustness of our results, we provided a series of checks, mainly by launching the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimations at individual and panel levels over the period 1990-2017. This was also to enable a fair comparative analysis of trends in institutional sustainability in each country, given the recent improvement in economic growth within the BRICS countries. Besides, testing for country-specific effects or cross-sectional dependence using fixed-effect Least Square Dummy Variable (LSDV) was designed to test whether specific characteristics of an individual country can interfere with our panel results (Licumba., Dzator & Zhang, 2016), and most significantly, the test enabled us to determine if we can generalise our results for all the five countries used in the study (Pereira., Ferraz., Araujo & Machado-Taylor, 2018; Akinola & Bokana, 2017).

Results and Discussion of Findings

Due to the possibility that the individual countries are interdependent (known as cross-sectional dependence), a major issue with the potential to undermine the validity of the models used and implications on parameter estimation and inference (Bindi, 2018), this study adopted the Pesaran cross-section dependence test due to its applicability to a wide variety of balanced and unbalanced panels with large T and N, as well as, good small sample properties, that is small T and N. (Bindi, 2018; Pesaran 2004).

The result of our Pesaran CD test (Appendix 3D) on INSTFIT- Institutional fitness variable (ln_INSTFIT) confirms the presence of cross-sectional dependence in the dependent variable since the test failed to rejects the H0 of cross-section independence at the 5% level of significance. This is also an indication that our variables lack a high degree of cross-sectional heterogeneity (Bindi, 2018), hence fixed and random effects estimators and also GMM may be used since all these assume a large degree of homogeneity (Bindi, 2018; Mohaddes and Raissi, 2017).

Panel Unit Root Test

To check the stationarity of our time series, a Panel Unit Root Test was conducted, rather than using the traditional ADF and PP tests. Consequently, the panel unit root test took the form of the Im-Pesaran-Shin (IPS) test and Levin-Lin (LLC) tests, based on the Central Limit Theorem (CLT) (Menon, 2017; Agrawal, 2015). The results of the unit root are shown in Appendix 3C. The results posit stationarity of our series at both first and second differences (Menon, 2017; Agrawal, 2015).

PEDRONI'S Panel cointegration test

To compare the trends in the level of institutional fitness in each country, given the recent improvement in economic growth within the BRICS countries, the study conducted a Panel Data Cointegration Analysis. We estimated the PEDRONI'S Panel cointegration test on each panel data set of the BRICS block. Pedroni's cointegration test at the panel level is deemed desirable to prevent spurious regressions that are usually associated with the direct use of Generalised Least Square or Ordinary Least Square to any non-stationary data (Agrawal, 2015). Moreover, Pedroni's cointegration test is effective in controlling for the country's size bias, as well as solving heterogeneity issues through parameters that may differ among individuals (Younsi & Bechtini, 2018; Javeria et al., 2017).

Table 3.1: Pedroni Panel Cointegration Test

Series: GDP, GDP2, FDI, DI, FINDEV, EXR, INF		
Alternative Hypothesis: Common AR coefs. (within-dimension)	**Statistics**	**Prob.**
Panel V-statistic	0.457	0.275
Panel rho-satistics	0.412	0.543
Panel PP statisics	-2.634	0.003***
Panel ADF statistics	-3.345	0.001***
Alternative hypothesis: individual AR coefs. (between-dimension)		
Group rho-statistic	1.543	0.845
Group PP statistics	-2.988	0.001***
Group ADF statistics	-3.453	0.000***

Note*:* *** null hypothesis (that variables are not cointegrated) rejection @ 1% level of significance.
Source: Author's computation

According to Pedroni (1999), out of the seven postulated statistics, the first four (Panel v-Statistic, Panel rho-Statistic, Panel PP-Statistic, and Panel ADF-Statistic) are termed panel cointegration statistics, while the last three (Group rho-Statistic, Group PP-Statistic, and Group ADF-Statistic) are known as group mean panel cointegration statistics (Agrawal, 2015; Pedroni, 1999). The result of the cointegration test in Table 3.1 inferred that economic growth and institutional fitness are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships.

The Hausman specification:

This study adopted a fixed and random effects estimator to investigate the influence of economic growth on institutional fitness variables within the BRICS countries.

Table 3.2: Results of Hausman Specification and GMM Tests

Variables	dependent Variable: INSTFIT								
	FE			RE			GMM		
	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value
lnGDP	0.21564	3.54	0.013**	0.26674	5.34	0.011*	0.245664	6.22	0.017**
$lnGDP^2$	0.39087	3.32	0.004*	0.40654	5.03	0.002*	0.497587	17.34	0.009*
lnFDI	0.00756	0.67	0.645	-0.00736	0.87	0.734	-0.00576	0.89	0.864
lnDI	0.73453	10.65	0.022**	0.77657	13.64	0.022*	0.79563	11.63	0.032**
lnFINDEV	0.40653	4.56	0.000*	0.44623	5.55	0.000*	0.46543	7.33	0.000*
lnEXR	-0.12543	-8.34	0.000*	-0.14542	-9.32	0.000*	-0.27658	-8.77	0.000*
lnINF	-0.13245	-4.67	0.143	-0.15243	-7.69	0.067***	-0.17653	-9.23	0.183
Constant	2.43567	5.76	0.000*	2.56536	8.27	0.000*	2.76575	7.73	0.000*
Obs.	135						135		
R^2	0.3463						0.3256		
Adj. R^2	0.4351						0.4032		
DF	97						92		
Prob>F	0.0000								
Prob>χ^2	0.0000								
Prob Hausman test	0.0000								
AR(2)	-------						0.311		
Hansen Test	-------						0.176		
Estimation chosen	Model with fixed effects								

Note: * and ** denotes statistical significance at 1% and 5%, respectively.
Source: Authors Computation

However, as differentiated from the work of Akinola and Bokana (2017), to control these endogeneity concerns - due to the use of dynamic panel approach static model on cross-country data and to incorporate country-fixed effects - this paper utilises the GMM approach as the first robustness check of our estimates (Blundell and Bond, 1998; El-Wassal, 2012).

From the estimates in Table 3.2, comparing the output of GMM with both fixed and random effect estimates, results from our GMM estimates are similar to both fixed and random effect estimates. Estimates from both fixed and random effect estimates are preferred to the GMM estimates since the estimates improved all goodness-of-fit measures significantly but lost 5 degrees of freedom.

Table 3.4: Hausman test for panel models

	(b) Fixed	(B) Random	(b-B) Difference	S.E.
lnGDP	0.21564	0.26674	-0.05110	0.07412
$lnGDP^2$	0.39087	0.40654	-0.01567	0.02382
lnFDI	0.00756	-0.00736	0.01492	0.02268
lnDI	0.73453	0.77657	-0.04204	0.06391
lnFINDEV	0.40653	0.44623	-0.03970	0.02201
lnEXR	-0.12543	-0.14542	0.01999	0.03039
lnINF	-0.13245	-0.15243	0.01998	0.03037

chi2(0) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 0.78; Prob>chi2 =0.0000
Decision: b=consistent under H0 and Ha; B=inconsistent under Ha, but efficient under H0
Test: H0: difference in coefficients not systematic the

Specifically, the Hausman test results in Table 3.4 suggest we reject the null hypothesis while accepting the alternative hypothesis. The implication is that we accept the results from our fixed effect and reject results from random effects. Hence, the fixed effect result is more suitable for our analysis. Consequently, results from Table 3.2 (under fixed effect-within-regression) show that all the independent variables (GDP, GDP-square, exchange rate, domestic investment, and financial development), except inflation risk and FDI, observed a positive influence on institutional fitness at 5% level of significance except again, the insignificance influence of inflation on institutional developments might not be unconnected with the negative impact of the Asian and global financial crises experienced during the study period (Menon, 2017; Gur, 2015).

Findings from this study also align with few previous mixed empirical studies on the relationships between institutional sustainability (fitness) and economic growth in both developed and developing countries, or bloc of developing countries (Eslamloueyan & Jafari, 2019; Kandil, 2009; Younsi & Bechtini, 2018; Constantine & Khemraj, 2019; Wanjuu & Le Roux, 2017; Effiong, 2016; Ang, 2013). The varied findings could be traced to the different measures of constructs and estimation techniques being adopted (Constantine & Khemraj, 2019; Wanjuu & Le Roux, 2017). Interestingly, Younsi and Bechtini (2018) and Ang (2013) sees the adoption of validations via multiple estimators and robustness checks as a probable way of reducing previous contradictory studies (Azevedo et al., 2018; Wanjuu & Le Roux, 2017).

Specifically, Kandil's (2009) study on the determinants of institutional quality observed a significant positive relationship between institutional quality and economic growth (measured by increased real GDP growth) across the Middle East and North Africa (MENA) countries. The study provides empirical support on the underlying roots of institutional quality. The study, therefore, advised policymakers to address shortcomings in their institutional development processes, based on the premise that any improvement in institutional quality will re-distribute the benefits of economic growth in the MENA region.

Similarly, Eslamloueyan and Jafari's (2019) study on the nexus between economic growth and institutional development was based on the notion that better growth and institutions could enhance the marginal product of capital and speed of adjustment in East Asia. The study was an extension of the traditional neoclassical theory to capture any probable deviation in current institutional quality from the ideal level. The study also observed a positive relationship between institutional quality and economic growth in the selected East Asia countries during the study period. The study, therefore, concluded that countries with better institutional quality in the region are less exposed to the adverse influence of any structural or financial crises (Eslamloueyan & Jafari, 2019; Kandil, 2009).

That notwithstanding, few other studies differ from the above positive relationships (Constantine & Khemraj, 2019; Wanjuu & Le Roux, 2017; Effiong, 2016; Ang, 2013). For example, Wanjuu and Le Roux's (2017) study also examined the cause and effect relationships between institutions and economic growth in the Economic Community of West African States (ECOWAS), using co-integration regression and vector error correction models as estimation techniques. Findings suggest an insignificant relationship between economic institutions and economic growth in ECOWAS during the studied period.

Similarly, Effiong's (2016) study examined the relationships between institutions, financial development, and economic growth via a panel of 21 Sub-Saharan African countries from 1986-2010, using standard growth regression as the estimation technique. Findings revealed an insignificant relationship between economic growth and institutional quality in the selected Sub-Saharan African countries during the study period but observed a significant positive relationship between financial developments and institutional quality. Notwithstanding the mixed results from previous studies, based on literature, the superiority of our findings could be seen from the various validations via multiple estimators and robustness checks (Azevedo et al., 2018; Younsi & Bechtini, 2018).

Robustness Checks and Discussions

Different robustness tests were used to assess the robustness of our results. First, we used the GMM estimators and pooled ordinary least square (POLS). Similar to a study by Blundell and

Bond (1998) and Arellano and Bond (1991), we selected two specific diagnostic tests, Hansen test, and second-order autocorrelation AR (2) test, to test for any probable over-identifying restrictions and serial correlations of the error terms, respectively. The results of our GMM estimators are shown in Table 3.2 and Appendix 3F. Estimates of the GMM largely attested to the robustness of our main preferred results (fixed effect) due to the unchanged signs and level of significance (mostly 1 and 5 percent). This is an affirmation of the robustness of our preferred estimates and the conclusion that institutional fitness is positively related to economic growth within the BRICS countries.

Again, the estimated results from our POLS and GMM, as presented in Appendix 3F, fell in line with our expectations by confirming that the coefficients for all considered independent variables remain the same sign and significance with our preferred fixed effect estimates (Arellano and Bond, 1991). Specifically, in our GMM results, the Hansen test for over-identification indicates the acceptance of the null hypothesis (Menon, 2017). Hence, a validation of our instruments and seemly uncorrelated with the error term (Akinola & Bokana, 2017). The AR (2) test estimate also indicated the presence of a second-order serial correlation in our model. In particular, the robustness analysis posits similarity in sign and magnitude as in our fixed-effects model.

The study also adopted a cross-sectional dependence test using fixed-effect Least Square Dummy Variable (LSDV) (Akinola & Bokana, 2017). As stated earlier, testing for cross-sectional dependence is important to test whether specific characteristics of the individual country can interfere with our panel results (Licumba., Dzator & Zhang, 2016), and most significantly, the test enabled us to determine if we can generalise our results for all the five countries used in the study (Akinola & Bokana, 2017). Our cross-sectional dependence test was, however, complemented with Panel Cointegration coefficients for five BRICS countries, via the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimations at individual and panel levels over the period 1990-2017 (Pedroni, 1999).

Table 3.5: Fixed Effects (LSDV) Estimation Results

	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnGDP	0.21564	8.03464	3.54	0.000*	1.3946	1.65422
$lnGDP^2$	0.39087	0.03455	3.32	0.000*	0.35658	0.45353
lnFDI	0.00756	0.04741	0.67	0.231	0.02316	0.05313
lnDI	0.73453	6.44783	10.65	0.000*	1.33318	1.68766
lnFINDEV	0.40653	0.34358	4.56	0.000*	3.43217	4.85320
lnEXR	-0.12543	0.75643	-8.34	0.000*	-4.54371	-6.78761
lnINF	-0.13245	0.44227	-4.67	0.000*	-3.53648	-4.76837
Country						
Brazil	3.426	0.856	0.61	0.642	-965.4562	1831.984
Russia	5.235	1.150	5.02	0.000*	3209.843	7335.732
India	0.984	0.733	1.23	0.245	-526.8393	2306.188
China	-7.324	0.832	-8.74	0.000*	-9072.894	-5745.974
South Africa	1.366	0.025	1.62	0.133	-349.5972	13688.917
_cons	-3.345	0.799	-0.39	0.545	-1854.491	1237.757
R-squared = 0.8345 = (overall) F(1.762) = 1.795; Prob> F = 0.0000 Number of obs = 135						

Note: *statistical significance at 1%.
Source: Authors Computation

The LSDV result in Table 3.5 is an extension of the fixed effects results, by adding a computation of coefficient for dummy variables as intercept or constant for all the five countries and also their statistical significance (Menon, 2017; Akinola & Bokana, 2017).

A comparative analysis of results from Table 3.5 (Fixed Effects-LSDV- Estimation Results) and 3.6 (FMOLS and DOLS) showed that out of the five BRICS countries investigated in our study, only two (China and Russia) observed statistically significant constants.

Table 3.6: Panel Cointegration coefficients for 5 BRICS Countries (1990-2017)

Country	Individual FMOLS		Individual DOLS	
	lnGDP	$lnGDP^2$	lnGDP	$lnGDP^2$
Brazil	-2.23 (-3.25)	0.22** (3.11)	0.83 (0.91)	-0.07 (0.69)
Russia	3.77* (1.65)	-0.99* (-1.11)	6.33* (5.22)	-0.35* (-4.98)
India	-0.33 (-0.20)	0.01 (0.26)	0.92 (0.81)	-0.72 (0.17)
China	9.34* (7.89)	-0.78* (-6.55)	6.55* (4.76)	-0.44* (-4.55)
South Africa	0.98 (1.01)	0.01 (0.33)	0.65 (0.34)	-0.03 (-0.34)
	Panel FMOLS		Panel DOLS	
Panel	1.68* (4.33)	-0.06* (-2.69)	1.05* (5.38)	-0.04* (-4.23)

Note: t-statistics=values in parentheses; *=1% level of significance; **=5% level of significance

The inference of this is that the cross-sectional dependence noticed may be more pronounced in these two countries, based on the presumption that the two countries share common features (Akinola & Bokana, 2017).

Similarly, the Fixed Effects (LSDV) Estimation Results were also corroborated by the FMOLS, and DOLS estimates in Table 3.6, with the upper and lower parts of the table showing individual countries and panel estimations, respectively. The coefficients of lnGDP and of $lnGDP^2$ yielded significant positive and negative estimators, respectively, on INSTFIT for the pool of all the five countries. Then we can conclude the significant influence of economic growth on institutional fitness within the panel sample but differs from one country to another.

However, the insignificance and sometimes negative results at both individual FMOLS and DOLS estimates for Brazil, India, and South Africa is an indication that economic growth has the potential to diminish institutional fitness in the three countries. Again, as depicted in Table 3.6, the outputs of the analyses are mixed, and they differ from one country to another in terms of the economic growth-institutional fitness nexus. This result seems to support the findings of Younsi & Bechtini (2018) and Javeria et al. (2017) that economic growth often dampens institutional developments in many developing countries. It is again noted that the log of GDP-square exhibits a very weak negative relationship with institutional fitness in the bloc. This is seen to be in contrast with the studies of Jamel and Maktouf (2017) and Agrawal (2015) which found a significant positive link between institutional fitness and the development over time of the overall economic growth.

Similar to a methodology in a study by El-Wassal (2012), our last robustness check was a temporal robustness check by re-estimating the preferred fixed effect specification test as a way of observing trends in institutional sustainability within the BRICS block as some members, like China are most likely to change the status to developed countries (Younsi & Bechtini, 2018). We, therefore, estimated separate fixed effects specifications for the full period (1990-2017) and three sub-periods, namely, Pre-Asian financial Crisis era (1990-1996), Asian financial Crisis era (1997-2006), Global financial crisis-era (2007-2017). The three sub-periods are to control for the variation in the period due to significant changes in the macroeconomic environment and institutional policies of most BRICS countries (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). The results are shown in Appendix 3E. Estimates in Appendix 3E attested to the robustness of our main preferred results. Specifically, by comparing the output of the full period

(1990-2017) and three sub-periods, we observed that both the lnGDP and $lnGDP^2$ estimates in all three sub-periods are positive and statistically significant at 5 and 1 percent levels of significance. This is an affirmation of the robustness of our preferred estimates and the conclusion that institutional fitness is positively related to economic growth within the BRICS countries.

Summary, Conclusion, and Implication of Study

Summary and Conclusion

This study analyses the effect of economic growth on institutional fitness within the BRICS countries using a panel dataset from 1990 to 2017. The main focus of the present study was on contriving policy options that would emanate from the linkage between economic growth and institutional sustainability. With countries in BRICS having different levels of institutional development to support economic growth, the study was eager to produce evidence that would enable the proposition of policy options to assist individual countries or subgroups of countries to deal with their institutional issues whilst remaining prescribed to the overall goals of the bloc. After testing for panel Unit Root, the study estimates via the system-Generalised Method of Moments (GMM) were, however, supported by the Hausman specification test to know which effect (both the fixed and random effects estimates) is more significant. Again, to compare the trends in the level, as well as, the capacity to generalise our panel results, the study conducted a Panel Data Cointegration Analysis, via PEDRONI'S Panel cointegration test on each panel data set of the BRICS block and also launched a cross-sectional dependence test, Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimations at individual and panel levels over the study period as robust checks.

Based on our findings, we can conclude the significant positive influence of economic growth on institutional fitness within the panel sample. This, however, differs from one country to another. Again, we also concluded that economic growth and institutional fitness are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships. Hence, the influence of economic growth on institutional fitness within the BRICS countries, though significant, was limited and varied.

Specifically, the study observed that China and Russia performed well among the five countries. Comparative findings from fixed effect Least Square Dummy Variable (LSDV), FMOLS and DOLS also observed that only China and Russia exhibited specific effects. Hence, our results can only be generalised within the two countries. The insignificance and sometimes negative results at both individual FMOLS and DOLS estimates for Brazil, India, and South Africa is an indication that economic growth has the potential to diminish institutional fitness in the three countries. Consequently, this study posits for a more radical policy mix to enhance institutional sustainability in the three (Brazil, India, and South Africa) countries.

Policy Implications and Recommendations

The focus on economic growth as a determinant of institutional fitness is intended to provide policy-makers and scholars with a framework for evaluating the association between economic growth and institutional fitness. Evidence from paper 2 depicts a positive influence of economic growth on institutional fitness in the BRICS bloc. However, results from our FMOLS and DOLS cautioned on the capacity of economic growth to diminish institutional fitness in Brazil, India, and South Africa. Consequently, this study posits for a more radical policy mix to enhance institutional sustainability in the three (Brazil, India, and South Africa) countries. The policies could focus on developing radical institutional development strategies, superior growth induced domestic investment and financial developments, as well as the creation of a circular economic model.

Superior growth induced domestic investment and financial developments can be achieved via radical interaction between the marketplace and extractive communities or regular contact between credit institutions and producers, to promote FDI that will increase the value of traditional knowledge, technology, capacity building, planting and replanting, social organization, aggregation of value, collection and quality of life.

Radical institutional development (fitness) could also be enhanced in the three countries (Brazil, India, and South Africa) by strengthening the role of non-governmental organisations (NGOs). This could serve as a way of exerting better inspection, social control, monitoring, inspecting, as well as demanding action from the government (Santana et al., 2014). Additionally, NGOs, as true umpire, could be encouraged to participate in major growth and sustainability policy formulation by way of supporting the design of national strategies, plans, and programmes (Younsi & Bechtini, 2018). Specifically, NGOs and other stakeholders can play a veritable role, at the grassroots level, on many developmental processes on land resource management. Stakeholders and policymakers in the BRICS bloc should also understand that the key to institutional (fitness) sustainability and success in the bloc lies in the sincere enablement of citizens, especially women, via the promulgation of institutional policies that will create alternative rural livelihoods (Azevedo et al., 2018).

Due to its successful implementations in Germany and China, this study believes that Brazil, India and South Africa countries can adequately tackle the challenges of poor and ineffective institutions and institutional developments arising from citizen's lack of access to clean water, poverty, water pollution, corruption and increasing CO2emissions by adapting the "circular economy" model. Consequently, compulsory circular economy principles should be embedded in strategic government legislations in the three countries. Stiffer penalties should be gazetted for defaulting companies by the government. However, the circular economy model must be done transparently and objectively, while effort must be made to reduce or eliminate the bureaucratic systems of government institutions in these countries. Each of the three countries could set-up circular economy zones that may be specifically targeting rural areas or provinces. The circular economy zones could be aimed at promoting institutional developments or renewable resources. This may also be integrated into their respective national development plans. Most importantly, the "circular economy" concept can be used to judge and monitor the performance of public/ civil servants, as well as the level of institutional developments in these countries after its implementations.

Furthermore, this study believes that the three vulnerable countries in the bloc (Brazil, India, and South Africa) should emulate the better performance of Russia and China in the bloc. Specifically, Russia’s tradition of sustainability could be traced to the promulgation of April 1996, Decree No 440 on the concept of Russia’s “Transition to Sustainable Development.” The Decree played a major role in influencing many newly established Russian public agencies, ministries, and institutions to grow "ministerial" tactics for sustainable development (Santana et al., 2014). There may be a need for better coordinated institutional sustainability-related strategies in different sectors, aimed at promoting growth and sustainability in the three countries. Targeted national committee (commission) and budget resources on growth and institutional sustainability could be allocated for these purposes in a national context.

Despite positive evidence in this study, to catch-up with more advanced countries, there may need to shift from sporadic to more systematic development and implementation of sustainability-related activities in both Russia and China, with a better target and coordination-oriented efforts from the regions, NGOs, experts, government, and local communities (Menon, 2017). Specifically, Russia still has a lot of work to be done in maintaining governance sustainability, reducing clientelism and political patronage, policy contradictions, and inadequate independent experts.

Additionally, due to a possibility that economic growth may diminish institutional fitness in Brazil, India and South Africa, the present study, therefore, suggests a radical policy stance on both Foreign Direct Investment (FDI) and inflationary risk, as well as, other positive determinants (economic growth, exchange rate, domestic investment, and financial development) of institutional fitness in the BRICS bloc to attain the much desired institutional sustainability and sustainable economic growth. The incentive for policymakers to alter the current configuration could be linked to the degree of their external vulnerabilities in embracing liberal policies (Hickel & Kallis, 2020; Mikulewicz & Taylor, 2020). Although collectively, BRICS bloc had been performing much better than the world average in the last decades, that notwithstanding, some BRICS countries are doing much better than others after the international financial crisis largely due to their varied capacities to administrate short-term economic policy to sustain growth (Jamel and Maktouf, 2017; Agrawal, 2015). For example, trade liberalization reform Brazil's was relatively rapid when compared to India's, which took more than ten years to have average nominal import tariffs close to Brazil's (Mikulewicz & Taylor, 2020). Also, changes in modus operandi to structurally reduce short-term interest rates and maintain competitive real exchange rates could reduce any probable negative impact of growth on institutions (Hickel & Kallis, 2020). This is also an opportunity for the BRICS members to show global leadership on protectionism by exercising restraint both collectively and individually (Onuonga, 2020). At a time when each of the BRICS' exports is falling, and when only India is expected to see faster economic growth, rather than focusing on fostering commercial ties, mega-regional free trade deals and promoting a New Development Bank, greater attention should be placed on the unilateral actions taken by various BRICS governments that artificially inflate exports and limit imports (Akadiri et al., 2019; Bartniczak & Raszkowski, 2019; Ahenkan & Osei-Kojo, 2014). Many scholars believe that there is little evidence to rigidly enforce the BRICS solidarity since one-third of the hits to BRICS commercial interests come from another BRICS member (Bartniczak & Raszkowski, 2019; Ahenkan & Osei-Kojo, 2014). Specifically, policymakers in the three vulnerable countries (Brazil, India, and South Africa) may have to address shortcomings in their institutional development processes, based on the premise that any improvements in institutional quality will re-distribute the benefits of economic growth in the bloc. Again, due to the notion that better economic growth and institutional development could enhance the marginal product of capital and speed of adjustment in the bloc, an extension of the traditional neoclassical theory to capture any probable deviation in current institutional quality from the ideal level, the present study also believes that countries with better institutional quality in the bloc may be less exposed to the adverse influence of any structural or financial crises (Eslamloueyan & Jafari, 2019; Kandil, 2009). Consequently, more stringent policies aimed at fostering FDI, economic growth, domestic investments, financial developments, as well as, reducing inflation should be encouraged in the three vulnerable countries. For example, a probable policy mix to spur institutional development and economic growth in the three countries should target both monetary and fiscal policies (Fakoya, 2013; Santana et al., 2014).

Theoretically, the contrived model in this study provides predictive implications on improved institutional fitness in the BRICS countries, given the activities of critical variables manifesting their sustainability. This concurs with our theoretical framework (Institutional Fitness theory) for this study. The theory suggests that sustainability of economic growth is determined more by institutional variables (Anyanwu and Yameogo, 2015); hence, the presupposition is that government policies should be executed within a sound institutional framework for the country to achieve the desired improvements in sustainable economic growth (Wilhelms, 1998). Consequently, national institutions, like education, markets, socio-cultural systems, and government, must be active and efficient in the process of transmitting various government policies to tangible derivatives (Ogasawara, 2018; Wilhelms, 1998).

Contribution to knowledge

The outcomes of this study will assist policymakers on the need to have strong institutions in achieving sustainable economic growth, which is important to tackling income inequality, unemployment, and poverty in many BRICS countries (World Bank Group, 2018; Menon, 2017). With countries in BRICS having different levels of institutional development to support economic growth, the study was eager to produce evidence that would enable the proposition of policy options to assist individual countries or subgroup of countries (especially, the vulnerable countries like Brazil, India and South Africa) in dealing with their institutional issues whilst remaining prescribed to the overall goals of the bloc.

Specifically, evidence from our study cautioned on the capacity of economic growth to diminish institutional fitness in Brazil, India, and South Africa; consequently, this study posits for a more radical policy mix to enhance institutional sustainability in the three (Brazil, India and South Africa) countries. Consequently, to the best of the researcher's knowledge, no study has investigated comprehensibly the institutional sustainability of growth policy options within BRICS to propose institutional sustainability and growth policy options. Paper two (2) was also a novel way of extending the present literature on economic growth- sustainability debates from the present concentrations on socioeconomic and environmental dimensions, by giving due recognition to the role of institutions (institutional sustainability) via institutional economics.

In addition to the validation of the institutional fitness theory, which could be seen as a better explanation of any noticeable improvement in economic growth, a position that has eluded both the perfect and imperfect markets, another novelty of the present study is the development of an aggregated composite index of institutional fitness based on the dictates of institutional economics, by looking at risk assessment factors of all the BRICS countries over time. Development of an aggregate composite index of institutions and evaluating the effect of economic growth on institutional variables in an attempt to predict the sustainability of economic growth in a group of developing countries and possibly using a mixture of methodologies has been positioned as a way out of the present contradictory findings in the literature (Tendetnik et al., 2018). To the best of the researcher’s knowledge, there seems not to be any study that has investigated these issues comprehensibly in sustainable development literature.

The output of the study will also aid policy formulation toward the role of the recent economic growth on institutional development in an attempt to predict the sustainability of economic growth in the three vulnerable countries (Brazil, India and South Africa), a goal similar to Goals 4 & 7 of the United Nations’ SDGs (Sesay et al., 2018; ISSA, 2017; United Nations, 2013). Another important theoretical contribution of the study, a gap raised in previous literature, is the role of institutional fitness in achieving sustainable economic growth in many fast-developing economies, like BRICS (Sesay et al., 2018). However, the relationship between institutions and economic growth has been largely debated in the literature (Tsaurai, 2019; Phong, 2019). Although, many studies believe that corruption is caused simply by failing institutions (Tsaurai, 2019), however, in many corrupt countries, those who are corrupt use the ‘institutions’ to perpetuate their corruption practices (Alzoubi et al., 2020; Phong, 2019). Ironically, this strengthened the institutions (Tendetnik et al., 2018). Again, observations have shown that corruption continued to occur unabated in many fast-developing countries, even when the country's economy has improved (Alzoubi et al., 2020). In some corrupt countries, there would be evidence that, in fact, corruption will lead to reduced inequalities for a larger part of the community, albeit not all (Tendetnik et al., 2018; Tekabe, 2018).

Notwithstanding any weak legal and judicial system as well as a lack of enforcement in each of the BRICS countries, the present study posits increasing incentive for policymakers to alter the current configuration due to changing dynamics in the macroeconomic environment, as well as the degree of their external vulnerabilities in embracing liberal policies (Hickel & Kallis, 2020; Mikulewicz & Taylor, 2020). Consequently, Wilhelms (1998) proposed the institutional fitness theory as a new effort to address the seemly variety of heterogeneous variables involved in the economic growth process, by bestowing more significance to institutions (Meso level), over both firms (micro variables) and the entire economy (macro variables) (Agrawal, 2015; Awan, 2013; Wilhelms, 1998).

This study is also an attempt to show the importance of critical analysis (Tendetnik, Clayton & Cathcart, 2018; Ogasawara, 2018) and evaluating the effect of economic growth on institutional variables in an attempt to predict the sustainability of economic growth (Elliott & Paton, 2018; Sesay, Yulin & Wang, 2018; David, Bloom & Canning, 2008) in a group of developing countries and possibly using a mixture of methodologies (Tendetnik et al., 2018; Tekabe, 2018; Akinola & Bokana, 2017).

Limitation and Suggestions for further studies

The first limitation, akin to most empirical studies on the economic growth determinants relationships using cross-country data from most developing countries, is the probable presence of periods and country-specific omitted variables (Azevedo et al., 2018; Menon, 2017). This is usually due to poor data collection by relevant government agencies (World Bank Group, 2018; Pereira et al., 2018). Secondly, another “inevitable” flaw in many regression results are the constructs/ specifications used to measure our variables (Menon, 2017). It could be argued that grouping some determinants that have been identified in the literature as prerequisites to improved institutional sustainability in one set and treating them equally may be misleading because they are not of equal importance (Anyanwu and Yameogo, 2015). Consequently, the main "inevitable" weakness of our estimated models was the items used to measure the determinants of institutional fitness, which might not include several other relevant variables. Further studies might consider the inclusion of these variables; chiefly among the variable are resource endowments, agglomeration effects, and the degree of diversification of the economy (Anyanwu & Yameogo, 2015; El-Wassal, 2012). Also, there may be problems of endogeneity (Anyanwu, 2012; Hailu, 2010). Also, most of the explanatory variables may probably be jointly endogenous with institutional fitness (Agrawal, 2015). This may lead to biases from simultaneous or reverse causation, since each of the institutional sustainability determinants may cause lower institutional sustainability as opposed to the opposite (Younsi & Bechtini, 2018).

However, the use of the GMM approach was a deliberate attempt to address any potential endogeneity; moreover, our well-designed study using longitudinal or panel data can also address the issue of causality (El-Wassal, 2012). Lastly, any probable cross-sectional dependence might be more evident in these five countries as it appears they share common features, again the degree of the common features may even vary when the growth process of BRICS is compared with other developing and developed blocs like the MINT and G-7 countries, respectively. This is an important area for further research.

CHAPTER 5

ECONOMIC GROWTH AND ENVIRONMENTAL SUSTAINABILITY WITHIN THE BRICS COUNTRIES: A COMPARATIVE ANALYSIS

5.1 Declaration

The work in this paper is my original work, as the Ph.D. candidate - Mr. Awolusi Olawumi Dele. Prof. Josue Mbonigaba, in serving as a supervisor, has contributed to his supervisory role by providing overall guidance to the coherence of this body of work. His contributions have been advisory; the writing of the paper in its entirety was done by me. In submitting this paper for consideration for publication, I (Mr. Awolusi Olawumi Dele), as the Ph.D. candidate was the primary and corresponding author.

5.2 Contribution of the paper to the literature

This paper accessed the nexus between economic growth and environmental sustainability within the BRICS countries using data sets from 1990 to 2017. The main focus of the paper was to produce evidence that would inform policy options for environmental sustainability in BRICS bloc. After deploying the Pesaran cross-section dependence test, the study tested for unit roots via the Pesaran Augmented Dickey-Fuller test. Again, due to the probable cross-sectional dependency errors, the study's estimates via the Auto Regressive Distributed Lag (ARDL) were supported by Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) estimates. As part of our robustness check, the study launched Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimations at individual and panel levels over the study period. The results confirm that economic growth and environmental sustainability are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships. Consequently, findings suggest that the influence of economic growth on environmental sustainability within the BRICS countries, though significant, was limited and varied.

Presenting the evidence of the relationship between economic growth and environmental sustainability, findings from our study depicts a favourable outcome in the present BRICS environmental sustainability policies. Specifically, our findings supported a significant negative impact of GDP growth on C02 emissions in the short-run; however, it seems to have reversed in the long run. This was tacit support for the EKH hypothesis in the BRICS bloc. Therefore, this study believes that all the BRICS countries should continue with the present environmental policy mix, but an effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability in the bloc. Contrary to most studies on the subject, these results are robust to all the robustness checks, including temporal and spatial changes. Again, the study contributed to the literature by providing environmental sustainability indexes that are robust to small sample size bias, as well as probable cross-sectional dependence (Younsi & Bechtini, 2018). To the best of the researcher's knowledge, there seems not to be any study that has investigated these issues comprehensibly in sustainable development literature.

Another major contribution of the present study is the adoption of various linear and non-linear estimators that are robust to both cross-sectional dependence and small sample size bias. Also, using different estimation techniques is another way of controlling for the likely homogeneity or heterogeneity that may exist between the BRICS countries (Polasky et al., 2019; Menon, 2017; Gur, 2015). Again, in line with a recent gap positioned in literature and also to aid sustainability and growth policy options, the main essence of establishing the relationships between environmental sustainability objective and economic growth in the BRICS countries is to derive environmental criteria for economic growth to be sustainable (Hofkes, 2017; Hamilton, 2015). Consequently, to the best of the researcher's knowledge, no study has investigated comprehensively the environmental sustainability of growth policy.

Additionally, results from this study were aimed at encouraging the attainment of the various BRICS's goals, as well as, with many similar goals of the year 2030 United Nations's Sustainable Development Goals (SDGs) (Sesay et al. 2018; Hochestler, 2014; United Nations, 2013). Again, in a deviation from previous studies that used a singular measure of financial development, part of the major contributions of this study was the development of an aggregated composite index of financial development that is robust to small sample size bias, as well as, probable cross-sectional dependency errors.

Another important theoretical contribution of the study was the validation of the EKC hypothesis (Sesay et al. 2018). The confirmation of the EKC hypothesis may be positioned as a negative explanation of the past three decades of economic growth in the BRICS countries, a position that has eluded both the perfect and imperfect markets (Zha et al., 2019; Anyanwu and Yameogo, 2015; Wilhelms, 1998). Besides, the econometric analysis showed the economic growth and environmental-related variables that are the most significant determinants of environmental sustainability in the BRICS countries (Menon, 2017; Carnoy, 2006).

5.3 Paper as submitted to the *International Journal of Green Economy*

ABSTRACT

Increasing environmental degradation is seen as a major threat to the attainment of sustainability in the BRICS (Brazil, Russia, India, China, and South Africa) countries. Therefore, understanding the knowledge of how economic growth would affect the environmental sustainability of individual countries is important in solving this problem. Consequently, this study analysed the effect of economic growth on environmental sustainability within the BRICS countries using a dataset from 1990 to 2017. The study's estimates via the Auto Regressive Distributed Lag (ARDL) were supported by Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) estimates. The results confirm that economic growth and environmental sustainability are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships. Our analysis also preferred estimates from the CS-ARDL; consequently, findings supported a significant negative impact of GDP growth on C02 emissions in the short-run; however, it seems to have reversed in the long run. This was tacit support for the EKH hypothesis in the BRICS bloc. Our results are robust to all the robustness checks, including temporal and spatial changes. Therefore, this study believes that effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability in the bloc. This could be achieved via objective integration of energy sector policies and sustainable development strategies. To the best of the researcher's knowledge, there seems not to be any study that has investigated these issues comprehensibly in the BRICS bloc. Additionally, confirmation of the EKC hypothesis in the Bloc is another way of extending current debates on economic growth-environmental sustainability nexus and by testing existing knowledge in an original manner in solving trending issues.

KEYWORDS: *Environmental sustainability; economic growth; environmental Kuznets curve (EKC) hypothesis; CS-ARDL; BRICS Countries*

Introduction

Based on the three principles of sustainability, namely, environment, society, and economy, "Sustainability," simply means putting scientific, technical, economic, social and ecological resources to ensure the maintenance of equilibrium state for some giving space and time (Mosteanu, 2019; Younsi & Bechtini, 2018; Spangenberg, 2004). Consequently, the present study defines environmental sustainability based on the three principles of 'sustainability' (namely, environment, society, and economy) as simply means putting ecological resources and emissions in metric tons per capita, ensuring the maintenance of equilibrium state at a certain rate or level for as long as is wanted (Omar & Inaba, 2020; Spangenberg, 2004). Similarly, "environmental sustainability" is often described in the literature as maintaining normative targets of present environmental problems like C02 emission, resource depletion or pollution (known as short term perspective), as well as, the imperative of a general reduction in the entire throughput of physical resources in the economy (longer-term perspective) for some time and in space (Younsi & Bechtini, 2018; Spangenberg, 2004).

Although many studies have investigated the environmental Kuznets curve (EKC) hypothesis (Fan & Zhen, 2013; Hediger, 2000; Spangenberg, 2001; Valentin & Spangenberg, 2000), with all the empirical findings, demonstrated mixed results, this, however, serves as reinforcements for additional studies to clarify these hypotheses (Jamel & Maktouf, 2017; Javeria et al., 2017; Spangenberg, 2004). Specifically, based on a Panel data analysis (both fixed and random effects) of BRICS, Javeria et al. (2017) observed a negative influence of the increasing CO_2 emissions and energy consumption (due to increasing economic growth) on economic developments in the BRICS countries. Consequently, to fill a major gap in the literature, Javeria et al. (2017: 58) posit for future studies to utilize an "extensive variables to estimate the impacts of economic growth on environmental degradation in BRICS countries." Besides, continuous evaluating the process of economic change has been seen as an important precondition to improving economic growth and emissions in both developing and developed economies (Omar & Inaba, 2020; Hayek, 1960, 1973; North, 2005). However, North (2005, 1989) posits that the tools we use to control and understand the present world are insufficient to deal with the issues (North, 1971, 2005).

BRIC was an abbreviation, coined in 2001 by Jim O'Neill (Goldman Sachs analyst), to represent a group of five countries, namely Brazil, Russia, India, and China. These countries are deemed to be at a comparable phase of freshly advanced economic growth (Goldman Sachs, 2001). However, BRIC was later expanded in 2010 to include South Africa and now referred to as BRICS (UNDP, 2014). The name, BRICS, is, therefore, an acronym for an association that comprises Brazil, Russia, India, China, and South Africa (Azevedo., Sartori, & Campos, 2018; ISSA, 2017).

However, understanding the knowledge of how economic growth would affect the environmental sustainability of individual countries is important in solving this problem. This can be empirically done by comparing the nexus between environmental sustainability dimensions with economic growth across countries, making up BRICS to observe coherence or contrast in results, a veritable avenue for alternative policy options (Ogasawara, 2018; Menon, 2017). Attesting to the important influence of economic growth on environmental sustainability, many empirical studies observed that economic growth is correlated with an initial augmentation in environmental degradation (Javeria et al., 2017; Fan & Zheng, 2013; Omer, 2008; Tahvonen & Kuuluvainen, 1993; Friedl and Getzner, 2003). Although many studies have investigated the environmental Kuznets curve (EKC) hypothesis (Fan & Zhen, 2013; Hediger, 2000; Pearce & Atkinson, 1993; Spangenberg, 2001; Valentin & Spangenberg, 2000), with all the empirical findings demonstrating mixed results, this serves as reinforcement for additional studies to clarify this hypothesis (Jamel & Maktouf, 2017; Javeria et al., 2017; Spangenberg, 2004). Specifically, based on a Panel data analysis (both fixed and random effects) of BRICS, Javeria et al. (2017) observed a negative influence of the increasing CO2 emissions and energy consumption (due to increasing economic growth) on economic developments. Consequently, to fill a major gap in the literature, Javeria et al. (2017: 58) posit for future studies to utilise "extensive variables to estimate the impacts of economic growth on the environment in BRICS."

Consequently, this study analysed the effect of economic growth on environmental sustainability within the BRICS countries using a dataset from 1990 to 2017. Specifically, the study is aimed at discussing the relationships between environmental degradation and economic growth as a precondition to deriving various environmental sustainability criteria for economic growth to be sustainable in the BRICS countries (Younsi & Bechtini, 2018; Spangenberg, 2004). Accordingly, this study was focused on achieving sustainable economic growth in all BRICS countries, in their quest toward achieving some self-determined goals, similar to the year 2030 Sustainable Development Goals (SDGs) of the United Nations (United Nations, 2013; UNCSD, 2012).

Sustainable economic growth is therefore conceptualised based on the United Nations description of sustainable development, as a growth that is capable of meeting the present needs without jeopardising the needs of future generations (Sesay et al. 2018; ISSA, 2017; Hochestler, 2014; United Nations, 2013; UNCSD, 2012). Hence, our study is premised on the notion that: to achieve sustainable economic growth in the BRICS countries. Efforts must be geared toward achieving legitimate social progress and economic growth, as well as improving environmental protection (Sesay et al. 2018; World Bank Group, 2018). Likewise, for sustainable economic growth to be beneficial, there must be the promotion of policies and strategies aimed at protecting the natural endowments (Menon, 2017; Agarwal & Khan, 2011; Gur, 2015; UNCSD, 2012).

Background and Problem Statement

BRICS' important environmental goals are poverty reduction through promotion of healthy living and well-being (Similar to Goal 3 of the United Nations' SDGs), combating climate change and its impacts (Similar to Goal 13 of the United Nations' SDGs); avoiding the destruction of the natural environment, as well as, the development of environmentally friendly technologies (Similar to Goal 7 of United Nations' SDGs) (Sesay et al., 2018; ISSA, 2017; Hochestler, 2014; United Nations, 2013; UNCSD, 2012). The BRICS countries had a combined nominal Gross Domestic Product (GDP) of US$ 16.039 trillion as at 2016; this is comparable to about 20% of the total gross world product (ISSA, 2017; Tsaurai, 2017; Behera & Mishra, 2016; Santana, Rebelatto, Périco & Mariano, 2014).

Again, environmental degradation is seen as another threat to the attainment of the overall goal of achieving sustainable economic growth for members (Similar to Goal 7 of the United Nations' SDGs), as well as, other specific goals like the goal of promoting an equitable international financial development, organisations and "creating a new world order" (Similar to Goals 16 and 17 of the United Nations' SDGs) (Sesay et al. 2018; ISSA, 2017; Hochestler, 2014; United Nations, 2013; UNCSD, 2012). This has been largely attributed to conflicts in the operational and financial development of the New Development Bank (NDB) (ISSA, 2017; Behera & Mishra, 2016). NDB is a "bank" created to counter the International Monetary Fund and World Bank, with a focus on lending for infrastructure and sustainable development (Behera & Mishra, 2016). Although, the myth of emerging powers has been largely critique in the literature, however, the two main priorities of the NDB (infrastructure and sustainable development projects) are incompatible since the high environmental costs of executing huge infrastructure projects may conflict with a separate set of different sustainable projects (Sesay et al. 2018; Behera & Mishra, 2016; Bond, 2016, 2014). Specifically, Bond (2016) posits the inability of the NDB to work completely different to the World Bank, IMF and other multilateral development banks has been largely attributed to the division-prone BRICS where different agendas now proliferate, as well as unsatisfying incrementalism that is largely fuelled by Donald Trump's uncontested appointment of David Malpass as World Bank president in 2019

(Mikulewicz & Taylor, 2020; Onuonga, 2020). Bond and Garcia (2015) therefore maintains that the BRICS is no alternative, but instead a rather, of contradictions created within Western-centric capitalism (Bond, 2016; Bond and Garcia 2015)

Furthermore, aside from facing stiffer competition from the western investment institutions, there is presently conflict of interest in the daily operations of the new bank, while the New Development Bank is also facing strong rivalry from the Asian Infrastructure Investment Bank (another China-led financial institution) since both perform similar functions (World Bank Group, 2018 Agrawal, 2015). Again, due to disagreements between member nations on burden sharing, fund management, differing economic systems, BRICS countries have not been able to agree on how to tackle the most important global financial and economic challenges (Onuonga, 2020; ISSA, 2017).

The increasing urbanisation, industrialisation, population, and lifestyle changes in the BRICS countries, and generally in the whole world, have also increased the threat of climate change and global warming (Javeria et al., 2017; World Bank Group, 2018; Agrawal, 2015). Specifically, based on the 2015 UNEP emission gap report, three of the BRICS (namely China-29%; Russia- and India) countries are among the six largest emitters of carbon dioxide-CO2 (majorly emissions from fossil-fuel combustion via coal consumption is the main source of the increasing global warming) in the world in 2013 (Javeria et al., 2017; World Bank Group, 2018).

Consequently, climate change was acknowledged, at the 2013 fifth BRICS meeting in Durban, as one of the major threats towards achieving the group's goal of sustainable economic growth and development (Javeria et al., 2017). Although, all the five BRICS countries have made voluntary pledges to reduce global emissions in their goals, as well as, through pledges to the Copenhagen Accord (World Bank Group, 2018; Gur, 2015; Hochestler, 2014), the uncooperative attitude of many BRICS countries (especially, China) with many developed countries has been attributed to the seemingly low number of comparative and empirical studies focusing on establishing the short and long-run influence of green economies on sustainable economic growth in developing group, like BRICS countries (Younsi & Bechtini, 2018; Javeria et al., 2017).

The above problems would not arise if there was knowledge of how economic growth would affect the environmental sustainability of individual countries. In case it affects the sustainability of individual countries differently, then countries can adopt differential sustainable growth policies, and if not, all the BRICS countries can adopt the same sustainable growth and development policies. To solve the aforementioned problems in the BRICS countries, it would require that countries adopt policies that are relevant to the key environmental issues, in particular the issues relevant to development imperatives of more vulnerable partners in the group (like South Africa and Brazil), so that growth path adopted to support and can be supported by environmental development of all countries sustainably (Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015). This is, however, a dilemma as countries will likely embrace policies that are more relevant to their circumstances. It is therefore hypothesised that the problem of possible diversity in interest among BRICS can be resolved by finding growth policy options within the block that would allow environmental sustainability within the block.

Consequently, estimating a comparative analysis on the influence of the recent economic growth on environmental degradation (a proxy for environmental sustainability) within the major contributing countries, like BRICS countries will enhance government policies on environmental pollution and climate change, especially on lower carbon emissions (Sesay, Yulin & Wang, 2018; Agrawal, 2015).

The problem is, therefore, a problem of growth policy options that would result in sustainability along environmental dimensions making justice to every member whether such options should be adopted per subgroup of countries based on comparable characteristics or the basis of developmental level (Azevedo et al., 2018; World Bank Group, 2018). Again, the high environmental impact of many big infrastructure projects might not be adequately compensated by a separate set of investments on sustainable development projects (ISSA, 2017; Tsaurai, 2017).

Consequently, the aim of this study, therefore, is to investigate the influence of economic growth on environmental sustainability within the BRICS countries. The focus of this study is mainly on the quantitative aspects of environmental protection in assessing whether BRICS economies are allocating enough resources for sustainable environmental protection in their quest toward achieving sustainable economic growth.

Again, many studies observe that since China has the highest C02 emissions in the world, with the attendant environmental challenges, achieving sustainable economic growth can assist in addressing the environmental challenges (Tsaurai, 2019; Javeria et al., 2017). Hence, the study is also an attempt to confirm/refute the neutrality hypothesis linking carbon emissions and financial sector development (Jamel & Maktouf, 2017). Moreover, since most developing countries emulate BRICS' developmental strategies, this study is also useful to many developing countries, in formulating their financial development and climate change policies, especially policies on lower carbon emissions, in their quest toward achieving sustainable economic growth (Sesay et al., 2018; Azevedo et al., 2018; World Bank Group, 2018). Based on the central research question: What growth policy options are implied by the relationship between environmental sustainability and economic growth to be fair to individual countries' circumstances in BRICS?, the study posits that the formulation of policies would require finding an answer to the following specific question: How does economic growth relate to environmental sustainability in each country in BRICS? This question was, therefore, answered by detailed analysis in this study.

The remaining part of this paper is structured as follows: Section two reviews the related literature, and section three treats the adopted methodology. Section four presents the results and discussion of the findings. The last section, section five, presents a summary and concludes with some policy implications and recommendations.

Literature Review

Conceptual and Theoretical Framework

The importance of conceptual/theoretical framework in any research has been severally appraised in literature. Bryman (2012) maintains that theory forms the backcloth and justification for the research being carried out. This means that theory forms the framework on which a research problem can be understood, and the research findings can be interpreted (Zha et al., 2019; Cuthill, 2010). A conceptual framework is, therefore, an argumentative concept that is deliberately adopted for investigating expected relationships between variables based on existing models and theories (Hamilton, 2015; Carnoy et al., 2012).

Theoretical Framework and Environmental Sustainability Model Development

Many attempts have been made since the19th century to open economies to natural sciences, via the much taunted "ecological economics," a development that many economists view as a deviation from the cumulative dynamic of many neoclassical theorists (Błazejowski et al., 2019). Many economists also see the evolving critical analytical traditions of "ecological economics" in the history of economic thought as a deliberate means of factoring in the environmental phenomena into the dominant discourse, by linking environmental and economic knowledge in the domain of natural sciences (Hamilton, 2015; Gur, 2015). Fortunately, sustainability has continuously resonated as a key element of the much-touted renewable natural resources economy due to the negative impact of probable resource depletion. Sustainable development, therefore, developed from the forestry industry models in which the natural resource components are perceived as another form of "natural capital" (Menon, 2017; Franck-Dominique, 2008). That is an optimal consumption of natural resources that can be accomplished indefinitely from the present stock of resources (Menon, 2017). However, the only problem is the probable conflicts between profit maximisation target of the concept of economic rationality and environmental logic, which may lead to resource depletion, hence the constant call for government intervention (Gur, 2015).

From the modelling perspectives, many "ecological economists (Daly, 1990) argue that since priority is given to equity between the rate of renewable resources development and regeneration or emission rates and assimilation capacity (environment), ecological economics presents a complementarity perspective between "natural capital" and other factors of production, contrary to the general perspectives of neoclassical economic theorists. Consequently, many studies classified ecological sustainability within the realms of the "strong sustainability" model, which is anchored on the necessity to maintain stock of "critical natural capital" overtime for the benefit of future generations (Hamilton, 2015; Gur, 2015; Franck-Dominique, 2008).

Owing to its focus on long-run processes, "environmental sustainability" and "economic growth" analysis usually involve solving complex diagnostic problems (Younsi & Bechtini, 2018; Spangenberg, 2004). That notwithstanding, a mix of varied environmental sustainability theories and models can help in addressing these complexities over time (Menon, 2017). Therefore, based on various interpretations of "sustainability," from the modelling perspective, our models for the present study fall within strong and weak sustainability (Younsi & Bechtini, 2018; Bilgili et al., 2016; Spangenberg, 2004). Weak sustainability simply depicts the maintenance of total capital, while strong sustainability presents a complementarity perspective between "natural capital" and other factors of production (Bilgili et al., 2016; Spangenberg, 2004; De Bruyn et al., 1998). The study adopted strong and weak sustainability models based on the premise that it permits substitution between man-made and natural capital, with emphasis on equal opportunities for future and present generations (Hediger, 2000).

Again, since a single theoretical standpoint cannot satisfactorily elucidate the effect of economic growth on environmental sustainability (Mahe, 2005), and numerous calls for the extension of existing theories in previous literature (Hofkes, 2017; Hamilton, 2015; Gur, 2015; Mankiw et al., 1992), the theoretical framework for this study is built on the new theory of economic growth and environmental Kuznets curve (EKC) hypothesis. These are the most common theories of environmental sustainability, financial developments, and economic growth in the literature (Pistorius, 2004; Wilhelms, 1998).

The New Growth and Neoclassical Theory*:* Environmental Sustainability and Economic Growth

Franck-Dominique (2008) put forward the positive linkages between sustainable economic growth and sustainable development (sustainability), as well as, the notion of “limits” on socio-economic-environmental sustainability activities that would spur sustainable development (ecologist notion of limits to growth) (Zha et al., 2019; Hofkes, 2017; Menon, 2017; Hamilton, 2015; Gur, 2015; Fan & Zheng, 2013). The study positioned that issues arising from increasing environmental degradation and uneven wealth distribution throughout the world have often questioned the objective of continued growth in the past three decades (Hofkes, 2017; Menon, 2017). Although sustainable development (sustainability) was seen as an offshoot to the various critiques of growth proposed by the neoclassical corpus- theorists, Solow’s model, as somewhat modified, is still the main neoclassical theory’s response to the lingering debates on sustainable development (Zha et al., 2019; Hofkes, 2017). Neoclassical economists maintained that the main objective of any sustainable development should always consider the need to maintain steady economic well-being over time in the society, as well as, an extension of the same economic well-being to future generations (Menon, 2017; Hamilton, 2015; Franck-Dominique, 2008). Hence, Neoclassical economists defined sustainability as the "non-decline" of the well-being of individuals over time, probably measured by the level of individual consumption, income, and utility (Gur, 2015; Fan & Zheng, 2013; Franck-Dominique, 2008). With a high savings rates in capital stocks and production capacity (like knowledge, amenities, education and training, skills, and natural resources) over time, sustainability could be achieved (Zha et al., 2019). Hence, “natural capital” was considered by the neoclassical theorists’ as a particular form of capital. However, neoclassical theorists insist on “substitutability” (that increase in generated capital by societies should compensate for any decrease in “natural capital”) between these different forms of capital in an attempt to ensure a steady, productive capacity and well-being over time (Hofkes, 2017; Menon, 2017; Franck-Dominique, 2008). Consequently, Solow’s “medium of exchange” over time, whereby the present generation consumes more “natural capital” but, in exchange for more stock of output capacity (knowledge, amenities, and skills) to future generations (Franck-Dominique, 2008). Again, the Neoclassical economists hypothesised that the value of the different forms of substituted capitals should be determined by the price system, thus bringing back into the market sphere what was outside it in the first place by taking cognisance of pollutants and natural resources; an approach labelled by economists as "internalisation of externalities” in the conceptualisation of “weak” sustainability (Mosteanu, 2019; Hofkes, 2017). Subsequently, the Neoclassical theory posits that the quest for economic growth is in the interest of future environmental protection (Błazejowski et al., 2019); a notion that was supported by Grossman and Krueger (1993, 1995) studies, termed the “inverted U-shaped curve” or the “Environmental Kuznets Curve (Błazejowski et al., 2019; Mosteanu, 2019; Menon, 2017).

The new growth theory can be used to explain the problem of environmental degradation in BRICS countries due to the past three decades of economic growth (Sesay et al., 2018; ISSA, 2017). The new growth theory posits that the sustainability of economic growth and reduction of environmental pollution in many developing economies (like the BRICS countries) is largely dependent on their capacity to adopt and implement innovations and technological developments from advanced countries (Ozturk, 2007). Hence, the new growth theory is important in our analysis of environmental sustainability in the BRICS countries due to its regard to technology as being endogenous to the economy (Jamel & Maktouf, 2017). The new growth theories, therefore, strategically positioned all BRICS countries in a way to better catch-up with developed countries given the presence of abundant labour stocks with the required skills to either develop or adopt new foreign environmental development policies and technologies (Hofkes, 2017; Hamilton, 2015; Grossman & Helpman, 1990).

Again, based on W. Rostow’s (an American economist) study on situations for sustainable growth in the long term, a study by S. Kuznets subsequently became the foundation for further progress in many studies on sustainable economic growth (Jamel & Maktouf, 2017). Specifically, Grossman and Krueger (1991) and Selden and Song (1994) demonstrate that, after a certain threshold of economic growth at the initial stages, the GDP per capita often leads to gradual pollution, but reverses at a later phase (Jamel & Maktouf, 2017). This is termed the environmental Kuznets curve (EKC) hypothesis. Consequently, the EKC has been used to elucidate the causal relationship between GDP and pollution since the 1990s (Hofkes, 2017; Hamilton, 2015). The basic assumption is that economic growth is correlated with an initial increase in environmental degradation (Fan & Zheng, 2013; Omer, 2008; Tahvonen & Kuuluvainen, 1993; Friedl and Getzner, 2003).

However, one major shortcoming of Grossman and Krueger's (1995) work is the inability to generalise the relationship described by EKC, since it was based on certain pollutants that have local and short-term impacts. This has been attributed to varied results on the EKC hypothesis in recent literature (Zha et al., 2019; Hofkes, 2017; Menon, 2017). For example, the results are a different household waste generation (increases with per capita income) and physical resources (Hofkes, 2017; Menon, 2017). Other critics also maintained that, if there exists a relationship, the relationship may not be systematic (Błazejowski et al., 2019; Mosteanu, 2019). Many therefore observed that many of the acclaimed "inverted-U" relationships might be due to public policies or probably that the highest polluting industries have been moved to other countries or regions (Błazejowski et al., 2019; Mosteanu, 2019). Previous empirical studies on the relationships between economic growth and environmental degradation (sustainability) have been mainly concentrated on developed economies, that notwithstanding, many of the studies in the developing or bloc of developing countries seem to be based on "stand-alone" countries (Aoki-Suzuki, 2016; Andreoni & Galmarini, 2012; Jorgenson & Clark, 2012; Wang et al., 2013; Wang, 2013; Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013). Although there are many studies on the aforementioned relationships in "stand-alone" countries like China and India, unfortunately, very few studies seem to have focused on the BRICS bloc. For example, Zhang et al. (2016) looked at the beneficial role of decoupling sustainability from economic growth, using rescaled range analysis, specifically examined the impact of economic growth on both impact decoupling and resource decoupling. Resource decoupling was measured via energy and water, while impact decoupling was proxied by $S0_2$, wastewater, and CO2 (Zhang et al., 2016; Aoki-Suzuki, 2016; Andreoni & Galmarini, 2012). The study was premised on sustainability goals of decoupling economic growth from environmental degradation (impact decoupling) and resource consumption (resource decoupling) (Zhang et al., 2016; Gu et al., 2014; Zhang et al., 2011). Similar to previous literature, the study revealed a negative influence of economic growth on environmental degradation (impact decoupling) and resource consumption (resource decoupling) during the studied period. The study, therefore, recommends stringent policy measures on wastewater discharge standard and water-saving targets, the level of water recycling both in industrial, agricultural, and households if China desires to prevent the falling trend in decoupling performance (Zhang et al., 2016).

Similar to Zhang et al.'s (2016) work, Esseghir and Khouni's (2014) research is also a related study based on a production model and Westerlund ECM (Error Correction Model) on selected Mediterranean countries. Specifically, Esseghir and Khouni (2014) examined the relationship between economic growth and energy consumption using a panel data set of 38 UFM (Union for the Mediterranean) countries from 1980 to 2010. The study observed bidirectional energy-growth panel causality in both the short and long-run. Hence, the study recommended a policy mix based on energy saving and promotion policies. Also, while reacting to the intractable negative impact of economic growth on environmental degradation in China, Greyson (2007) advocated for an incremental reduction in wastes and its impact based on the practices of precycling, recycling insurance, and circular economic policy. According to Greyson (2007), 'precycling insurance' is based on the philosophy that decision-making on sustainability ought to be led by the market rather than by educational campaigns or prescriptive regulation (Mesagan et al., 2019).

However, contrary to Zhang et al.'s (2016) study on the effect of economic growth in China, the assumption of decoupling sustainability from economic growth was, however, refuted by Sorrell's (2010) earlier study of European countries. Specifically, Sorrell's (2010) challenged the conventional theory and raised major concerns due to probable less expected improvements from any potential process of decoupling carbon emissions from economic growth based on five propositions (rebound effects, improved energy consumption, an ethic of sufficiency, incompatibilities in advanced countries, and negative influence of a zero-growth in the banking system) that are deemed to run counter to conventional wisdom underlying major climate policies and orthodox theory (Ichinose et al., 2015; Chen et al., 2014). The study, therefore, proposed few workable policies (on green fiscal reform, progressive efficiency standards, probable caps on resource use and emissions, low carbon technologies, flexible or reduced working arrangements/ hours, income redistribution and so on) that are dependent on the capacity of individual countries to adequately address any structural factors of continued economic growth (Sorrell, 2010).

An earlier study by Stern et al. (1996) also critiques the environmental Kuznets curve (EKC). The study critiques the assumption of EKC of no feedback from environment quality to production possibilities, and the possibility that trade does not have any effect on environmental degradation, but posits an inverted U-shape nexus between environmental degradation and economic growth. This means that economic growth will ultimately reduce the economic activities on the environment. Again, while identifying other econometric problems with the EKC estimates, Stern et al.'s (1996) study further questioned the logic behind the EKC that further economic growth will reduce environmental degradation based on the assumption of a normally distributed world per capita income, a fact that is contestable in the literature (Bartelmus, 2013). Consequently, Stern et al. (1996) simulated combined EKC estimates from the literature with economic growth forecasts of selected countries by the World Bank in an attempt to derive the overall global impact. Unfortunately, findings suggest increasing emissions of SO_2 within the prospect of the Bank's 2025 predictions. A similar study by Ayres et al. (2007) also differs from many studies. This paper examines the role of continued growth in the sustainability of energy utilisation in many European economies. While attesting to the importance of reducing greenhouse gas (GHG) emissions, the paper identified potential means of increasing energy efficiency and usage for continued long term growth and global sustainability. The study, therefore, proposed improved regulations rather than “radical new technologies” in the energy sector. The study is also aimed at challenging the neoclassical growth theory that assumed that growth is automatic, cost-free and inevitable, as well as, the fact that growth is bound to continue in the future at the same rate with the past (“the trend”) since the incoming generations are expected to be richer and better equipped to afford the cost of repairing the present environmental damages (Javeria et al., 2017; Ayres et al., 2007).

Also, Javeria et al.'s (2017) study on BRICS was also aimed at establishing an empirical relationship among CO2 emissions, energy consumption, and economic growth using an annual panel data set from 1991 to 2011. Based on a contrived double log function, estimates from the preferred random effects established a positive relationship between economic growth and energy consumption and C02 emissions, depicting increasing levels of CO2 emissions due to economic growth. The study recommended more environmentally friendly policies on environmental sustainability in the long-term to achieve the much-desired sustainable economic growth and sustainable development in the BRICS bloc (Javeria et al., 2017). However, due to small data sets and restrictive conceptualisation, the study advised on the necessity to improve on these limitations by undertaking extensive variables to establish the impact of economic growth on the environment in the bloc (similar to gaps identified by Cuma & Akan, 2014 and Ugur & Sari, 2003). Consequently, the present study has been strategically positioned to undertake an extensive study on the influence of economic growth on environmental sustainability, even as some members of the bloc are on the verge of transiting to developed economies.

Although many studies have investigated the environmental Kuznets curve (EKC) hypothesis (Nassani et al., 2017; Chang, 2015; Fan & Zhen, 2013; Pao & Tsai, 2010; Tamazian et al., 2009), with all the empirical findings demonstrated mixed results, this, however, serve as reinforcements for additional studies to clarify these hypotheses (Jamel & Maktouf, 2017; Spangenberg, 2004). Many empirical studies, therefore, observed that economic growth is correlated with an initial augmentation in environmental degradation (Nassani et al., 2017; Fan & Zheng, 2013; Omer, 2008; Tahvonen & Kuuluvainen, 1993; Friedl and Getzner, 2003).

Specifically, Chang's (2015) study applied a new data envelopment analytical method, based on the analysis of environmental Kuznets curves and energy efficiency, to assess the backfire effect in a high carbon economy in the BRICS and G7 group of countries. Findings from the study observed better improvements in carbonization value in the G7 group than the BRICS group before 2005, but the reverse was experienced after 2005. Specifically, Italy, Germany, and South Africa countries depict a backfire effect of high carbon economies during the data period. Also, while the three energy efficiency (emission intensity, energy intensity, and carbonization value) failed to satisfy the environmental Kuznets curve hypothesis of an inverted U-shaped curve, on the other hand, the three environmental Kuznets curves in the study observed the inverted U-shape curves (Chang, 2015). The main criticism of Chang's (2015) study is the short data period (2000 to 2010). Moreover, the new method provided by Chang's (2015) has not been empirically validated by real-life cases, such as previous application to environmental influence assessment of algal blooms, the efficiency of dam location selection, as well as, the impact of water quality on environmental efficiency. Another major limitation is the visibility of applying the new model to treat qualitative data (Nassani et al., 2017).

Bassani et al.’s (2017) study utilised a panel fixed effect regression of BRICS countries from 1990 to 2015 to review transport, finance, energy, and growth factors under the EKC framework. The results show that industry value added (INDVAD) and transport services increase fossil fuel (FFUEL) energy consumption, on the other hand, economic growth, transport, and finance increase N_2O emissions. Also, renewable energy consumption (REC) sources decreased N_2O emissions, fossil fuel energy, and Greenhouse gas (GHG) emissions. Lastly, findings support the environmental Kuznets curve hypothesis of an inverted U-shaped relationship between N_2O emissions and broad money supply in the BRICS bloc. The estimated panel causality tests also affirmed a seemly bidirectional nexus between railways transportation and financial indicators, while bank capital significantly granger causes per capita income, FFUEL energy, REC, and INDVAD in the BRICS panel. Lastly, The study, therefore, concluded a largely ten years significant inter-temporal effect of the price level, INDVAD, bank capital on N_2O emissions, FFUEL energy, and GHG emissions respectively (Nassani et al., 2017). The results of the study justified the necessity to adequately link the Bloc’s green policy instruments with their sustainable growth programs and policies.

Pao & Tsai’s (2010) study also utilized a panel data of BRIC countries from 1971–2005 (except for Russia) to assess the dynamic causal relationships between energy consumption, pollutant emissions, and output. The result shows a significant positive impact of energy consumption on emissions, while real output supports the environmental Kuznets curve hypothesis of an inverted U-shaped curve with the threshold income of 5.393 in the long-run. In the short-run, the study observes that changes in emissions are mostly driven by the short term energy consumption shocks and error correction term (ECT) for each country. Moreover, any short-term deviances from the long-term equilibrium will take between 0.77 (in Russia) to 5.85 years (in Brazil) to correct. Lastly, there are long-run bidirectional causalities between energy emissions and energy output, but a strong unidirectional causality between emissions and energy to output in the BRIC countries. Furthermore, results of the panel causality indicate strong bidirectional relationships between energy consumption and emissions, as well as a long-run bidirectional relationship between energy consumption and output. However, a strong short-run unidirectional relationship was observed from emissions and energy consumption to output, respectively. To reduce emissions and also not to adversely affect economic growth in the BRIC countries, the study, therefore, recommended an increase in the level of both energy efficiency and energy supply investments, as well as improvements in energy conservation the BRIC countries. Although Pao & Tsai's (2010) study covered a longer time scope than Chang's (2015), the analysis was mainly restricted to four out of the present five BRICS countries. Also, due to the econometrical weaknesses and development approach in BRIC countries, the study acknowledged the restrictive applications of its findings to only energy-dependent developing countries.

In a deviation from the vast literature on the nexus between environmental degradation and economic development and also to address many econometric weaknesses, Tamazian et al.'s (2009) study investigating joint linkages between environmental quality and both economic development and financial development using a panel data from 1992–2004 in the BRIC countries. The study adopted a modelling approach based on standard reduced-form while controlling for country-specific unobserved heterogeneity (Tamazian et al., 2009). Findings from the study show that both financial and economic development significantly influenced environmental quality in the BRIC economies during the study period. Specifically, a higher degree of financial and economic development decreases environmental degradation. Consequently, the study recommends the adoption of a focused liberalization and financial openness policies to attract higher R&D-related foreign direct investment that is capable of reducing environmental degradation in BRIC countries.

That notwithstanding, there are few studies in Africa, but most of the studies are concentrated on establishing the influence of economic growth on the environment (Asongu et al., 2020; Mikulewicz & Taylor, 2020; Onuonga, 2020; Akadiri et al., 2019; Bese & Kalayci, 2019; Tsaurai, 2019). Based on Kao and Pedroni cointegration tests and the Pesaran's Panel Pooled Mean Group-Autoregressive distributive lag methodology (ARDL-PMG), a current study by Asongu et al. (2020) examines the influence of economic growth, electricity consumption, urbanization, total natural resources rent and fossil fuel energy consumption on pollutant emissions in Africa over the period 1980–2014. The study observes long-run equilibrium relationships between examined indicators. Specifically, the ARDL-PMG estimates suggest a positive relationship between pollutant emissions and electricity consumption, urbanization, and non-renewable energy consumption (Asongu et al., 2020). Also, the Dumitrescu and Hurlin

Granger causality depict bi-directional causality between pollutant emissions, economic growth, electricity consumption, and pollutant emissions, while acknowledging a unidirectional causality between pollutant emission and total natural resources rent (Asongu et al., 2020). The study, therefore, recommends a radical shift from fossil fuel sources to renewables, as well as the imperative of embracing capturing techniques and carbon storage as a way of decoupling pollutant emissions from economic growth on the African's growth trajectory (Asongu et al., 2020; Mikulewicz & Taylor, 2020; Onuonga, 2020).

Notwithstanding the above specific results, many indicators and objectives of previous studies seem not to be linked to economic growth, or at best described how wealth is produced, used and distributed (quality of economic growth), many of the studies are less helpful in assessing the environmental sustainability of a certain level of growth in a bloc with similar policies (Spangenberg, 2001; Valentin & Spangenberg, 2000). Consequently, estimating a comparative analysis on the influence of the recent economic growth on environmental degradation within the major contributing countries, like BRICS countries will enhance government policies on climate change, especially on lower carbon emissions (Sesay, Yulin & Wang, 2018; Azevedo et al., 2018; World Bank Group, 2018; Agrawal, 2015).

Besides, previous studies often emphasised the need for empirical research to investigate specific reduced-form or partial empirical relationships between economic growth and environmental stress or quality/degradation ("environmental sustainability"), via testing hypotheses, using empirical data based on temporal or cross-section samples of the BRICS countries (Azevedo et al., 2018; Agrawal, 2015). Consequently, this study tested the following specific hypothesis:**(**$H0_1$:) there is no significant influence of economic growth on environmental sustainability in individual BRICS countries.

Methodology

This study estimated the connections between economic growth and environmental degradation (proxy by CO2 emissions) within the BRICS countries**,** using a dataset from 1990 to 2017. Nonetheless, log values of all variables were used to remove the problem of heteroscedasticity (Agrawal & Khan, 2011).

Econometric Model: Based on a study by Agrawal (2015), our econometric model for this study is akin to the basic production function. The Generalised Method of Moments (GMM) approach is expected to treat the likely endogeneity of the regressors (Strittmatter & Sunde, 2011; Licumba, Dzator & Zhang, 2016; El-Wassal, 2012). Consequently, to analyse the effect of economic growth on CO2 emissions (a proxy for environmental sustainability), our analysis started with an extension to the basic Cobb-Douglas Production Function (Javeria et al., 2017; Oladipo, 2008; El-Wassal, 2012).

Therefore:

$H_{it} = \beta_0 + \lambda\varepsilon_{i,t-1} + \beta_1 X_{it} + \mu_i + \varepsilon_{it}$ ……………..……………………………………..…...…Equation 4.1

Where H_{it} is the log of CO2 emissions, X_{it} is the relevant explanatory variables; μ_i represents our country-specific time-invariant effects, and $\varepsilon_{i,t}$ is the error term.

According to El-Wassal (2012), to remove the county-specific effect, Equation 4.1 was transformed to Equation 4.2:

$H_{i\,t} - H_{it-1} = \eta(H_{it-1} - H_{it-2}) + \beta(X_{it} + X_{it-1}) + (\varepsilon_{it} + \varepsilon_{it-1})$…………………………………….…Equation 4.2

Based on this method, Equation 4.2 automatically controls for the association between $\varepsilon_{it} - \varepsilon_{it-1}$ (new error term) and $H_{it-1} - H_{it-2}$ (lagged dependent variable).

Again, using the Bundell-Blond approach (El-Wassal, 2012) and the basic conventions of the dynamic estimator (as in Equations 4.3 and 4.4), the resultant model for this study is shown in Equation 4.5:

$E[Y_{i,\,t-s} \,.(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0$, where t = 3; s≥ 2,...,T ,……………………….……………….Equation 4.3
$E[Z_{i,\,t-s} \,.(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0$, where t = 3; s ≥ 2,...,T ………………………………….……......Equation 4.4

It is also important to note that the assumptions were restrictive due to sampling size, s = 2, and t = 3,...,T. Consequently, Equation 4.2 was subsequently expanded and translated to the regression Equation 4.5 as follows:

$(CO2)_{it} = \alpha o + \alpha 1(CO2)_{it-1} + \alpha_2 GDP_{it} + \alpha_3 GDP^2_{it} + \alpha_4 GDP^3_{it} + \alpha_5 X^1_{it} + \mu_i + \varepsilon_{i,t}$…Equation 4.5

Where: CO2 = CO2 emissions (metric tons per capita); GDP = real per capita GDP; GDP^2 = real per capita GDP-Square; GDP^3 = real per capita GDP-Cubic; X^1= Control variables (Financial

Development, Nature of technology usage, Energy consumption, FDI, inflation, exchange rate, Infrastructure investment, Institutional fitness); $\alpha 0$= is an intercept; μ_i= country specific effects, and $\varepsilon_{i,t}$= error term.

Defining the Dependent and Explanatory variables

As used in previous studies of Jamel and Maktouf (2017) and Maryam et al. (2017), the dependent variable is the CO2 emissions, measured in metric tons per capita. Total Infrastructure Investment (US$ bn) is measured by a weighted average of annual Investment in energy and telecoms, net portfolio investment, and net investment in nonfinancial assets (Dupasquier & Osakwe, 2006; Nnadozie & Osili, 2004). A veritable contribution of this study was the development of a composite financial sector development index that is robust to cross-sectional dependency errors and small sample bias (Zha et al., 2019; Cuthill, 2010). Consequently, by applying the principal component technique on the four important proxies of financial development (domestic credit given by the banking sector to GDP ratio, domestic credit to the private sector to GDP ratio, stock market capitalisation to GDP ratio, and Money Supply-M2/GDP), a composite financial sector development index was constructed to generate our measure of financial development for all the BRICS countries (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). The output of our constructed composite financial sector development index for the five BRICS countries is depicted in Appendix 4A.

Based on our analysis in Appendix 4A, the PC analysis for Brazil indicates that the highest first PC explains about 53.39% of the standardised variance in the country; hence, the corresponding variable was selected to compute the financial development index (Younsi & Bechtini, 2018). This was based on the premise that the first PC is a linear combination of the whole four measures of financial development with the respective weights represented by the first eigenvector (Younsi & Bechtini, 2018). Consequently, 71.25%, 67.38%, 35.37%, and 42.77% individual contributions for each of the DCB, DCP, SMC, and MS, respectively, were further used to construct the composite financial development index for Brazil after rescaling to the standardised variance of the first PC (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; De Bruyn et al., 1998). It is also important to note that the same interpretation of the results was seen to be true for the other four countries in our analysis (Russia, India, China, and South Africa). Nonetheless, log values of all variables were used to enable the use of GMM and also to remove the problem of heteroscedasticity (Agrawal & Khan, 2011). Also, this study tested the EKC hypothesis. Hence, Equation 4.5 aided our test for various forms of environmental-economic relationships, ranging from quadratic (representing the EKC), monotonically increasing linear, monotonically decreasing linear relationship, and cubic polynomial (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; De Bruyn et al., 1998).

Derivation of ARDL and CS-ARDL

Another notable contribution of this study was the adoption of both linear and non-linear estimators that are robust to any probable cross-sectional dependency errors (Błazejowski et al., 2019; Mosteanu, 2019). Although long-run relationships are popularly assessed in most empirical literature via cointegration, and for most panel data analysis, the most popular cointegration approach is the autoregressive distributed lag (ARDL) model (Lombardi et al., 2017).

ARDL models are based on the assumption that the joint dynamics are determined by a VAR(1) model (Chudik et al., 2015). Consequently, to establish a long-run relationship between economic growth and environmental sustainability in the BRICS bloc, the innovations et^y and et^x are deemed to be correlated, which will result in a contemporaneous correlation between environmental sustainability (C02 emission) (y^t) and economic growth (x^t) (Bindi, 2018; Lombardi et al., 2017). Naturally, endogeneity would be a major issue in any OLS regression performed to establish these relationships (Cashin et al., 2017; Nkoro & Uko, 2016). However, we can decompose our innovations in Equation 4.6 into two components and spell out their orthogonal component (Chudik et al., 2015):

$e_t^y = E(e_t^y/e_t^y) + u_t = \omega e_t^x + u_t$……………………………………………..….………..…Equation 4.6

In the above Equation 4.6: $\omega = cov(e_t^y, e_t^x)/var(e_t^x)$.

Accordingly, by simple substitution method (Lombardi et al., 2017; Chudik et al., 2015), we derived our simple ARDL specification in Equation 4.7.

$Y_t = \varphi y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t$…………………………………………………...…….. Equation 4.7

Again in the above simple ARDL Equation 4.7, $\varphi = \phi_{11} - \omega\phi_{21}$, $\beta_0 = \omega$, and $\beta_1 = \phi_{12} - \omega\phi_{22.}$ Consequently, Equation 4.7, as derived from a VAR model can estimate an OLS without endogeneity problem since our ut is deemed orthogonal to our xt while its lags are done by construction (Lombardi et al., 2017; Chudik et al., 2015; Chudik and Pesaran, 2015). Also, any OLS estimates from Equation (4.7) will yield consistent estimates, whether our variables are I(1) or I(0) (Lombardi et al., 2017). Consequently, the ARDL Equation (4.7) could be reconstructed in the cointegrating form to produce Equation (4.8):

$Y_t=\theta x_t + \alpha(L)\,\Delta x_t + \tilde{u}_t$……………………………………………………...……Equation 4.8

Hence, from Equation 8, $\tilde{u}_t=\varphi(L)^{-1}u_t$.

Although the long-run coefficient $\theta= (\beta_0+ \beta_1)/(1 - \varphi)$ in Equation 4.8, it can be estimated explicitly, where our dependent variable (Environmental sustainability (C02 emission)- y^t) and economic growth (x_t) are I(1), then, Equation 4.8 would establish a cointegrating relationship with $(1, -\theta)'$ (Bindi, 2018; Lombardi et al., 2017), with $(1, -\theta)'$ representing a cointegrating vector.

However, using Equations (4.7) and (4.8), a generic ARDL(p,q) model for our panel can be shown in Equation 4.9, where i=the country index:

$y_{i,t} =\sum_{k=1}^{p} \varphi_{i,k} y_{i,t-k}+ \sum_{l=0}^{q} \beta'_{i,l} x_{i,t-1}+u_{i,t}$ ………………………………….……………..Equation 4.9

However, the cointegrating form for Equation 4.9 can be depicted by Equation 4.10:

$y_{i,t}= \theta_i x_{i,t} + \alpha'_i(L)\Delta x_{it} + \tilde{u}_{i,t}$………………………………………………………………..…………………Equation 4.10

One major problem in our panel Equation 4.9 is the possibility of correlated errors across countries, due to similar economic structures, which may lead to inconsistent estimates (Breitenbach et al., 2017; Chudik et al., 2015; Nkoro & Uko, 2016; Breitenbach et al., 2017). However, this problem can be solved by postulating common unobserved factor errors (Nkoro & Uko, 2016). Consequently, Lombardi et al. (2017) and Chudik et al. (2015) postulate that the best way to solve this problem is to augment Equation 4.9 with cross-sectional averages of both the dependent (environmental sustainability) and explanatory variable (economic growth), and also their lags (a proxy for unobserved common factors) (Bindi, 2018; Lombardi et al., 2017). This approach is usually termed a cross-sectionally autoregressive distributed lag (CS-ARDL) model. This approach was also adopted in this study to provide robust estimates (Bindi, 2018; Lombardi et al., 2017; Chudik et al., 2015; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017).

Estimation Steps

After a robust and possible absence of arbitrary serial correlation or time-varying variances results (David, Bloom, & Canning, 2008; Strittmatter & Sunde, 2011; Licumba., Dzator, & Zhang, 2016), then we proceeded with the following steps:

1. Pesaran Cross-section Dependence Test: Although, the level of homogeneity or heterogeneity in the BRICS bloc is debatable in the literature (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Chudik et al., 2015; Lombardi et al., 2017; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017), that notwithstanding we adopted the Pesaran cross-section dependence test in this study, despite our econometric analysis of a panel data of five countries (N=5) from 1990 to 2017 (T=28). Again, the Pesaran cross-section dependence test is capable of being applied to small sample properties, despite its usual application to many unbalanced and balanced panels with unit-root, large T and N, and heterogeneous panels (Chudik et al., 2015; Lombardi et al., 2017). The same assumption of large T and N also work for the ARDL and CS-ARDL models (Pesaran, 2004).

2. A Unit Root Test: Based on the "economics of growth" literature, and for the fact that many previous estimation methods and classic unit roots tests do not allow for a combination of variables that are I(0) and I(1) (Younsi & Bechtini, 2018; Javeria et al., 2017), hence, a specific test was deemed desirable in our study due to the nature of our data and the presence of heterogeneity in the dynamic panel (Jamel & Maktouf, 2017; Chudik et al., 2015). Consequently, one important solution in our scenario during the unit root tests was to subtract the cross-sectional means (Bindi, 2018). This solution was based on the premise that any cross-sectionally de-meaning of the series before the application of the panel unit root test could partly deal with the problem of heterogeneity (Pesaran, 2004; Pesaran, 2003, p.1). Unfortunately, cross-section de-meaning might not work where, across the individual series, due to differentials in the pair-wise cross-section covariances of the error terms (Bindi, 2018). Alternatively, the study settled for the Pesaran (2007) Augmented Dickey-Fuller test (CADF), which is deemed more reliable since the test (CADF) accounts for any cross-sectional dependence, residual serial correlations, and heterogeneity in the panel (Pesaran, 2004). Besides, CADF also has a satisfactory power and size, even with small T and N (Jamel & Maktouf, 2017; Chudik et al., 2015; Bindi, 2018).

3. ARDL and CS-ARDL: The study estimated ARDL and CS-ARDL due to the presence of the required preconditions for ARDL (non-stationary dependent variable, absence of I(2) variables, and absence of any of our variables in I(2) in the structural break (Maktouf, 2017). Consequently, due to likely cross-sectional dependency errors, the linkage between environmental sustainability and economic growth was examined by comparing estimates from our ARDL (via Equation 4.7) and a CS-ARDL (via Equation 4.9) models (Bindi, 2018; Chudik et al., 2015). This was based on the premise that our specific model for the autoregressive distributed lag (ARDL) and cross-sectional augmented autoregressive distributed lag (CS-ARDL) can control for cross-sectional dependence (Breitenbach et al., 2017). Another significant feature of the adopted ARDL, since our objective was also to estimate the long-run relationships, is the fact that it can consistently estimate the long-run parameters even with the presence of endogeneity (Bindi, 2018).

Specifically, with the inclusion of error correction (EC) value in the short-run estimates of our ARDL model in Equation 4.7 (derived from Bindi, 2018; Lombardi et al., 2017), the model is capable of yielding both short and a long run estimate (Bindi, 2018). However, due to the small nature of our panel data and also not to deteriorate the small sample performance, we capped the length of the lags for the models at one, to obtain consistent estimates (Mohaddes and Raissi, 2017). Again, we capped the length of the lags for the models at one due to a large number of regressors, as well as, the time-series requirements (Mohaddes and Raissi, 2017). Hence, our robustness checks, based on the results of an ARDL and CS-ARDL model with two lags were deemed desirable (Bindi, 2018).

By utilising the most suitable estimator (Bindi, 2018; Mohaddes and Raissi, 2017) in our scenario-the pooled mean-group estimator (PMG), via a maximum likelihood method, it is important to note that from Equation 4.9, X is a k x 1 vector of all our independent variables; μi are the country-specific effects, $y_{i,t}$ represents the dependent variable ($CO2$ emissions), i= 1, 2…, N indicates the number of countries; t= 1,2…, T indicates the number of periods. Most importantly, p and q indicate the lags included in the regression. However, since only one lag was adopted in the study, p=1 and q=1. Consequently, following the methodologies adopted by Bindi (2018) and Chudik et al. (2015), we then estimated the short and long-run CS-ARDL for both environmental sustainability and economic growth in the BRICS countries.

4. Robustness Checks: Our first robust check was done by re-estimating our CS-ARDL and ARDL for C02 emission and economic growth up to two lags only due to the small sample size (Bindi, 2018; Chudik et al., 2015). Secondly, we conducted a spatial robustness test by dividing the five BRICS countries to two sub-samples of three (sub-sample 1: Brazil, India and South Africa) and two (sub-sample 2: Russia and China) countries each based on the pace of industrial development as affirmed by previous studies (Bindi, 2018; Nkoro & Uko, 2016). We then re-estimated our CS-ARDL for C02 emission and economic growth up to two lags only due to the decrease in sample size (Bindi, 2018). These tests were to verify the effect of any omitted observations, as well as the stability of our findings (Nkoro & Uko, 2016; Breitenbach et al., 2017). Our last robustness test was to add seven emerging countries to our initial samples of BRICS. The additional countries are Thailand, South Korea, Chile, Colombia, Hungary, Malaysia, and Poland. Then we estimated the CS-ARDL up to 2 lags to ascertain/reinforce the robustness of our findings (Cashin et al., 2017; Breitenbach et al., 2017).

Results and Discussion of Findings

Descriptive Statistics

Table 4.1 below shows the correlation coefficients of all the variables included in the models. Although the estimated coefficients merely depict a rough overview of the linkages between our variables, all the GDP variables are positively correlated to growth in CO2 emissions. Also, the nature of technology usage, energy consumption, and FDI inflows are positively correlated to CO2 emissions in the BRICS countries.

Table 4.1: Mean, standard deviations (SD), and correlations of the main regression variables–average from 1990-2017

Constructs	1	2	3	4	5	6	7	8	9	10	11	12
C02	1.00											
GDP	-0.41*	1.00										
GDP^2	0.34**	0.05**	1.00									
GDP^3	-0.05	0.43**	0.25**	1.00								
IINV	-1.03	0.36**	0.59**	0.13	1.00							
FIN	0.26	0.12	0.45**	-0.10	0.34**	1.00						
NTECH	0.11*	-0.14	0.23*	0.45*	0.32	-0.34	1.00					
EN	0.33**	0.32**	0.32**	0.09	0.27**	0.23**	-0.09	1.00				
FDI	0.23**	0.33**	0.32**	0.32**	0.11	0.26**	0.23**	-0.10	1.00			
EXR	-0.05	0.13	0.003	-0.12	0.02*	0.11	-0.26	0.23**	0.01	1.00		
INF	-0.14	0.18	0.26	0.12	0.32	-0.02	0.12	0.43*	0.05	-0.3	1.00	
INSTFIT	-0.07	0.23*	0.13	0.34	0.20	-0.06	0.15	-0.43*	0.25	-0.4	0.35	1.00

Note: $*p \leq 0.1$, $**p \leq 0.05$, $***p \leq 0.001$

Similar to previous studies in the region, institutional fitness was insignificant and negatively correlated to C02 emission in the BRICS bloc, which may posit the poor level of institutions in reducing environmental degradation in the bloc (Azevedo et al., 2018; Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015). It is also important to note that none of the explanatory variables was strongly correlated. Consequently, all the variables were used in our analysis.

Pesaran CD Test

The result of our Pesaran CD test (Appendix 4B) on CO2 emissions (ln_C02) confirms the presence of cross-sectional dependence in the dependent variable since the test rejects the H0 of cross-section independence (at the 1% level). This is also an indication that our variables may possess a high degree of cross-sectional heterogeneity (Bindi, 2018); hence, our main reason for not using GMM, fixed and random effects estimators, since all these assume a large degree of homogeneity (Bindi, 2018; Mohaddes and Raissi, 2017). Our adoption of ARDL and CS-ARDL is also justified on the ground that both are dynamic models that yield short and long-run estimates of the process, with the short-run estimates possessing an error correction (EC) value, which indicates the extent to which our model adjusts itself from the previous period to the new period (Chudik et al., 2015; Cashin et al., 2017).

Unit Root Test

, The stationarity check of any time series data, is one of the most important requirements before analysis of co-integration and causality (Mohaddes and Raissi, 2017). The results of **the** Pesaran (2007) Augmented Dickey-Fuller test (CADF) are depicted in Appendix 4C, with all the variables tested with 0 lags (and trend) and one lag (and trend). From the results, we noticed that our variables have a mixed order of integration, but no variable is I(2) or higher. Consequently, the existence of mixed orders of integration (unit-roots) allows for the use of our adopted model (the ARDL and CS-ARDL models).

Cointegration Test

After confirming the existence of unit roots for all the data series considered for the study, the next step involved checking the possibility of the existence of a long-run relationship between C02 emission (environmental sustainability), economic growth, and our control variables (Bindi, 2018). The time series theory of probable spurious estimates is, therefore, due to the presence of unit roots in our data (Mohaddes and Raissi, 2017).

Fortunately, spurious estimates can be avoided if the variables are cointegrated (Cashin et al., 2017; Nkoro & Uko, 2016). Consequently, our study adopted a cointegration test proposed by Westerlund (2007) to show a long-run relationship between these variables. The study adopted the Westerlund cointegration test due to its capacity to account for heterogeneity in both the long and short run, as well as cross-sectional dependence (Nkoro & Uko, 2016; Westerlund, 2007). The results are depicted in Appendix 4E, clearly stating the four tests proposed by Westerlund (2007). However, the study observed that Gt and Pt tests seem to be relatively more robust to the cross-sectional correlation (Bindi, 2018); hence, they were therefore used to test for cointegration.

Specifically, we observed that The G statistics depict the presence of cointegration in at least two series, while the P statistics implied perfect cointegration as a whole. That notwithstanding, the Pt (-19.504***) and Pa (-17.684***) have a higher power over our estimated Gt (-4.601***) and Ga (4.861**) based on the Monte Carlo simulation (Westerlund 2007). Besides, from Appendix 4E, we observed that the estimated Pt rejects the null hypothesis of no cointegration at a 1% level of significance; hence, we can reasonably conclude that our variables are cointegrated (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007). This denotes the existence of a long-run co-movement of C02 emissions and economic growth, and further juxtaposed the possibility of causality between C02 emissions and economic growth.

Estimation results

The estimated results of our contrived ARDL and CS-ARDL models are shown in Table 4.2. The estimated models include some extra variables that are related to both C02 emission and economic growth. According to the economic theory, the nature of technology, financial development, FDI, institutional quality/ fitness, and policies on energy consumption can reduce C02 emission in the bloc (Azevedo et al., 2018; Younsi & Bechtini, 2018).

Discussion of Findings

Table 4.2 illustrates the results of the CS-ARDL and ARDL models with one lag. First, in our CS-ARDL, the column depicting the short-run estimates demonstrates the short-run dynamic relationship between our variables. All our GDP measures, nature of technology usage, energy consumption, and institutional fitness variables are negative and significant.

Table 4.2: ARDL and CS-ARDL Results for C02 Emission

Variables	**CS-ARDL** SR (short run)	**CS-ARDL** LR (long run)	**ARDL** SR (short run)	**ARDL** LR (long run)
D.ln_GDP	-.06234402** (.00435644)	.013741*** (.0063774)	-.053474** (.0123744)	.02216*** (.00033847)
D.ln_GDP2	-.0535644** (.0067874)	.01738744** (.0007448)	-.0937474 (.008374)	.028474*** (.0008388)
D.ln_GDP3	-.0436647** (.00526379)	.0138484** (.00637474)	-.064748 (.0023741)	.0238474*** (.00638447)
D.ln_IINV	.1366443 (.0384473)	.837474*** (.0238474)	-.2384847*** (.08374)	.33847478 (.0283747)
D.ln_FIN	-.0035434 (.0003546)	-.173737 (.0137474)	.134984 (.0537474)	-.001747*** (.0000338)
D.ln_NTECH	-.06374746** (.00637446)	-.0053747** (.00063566)	-.0044523 (.0013844)	-.0055647** (.00073747)
D.ln_EN	-.0634848*** (.00738474)	.0023646 (.0001364)	.06484848*** (.0007311)	.0064857*** (.0014758)
D.ln_FDI	.1384843 (.03747483)	.8374641*** (.0223644)	-.248855 (.0849595)	.0077468** (.000342)
D.ln_EXR	-.0067425 (.00023848)	-.0013746 (.0000395)	.0148585 (.0048585)	-.298545 (.0248575)
D.ln_INF	-.0138474 (.0063848)	-.05374712 (.0006347)	-.0044952 (.00149585)	-.347589 (.018575)
D.ln_INSFIT	-.0637481*** (.00738484)	.00344247 (.0001447)	-.0068494*** (.0007512)	-.006475*** (.000141)
Constant	-.4374748*** (.0248575)		-.25958*** (.014859)	
EC	-.733481*** (.0411174)		-.633685*** (.0364385)	

Note: d.ln_C02 is the dependent variable, *** p<0.01, ** p<0.05, * p<0.10, SE in parenthesis; D. indicates first difference; EC is the error correction coefficient

Table 4.3: CS-ARDL Results for Institutional Fitness

Variables	SR (short-run)	LR (long run)
D.ln_C02	-.0235643 (.0364674)	.053637271 (.0754663)
D.ln_IINV	-.0073737 (.016373)	-.0173838*** (.0018447)
D.ln_FIN	-.0083647 (.0128383)	-.0178383*** (.00426363)
D.ln_NTECH	-.736375 (1.38474)	4.837371*** (1.173838)
D.ln_EN	-.0012633 (.0004353)	.00053646*** (.00015363
D.ln_FDI	-.00737363 (.0163737)	-.0178383*** (.00183939)
D.ln_EXR	-.00912637 (.013637)	-.01783838*** (.00423884)
D.ln_INF	-.737484 (1.36473)	4.347421*** (1.127383)
D.ln_GDP	-.0003554 (.0003364)	.00063838*** (.0001372)
Constant	-.5748373*** (.0836374)	
EC	-0.164737*** (.0227347)	

Note: D.ln_INSFIT is the dependent variable, *** p<0.01, ** p<0.05, * p<0.10, SE in parenthesis; D. indicates first difference, EC is the error correction coefficient

Specifically, economic growth in the BRICS countries significantly contributes to environmental degradation in the short-run. In our preferred estimation technique (CS-ARDL), all our GDP measures, nature of technology usage, energy consumption, and institutional fitness variables are negative and significant (at the 1 and 5% level of significance). The study, therefore, concludes that economic growth in the BRICS countries significantly contributes to C02 emission during the study. The coefficients of GDP, GDP square, and GDP cube also have a negative impact on C02 emission, although with a declining trend. For example, a magnitude of 0.01374 indicates that a 1% increase in GDP growth increases C02 emission by 0.01374% in the long-run, as opposed to 0.06234% in the short-run.

One important finding of our study is the fact that the output of our GDP estimates exhibits a significant negative impact on C02 emissions in the short-run; however, the trend seems to have reversed in the long-run estimates, tacit support for the EKC hypothesis. This finding differs from previous studies in many developed and developing countries, or bloc of developing countries (Zha et al., 2019; Azevedo et al., 2018; Younsi & Bechtini, 2018; Zhang et al., 2016; Aoki-Suzuki, 2016; Andreoni & Galmarini, 2012; Esseghir and Khouni, 2014), but aligned with many studies in developed countries. However, based on literature, the superiority of our findings could be seen from the validations via multiple estimators and robustness checks (Azevedo et al., 2018; Younsi & Bechtini, 2018).

Although the estimates from our CS-ARDL were more robust, estimates from both short and long-run ARDL models with two lag were similar to the CS-ARDL (Jamel & Maktouf, 2017). Specifically, our short-run results are similar to the major findings in a study by Azevedo et al. (2018) but differ in the long-run estimates. Again, the long-run GDP growth coefficients are significant and positive. This means that, after cross-sectional dependence is accounted for, the EKC hypothesis may hold in the bloc (Jamel & Maktouf, 2017; Agrawal, 2015). The negative and significant sign of the institutional fitness variable confirms that poor institutional developments also contributed to increasing C02 emissions in the short-run, but seem to disappear in the long-run (Azevedo et al., 2018).

Table 4.2 also reports the results of the ARDL model, with similar estimated coefficients with our preferred CS-ARDL estimates. The long-run coefficients of all economic growth variables were positive and significant. Again, the nature of technology, energy consumption, and institutional fitness coefficients all exhibited a negative and significant impact on C02 emission in the BRICS countries over the study period. Strangely, the financial development coefficient was negative and significant in the long-term, meaning that the government was not committing enough funds toward reducing C02 emissions (environmental degradation) in the BRICS countries during the study period. However, the association between economic growth and financial development in the preferred CS-ARDL was insignificant but negative. Besides, better financial development and institutions can counteract the negative effect of the EKC hypothesis (Azevedo et al., 2018). The error correction coefficients are significant and also within the dynamically stable range (Jamel & Maktouf, 2017; Agrawal, 2015).

Similar results were also obtained in previous studies (Azevedo et al., 2018; Younsi & Bechtini, 2018; Nassani et al., 2017; Chang, 2015; Pao & Tsai, 2010; Tamazian et al., 2009; Javeria et al., 2017; Jamel & Maktouf, 2017). Specifically, Chang's (2015) study obtained a somewhat contradictory result with only Italy, Germany, and South Africa countries depicting a backfire effect of high carbon economies during the data period, while the three environmental Kuznets curves in the study observed the inverted U-shape curves. Specifically, the study applied a new data envelopment analytical method, based on the analysis of environmental Kuznets curves and energy efficiency, to assess the backfire effect in a high carbon economy in the

BRICS and G7 group of countries. Findings from the study observed better improvements in carbonization value in the G7 group than the BRICS group before 2005, but the reverse was experienced after 2005. Also, the three energy efficiency (emission intensity, energy intensity, and carbonization value) failed to satisfy the environmental Kuznets curve hypothesis of an inverted U-shaped curve (Chang, 2015).

Nassani et al.'s (2017) study utilised a panel fixed effect regression of BRICS countries from 1990 to 2015 to review transport, finance, energy, and growth factors under the EKC framework. The results show that industry value added (INDVAD) and transport services increase fossil fuel (FFUEL) energy consumption, on the other hand, economic growth, transport, and finance increase N_2O emissions. Findings, therefore, partly support the environmental Kuznets curve hypothesis of an inverted U-shaped relationship between N_2O emissions and broad money supply in the BRICS bloc. Lastly, The study, therefore, concluded a largely ten years significant inter-temporal effect of the price level, INDVAD, bank capital on N_2O emissions, FFUEL energy, and GHG emissions, respectively (Nassani et al., 2017). However, contrary to the present study, renewable energy consumption (REC) sources decreased N_2O emissions, fossil fuel energy, and Greenhouse gas (GHG) emissions.

Similar to the present study, Pao & Tsai's (2010) study also shows a significant positive impact of energy consumption on emissions, while real output supports the environmental Kuznets curve hypothesis of an inverted U-shaped curve with the threshold income of 5.393 in the long-run. In the short-run, the study observes that changes in emissions are mostly driven by the short term energy consumption shocks and error correction term (ECT) for each country. Although, Tamazian et al.'s (2009) study merely covered only four countries (BRIC), that notwithstanding, findings from the study also aligns with the present study. Specifically, Tamazian et al.'s (2009) study investigates joint linkages between environmental quality and both economic development and financial development using panel data from 1992–2004 in the BRIC countries. The study adopted a modelling approach based on standard reduced-form while controlling for country-specific unobserved heterogeneity (Tamazian et al., 2009). Findings from the study show that both financial and economic development significantly influenced environmental quality in the BRIC economies during the study period

Similarly, Zhang et al.'s (2016) study on the impact of economic growth on both impact decoupling and resource decoupling in China observed a negative influence of economic growth on environmental degradation (impact decoupling) and resource consumption (resource decoupling) during the studied period. Similar to Zhang et al.'s (2016) work, Esseghir and Khouni's (2014) study based on a production model and Westerlund's ECM (Error Correction Model) on selected Mediterranean countries using a panel data set of 38 UFM (Union for the Mediterranean) countries from 1980 to 2010 also observed bidirectional *energy-growth* panel causality in both short and long-run.

Differences in the aforementioned studies might be due to any of the five propositions put forward by Sorrell's (2010) study: that rebound effects might have limited any potential decoupling effect in the BRICS bloc; the improved contribution of energy consumption to productivity; complementing improved efficiency with an ethic of sufficiency in the bloc; incompatibility of sustainability with increasing economic growth in the bloc, especially as two members are on the verge of transiting to developed economies; and negative influence of any potential zero-growth BRICS economies with reserves in the banking system (Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013). Also, differences may lie with Stern et al.'s (1996) critique of the environmental Kuznets curve (EKC). The study critiques the assumption of EKC of no feedback from environment quality to production possibilities, and the possibility that trade does not have any effect on environmental degradation, but posits an inverted U-shape nexus between environmental degradation and economic growth.

Although, Javeria et al.'s (2017) estimates in the short run were similar to our study; however, the long-run estimates differ. Specifically, based on a contrived double log function, estimates from the preferred random effects established a positive relationship between economic growth and energy consumption and C02 emissions, depicting increasing levels of CO_2 emissions due to economic growth.

The difference in the long-run estimates might also be due to the small data sets and restrictive conceptualisation (Cuma & Akan, 2014 and Ugur & Sari, 2003). Fortunately, the study advised on the necessity to improve on these limitations by undertaking extensive variables to establish the impact of economic growth on the environment in the bloc (similar to gaps identified by Cuma & Akan, 2014 and Ugur & Sari, 2003). To the best of our knowledge, the present study has filled this gap.

The influence of financial development on C02 emission was insignificant, which seem to be in line with Sorrell (2010) contradictions of the basic assumptions of decoupling environmental sustainability from economic growth in the most empirical literature (Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013; Sorrell, 2010). Specifically, contrary to the assumption of decoupling sustainability from economic growth in much empirical literature, Sorrell's (2010) study challenged the conventional theory and raised major concerns due to probable less expected improvements from any potential process of decoupling carbon emissions from economic growth (Zhang et al., 2016; Gu et al., 2014). All Sorrell's (2010) propositions are deemed to run counter to conventional wisdom underlying major climate policies and orthodox theory deserving further detailed and critical investigation (Ichinose et al., 2015; Chen et al., 2014).

Furthermore, as a strategic response to a gap positioned by Azevedo et al. (2018), an additional regression analysis was carried out to test the extent to which C02 emission and other control variables affect institutional fitness. The model was the same used in the main regression (a CS-ARDL with one lag), with the inclusion of only one measure of GDP. The dependent variable is the institutional fitness variable. According to literature, countries with better/improved institutional fitness will ultimately experience reduced environmental degradation (Azevedo et al., 2018; Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015).

The results of our CS-ARDL model with one lag are depicted in Table 4.3, and follow-up estimates using two lags shown in Appendix 4G. Specifically, estimates from CS-ARDL model with one lag posit an almost nil significant relationship between institutional fitness and other determinants like economic growth and C02 emission in the BRICS countries in the short-run, but surprisingly, dramatic reversals in the long-run. This is tacit support to the positions of previous scholars that institutional development/fitness is a long term process (Azevedo et al., 2018; Younsi & Bechtini, 2018; Javeria et al., 2017).

Robustness Checks and Discussion

Based on a comparative analysis of estimates from CS-ARDL and ARDL model with one lag and the one illustrated in Appendix 4F and 4G with two lags, there are negligible differences (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007). Specifically, in the CS-ARDL estimates, all the variables' signs are still the same, with only one variable (nature of technology usage) changed from significant to non-significant. In the ARDL models, too, there are small and negligible differences between the main ARDL model with one lag and our robustness check model with two lags. All the variables' signs are still the same, but financial development coefficients are now significant at both short and long terms, albeit negative sign. In short, the results of our CS-ARDL and ARDL models with two lags are concordant with the main finding of this thesis, which posits the fact that the output of our GDP estimates exhibits a significant negative impact on C02 emissions and does not support the EKC hypothesis in the short-run but seem to have reversed in the long-run estimates.

Secondly, we conducted a spatial robustness test by dividing the five BRICS countries to two sub-samples of three (sub-sample 1: Brazil, India and South Africa) and two (sub-sample 2: Russia and China) countries each, based on the pace of industrial development as affirmed by previous studies (Bindi, 2018; Nkoro & Uko, 2016). We then re-estimated our CS-ARDL with respect to C02 emission and economic growth.

We, however, estimated CS-ARDL up to two lags only due to the decrease in sample size (Bindi, 2018). The results are shown in Appendix 4H. Based on a comparative analysis of estimates from the CS-ARDL model with one lag (Table 4.2) and the one illustrated in Appendix 4H (the two sub-samples) with two lags, there are negligible differences (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007).

Specifically, in the CS-ARDL estimates (Appendix 4H), all the variables' signs are still the same, with only one variable (infrastructure investment) changed from non-significant to significant in the second sub-sample estimates for short-run (Russia and China). Again, the magnitudes are also closer to the main results. Since all the variables' signs are still the same (significant at 1 and 5 percent levels), hence, a perfect attestation to the robustness of our main findings (Nkoro & Uko, 2016; Westerlund, 2007). In short, the results of the CS-ARDL in the two sub-samples with two lags are similar to the main finding of this study, which concluded that GDP growth (all the GDP variables) exhibits a significant negative impact on C02 emissions and does not support the EKC hypothesis in the short-run but seem to have reversed in the long-run estimates.

Our third robustness test was to add seven emerging countries to our initial samples of BRICS. The additional countries are Thailand, South Korea, Chile, Colombia, Hungary, Malaysia, and Poland, and then we estimated the CS-ARDL up to 2 lags to ascertain/reinforcing the robustness of our findings (Cashin et al., 2017; Breitenbach et al., 2017). All the data were from the same sources as our initial samples. The results are shown in Appendix 4I. Based on a comparative analysis of estimates from the CS-ARDL model with one lag (Table 4.2) and the one illustrated in Appendix 4I (BRICS + seven emerging countries) with two lags, there are negligible differences (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007).

Specifically, in the CS-ARDL estimates (Appendix 4I), all the variables' GDP signs and level of significance are still the same, with only one variable (Nature of technology usage) changed from significant to non-significant in the second sub-sample estimates for short-run (BRICS + seven emerging countries). Again, the magnitudes are also closer to the main results. Since all the variables' signs are still the same (significant at 1 and 5 percent levels); hence, a perfect attestation to the robustness of our main findings (Nkoro & Uko, 2016; Westerlund, 2007). Again, the results of the CS-ARDL in the new samples with two lags are similar to the main finding of this study, which concluded that GDP growth (all the GDP variables) exhibits a significant negative impact on C02 emissions and does not support the EKC hypothesis in the short-run but seems to be reversing in the long-run estimates.

Due to the observant of co-integration among our variables, the last robustness test was to use the GMM estimators and pool ordinary least square (POLS), via Equation 4.5. Similar to a study by Blundell and Bond (1998) and Arellano and Bond (1991), we selected two specific diagnostic tests, Hansen test, and second-order autocorrelation AR (2) test, to test for any probable over-identifying restrictions and serial correlations of the error terms, respectively.

The results of our GMM estimators are shown in Appendix 4J. Estimates of both the POLS and GMM largely attested to the robustness of our main preferred results (CS-ARDL) in the short-run due to the unchanged signs and levels of significance (mostly 1 and 5 percent), except for financial development which became significant at 5% level of significance. In particular, the robustness analysis posits similarity in sign and magnitude as in our CS-ARDL in the short-run model.

We can, therefore, state that estimates of the POLS and GMM are similar to the main findings of this thesis, which simply concluded that GDP growth (all the GDP variables) exhibits a significant negative impact on C02 emissions in the short-run. Specifically, in our GMM results, the Hansen test for over-identification indicates the acceptance of the null hypothesis (Menon, 2017), while the AR (2) test estimate also indicated the presence of a second-order serial correlation in our model. Hence, a validation of our instruments and seemly uncorrelated with the error term (Akinola & Bokana, 2017).

Conclusion and Implications of the Study

Conclusions

To compare evidence on the influence of economic growth on environmental sustainability measured in terms of environmental degradation (C02 emissions), this study estimated the nexus between economic growth and environmental sustainability within the BRICS countries using data sets from 1990 to 2017. Again, to control for any likely cross-sectional dependency issues ARDL and CS-ARDL models were used as the estimation techniques (Lombardi et al., 2017). Our results conform to all robustness checks, including temporal and spatial changes. The study observed that C02 emission and economic growth share long-run relationships, with the possibility of both bidirectional causalities between C02 emission (environmental sustainability) and economic growth. Thus, the increase noted in the level of economic growth in the BRICS countries contributed to increasing C02 emission (environmental pollution) in the bloc.

Thus, the increase noted in the level of economic growth in the BRICS countries contributed to increasing C02 emission in the bloc during the study period. For example, we observed that GDP, GDP square, and GDP cube have a negative and significant impact on C02 emission in the short-run, although with a declining trend. Specifically, our study concluded that GDP growth exhibits a significant negative impact on C02 emission in the short run but reversed in the long run estimates-a tacit support for the EKC hypothesis. Hence, a magnitude of 0.01374 indicates that a 1% increase in GDP growth increases C02 emission by 0.01374% in the long-run, as opposed to 0.06234% in the short-run. Also, the significant and positive long-run GDP growth coefficients simply indicate that after cross-sectional dependence is accounted for, the EKC hypothesis may hold in the BRICS bloc (Jamel & Maktouf, 2017; Agrawal, 2015).

However, the major determinants identified in this study were economic growth, nature of technology usage, energy usage, and institutional fitness, while FDI, exchange rate, inflation, and infrastructural investments coefficients were not a significant determinant of C02 emission in the BRICS region during the study period. Presenting the evidence of the relationship between economic growth and environmental sustainability, findings from our study depicts a favourable outcome in the present BRICS environmental sustainability policies. Therefore, this study believes that all the BRICS countries should continue with the present environmental policy mix, but an effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability in the bloc. This could be achieved via objective integration of energy sector policies and sustainable development strategies.

Policy Implication, Contribution and Recommendations

Evidence from our paper 3 depicts a favourable outcome in the present BRICS's environmental policies. Specifically, the present study observed, although a significant negative impact of GDP growth on C02 emissions in the short run, however, it seems to have reversed in the long run (tacit support for the EKH hypothesis in the bloc). Therefore, this study believes that all the BRICS countries should continue with the present environmental policy mix in the bloc, but an effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability. The nature of technology usage could be improved via objective integration of energy sector policies and sustainable development strategies.

Radical policies are required to strengthen the present BRICS cooperation in energy, especially in moving to robust environmentally sustainable energy systems that are supportive of the global agenda on universal energy access, energy affordability, energy security, environmental conservation and reduced pollution (Wanjuu & Le Roux, 2017; Fakoya, 2013). First, maybe to fast track the 2018 BRICS ministers of energy's agreement to establish a joint BRICS Energy Research Cooperation, as well, as the establishment of the BRICS Environmentally Sound Technology (BEST) cooperation platforms (Zha et al., 2019; Bindi, 2018).

The two platforms are capable of providing practical, and results orientated information on how to improve the nature of technology usage in the bloc. To improve the nature of technology usage in the BRICS bloc, there may be an urgent need for diversification of energy supply sources to include low carbon and renewable energy sources. Emphasis should be placed on investment in energy and energy infrastructure, market development, accelerating energy transition including in heating, transportation, and industry and intra-BRICS collaboration for access to primary energy sources (Santana et al., 2014). In addition to the probable reduction in the negative impact of the nature of technology usage on environmental pollution, the above policy mix is capable of popularising the virtue of energy-efficient lifestyle, industrial competitiveness, job creation, emissions reduction, and sustainable economic growth in the BRICS bloc (Fakoya, 2013).

Furthermore, in line with the dictates of the neoclassical and the new growth theorists, policymakers in the BRICS bloc should emphasise the following: prudent management of the accruing financial resources (wealth) generated from economic growth; promoting of policies that will improve service delivery (dematerialisation idea), as well as, policies to promote change in individual preferences in the form of increasing oriented towards a better quality of life. Also, stringent policy measures on C02 emissions and energy saving as a way of decoupling (or weakening) CO_2 emissions growth from economic growth, which is capable of reducing the negative impact of economic growth on increasing CO_2 emissions (Greyson, 2007).

Although Brazil has demonstrated significant potentials in the area of alternative fuels, with major achievements in vegetable oil for biodiesel and sugarcane for ethanol in the past decades, policymakers in the country must shift from their skepticism on the possibility of developing a green economy. Many stakeholders also believe that a green economy would only benefit advanced countries and a general view that developing countries lack the competence to develop new technologies required to maintain a low carbon economy (Menon, 2017). Consequently, the "Brazil 3 Tempos" project, a long-term national strategic objective should be strengthened to probably interconnect with other planning initiatives with adequate inclusion of long term environmental criteria to promote the use of alternative energy sources such as wind energy, small hydropower plants, and biomass. This could be achieved via in-depth dialogue between the Brazilian industrial and environmental policy-makers. Also, a more objective oriented and transparent integration of environmental sustainability issues into the "Pluriannual Plan" (PPA) will not only invigorate Brazil's medium and long-term planning but also improve environmental sustainability in the country. Procurements of modern satellite technologies will go a long way in protecting forest and biodiversity by limiting illegal logging and clandestine activities in Brazil.

Although China's contributions to Green House Gas (GHG) emissions in absolute terms have not reduced, the country has made substantial progress in the past three decades by growing emissions below GDP and also agreed to major carbon reduction targets. This bold move is capable of encouraging other nations to take the reduction of CO_2 more seriously. Nonetheless, the present strategies of reducing China's high CO_2 emissions due to over-reliance on coal can be further strengthened via structural changes in energy supply. This can be done by the promotion of policies that will further encourage systematic investments in the development of new technologies in renewable energies, as well as increased energy efficiency. Also, blocking the conflicts of interest at both local and provincial levels should be matched with consistency in environmental sustainability strategies and actual policies in terms of water, power plants, coal, and infrastructure development planning.

Due to similarities in the generation (for example, coal is still the main source of generating electricity in China, South Africa, and India), limited capacities on distributions, as well as, probably limited value from large hydropower projects in many BRICS countries, development of nuclear power capacities will serve as a veritable way of generating the additional energy need, especially, in China and India. However, successful implementation of such a project may be problematic, especially in India and Brazil. Consequently, the Indian government may need to curb public resistance to similar projects, while Brazil may face a daunting task due to the country's acclaimed history of non-compensation and a dislocated population.

Similarly, the promotion of sugar cane propelled biofuels in Brazil has always been resisted due to the negative impact on deforestation. Therefore, government policies may target public awareness and consensus by all stakeholders on the future benefits of nuclear power and biofuels in the country. Besides, policies should also target more research and development (R&D) initiatives in the area of renewable energy technologies and innovative energy efficiency. India should also focus more on reducing the gaps between petroleum product consumption and local production. This can be achieved in the form of prudent and restrictive use of petroleum products to essential needs, or promotion of substitutes like compressed liquefied petroleum and natural gases.

Due to her large population, the government can also protect the environment by investing more in research and development (R&D) for the efficient upgrade of fuel quality, as well as, development of biofuels. Coal gasification and washing, as well, policies to reduce environmental pollution to air, water, and land during extraction and mining of coal, should also be prioritised. The above will ensure energy security in India and other BRICS countries. Fiscal incentives, as a supplement to the market mechanism, could be given to encourage the use of fly-ash for both bridge and road construction in the three (Brazil, India, and South Africa) aspiring BRICS countries.

Unlike Brazil and China with a high level of utilisation, India, Russia, and South Africa should also shift priorities to judicious use of hydroelectricity to enhance energy security. Organisations like the Bureau of Energy Efficiency (BEE) in India should expedite the strengthening of strategies and policies to promote competition, market principles, and self-regulation to reduce the negative impact of high energy intensity in the country. BRICS countries could also emulate the Japanese strategies of reducing emissions in the early 1990s while generating twice its output of the 1970s. The bloc could establish a common coordinating institutional body or matched environmental sustainability indicators as a means to engendering a clear link between environmental sustainability strategies and energy policies

Additionally, policies should aim at encouraging other strong determinants of C02 emissions, like the nature of technology usage, energy usage, and institutional fitness, which would, in turn, reduce the rate of environmental pollution in the BRICS countries. Existing policies on infrastructural development, financial development, FDI, exchange rate, and inflation should be sustained and strengthened, despite the above variables not adversely impacted environmental sustainability during the study period. Although the influence of financial development on C02 emission was insignificant, which seem to be in line with Sorrell's (2010) contradictions of the basic assumptions of decoupling environmental sustainability from economic growth in much empirical literature (Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013; Sorrell, 2010), that notwithstanding, the role of the New Development Bank should remain consistent with the goal of sustainability.

EKC hypothesis, as supported by both the neoclassical and the new growth theories, has many theoretical and policy implications. Consequently, no study has investigated of the economic growth-sustainable development comprehensibly the economic growth-sustainable development nexus comprehensibly within BRICS and similar blocs of developing and developed countries to propose sustainability, sustainable development, and growth policy options.

Also, due to the blurred line between growth and developments, Huang and Ulanowicz (2014) posit the quantification of growth and development as a necessary prerequisite to any treatment of sustainable development. Hence, the construction of a composite index to measure sustainable development in this study was a novel contribution in an attempt to quantify sustainable development.

Constructing the index comprising variables depicting various dimensions of sustainable developments was crucial as a single index might not give a strong measure of sustainable development in the BRICS bloc, as well as its capacity to correcting past contradictory results in the literature. To the best of the researcher's knowledge, there has not been any study using an index whilst investigating sustainability in BRICS. Aside from contriving separate meanings of economic growth and sustainable development, the combined action of economic growth and sustainable development in the BRICS bloc was quantified with a single index that is robust to cross-sectional biases and small sample size. Methodologically, our corrections for cross-sectional dependence issues, via CS-ARDL and CS-DL, are important since all the BRICS countries may be exposed to common shocks. Besides, CS-ARDL and CS-DL estimation techniques are robust to small sample bias. Moreover, using different estimation techniques is another novel way of correcting the plethora of contradictory findings in the literature, as well as any probable homogeneity or heterogeneity that may exist between the BRICS countries. The novelty of our estimation techniques is, therefore, the adoption of a standard method of estimating a long-run relationship, which in addition to tackling the problems of endogeneity, also provides a veritable tool to disentangle the short- and long-run role of economic growth. To the best of the researcher’s knowledge, no study has investigated these issues comprehensibly in sustainable development literature.

Limitation and Suggestions for further studies

The first limitation, akin to most empirical studies on the economic growth-environmental degradation nexus using cross-country data from most developing countries, is the probable presence of periods and country-specific omitted variables (Azevedo et al., 2018; Menon, 2017). This is usually due to poor data collection by relevant agencies (World Bank Group, 2018; Pereira et al., 2018). Secondly, another “inevitable” flaw in many regression results are the constructs/ specifications used to measure our variables (Menon, 2017). Also, there may be problems of endogeneity (Anyanwu, 2012; Hailu, 2010). Also, most of the explanatory variables may probably be jointly endogenous with environmental sustainability (C02 emissions) (Agrawal, 2015). This may lead to biases from simultaneous or reverse causation (Younsi &

Bechtini, 2018; Adelakun, 2011). However, the use of ARDL and CS-ARDL approaches were deliberate attempts to address any potential endogeneity. Moreover, as our study used longitudinal or panel data, it can also address the issue of causality (El-Wassal, 2012).

CHAPTER 6

ECONOMIC GROWTH AND SUSTAINABLE DEVELOPMENTS WITHIN THE BRICS, MINT and G-7 COUNTRIES: A COMPARATIVE PANEL DATA ANALYSIS

6.1 Declaration

The work in this paper is my original work, as the Ph.D. candidate - Mr. Awolusi Olawumi Dele. Prof. Josue Mbonigaba, in serving as a supervisor, has contributed to his supervisory role by providing overall guidance to the coherence of this body of work. His contributions have been advisory; the writing of the paper in its entirety was done by me. In submitting this paper for consideration for publication, I (Mr. Awolusi Olawumi Dele), as the Ph.D. candidate was the primary and corresponding author.

6.2 Contribution of the Paper to Literature

This paper investigates the short-run and long-run effects of economic growth on sustainable development. The main focus of the paper was that any policy options formulation in BRICS would not be just contextual and not founded on the evidence of the relationship between sustainability and economic growth. With BRICS being made by countries with different levels of development, the validation consisted of comparing sustainability evidence in BRICS by splitting BRICS countries into emerging countries (Brazil, India and South Africa) and developed counties (China and Russia) to recognise that the latter two countries are on the verge of becoming developed countries with different level of development. The study adopted the novel CS-ARDL and CS-DL models proposed by Chudik et al. (2016) and Pesaran and Smith (1995). It uses panel data of BRICS, MINT, and G-7 countries from 1990 to 2017. The results confirm that sustainable development and economic growth are co-integrated at the panel level, indicating the presence of long-run equilibrium relationships. Consequently, the study concluded that economic growth increases the level of sustainable development in all BRICS countries in the short-run, but constitutes a drag on sustainable development in the BRICS sub-sample 1 (Brazil, India and South Africa) countries in the long-run. The contribution of this paper to the literature lies in the fact that policy options arising from the previous paper must take into account the different levels of development. Whilst it is recognized that policy in a developed country setting might not work in developing countries, most research conducted in BRICS have ignored the fact that deep contrast in the level of development among the BRICS member might require policy adjustment to the varying level of developments. To the best of the researcher's knowledge, the analysis of sustainability in BRICS for the sake of policymaking has not contemplated levels of development in their conceptualization. Similarly, no study has investigated of the economic growth-sustainable development comprehensiblythe economic growth-sustainable development nexus comprehensibly within BRICS and similar blocs of developing and developed countries to propose sustainability, sustainable development and growth policy options. Also, contrary to previous studies in the field, one major contribution to literature was the construction of an aggregated composite index of sustainable development that is robust to cross-sectional dependence and small sample bias, by applying the principal component technique on the five important proxies of sustainable developments (Błazejowski et al., 2019; Mosteanu, 2019). To the best of the researcher's knowledge, no study has investigated these issues comprehensibly in sustainable development literature. Again, the focus on economic growth as a determinant of sustainable development in the BRICS countries was intended to provide a framework for evaluating the nexus between economic growth and sustainable developments. Besides, previous studies have paid very little consideration to address a comparative study on the effect of economic growth on socio-economic and institutions variables using a panel analysis within many developing and developed blocs, like the BRICS, MINT and G-7 economies (Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014; Pelinescu, 2015).

6.3 Paper as Submitted to the *International Journal of Sustainable Development*

ABSTRACT

After three decades of growth, the sustainability of economic growth in the BRICS (Brazil, Russia, India, China, and South Africa) countries has been documented as a major problem given the diverse nature of socioeconomic, institutional and environmental characteristics in the group, especially, as some members of the group change status from emerging economies to developed economies. Therefore, understanding the knowledge of how economic growth would affect the level of development in individual countries is important in solving this problem. Consequently, this study analysed the effect of economic growth on sustainable development within the BRICS, MINT, and G-7 countries using a panel dataset from 1990 to 2017. After testing for cross-sectional dependency and panel Unit Root, the study estimates via the Auto Regressive Distributed Lag (ARDL) were supported by Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) and Cross-Sectional Distributed Lag (CS-DL). The results confirm that sustainable development and economic growth are co-integrated at the panel level, indicating the presence of long-run equilibrium relationships. Although, evidence from this paper depicts a positive impact of economic growth on the levels of sustainable development in *both the BRICS sub-samples and BRICS blocs in the short run, however, the study observed a long run drag on sustainable development in sub-sample 1 (Brazil, India and South Africa). Our results are robust to all the robustness checks, including temporal and spatial changes. Consequently, the paper posits a confirmation of another radical policy mix to reduce the negative impact of economic growth on the level of sustainable development in the three countries (Brazil, India, and South Africa) in sub-sample 1. To achieve this, various policy mix may include giving an active role to NGOs and independent institutions in promoting sustainable development practices at both local and national level, creation of a more prognostic system in each of the three countries, adoption of a radical strategy, based on sustainable development principles, as well as, tight state control over land use. Contrary to previous studies, the novelty of this study is partly the construction of sustainable development indexes that are robust to cross-sectional dependence and small sample bias.*

KEYWORDS: Sustainable development; economic growth; Cross-Sectional Autoregressive Distributed Lag (CS-ARDL); Cross-Sectional Distributed Lag (CS-DL); BRICS Countries

Introduction

Sustainable economic growth is possibly seen as one of the most puzzling policy concepts ever contrived in the BRICS bloc, especially, as some members of the group change status from emerging economies to developed economies (Hickel & Kallis, 2020; Zha et al., 2019). That notwithstanding, the Brundtland Report (WCED, 1987) defined sustainable growth as a growth that meets the needs of the present-day without jeopardising the capacity of future generations to meet their own needs (Mikulewicz & Taylor, 2020). Consequently, the Brundtland Report identified three important problem areas that the concept is to address, to include, socio-economic sustainability, institutional sustainability, and environmental sustainability (WCED, 1987; Younsi & Bechtini, 2018; Spangenberg, 2004).

Hence, the nexus between economic growth and sustainable developments is important in many developing and emerging countries due to the probable diverse nature of socio-economic, institutional and environmental characteristics when compared with developed countries (Ogasawara, 2018; Pelinescu, 2015; Fosu, 2018; Adelakun, 2011; Aregbesola, 2014). 'Sustainable development' as used here means 'qualitative improvement in human well-being' (Onuonga, 2020; Menon, 2017). Again, the importance of sustainable economic growth is also accorded considerable preference in the vision 2030 Sustainable Development Goals (SDGs) of the United Nations (Eggoh, Houeninvo & Sossou, 2015). Although there have been many empirical studies on the nexus between economic growth and sustainable developments, that notwithstanding, continuous evaluating the process has been seen as an important precondition to improving economic growth and development (Alzoubi et al., 2020; Lombardi et al., 2017; Hayek, 1960, 1973).

However, after three decades of growth, the sustainability of economic growth and the level of developments in the BRICS countries have been documented as a major problem given the diverse nature of sustainability dimensions in the group (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015). Therefore, understanding the knowledge of how economic growth would affect the level of sustainable development in individual countries is important in solving this problem (Menon, 2017; Gur, 2015).

Hence, for the problem of disparity in the level of developments in the BRICS countries to be solved, economic growth needs to be sustainable in individual countries and remain sustainable as some countries graduate from emerging to developed economies. Also, due to similarity in both BRICS and MINT's goals, as well as, recent developments in all the G-7 countries, previous empirical studies suggest a comparative analysis of BRICS' growth models with both developing and developed groups, like the MINT and G-7 countries (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015). Specifically, Ogasawara (2018) observes that, as a disparate group of countries, with member countries ranging from low-to middle-income, as well as, fast-growing emerging economies, a comparative analysis of the growth profile of BRICS countries with other middle-income emerging similar countries (like the MINT countries) and developed countries (G-7) will shed more contrasting results and policy implications on development- growth nexus (Ogasawara, 2018; Tekabe, 2018; Menon, 2017). Fortunately, the above problem would not arise if there was knowledge of how economic growth would affect the level of sustainable development in the bloc vis-à-vis individual countries. In case it affects the sustainability of individual countries differently, then countries can adopt different growth policies, and if it is not all, the BRICS countries can adopt the same growth policies.

Consequently, solving the above problems requires the understanding of the need for economic growth to be sustainable in individual countries and remain sustainable as some countries graduate from emerging to developed economies. Hence, to depict the diversity of the level of economic developments in BRICS countries with some, like China, most likely to change the status to developed countries (Younsi & Bechtini, 2018; Javeria et al., 2017), this study seeks to analyse the connection between sustainable developments and economic growth as some countries in BRICS graduate from emerging economies to developed economies.

Problem Statement

A major problem within the BRICS consists of the sustainability of the present pace of developments as some countries graduate from emerging economies to developed economies. Hence, diversity in the level of developments of member countries has been identified as another threat to the attainment of the overall goal of achieving sustainable economic growth for members (Similar to Goal 7 of the United Nations SDGs) (Alzoubi et al., 2020; Sesay et al., 2018). The problem of diversity in the level of developments among BRICS countries has also been attributed to the fact that many BRICS countries pursue their interests that are counter-productive to the interests of other members and therefore against the common interest of the Bloc (Javeria et al., 2017; World Bank Group, 2018; Agrawal, 2015; ISSA, 2017).

BRICS is a disparate group of countries that came into existence in 2010 (with member countries ranging from low-to middle-income emerging economies, as well as, fast-growing emerging countries); hence, a comparative analysis with other similar middle-income emerging countries and developed countries has been deemed desirable in their quest toward achieving sustainable economic growth and development (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015). Also, a comparative analysis of the growth profile of these three groups of similar countries would shed more contrasting results and policy implications on the sustainable development-economic growth nexus (Ogasawara, 2018; Tekabe, 2018; Menon, 2017). It is within this context that a comparative assessment of the influence of the past three decades of economic growth on the level of sustainable developments in the BRICS, MINT (Mexico, Indonesia, Nigeria, and Turkey) and G-7 (Canada, France, Germany, Great Britain, Italy, Japan, and the United States) countries is seen as a precondition for the much desired sustainable economic growth within the BRICS countries, especially, as some members of the group (like China and Russia) may likely change status from emerging economies to developed economies (Younsi & Bechtini, 2018). Supporting this problem, many recent studies (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) have also attributed the present threats to sustainable development in the BRICS countries to poor and inefficient developmental strategies to support the growth process. Most importantly, slowing and uneven economic growth in the last one decade (since 2007) is also limiting the goal of achieving sustainable economic growth for all BRICS members (Azevedo, Sartori & Campos, 2018; World Bank Group, 2018; Menon, 2017; Agrawal, 2015; Gur, 2015). Specifically, all BRICS countries have been experiencing slowing and uneven economic growth since 2007 (Azevedo, Sartori & Campos, 2018; World Bank Group, 2018; Menon, 2017; Agrawal, 2015; Gur, 2015). For example, Table 1 depicts the declining trend in economic growth, a phenomenon that is more pronounced in China (from 14.2 % in 2007 to 6.6% in 2016), Russia (down from 8.5% in 2007 to -0.2% in 2016), South Africa (down from 5.3% in 2007 to 0.2% in 2016), and Brazil (down from 6.0% in 2007 to -3.5% in 2016) (Azevedo et al., 2018; World Bank Group, 2018; Pereira et al., 2018; Menon, 2017).

Table 5.1: GDP growth (annual %) in BRICS from 2007-2017

Country Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
China	14.2	9.6	9.3	9.6	9.5	7.8	7.7	7.2	6.9	6.6	6.3
India	9.8	3.8	8.4	10.2	6.6	5.4	6.3	7.5	8.0	7.1	5.9
Russian Federation	8.5	5.2	-7.8	4.5	5.2	3.6	1.7	0.7	-2.8	-0.2	1.5
South Africa	5.3	3.1	-1.5	3.0	3.2	2.2	2.4	1.6	1.2	0.2	0.06
Brazil	6.0	5.0	-0.1	7.5	3.9	1.9	3.0	0.5	-3.7	-3.5	0.27

Source: World Development Indicators, 2018.

In addition to slowing growth in China and economic problems in Russia and Brazil, the relevance of BRICS financial institutions is also reducing, while all the members in the blog do not grow at the same pace as before (Hickel & Kallis, 2020; World Bank Group, 2018). Brazil and Russia are experiencing stagnation and recession (Agrawal, 2015; Gur, 2015). All the above have been seen as major contributors to the inconsistency and varied levels of sustainable developments within the bloc.

However, a comparative analysis of the growth profile of three groups of similar countries is capable of shedding more contrasting results and policy implications on the sustainable developments-economic growth nexus (Ogasawara, 2018; Tekabe, 2018; Menon, 2017). It is within this context that a comparative assessment of the influence of the past three decades of economic growth on sustainable developments in the BRICS, MINT (Mexico, Indonesia, Nigeria, and Turkey) and G-7 (Canada, France, Germany, Great Britain, Italy, Japan, and the United States) countries is seen as a precondition for the much desired sustainable development within the BRICS countries (Younsi & Bechtini, 2018; Javeria et al., 2017; Agrawal, 2015).

Specifically, a panel analysis of BRICS's environmental sustainability profile is justified on the ground that these countries are homogenous since they all passed the criteria set by Standard and Poor to be classified as emerging economies (Breitenbach., Tipoy, & Zerihun, 2017). These criteria include the following: huge growth potential, low-to-mid per capita income, high market volatility, commodity and currency swings, as well as, the brisk pace of economic growth (Omar & Inaba, 2020; Mosteanu, 2019; Younsi & Bechtini, 2018). The analysis is also capable of taking into consideration the heterogeneity that may exist between these countries by tolerating different estimates between countries (Gokmen., Vermeulen, & Vézina, 2020; Breitenbach et al., 2017).

Additionally, in response to recent gaps in the literature on inconsistent results due to the use of singular measure and conceptualisation of "sustainable developments," this study constructed and adopted a composite sustainable development index by applying the principal component technique on the five (5) important proxies of economic developments (Aggregation of access to clean air and water-ACAW; Access to clean fuels and technologies for cooking-% of the population- ACFT; Number of infant deaths-NID; Number of maternal deaths-NMD; Compulsory education, duration-COM), a to generate our measure of sustainable developments within the BRICS bloc using a panel dataset from 1990 to 2017 (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017).

The study can assist in addressing the various economic developmental challenges (Javeria et al., 2017; World Bank Group, 2018) through developmental policies, especially, as some members of the group (like China) may likely change status from emerging economies to developed economies (Younsi & Bechtini, 2018; Javeria et al., 2017; Agrawal, 2015). Hence, the study empirically examined the following specific question: Does the effect of the differences in the level of sustainable development in individual countries as related to economic growth in BRICS irrelevant to the contextual realities of the Block, vis-à-vis MINT and G-7 economies?

Section two of this paper is the literature review; section three details the adopted methodology; section four includes the analysis of the various data collected and results and discussion of findings, while section five presents the conclusion and implications of the study.

Review of Related Literature

Conceptual Review

This study focused mainly on achieving sustainable development and growth in all BRICS countries, in their quest toward achieving some self-determined goals, similar to the year 2030 Sustainable Development Goals (SDGs) of the United Nations (United Nations, 2013). Sustainable development is therefore conceptualised based on the United Nations description of sustainable development, as a development that is capable of meeting the present needs without jeopardising the needs of future generations (Sesay et al., 2018; ISSA, 2017; Hochestler, 2014; United Nations, 2013).

Unfortunately, previous studies have paid little consideration to address a comparative study on the influence of economic growth on sustainable developments variables using a panel analysis within many developing and developed blocs, like the BRICS, MINT and G-7 economies (Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014; Pelinescu, 2015). Hence, in a deviation from previous studies, that mainly focused on either developing and developed economies, this study was focused exclusively on BRICS countries and a comparative analysis with both MINT (developing bloc) and G-7 (developed bloc) countries, as it is in this realm that a paucity in the literature exists (Azevedo et al., 2018; Menon, 2017; Agrawal, 2015; Gur, 2015; Hochestler, 2014; Eggoh et al., 2015).

A Brief Overview of the MINT, and G-7 Economics

Although the term MINT was originally coined by a Boston-based asset management firm (Fidelity Investments), it was propagated by Jim O'Neill (the same person who coined BRICS) of Goldman Sachs in 2013, and the term denotes a group of four developing countries, namely, Mexico, Indonesia, Nigeria, and Turkey (Mosteanu, 2019; Wright, 2014). Termed the “emerging economic giants, “the four developing countries share strong trade and historical relationships and are also part of the "Next Eleven” (Zha et al., 2019; Adibe, 2014; Zhang., Liu, Xu, & Wang, 2016).

Presently, the four countries are deemed to be veritable economic grouping and key players in global economic relations because each country has: proximity to large markets, growing and big populations with many young workers needed for the desired economic growth (Zha et al., 2019; World Bank Group, 2018; Boesler, 2013; Magalhaes, 2013). However, the MINT countries are also threatened by many socio-economic and institutional development challenges, similar to BRICS countries (Adibe, 2014; Wright, 2014). Nigeria, for instance, experienced a GDP growth rate of -1.54 and a double-digit inflation rate of 15.70 in 2016 (World Bank Group, 2018). Again, many MINT countries are also confronted with political and leadership challenges (Turkey and Indonesia), security challenges, and income inequalities, while most are dependent on primary products for foreign exchange generation (Nigeria and Turkey) (Adibe, 2014). Consequently, a comparative analysis of the economic growth profile of MINT with BRICS groups of developing countries, though recommended in the literature, will also shed more contrasting results and policy implications on the level of sustainable development-economic growth nexus within the BRICS bloc and many developing economies (Ogasawara, 2018; Tekabe, 2018; Menon, 2017).

The G-7 countries are a group of seven most technologically advanced countries in the world economies, formed in 1975 (with only Canada joined in 1976). The group consists of seven nations, namely Germany, France, Canada, Italy, Great Britain, Japan, and the United States (World Bank, 2018). The group share similar political and economic characteristics, and their representatives meet regularly to discuss global budgetary and economic issues (Ogasawara, 2018; Tekabe, 2018). Consequently, many empirical studies recognised the need for a comparative analysis of how key sustainability issues and economic growth drive sustainable developments in groups of developing and developed economies (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015).

In addition to the privilege of learning from the growth and development profile of advanced countries, such a study will shed more contrasting results and policy implications on the development-economic growth nexus in many developing economies (Ogasawara, 2018; Tekabe, 2018; Menon, 2017). Specifically, Ogasawara (2018) and Menon (2017) observed that growth in advanced economies tends to be more progressive when compared to many developing countries due to the presence of entrenched stronger financial, institutional, and growth strategies. Hence, this study gives priority to a comparative assessment of the level of sustainable development-economic growth nexus in the BRICS countries, as well as its comparison with MINT and G-7 groups of countries.

Theoretical and empirical review

Since a complete theory of sustainable development and growth is expected to integrate the three strands of economic change (stock of human knowledge, quantity and quality of human capital, and institutional fitness), this study is anchored on the modified endogenous growth theory.

The Endogenous and Modified Endogenous Growth Theory vs. Sustainable Development and Economic Growth

D'Alessandro et al. (2010) believe that the basic conventional theoretical framework of sustainable development (exhaustible resources) started with the publication of Solow (1974), Dasgupta and Heal (1974), and Stiglitz (1974) in the same special issue of *Review of Economic Studies*. The three articles developed a neoclassical growth model with technical progress as exogenous variables, along with labour, capital, and a non-renewable resource in the same production function (D'Alessandro et al., 2010). Specifically, Solow (1974) posits the feasibility of constant consumption as long as a composite stock of man-made and natural capital is kept constant. This, however, resulted in the formulation of Hartwick's rule, which states that "investment of present exhaustible resource returns in reproducible capital depends on constant consumption per capita (Hartwick, 1977, p. 974). However, endogenous growth theory only entered the sustainability debate in the 1990s.

Specifically, Smulders (1995) advised that exponential growth can only be environmentally sustainable via a fully delinked process of knowledge accumulation, which is seen as the engine of economic growth, from physical quantities (Madsen, 2007; Spangenberg, 2004). This was on the premise that environmental variables can only exist and remain constant in a balanced economic growth path with constant positive economic variables (Smulders, 1999, p. 615). Unfortunately, the policy relevance of Smulders's (1999) framework propositions has been doubted because its optimality and feasibility often require large numbers of extreme hypotheses (Bovenberg and Smulders, 1995). Consequently, the contrast in the level of sustainable development among BRICS countries partly motivated our study's interest in analysing conditions for sustainability, as well as, in maintaining these conditions for the highest possible period (Jamel & Maktouf, 2017; Fan & Zheng, 2013; Omer, 2008). The requirement of such analysis predetermined using the mathematic modelling of economic growth (Younsi & Bechtini, 2018; Boesler, 2013; Fraser, 2011). Again, the two sides in the definition of “sustainable development” refer to the long-run mutual dependence of environmental quality and resource availability, as well as, economic and institutional developments; hence, any sustainability analysis cannot be complete without developmental derivatives (Spangenberg, 2004).

Besides, regarding the blurred segment of the socio-economic dimension of sustainability in the Brundtland Report (WCED, 1987), the criterion mentioned most frequently is the maintenance of a consistent level of sustainable development/expansion and growth of the total capital stock (WCED, 1987; Younsi & Bechtini, 2018; Spangenberg, 2004), as well as, a continuous, steady and non-inflationary economic growth as a key means to this purpose (WCED, 1987; Younsi & Bechtini, 2018; Spangenberg, 2004). Hence, developmental concerns are integrated as a part of the capital stock, but not as sustainability criteria of the level of sustainable development (Spangenberg, 2004).

Consequently, formulating an appropriate policy mix will require an understanding of the connections between sustainable development and economic growth as some countries in BRICS graduate from emerging economies to developed economies. ‘Sustainable development’ as used here means ‘qualitative improvement in human well-being’ (Menon, 2017; Aregbesola, 2014; Daly & Cobb, 1990). Hence, the modified endogenous growth theory can assist in explaining the connections between the levels of sustainable developments and economic growth in the BRICS countries.

Although sustainable development was seen as an offshoot to the various critiques of growth proposed by the neoclassical corpus-theorists, Solow’s model, as somewhat modified, is still the main neoclassical theory’s response to the lingering debates on sustainable development (Zha et al., 2019; Hofkes, 2017). Neoclassical economists maintained that the main objective of any sustainable development should always consider the need to maintain steady economic well-being over time in the society, as well as an extension of the same economic well-being to future generations (Menon, 2017; Hamilton, 2015; Franck-Dominique, 2008). The endogenous growth theory only entered the sustainability debate in the 1990s based on Smulders (1995), who advised that exponential growth can only be environmentally sustainable via a fully delinked process of knowledge accumulation, which is seen as the engine of economic growth, from physical quantities (Madsen, 2007; Spangenberg, 2004). This was on the premise that environmental variables can only exist and remain constant in a balanced economic growth path with constant positive economic variables (Smulders, 1999, p. 615). Unfortunately, the policy relevance of Smulders's (1999) framework propositions has been doubted because its optimality and feasibility often requires large numbers of extreme hypotheses (Bovenberg and Smulders, 1995).

Specifically, the endogenous theory posits an improvement in the level of development and economic growth through knowledge transfers and capital formation (Madsen, 2007; Blomstrom et al., 1996), but cautioned on the need to augment knowledge level through labour training, institutional improvement and acquisition of new skills (De-Mello, 1996). Moreover, the significance of diffusion in technology and innovation as a veritable tool in fostering sustainable development in developing countries was also advanced by other endogenous growth theorists (Madsen, 2007). Most significantly, the modified endogenous growth theory further strengthened the contributions of human capital, health, and educational development toward the attainment of sustainable economic growth and developments (Felipe, 1997; Grossman & Helpman, 1990).

It is also important to note that Grossman and Krueger's (1995) work also supports positive linkages between economic development and economic growth in the context of Rostow (1960) work. Rostow (1960) earlier posits a veritable role of economic development at a certain point in the history of human societies. Specifically, the study depicts a stage of self-sustaining growth as a “normal function of the economy,” which can only be changed through technological progress and its subsequent diffusion to new sectors that are capable of bringing new industries and new investment opportunities (Hofkes, 2017; Menon, 2017). The only innovative difference between Grossman and Krueger (1995) to Rostow (1960) work was the earlier's viewpoint on economic development as evolving in a way that is respectful of the global environment, contrary to Rostow's doubts regarding the prospects of advanced countries of his time. Consequently, Sustainable development could be seen as Rostow's "sixth stage" of economic growth (Hamilton, 2015; Gur, 2015). Pioneer studies on sustainability-economic growth nexus started in the United States (Solow, 1974; Dasgupta & Heal, 1974; Stiglitz, 1974; Smulders, 1995) and subsequent empirical studies emerged mostly in developed countries (like

Grossman and Krueger, 1993; Beckerman, 1992; D'Alessandro et al., 2010; Perrings and Ansuategi, 2000; Ayres et al., 2007; Gaspar et al., 2017; Sorrell, 2010; Islam et al., 2004; Spangenberg, 2010).

Although the endogenous growth theory only entered the sustainability debate in the 1990s, there seem to be scanty studies concentrating on the nexus between sustainable development and economic growth in the BRICS bloc, despite the probable transition of some of the BRICS countries (for example, China and Russia) to developed status (Zha et al., 2019; Hofkes, 2017). Again, similar studies like Fan and Zheng (2013), Younsi and Bechtini (2018), and Javeria et al. (2017) merely covered one dimension of sustainable development or solely a Chinese study.

Jamel & Maktouf (2017) and Agrawal (2015) attributed the present threats to sustainable development, as a prerequisite to sustaining the past three decades of economic growth, in the BRICS countries to inefficient economic and sustainable development strategies to support the growth process. Many scholars also believe that slowing and uneven economic growth in the last one decade are also contributing to the seemly uneven levels of developments and the goal of achieving sustainable economic growth for all BRICS members (Azevedo, Sartori & Campos, 2018; World Bank Group, 2018; Menon, 2017).

Consequently, one of the main focuses of this study is the validation of the modified endogenous growth theory (theoretical framework) in the BRICS context. This study is, therefore expected to shed more light on some aspect of sustainable development determinants that account for a country's level of development (Wilhelms, 1998). However, since the emphasis is placed on the association between sustainable development and economic growth, this study is concentrated on country determinants, rather than firm or industry determinants of sustainable development (Pelinescu, 2015; Wilhelms, 1998). Also, firm and industry factors are less important when country-related factors are already inhibiting sustainable development in the BRICS bloc (Ogasawara, 2018).

Previous empirical studies on the relationships between economic growth and sustainable development have been mainly concentrated on developed economies. For example, Franck-Dominique (2008) put forward the positive linkages between economic growth and sustainable development, as well as, the notion of "limits" on growth and sustainability-related activities that would spur sustainable development (ecologist notion of limits to growth) (Zha et al., 2019;

Hofkes, 2017; Menon, 2017; Hamilton, 2015; Gur, 2015; Fan & Zheng, 2013). The study positioned that issues arising from increasing degradation and uneven wealth distribution throughout the world have often questioned the objective of continued growth in the past three decades (Hofkes, 2017; Menon, 2017). A related study by Mosteanu (2019) was aimed at balancing the level of inequalities in development in the territory of European and GCC countries due to diversities in changing economic conditions (economic growth). The study was an exploratory (qualitative) research on the relationships between economic growth and sustainable development challenges in Europe and the Middle East, given the diversity of geographical and economic conditions. The study concluded that the influence of economic growth on sustainable development could be significantly improved if economic policies are properly aligned with regional development objectives, via the promotion of artificial intelligence and new industrial technologies (New theory of growth) (Moşteanu and AlGhaddaf, 2019). Consequently, the study advocated for a balanced, harmonious, and sustainable development in line with the reduction of inequalities in internal regional (Moşteanu, 2019b)

That notwithstanding, many of the studies in the developing or bloc of developing countries seem to be based on a "stand-alone" countries like China and India. Unfortunately, very few studies seem to have focused on BRICS bloc. For example, in an attempt to quantify economic growth and sustainable development of Beijing via ecological network analysis (ENA), Huang and Ulanowicz (2014) study assessed the links between economic growth and sustainable development based on 11 input-output (I-O) tables of Beijing's economic system from 1985 to 2010. Although the study observed a positive relationship between exponential economic growth and sustainable development, the impact was insignificant and merely fluctuated within a small range.

The study recommended that to improved sustainable development, system ascendency should be increased via strengthening those pathways with positive contributions or weakening those with negative effects (Huang and Ulanowicz, 2014). Similar to our present study, the novelty of Huang and Ulanowicz's (2014) study is the distinction between economic growth and economic development. Aside from contriving separate meanings of economic growth and development, the combined action of growth and development was quantified with a single index (Zha et al., 2019; Hofkes, 2017). Perrings and Ansuategi's (2000) study contradicts the Brundtland Report (WCED, 1987) on sustainable development. The Brundtland Report (WCED,

1987) maintained that the main threats to sustainable development in both developing countries and developed countries as basically the poverty-driven depletion of environmental resources and consumption-driven pollution of the atmosphere, respectively.

Consequently, Perrings and Ansuategi's (2000) study, on the empirical relationship between economic growth and sustainable development observes that although few indicators of water quality and local air are initially worsened by economic growth, the level of sustainable development later improves as per capita incomes increases in the long term (Perrings and Ansuategi, 2000). The paper, therefore, argues that the important question should not be the impact of economic growth, but whether the impact of economic growth threatens the resilience of the ecological systems on which sustainable growth and development depend. This was based on the premise that any loss of ecological resilience will imply the unsustainability of the economic growth, and that this should be the major focus of strategies for sustainable development (Perrings and Ansuategi, 2000).

Gaspar et al.'s (2017) main focus were on establishing the nexus between economic growth-sustainable development nexus using a panel of annual data sets of 20 European countries from 1995–2014. While proposing the Index of Sustainable Economic Welfare (ISEW) as a better measure of sustainable development (rather than GDP), findings of the study posit contradictory results in using the traditional GDP (economic growth) when compared with using Index of Sustainable Economic Welfare (ISEW). Specifically, the study observed a new negative feedback hypothesis for ISEW (the alternative measure of SD) but maintained a conservative hypothesis for the nexus between economic growth and energy consumption (sustainability). The study, therefore, posits that policies focused on GDP (economic growth) might find it difficult to improve the much-desired influence on sustainable development. The study, therefore, concluded wrong interpretations of the economic growth approach (using GDP) by policymakers in their quest for the much desired increased sustainable development.

Few studies based on Africa are also noted in the literature (Bartniczak & Raszkowski, 2019; Ahenkan & Osei-Kojo, 2014). Based on the necessity to shift the pursuit of development to sustainable development in all African countries, Ahenkan and Osei-Kojo's (2014) study utilized the narrative analysis method to assess the progress of sustainable development targets in Africa. The study, however, observes mixed progress in sustainable development targets across indicators. Specifically, the study observes notable progress by many African countries in improving agriculture, reducing poverty, building strong economies, and strengthening democratic institutions. However, notable challenges can be found in areas such as population growth, unemployment, and climate change (Ahenkan & Osei-Kojo, 2014). To achieve sustainable development, the study, therefore, recommends innovative policies to tackle climate change, create jobs, and improve agriculture in the African continent (Ahenkan & Osei-Kojo, 2014).

A similar study by Bartniczak and Raszkowski (2019) utilizes the synthetic measure of development (SMD) to assess the level of implementation of the sustainable development targets by all Africa countries from 2002 to 2016. The study observes major improvements in sustainable development targets of many African countries in the period under analysis. However many are still experiencing crucial problems. Specifically, Cape Verde and Ghana seem to be among the best performing African countries, while the Democratic Republic of the Congo, Chad, Liberia, Eritrea and the Central African Republic is still lagging (Bartniczak & Raszkowski, 2019).

Another study by Domfeh et al. (2012) utilizes sustainability frameworks to assess the achievability of strategic development goals in Ghana but observes that the country is still characterised by poor environmental, sanitation and human health, poverty, low access to energy, potable drinking water, and increasing population growth. The study, therefore, suggests the implementation of key policies related to poverty reduction, sanitation, energy, environment, health, and population growth if the desired strategic development goals are to be achieved (Domfeh et al., 2012).

Notwithstanding the above specific results, many empirical works on sustainable development-economic growth nexus are often seen as confusing and contradictory, probably due to the use of singular measure and estimation technique (Zha et al., 2019; Hofkes, 2017; Spangenberg, 2010; Islam et al., 2004). Consequently, comparative validations of estimation techniques and robustness checks in this study have been positioned as probable alternatives (Zha et al., 2019; Hofkes, 2017). Hence, the study centrally hypothesised that: "Economic growth will be sustainable in BRICS countries if it is sustainable in individual countries in the block and it remains sustainable as some countries change status from emerging economies to developed economies." However, based on the above conceptual and theoretical background, the specific hypothesis is stated thus: **Hypothesis:** H1: there are no significant differences in the level of sustainable development in individual countries as related to economic growth in BRICS vis-à-vis MINT and G-7 economies.

Methodology

Derivation of ARDL, CS-ARDL, and CS-DL

Long-run relationships are popularly assessed in most empirical literature via cointegration, and for most panel data analysis, the most popular cointegration approach is the autoregressive distributed lag (ARDL) model (Lombardi et al., 2017). Using Chudik et al.'s (2015) approach and assuming that the joint dynamics is determined by a VAR(1) model, to establish a long-run relationship between sustainable developments and economic growth in the BRICS bloc, the innovations et^y and et^x are deemed to be correlated, which will result in a contemporaneous correlation between sustainable development (y^t) and economic growth (x^t) (Bindi, 2018; Lombardi et al., 2017). Hence, endogeneity would be a major issue in any OLS regression performed to establish these relationships (Cashin et al., 2017; Nkoro & Uko, 2016). However, we can decompose our innovations in Equation 5.1 into two components and spell out their orthogonal component (Chudik et al., 2015; 2016):

$$e_t^y = E(e_t^y / e_t^y) + u_t = \omega e_t^x + u_t \text{……………………………………………….………….. Equation 5.1}$$

in the above equation $\omega = cov(e_t^y, e_t^x)/var(e_t^x)$. According to Lombardi et al. (2017) and Chudik et al. (2015), by simple substitution method, we can derive our simple ARDL specification in equation 5.2

$$Y_t = \varphi y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t \text{………………………………………………………. Equation 5.2}$$

Again in the above simple ARDL equation (12), $\varphi = \phi_{11} - \omega\phi_{21}$, $\beta_0 = \omega$, and $\beta_1 = \phi_{12} - \omega\phi_{22}$ Consequently, ARDL specification in Equation 5.2 can simply estimate an OLS without endogeneity problem. Also, our ut is deemed orthogonal to our xt while its lags are done by construction (Lombardi et al., 2017; Chudik et al., 2015).

Again, according to Lombardi et al. (2017), any OLS estimated by Equation 5.2 will yield consistent estimates, whether our variables are I(1) or I(0). Consequently, Chudik et al.

(2015) and Cashin et al. (2017) reconstructed the simple ARDL Equation 5.2 in the cointegrating form to produce Equation 5.3:

$Y_t=\theta x_t + \alpha(L)\, \Delta x_t + \tilde{u}_t$………………………………………………………….. Equation 5.3

From Equation 5.3, $\tilde{u}_t=\varphi(L)^{-1}u_t$

Although, the long-run coefficient $\theta= (\beta_0+ \beta_1)/(1 - \varphi)$ in Equation 5.3 can be estimated explicitly, where our dependent variable (sustainable development- y^t) and economic growth (x_t) are I(1), then, Equation (5.3) would establish a cointegrating relationship with (1, –θ)' (Bindi, 2018; Lombardi et al., 2017). Note that (1, –θ)' represents a cointegrating vector.

An alternative estimation approach, known as distributed-lag (DL), is a direct estimation of Equation 5.3, by truncating the α(L) (lag polynomial) at a satisfactorily high level (Bindi, 2018; Lombardi et al., 2017; Chudik et al., 2015). One advantage of the DL approach is that the estimates yield significantly lower uncertainty, particularly with a small sample size (Nkoro & Uko, 2016).

However, using Equations 5.2 and 5.3, a generic ARDL(p,q) model for our panel can be shown in Equation 5.4, where i=the country index:

$y_{i,t} =\sum_{k=1}^{p} \varphi_{i,k} y_{i,t-k} + \sum_{l=0}^{q} \beta'_{i,l} x_{i,t-1} + u_{i,t}$ ……………………………...……………..Equation 5.4

However, the cointegrating form for Equation 5.4 can be depicted by Equation 5.5:

$y_{i,t}= \theta_i x_{i,t} + \alpha'_i(L)\Delta x_{it} + \tilde{u}_{i,t}$………………………………………………………………………………...……… Equation 5.5

That notwithstanding, one major problem in our panel Equation 5.4 is the possibility of correlated errors across countries, which may lead to inconsistent estimates (Breitenbach et al., 2017). Hence, it is always good to test for the likely presence of cross-sectional dependence problem since some of the BRICS countries (like China and India) are from the same geographical region, besides due to probable similar economic structures, shocks may be transmitted between countries (Chudik et al., 2015; Nkoro & Uko, 2016; Breitenbach et al., 2017).

However, this problem can be solved by postulating common unobserved factor errors (Nkoro & Uko, 2016). Consequently, Lombardi et al. (2017) and Chudik et al. (2015) postulate that the best way to solve this problem is to augment Equation 5.4 with cross-sectional averages of both the dependent (sustainable development) and explanatory variable (economic growth), and also their lags (a proxy for unobserved common factors) (Bindi, 2018; Lombardi et al., 2017).

This approach is usually termed a cross-sectionally autoregressive distributed lag (CS-ARDL) model. Similarly, Lombardi et al. (2017) and Chudik et al. (2015) observed that the same method adopted in the CS-ARDL approach, by augmenting our regression with cross-sectional averages could also be adopted indirect estimation of our Equation 5.5. This alternative approach is commonly referred to as cross-section augmented DL (CS-DL). Both approaches were adopted in this study to provide robust comparable estimates in this study (Bindi, 2018; Lombardi et al., 2017; Chudik et al., 2015; Cashin et al., 2017; Nkoro & Uko, 2016; Breitenbach et al., 2017).

Econometric Model: Derivation of Sustainable Development Model

Since, 'sustainable development' as used here simply implied 'qualitative improvement in human well-being' (Menon, 2017; Aregbesola, 2014; Daly & Cobb, 1990); hence, to depict the diversities in the level of sustainable developments in BRICS countries with some, like China, most likely to change the status to developed countries (Younsi & Bechtini, 2018; Javeria et al., 2017), our robustness check via GMM was based on a panel data study by Agrawal (2015). Panel data analytical techniques are considered desirable for this paper because panel data offers more variability and explanatory data, but less collinearity among the variables; again, panel data can control for heterogeneity in individual data, as well as, its suitability for the study of dynamic adjustment (Agrawal, 2015; Pedroni, 1999).

Moreover, Panel data is capable of ascertaining and measuring effects that may not be detectable in pure time series or cross-section data (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). Consequently, to analyse the effect of economic growth on sustainable developments, the basic Cobb-Douglas Production Function was extended based on the ascendency principles (the combination of economic growth and sustainable development) of Huang and Ulanowicz (2014) and also in line with similar studies of Agrawal (2015) and El-Wassal (2012).

Therefore:

$Y_{it} = \beta_0 + \lambda\varepsilon_{i,t-1} + \beta_1 X_{it} + \mu_i + \varepsilon_{it}$ ……………………………………………………......................…Equation 5.6

Where Y_{it} is the log of sustainable development indexes, X_{it} is the relevant explanatory variables; μ_i represents the country-specific time-invariant effects, and $\varepsilon_{i,t}$ is the error term.

According to El-Wassal (2012), to relax the postulation of exogeneity (strict) and also to remove the county-specific effect, Equation 5.6 was subsequently transformed to Equation 5.7:

$Y_{i\,t} - Y_{it-1} = \eta(Y_{it-1} - Y_{it-2}) + \beta(X_{it} + X_{it-1}) + (\varepsilon_{it} + \varepsilon_{it-1})$…………………………………Equation 5.7

Based on this method, Equation 5.7 automatically controls for the association between $\varepsilon_{it} - \varepsilon_{it-1}$ (new error term) and $Y_{it-1} - Y_{it-2}$ (lagged dependent variable). Therefore, using the Bundell-Blond approach (El-Wassal, 2012), with its basic assumptions, the resultant sustainable development model is shown in Equation 5.9, as derived from the functional notations in Equation 5.8:

$DEV_t = \{lnGDP_t, lnINQ_t, lnINSTFIT_t, lnCO2_t, lnX^1_t\}$…....................................Equation 5.8

$(DEV)_{it} = \alpha o + \alpha 1(DEV)_{it} + \alpha_2(GDP)_{it} + \alpha_3(INQ)_{it} + \alpha_4(INSTFIT)_{it} + \alpha_5(C0_2)_{it} + \alpha_6(X^1)_{it} + \mu_i + \varepsilon_{i,t}$….Equation 5.9.

Again, in a deviation from previous literature (Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015), that uses mostly quadratic models, this study adopted the log-linear models. The adoption of the log-linear model is on the premise that it gives better efficient results than linear models. Consequently, Equation 5.9 was re-written as follows (Equation 5.10):

$ln(DEV)_{it} = \alpha o + \alpha 1 ln(DEV)_{it} + \alpha_2 ln(GDP)_{it} + \alpha_3 ln(INQ)_{it} + \alpha_4 ln(INSTFIT)_{it} + \alpha_5 ln(C0_2)_{it} + \alpha_6 ln(X^1)_{it} + \mu_i + \varepsilon_{i,t}$……………………………………………………………..……Equation 5.10

Where:

DEV= Sustainable Developments (Aggregation of access to clean air and water-ACAW; Access to clean fuels and technologies for cooking-% of the population- ACFT; Number of infant deaths-NID; Number of maternal deaths-NMD; Compulsory education, duration-COM); GDP =

GDP per capita growth (annual %); INSTFIT = Institutional fitness variable (Aggregations of economic, political and institutional indexes as a proxy for institutional fitness)

INQ= Gini coefficient

CO2=$C0_2$ emissions

X^1= Control variables (Financial development; exchange rate volatility, inflation risk, FDI, domestic investment)

$\alpha 0$= is an intercept

Ln= Log

μ_i= country-specific effects, and

$\varepsilon_{i,t}$= error term.

Defining the Dependent and Explanatory variables

The dependent variable is DEV (Author's own composite sustainable development index). Accordingly, by applying the principal component technique on the five important proxies of developments (access to clean air and water-ACAW; Access to clean fuels and technologies for cooking-% of the population- ACFT; Number of infant deaths-NID; Number of maternal deaths-NMD; Compulsory education, duration-COM), a composite development index was constructed to generate our measure of trends in the level of sustainable developments within the BRICS bloc (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017). All the variables are shown in Appendix 5B.

Consequent upon the above model, the methods proceeded with the following steps:
(1) Cross-sectional Dependence Test (2) Unit Root Test (3) Cointegration Test (4) ARDL, CS-ARDL, CS-DL (5) Robustness Checks.

Our first robustness check was the estimation of a pooled ordinary least square (POLS) and the Generalised Method of Moments (GMM). The GMM utilises a set of instrumental variables (IV) to solve the endogeneity problem (Nkoro & Uko, 2016). Accordingly, to examine the soundness of our instruments, we adopted both the Hansen test (to test the over-identifying restrictions) and the second-order autocorrelation AR (2) test (Jamel & Maktouf, 2017). Again, similar to a study by Chudik et al. (2015) and Breitenbach et al. (2017), our study added seven emerging countries to our initial samples of BRICS countries. The additional countries are Thailand, South Korea, Chilli, Colombia, Hungary, Malaysia, and Poland, and then we re-estimated the CS-DL up to 3 lags to ascertain/reinforcing the robustness of our findings (Cashin et al., 2017; Breitenbach et al., 2017).

Results and Discussion of Findings

The results of our constructed composite sustainable development index for the five BRICS countries are depicted in Appendix 5A. From the table in Appendix 5A, the PC analysis for Brazil indicates that the highest first PC explains about 63.05% of the standardised variance in that country model; hence, the variable was selected to compute the sustainable development index (Younsi & Bechtini, 2018). This adoption was premised on the fact that the first PC is a linear combination of the whole five measures of sustainable development with the respective weights represented by the first eigenvector (Younsi & Bechtini, 2018). Consequently, 62.73%, 58.26%, 33.77%, 37.33% and 42.84% individual contributions for each of the ACAW, ACFT, NID, NMD, and COM respectively were further used to construct the composite financial development index for Brazil after rescaling to the standardised variance of the first PC (Younsi & Bechtini, 2018; Jamel & Maktouf, 2017; De Bruyn et al., 1998). The same interpretation of the results was seen to be true for the other four countries in our analysis (Russia, India, China, and South Africa). Consequently, the results of our estimation process are as follows:

Pesaran CD Test

The results of our Pesaran CD test (Table 5.2) on DEV (ln_DEV) for the BRICS panels strongly confirm the presence of cross-sectional dependence in the dependent variable of our models, since the test rejects the H0 of cross-section independence (at the 5% level). This is an indication that our variables in the various panels may possess a high degree of cross-sectional heterogeneity (Bindi, 2018), hence a better justification for estimating ARDL, CS-ARDL, and CS-DL in this study, since the short-run estimates possess an error correction (EC) value for probable adjustment from one period to another (Chudik et al., 2015; Cashin et al., 2017).

Panel Unit Root Test

Since the Stationarity check of any time series data is one of the most important requirements before analysis of co-integration and causality (Mohaddes and Raissi, 2017), the results of the estimated Pesaran (2007) Augmented Dickey-Fuller test (CADF) are depicted in Appendix 5D. All the variables were tested with 0 lags (and trend) and one lag (and trend). Based on the results, all the variables have a mixed order of integration, but none of our variables is I(2) or higher. Again, the existence of mixed orders of integration (unit-roots) also justified our adopted estimators (ARDL, CS-ARDL, and CS-DL).

Panel Cointegration Test

After confirming the existence of unit roots in our data series, the next step was to check for the possibility of a long-run relationship between sustainable development and economic growth (Bindi, 2018). This is premised on the time series theory of probable spurious estimates due to the presence of unit roots in our data (Mohaddes and Raissi, 2017). Fortunately, spurious estimates can be avoided if the variables are cointegrated (Cashin et al., 2017; Nkoro & Uko, 2016). Consequently, the results of our Westerlund cointegration test (as depicted in Appendix 5E), clearly observed that Gt and Pt tests seem to be relatively more robust to the cross-sectional correlation in all the three panels, hence, all were used to test for cointegration (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007).

Specifically, we observed that both the G and P statistics depict the presence of perfect cointegration in all our panels. That notwithstanding, the Pt and Pa estimates have a higher power over our estimated Gt and Ga based on the Monte Carlo simulation in all the BRICS, MINT, and G-7 Panels (Westerlund 2007). Again, from Appendix 5D, we also observed that all the estimated Pt and Pa rejects the null hypothesis of no cointegration at a 1% level of significance. Hence, we can reasonably conclude that our variables are cointegrated (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007). The existence of cointegration simply denotes the presence of long-run co-movement of sustainable development and economic growth in the BRICS, MINT, and G-7 countries, a further juxtaposition for the possibility of causality between sustainable development and economic growth.

Estimation Results and Discussion of Findings

This section is our attempt to analyse the long-run relationship between sustainable development and economic growth, and most importantly, checking the possibility of non-linearity in these relationships.

Long-run Effects

To test for the long-run effect of economic growth on sustainable development in our five panels of BRICS, BRICS Sub-sample 1, BRICS Sub-sample 2, MINT, and G-7 countries, we initially estimated the baseline specification by relating GDP growth to (changes in) sustainable development. Table 5.2 depicts our two major results for CS-ARDL and CS-DL models, as well as the results of the ARDL model without cross-sectional correction. We reported the p-values of all CSD tests. Interestingly, all results (CSD tests) showed that the adjustments are capable of eliminating cross-sectional dependence at mostly a 5% significance level in all the panels. Although the study experimented with a different selection of AR lag lengths, however, we ultimately fixed to three the number of lags for the cross-sectional correction based on the findings from the Pesaran (2004) test for cross-sectional correlation of the residuals (Lombardi et al., 2017).

Our main finding from all the estimates for the (changes in) sustainable development is that all the coefficients are statistically significant and negative (except for our BRICS Sub-sample 2- Russia and China- and G-7 countries estimates), which suggests that in the long-run, economic growth is a drag on sustainable development in the BRICS sub-sample 1 (Brazil, India and South Africa) and MINT countries. Specifically, we also observed that most long-run coefficients in our estimates for BRICS sub-sample 1 (Brazil, India, and South Africa) and MINT countries seem to cluster around –0.1. This implied that a one percentage increase in economic growth in the long-run is associated with a 0.1% decline in sustainable development.

Table 5.2: Baseline Specification Results

PANEL		Sustainable Development		
		ARDL	CS-ARDL	CS-DL
	1 lag			
	Theta	-0.072** (0.024)	-0.061** (0.021)	-0.045** (0.018)
	CSD test	122.21**	1.72**	0.93
	2 lag			
	Theta	-111*** (0.040)	-0.105** (0.34)	-0.075** (0.024)
	CSD test	118.11**	1.56*	0.77
	3 lag			
	Theta	-0.141 (0.069)	-0.122** (0.029)	-0.081** (0.019)
BRICS Countries (sub-sample 1: Brazil, India and South Africa)	CSD test	112.11***	1.91**	0.98*
		ARDL	CS-ARDL	CS-DL
	1 lag			
	Theta	0.173** (0.069)	-0.071** (0.039)	0.051** (0.021)
	CSD test	89.11**	1.91**	0.89
	2 lag			
	Theta	-241*** (0.087)	0.111** (0.39)	0.081** (0.021)
	CSD test	56.26**	1.81*	0.71
	3 lag			
	Theta	-0.355 (0.121)	0.133** (0.031)	0.072** (0.021)
BRICS Countries (sub-sample 2: Russia and China)	CSD test	45.33**	1.79*	0.87
		ARDL	CS-ARDL	CS-DL
	1 lag			
	Theta	-0.075** (0.025)	-0.062** (0.022)	-0.047** (0.016)
	CSD test	121.23**	1.78**	0.97
	2 lag			
	Theta	-112*** (0.041)	-0.102** (0.36)	-0.077** (0.024)
	CSD test	116.11**	1.65*	0.88
	3 lag			
	Theta	-0.137 (0.067)	-0.122** (0.029)	-0.081** (0.019)
BRICS Countries	CSD test	110.34***	1.89**	0.99*
		ARDL	CS-ARDL	CS-DL
	1 lag			
	Theta	-0.087** (0.035)	-0.092** (0.022)	-0.051** (0.019)
	CSD test	117.44**	1.55**	0.86
	2 lag			
	Theta	-0.122*** (0.039)	-0.109** (0.26)	-0.063** (0.021)
	CSD test	109.22**	1.72*	0.66
	3 lag			
	Theta	-0.156 (0.055)	-0.134** (0.037)	-0.071** (0.017)
MINT Countries	CSD test	102.34**	1.78*	0.81

		ARDL	CS-ARDL	CS-DL
	1 lag			
	Theta	0.165** (0.066)	-0.062** (0.042)	0.047** (0.016)
	CSD test	87.33**	1.89**	0.93
	2 lag			
	Theta	-232*** (0.082)	0.102** (0.36)	0.077** (0.024)
	CSD test	57.34**	1.76*	0.79
	3 lag			
	Theta	-0.343 (0.112)	0.122** (0.029)	0.061** (0.019)
G-7 Countries	CSD test	43.67**	1.81*	0.82

Note: CSD= Cross sectional dependence; ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent level respectively; ARDL= Autoregressive distributed lag; CS-ARDL= Cross-section augmented Autoregressive distributed lag; CS-DL= Cross-section augmented distributed lag; Standard errors are in parentheses.

Alternatively, estimates from the BRICS Sub-sample 2 (Russia and China) and G-7 models exhibit positive coefficients, which seem to indicate that higher economic growth is related to higher sustainable developments in the long-run. Similar studies (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017; Agrawal, 2015) also reported related results of long-run economic growth's drag on sustainable development. For example, based on a Panel data analysis (both fixed and random effects) of BRICS, Javeria et al. (2017) observed a negative influence of the increasing CO2 emissions and energy consumption (due to increasing economic growth) on developments. The study (Javeria et al., 2017: 58), therefore, advocated for the need to promote economic development by investing in environmentally friendly projects to enhance sustainable development. However, to fill a major gap in the literature, Javeria et al. (2017: 58) posit for future studies to undertake "extensive variables to find the impacts of economic growth on sustainability variables in BRICS countries."

Short-Run Effects

The various estimated models in our effort to assess the long-run effect of economic growth on the level of sustainable development (Table 5.2), based on the cointegrating form of Equation 5.4 was also used to retrieve the short-run dynamics by including the contemporaneous value of the independent variable in other to account for any possible endogeneity (Lombardi et al., 2017).

Table 5.3: Results on the Short-run Impact of Economic Growth

PANEL	Sustainable Development growth			
		1 lag	2 lags	3 lags
	Theta	0.113** (0.024)	0.157** (0.029)	0.141*** (0.035)
	Alpha1	0.029** (0.004)	0.038** (0.007)	0.089* (0.008)
	Alpha2		0.03** (0.005)	0.005 (0.010)
	Alpha3			0.011(0.025)
BRICS (sub-sample 1: Brazil, India and South Africa)	CSD test	1.34	1.49**	1.99*
		1 lag	2 lags	3 lags
	Theta	-0.142** (0.029)	-0.161** (0.037)	-0.152** (0.051)
	Alpha1	0.042** (0.015)	0.052** (0.019)	0.072* (0.013)
	Alpha2		0.015** (0.011)	0.014 (0.009)
	Alpha3			0.021 (0.08)
BRICS (sub-sample: Russia and China))	CSD test	1.32	1.61**	1.89*
		1 lag	2 lags	3 lags
	Theta	0.112** (0.021)	0.167** (0.029)	0.141*** (0.035)
	Alpha1	0.031** (0.005)	0.035** (0.008)	0.087* (0.009)
	Alpha2		0.02** (0.006)	0.003 (0.009)
	Alpha3			0.003 (0.021)
BRICS Countries	CSD test	1.34	1.49**	1.99*
		1 lag	2 lags	3 lags
	Theta	0.125** (0.031)	0.171** (0.033)	0.183*** (0.054)
	Alpha1	0.042** (0.015)	0.053** (0.012)	0.076* (0.013)
	Alpha2		0.13** (0.016)	0.012 (0.003)
	Alpha3			0.012 (0.011)
MINT Countries	CSD test	1.20	1.29**	1.81*
		1 lag	2 lags	3 lags
	Theta	-0.134** (0.033)	-0.154** (0.031)	-0.149** (0.041)
	Alpha1	0.045** (0.013)	0.041** (0.017)	0.069* (0.012)
	Alpha2		0.013** (0.003)	0.012 (0.003)
	Alpha3			0.013(0.01)
G-7 Countries	CSD test	1.29	1.55**	1.91*

Note*:* CSD= Cross-sectional dependence; ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent level respectively; Standard errors are in parentheses.

Consequently, we investigated (short-run dynamics) how changes in economic growth would spill over to sustainable development in the BRICS, BRICS Sub-sample 1, BRICS Sub-sample 2, MINT, and G-7 countries via CS-ARDL. The results are shown in Table 5.3. Based on the results in Table 5.3, we observed that economic growth increases the level of sustainable developments in the BRICS, MINT, and G-7 countries in the short-run.

Specifically, all the coefficients on the first, second, and third lags of the short-run part of the cointegrating equation are significant and positive at mostly 10% level but decrease in magnitude towards the third lags. The decreasing magnitude is an indication that the bulk of the pass-through of improving economic growth to sustainable development growth occurs within the first few years (Lombardi et al., 2017; Javeria et al., 2017).

Our findings summarise that economic growth increases the level of sustainable developments in the BRICS, MINT, and G-7 countries in the short-run, but constitutes a drag on sustainable development in the BRICS sub-sample 1 (Brazil, India and South Africa) and MINT countries in the long-run. Specifically, the magnitude of 0.113 (Theta) and 0.112 (Theta) indicates that a 1% increase in GDP growth in BRICS Sub-sample 1 (Brazil, India and South Africa) and BRICS increases sustainable development by 0.113% and 0.112% in the short-run, but reversed to a decrease of 0.072 and 0.075% in the long-run, respectively. Similar results on the impact of economic growth on sustainable development were also obtained in previous studies (Azevedo et al., 2018; Younsi & Bechtini, 2018; Javeria et al., 2017). However, reversed results were obtained in the case of BRICS Sub-Sample 2 (Russia and China) and G-7 countries, where a magnitude of -0.142 (Theta) and -0.134 (Theta) indicates that a 1% increase in GDP growth in BRICS Sub-Sample 2 (Russia and China) and G-7 countries decreases sustainable development by 0.142% and 0.134% in the short-run, but reversed to an increase of 0.0173 and 0.165% in the long-run, respectively.

Findings from the present study vary with previous empirical studies on the relationships between economic growth and sustainable development, which has been mainly concentrated on developed economies (Mosteanu, 2019; Gaspar et al., 2017; Huang and Ulanowicz, 2014; Franck-Dominique, 2008; Perrings and Ansuategi, 2000). For example, our results are similar to major findings in Franck-Dominique (2008) in respect of the positive linkages between economic growth and sustainable development (Zha et al., 2019; Hofkes, 2017). A related exploratory (qualitative) research by Mosteanu (2019), aimed at balancing the level of inequalities in development in the territory of European and GCC Countries due to diversities in changing economic conditions (economic growth). The study observed a significant positive relationship but concluded that the influence of economic growth on sustainable development could be significantly improved if economic policies are properly aligned with regional development objectives, via the promotion of artificial intelligence and new industrial technologies (New theory of growth) (Moşteanu and AlGhaddaf, 2019).

Our findings also observed similarities with a few related studies in developing countries. For example, Huang and Ulanowicz (2014) study assessed the links between economic growth and sustainable development based on 11 input-output (I-O) tables of Beijing economic system from 1985 to 2010. Although the study observed a positive relationship between exponential economic growth and sustainable development, the impact was insignificant and merely fluctuated within a small range. This is, however, similar to our estimates in the BRICS sub-sample 1 (Brazil, India, and South Africa). Similar to our present study, the novelty of Huang and Ulanowicz's (2014) study was the distinction between economic growth and economic development. Aside from contriving separate meanings of economic growth and development, the combined action of growth and development was also quantified with a single index (Zha et al., 2019; Hofkes, 2017).

However, Perrings and Ansuategi (2000) study, on the empirical relationship between economic growth and sustainable development observe that although few indicators of water quality and local air are initially worsened by economic growth, the level of sustainable development later improves as per capita incomes increase in the long term (Perrings and Ansuategi, 2000). This is a complete opposite of what our study observed in the estimates from BRICS sub-sample 1 (Brazil, India, and South Africa). Also, Gaspar et al.'s (2017) main focus was on establishing the nexus between economic growth-sustainable development nexus using a panel of annual data sets of 20 European countries from 1995 to 2014. While proposing the Index of Sustainable Economic Welfare (ISEW) as a better measure of sustainable development (rather than GDP), findings of the study posit contradictory results in using the traditional GDP (economic growth) when compared with using Index of Sustainable Economic Welfare (ISEW). Specifically, the study observed a new negative feedback hypothesis for ISEW (the alternative measure of SD) but maintained a conservative hypothesis for the nexus between economic growth and energy consumption. The study, therefore, posits that policies focused on GDP (economic growth) might find it difficult to improve the much-desired influence on sustainable development.

Robustness Checks and Discussions

To check for the robustness of our results, we considered the inclusion of additional elements in the long-run relationship, such as institutional fitness, socio-economic inequality, environmental degradation, financial development, exchange rate volatility, inflation risk, FDI, and domestic investment. This was done via our CS-ARDL estimation techniques. The aim was to understand additional explanatory variables that could also play a significant role in explaining the long-run sustainable development trends in BRICS, MINT, and G-7 countries, as well as their interaction with economic growth. The results, as depicted in Appendix D, suggest that the long-run relationship between sustainable development and economic growth is not undermined by the inclusion of the eight (8) additional independent variables since all the baseline coefficients remain statistically significant and negative. Hence, confirmation of the robustness of our main result: that economic growth increases the level of sustainable developments in the BRICS countries in the short run, but constitutes a drag on sustainable development in the long-run. Similar to previous studies (Younsi & Bechtini, 2018; Agrawal, 2015), the results of the additional variables were in line with expectations. For example, increasing socio-economic inequality, C02 emission, and inflation depress sustainable development, while increasing FDI, domestic investment, and financial development have a significant positive relationship with the level of sustainable developments in the BRICS, MINT and G-7 countries during the study period. Surprisingly, institutional fitness seems to support sustainable developments in both BRICS and G-7 countries, but negative in the MINT countries (Javeria et al, 2017; Jamel & Maktouf, 2017).

Our last robustness test was to add seven (7) emerging countries to our initial samples of BRICS countries only. The additional countries are Thailand, South Korea, Chile, Colombia, Hungary, Malaysia, and Poland, and then we estimated the long-run ARDL, CS-ARDL, and CS-DL up to 3 lags to ascertain/to reinforce the robustness of our findings (Cashin et al., 2017; Breitenbach et al., 2017). All the data were from the same sources as our initial samples of BRICS countries. The results are shown in Appendix E. Based on a comparative analysis of our estimates from ARDL, CS-ARDL and CS-DL models with one-three lags (Table 2) and the one illustrated in Appendix E (BRICS+ seven emerging countries) with one to three lags. There are negligible differences (Bindi, 2018; Nkoro & Uko, 2016; Westerlund, 2007). Specifically, all the variables' signs and level of significance (significant at 1 and 10 percent levels) are still the same. Again, the magnitudes are also closer to the main results. Consequently, this is a perfect attestation to the robustness of our main findings: that economic growth increases the level of sustainable developments in the BRICS countries in the short run, but constitutes a drag on sustainable development in the long-run.

Conclusion and Implication of the Study

Conclusion

This study investigates the long-run and short-run effect of the past three decades of economic growth on sustainable development using the novel CS-ARDL and CS-DL models proposed by Chudik et al. (2016) and Pesaran and Smith (1995). It uses panel data of BRICS, MINT and G-7 countries from 1990 to 2017. Our results conform to all robustness checks, including temporal and spatial changes. Evidence from this paper depicts a positive impact of economic growth on the levels of sustainable development in both the BRICS sub-samples and BRICS blocs in the short run. However, the study observed a long run drag on sustainable development in sub-sample 1 (Brazil, India, and South Africa). Also, since most long-run coefficients in our estimates for BRICS and MINT countries seem to cluster around –0.1, the study concluded that a one percentage increase in economic growth, in the long run, is associated with a 0.1% decline in sustainable development in the BRICS and MINT blocs. The study also concluded that economic growth and sustainable development are co-integrated at all the panel levels, indicating the presence of long-run equilibrium relationships. Hence, the influence of economic growth on sustainable developments within the blocs and sub-samples countries, though significant, was limited and varied. Specifically, all the coefficients on the first, second, and third lags of the short-run part of the cointegrating equation are significant and positive at mostly 10% level but decrease in magnitude towards the third lags. The decreasing magnitude is an indication that the bulk of the pass-through of improving economic growth to sustainable development growth occurs within the first few years (Lombardi et al., 2017; Javeria et al., 2017). Our findings summarise that economic growth increases the level of sustainable developments in the BRICS sub-samples, BRICS, MINT, and G-7 countries in the short run, but constitutes a drag on sustainable development in the BRICS sub-sample 1 (Brazil, India and South Africa) and MINT countries in the long-run.

Policy implications and recommendations

The focus on economic growth as a determinant of sustainable development in the BRICS countries is intended to provide policy-makers and scholars with a framework for evaluating the nexus between economic growth and sustainable developments. Our findings have clearly shown that sustainable development has not been adequately supported and developed in all the BRICS countries. Consequently, this study posits a more radical policy mix to reduce the negative impact of economic growth on the level of sustainable development in Brazil, India, and South African countries. These policies should take the form of focused, sustainable development strategies and energy policies, creation of a "new economy," improved education, and equal distribution of resources.

To achieve focused sustainability development strategies and energy policies, radical water management and water supply, land, agriculture, and soil degradation, as well as biodiversity and conservancies issues, should be prioritised. For example, marine resource management should be a major concern in South Africa. The country should add more exploiters of marine resources to the established fund for marine resource management in addition to the fishing companies. In India, the government must urgently tackle the increasing pressure on soil resources (like biodiversity loss and deforestation) due to social deprivation in major rural areas. In Brazil, government efforts should be geared toward reducing the impact of domestic migration on environmental degradation. Similar to the local practice in Brazil, the three (Brazil, India, and South Africa) countries could lead the present demand for compensation due to the increasing exploitation of natural resources and biodiversity by global corporations and developed countries. Also, to improve the current decline in sustainable development in Brazil, India, and South Africa, the present study posits for the creation of a "New Economy." A "New Economy" can be created through macro-level inclusion of local and national environmental factors in strategic economic evaluations.

There is also a need to develop strong ethics of financial markets, while the old-fashioned slogan of "first growth, then environment" should be replaced. This is on the premise that clever environmental policies also have the potential to contribute to growth in the bloc. Although continuity of sustainable development process is vital, BRICS countries should understand that sustainability and sustainable development are two complex problems with no single solution. Therefore, efforts should be geared towards the development of objective measures of sustainable development in the bloc as a follow-up, while more dialogue could also help in sharing experiences among local and international stakeholders. The creation of a "New Economy" in Brazil, India, and South Africa is also possible through the establishment of strong targets and indicators of social and environmental sustainability. The targets must be jointly developed with civil society and academia.

That notwithstanding, government commitment to sustainable development must be firm, and the general public should be bold enough to hold government accountable to any environmental and social targets. Objective sustainable development targets and guidelines will also enhance government facilitating roles. Therefore, multi-stakeholder processes should be encouraged to prevent the kind of stagnating growth rates experienced in Brazil, and the attendant regional migration and environmental problems. A strict top-down approach could be adopted by the political class to encourage grass-root participation in the decision-making process. This study is also of the opinion that an improved and inclusive educational system, as well as, equal distribution of resources, will go a long way in reducing the declining level of sustainable development in the three BRICs countries (Brazil, India, and South Africa). Education and compromise are also required in the seemly conflicts of interest between the two triangles (socioeconomic, institutional, and environmental dimensions vs. society, business, and government) of "sustainable development" strategy/ policy implementation. Hence, to achieve any meaningful improvements in the level of sustainable development, there is an urgent need for the three "vulnerable" countries (Brazil, India, and South Africa) in the bloc to balance this divide. Contrary to the negative sentiments on the implementation of foreign sustainable development models and unified strategies, this study believes that the acclaimed risks should not prevent the adoption of previous approaches/ solutions in other countries. Thus, the three countries could emulate the positive policy stance in both China and Russia. Specifically, the positive findings in our Russian models during the study period might be due to the active role of Russian NGOs and independent institutions in promoting sustainable development practices at both local and national level (Azevedo et al., 2018; Santana et al., 2014).

However, care must be taken in the bloc to balance the interest of the various NGOs, media, and other independent organisations. Nowadays, many business and personal interests are usually concealed under the guise of 'civil society' interests and NGO status. Also, Russian scientific organisations were deemed to have shown more interest in sustainable development by creating a more prognostic system for the country. Similarly, to reduce the negative impact of economic growth on the level of sustainable development in our sub-sample 1 (Brazil, India, and South Africa countries), the three countries could adopt a similar radical strategy. The strategy must be based on sustainable development principles, as well as tight state control over land use (Javeria et al., 2017). For example, the strict adoption of an ecology-oriented land policy could enhance land preservation and productive usage of natural resources at both regional and municipal levels.

There is also a need for special focus on probable (innovative) methods to advance sustainable development across sectors in the three countries making up our sub-sample 1 (Brazil, India, and South Africa countries). However, many of the general strategies/ approaches could be placed in the realm of public finance policy. This could be in the form of an "outcome versus outlay budgets," where various outcomes of each scheme/ programme can easily be defined in the context of sustainable development imperatives of each country (Fakoya, 2013). Consequently, to improve sustainable development outcomes, the budgeting process in each country could be designed to integrate sustainable development principles into specific sectoral strategies and policies. On the other hand, the revenue side of the budget may witness a shift in tax burdens from labour to resource exploiters.

To improve the declining level of sustainable development in Brazil, India, and South Africa countries, the government must create a societal culture that is favourable to sustainable developments in each country. Government institutions must work harmoniously with both civil society and business sectors. Also, the creation of a societal culture that is favourable to sustainable development can be created through local level's promotion of best practices, increase in consumers' demand for environmentally clean services and products, corporate reporting, as well as, the required political will on the part of the government to provide the necessary funding, institutional support, and other incentives. A societal culture could also be created through consumer and media awareness. Although strengthening consumer awareness may be difficult since businesses are deemed too strong, while the media are practically being controlled by businesses in many BRICS countries.

That notwithstanding, countries like China and Brazil could build on their past successes in sustainable development initiatives; for example, the "26 degrees" campaign on various media platforms by the Beijing Global Village Organisation to encourage citizens to lower their air-conditioners in summer was a veritable example of successful sustainable development initiatives aimed at saving energy. Also, the Brazilian sustainable development initiative initiated by the NGO "Acatu" was successful in encouraging manufacturers to upload sustainability information of their production methods on the website of selected consumer interest groups. The initiative was aimed at encouraging superior consumption decisions by consumers. Consequently, the development of public awareness initiatives about sustainable development in the BRICS countries should be prioritized by all stakeholders. This is on the premise that policies can only succeed when they can respond to citizen's real needs (Javeria et al., 2017). Finally, since environmental sustainability crusade seems to be more popular in the BRICS bloc, this study is of the view that communicating the three-dimensional concept (socioeconomic, institutional and environmental dimensions) of sustainable development (similar to the German sustainable development strategy) in the BRICS bloc will go a long way in reaching out to wider audiences than just the environmental stakeholders.

Managerial and theoretical contributions/ Implications

The contribution of this paper to the literature lies in the fact that policy options arising from the previous studies must take into account the different levels of development. Whilst it is recognized that policy in a developed country setting might not work in developing countries, most research conducted in BRICS have ignored the fact that deep contrast in the level of development among the BRICS member might require policy adjustment to the varying level of developments. To the best of the researcher's knowledge, the analysis of sustainability in BRICS for the sake of policymaking has not contemplated levels of development in their conceptualization. Similarly, no study has investigated of the economic growth-sustainable development of comprehensibly economic growth-sustainable development nexus comprehensibly within BRICS and similar blocs of developing and developed countries to propose sustainability, sustainable development, and growth policy options.

Also, due to the blurred line between growth and developments, Huang and Ulanowicz (2014) posit the quantification of growth and development as a necessary prerequisite to any treatment of sustainable development. Hence, the construction of a composite index to measure sustainable development in this study was a novel contribution in an attempt to quantify sustainable development. Constructing the index comprising variables depicting various dimensions of sustainable developments was crucial as single index might not give a strong measure of sustainable development in the BRICS bloc, as well as, its capacity to correcting past contradictory results in the literature. To the best of the researcher's knowledge, there has not been any study using an index whilst investigating sustainability in BRICS. Aside from contriving separate meanings of economic growth and sustainable development, the combined action of economic growth and sustainable development in the BRICS bloc was quantified with a single index that is robust to cross-sectional biases and small sample size.

Additionally, the output of this research is beneficial to policymakers in the BRICS countries not only in estimating the achievement of many BRICS goals but also serve as a "double-edge" tool for monitoring the BRICS's progress towards the attainment of the United Nations SDGs by the year 2030 (World Bank Group, 2018; Agrawal, 2015; Awan, 2013). Hence, our results are imperative to the attainment of the various BRICS's goals, as well as, with many similar goals of the year 2030 United Nations's Sustainable Development Goals (SDGs) (Sesay et al. 2018; ISSA, 2017; Hochestler, 2014; United Nations, 2013; UNCSD, 2012). Consequently, this study provides new empirical evidence concerning the relationships between sustainable development and economic growth in the BRICS countries (Pereira et al., 2018; Menon, 2017; Gur, 2015; Agrawal, 2015).

However, the results of this study should be adopted with care. It could be argued that grouping some determinants that have been identified in the literature as prerequisites to improved sustainable development in one set and treating them equally may be misleading because they are not of equal importance (Pearce et al., 2014; Pearce & Atkinson, 1993). Consequently, the main "inevitable" weakness of our estimated models is the items used to measure the determinants of sustainable development, which might not include several other relevant variables. Further studies might consider the inclusion of these variables; chiefly among the variable are nature of technology usage, human capital development, resource endowments, agglomeration effects, and the degree of diversification of the economy (Pearce et al., 2014).

CHAPTER 7

CONCLUSIONS AND POLICY RECOMMENDATIONS

7.0 Introduction

After three decades of growth, the sustainability of economic growth in the BRICS (Brazil, Russia, India, China, and South Africa) countries has been documented as a major problem in the BRICS countries, especially, as some members of the group change status from emerging economies to developed economies. Therefore, this thesis posits that understanding the knowledge of how economic growth would affect the socio-economic, environmental, and institutional sustainability of individual countries is important in solving this problem. Hence, the thesis aims to assess the influence of economic growth on sustainability (all dimensions) in the BRICS countries. Again, analysing the effect of economic growth on sustainable development within the BRICS, MINT, and G-7 countries is also an attempt to compare evidence since differing levels of industrial development might mean different concerns about sustainability issues.

Therefore, to achieve the above four (4) objectives, we used various linear and non-linear estimators that are robust to both cross-sectional dependence and small sample size bias. The four related questions/ hypotheses were answered by detailed analysis, with each question/hypothesis being analysed within a paper/ article using a yearly dataset from 1990 to 2017. Consequently, this chapter depicts the summary of general reflection on findings, conclusions, policy implications, and recommendations, as well as contributions to knowledge.

7.1 Summary of general observations

One interesting general observation is the divided nature of findings between developing and advanced economies. Specifically, except fron the major findings in Mosteanu’s (2019) study on European and GCC Countries), all major results in the four articles tend to support major finding from previous studies in developing countries {Zha et al., 2019 (China) Zhang et al., 2016 (China); Al-mulali et al., 2014 (Latin American countries); Shahbaz et al., 2013 (Pakistan); Huang and Ulanowicz, 2014 (China); Andersson and Karpestam, 2013 (Asian countries); Greyson, 2007 (China)}, but tends to differ from most reviewed empirical studies from developed countries {Gaspar et al., 2017 (European countries); Esseghir and Khouni, 2014

(Mediterranean countries); Andreoni and Galmarini, 2012 (Italy); Dawson et al., 2010 (Canada); Cuthill, 2010 (Australia); Sorrell, 2010 (Europe countries) D'Alessandro et al., 2010 (European countries); Perrings and Ansuategi, 2000 (European countries); Ayres et al., 2007 (European countries); Bartelmus, 1999 (Mediterranean)}.

These novel differences in empirical findings between developed and developing may be linked to probable contradictions of the basic assumptions in any process of decoupling sustainability dimensions from economic growth (Zhang et al., 2016; Gu et al., 2014; Sorrell, 2010). Specifically, Sorrell (2010) study challenged the conventional theory and raised major concerns due to probable less expected improvements from any potential process of decoupling carbon emissions from economic growth (Zhang et al., 2016; Gu et al., 2014). Sorrell (2010) contrary arguments were therefore based on five propositions: that rebound effects could limit any potential decoupling; the improved contribution of energy consumption to productivity; complimenting improved efficiency with an ethic of sufficiency; incompatibility of sustainability with increasing economic growth in advanced countries; and negative influence of a zero-growth economy with reserves in the banking system (Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013).

Again, while studies in developing countries (like Zha et al., 2019-China; Zhang et al. 2016-China; Al-mulali et al., 2014-Latin American countries; Shahbaz et al., 2013-Pakistan; Huang and Ulanowicz, 2014-China; Andersson and Karpestam, 2013-Asian countries; Greyson, 2007-China) shared and support the major findings in this present study, other studies in developed countries (Gaspar et al., 2017- European countries; Esseghir and Khouni, 2014-Mediterranean countries; Andreoni and Galmarini, 2012-Italy; Dawson et al., 2010-Canada; Cuthill, 2010-Australia; Sorrell, 2010-Europe countries; D'Alessandro et al., 2010-European countries; Perrings and Ansuategi, 2000-European countries; Ayres et al., 2007-European countries; Bartelmus, 1999-Mediterranean countries) cautions or differs.

For example, the established positive sentiments/ relationships between economic growth and sustainability dimensions (impact decoupling and resource decoupling) in Zhang et al.'s (2016) study differ from the output of a similar study by Sorrell (2010). Consequently, based on his five assumptions, Sorrell (2010) study, therefore, concluded by proposing practical policy options of green fiscal reform, progressive efficiency standards, probable caps on resource use and emissions, low carbon technologies, flexible or reduced working arrangements/ hours, income redistribution and so on (Sorrell, 2010). However, the study cautioned about the failure of the above policy options if any of the structural factors of continued economic growth are not properly unaddressed (Sorrell, 2010).

A similar study by Mosteanu (2019) in European and GCC Countries was also aimed at balancing the level of inequalities in development due to diversities in changing economic conditions (economic growth). The study concluded that the influence of economic growth on sustainability could be significantly improved if economic policies are properly aligned with regional development objectives, via the promotion of artificial intelligence and new industrial technologies (Moşteanu and AlGhaddaf, 2019). Hence, it advocated for a balanced, harmonious, and sustainable development in line with the reduction of inequalities in internal regional (Moşteanu, 2019b).

Also, due to the negative impact of economic growth on sustainability in China, Greyson (2007) advocated for an incremental reduction in wastes and its impact based on the practices of precycling, recycling insurance, and circular economic policy. A similar study by Zha et al. (2019) based panel decomposition technique of data envelopment analysis (DEA) and distance functions from 2005–2016 in China's tourism industry also varied impact of economic growth on sustainability dimension (CO2 emissions). Specifically, the study posits that the scale effect of economic growth was the highest (largest) factor impacting sustainability (CO2 emissions growth). Hence, it recommends effective promotion of technical progress via the introduction of more advanced energy-saving technologies (e.g., advanced energy-efficient facilities and low-emission vehicles), increasing investment in technological development, and strengthening institutional innovation and management innovation. On the other hand, many notable studies in developed countries (Gaspar et al., 2017- European countries; Esseghir and Khouni, 2014-Mediterranean countries; Andreoni and Galmarini, 2012-Italy; Dawson et al., 2010-Canada; Cuthill, 2010-Australia; Sorrell, 2010-Europe countries; D'Alessandro et al., 2010-European countries; Perrings and Ansuategi, 2000-European countries; Ayres et al., 2007-European countries; Bartelmus, 1999-Mediterranean countries) differs from the present study.

For example, Stern et al. (1996) largely critique the environmental Kuznets curve (EKC) assumption of zero feedback from environmental quality to production possibilities and the possibility that trade does not have any effect on environmental degradation (sustainability), but posits (EKC) an inverted U-shape nexus between environmental degradation (sustainability) and income per capita (economic growth). This means that economic growth will ultimately reduce the economic activities on the environment (sustainability). Consequently, Stern et al. (1996) simulated a combined (sustainability estimates from literature) EKC estimates from the literature with economic growth forecasts of selected countries by the World Bank in an attempt to derive the overall global impact. Unfortunately, findings suggest a declining sustainability index within the prospect of the Bank's 2025 predictions.

Similar Stern et al. (1996) contradictions, D’Alessandro et al. (2010) study, were a stylised dynamic model in the field of renewable energy that depicts the imperatives of investment in smooth technological progress. Based on However, based on Solow’s (1974) position on the feasibility of constant consumption as long as a composite stock of man-made and natural capital is kept constant and the potential energy shortage, the study took into consideration the necessity of investing in smooth technical change via renewables (D’Alessandro et al., 2010). The study, therefore, established a positive link between economic growth and the acceleration of exhaustible resource depletion time. Consequently, the study highlights the danger of accelerated economic growth, and subsequently opined that policies should discourage consumption growth, stimulate investment in alternative energy sources and target low growth rates to facilitate sustainability.

Perrings and Ansuategi's (2000) study started by contradicting the Brundtland Report (WCED, 1987), which simply maintained that the main threats to the environmental sustainability of development in both developing countries and developed countries were the poverty-driven depletion of environmental resources and consumption-driven pollution of the atmosphere respectively. Specifically, Perrings and Ansuategi's (2000) study, on the empirical relationship between economic growth and sustainability observes that although few indicators of water quality and local air are initially worsened by economic growth, later improve as *per capita* incomes increases in the long term. The paper, therefore, argues that the important question should not be the impact of economic growth on environmental sustainability, but whether the impact of economic growth threatens the resilience of the ecological systems on which economic growth depends (Perrings and Ansuategi, 2000).

Likewise, Ayres et al.’s (2007) paper examine the role of continued growth on the sustainability of energy utilisation in many European economies. While attesting to the importance of reducing greenhouse gas (GHG) emissions, the paper identified potential means of increasing energy efficiency and usage for continued long term growth and global sustainability. The study, therefore, proposed improved regulations rather than "radical new technologies" in the energy sector. While contradicting the prevailing policy stance in Europe, the paper observed that the introduced carbon tax, as a way of increasing energy costs to promote sustainability, maybe ineffective under present market structures and may negatively impact both growth and sustainability. Ayres et al.'s (2007) work proposed simultaneous strategies of reducing GHG emissions and boosting sustained technology-driven growth.

7.2 Conclusion

Overall the findings from these papers suggest that economic growth affects sustainability variables in different ways, which would require the formulation of policies to ensure that sustainability aspirations in each set of countries are not affected. That notwithstanding, one interesting general observation is the divided nature of findings between developing and advanced economies. Specifically, except from the major findings in Mosteanu's (2019) on European and GCC Countries, all major results in the four articles tend to support major finding from previous studies in developing countries (Zha et al., 2019; Zhang et al. 2016; Al-mulali et al., 2014; Shahbaz et al., 2013; Huang and Ulanowicz, 2014; Andersson and Karpestam, 2013; Greyson, 2007) but tends to differ from most reviewed empirical studies from developed countries (Gaspar et al., 2017; Esseghir and Khouni, 2014; Andreoni and Galmarini, 2012; Dawson et al., 2010; Cuthill, 2010; Sorrell, 2010; D'Alessandro et al., 2010; Perrings and Ansuategi, 2000; Ayres et al., 2007; Bartelmus, 1999; Stern et al., 1996).

This novel differences in empirical findings between developed and developing might be linked to probable contradictions of basic assumptions of decoupling sustainability dimensions from economic growth due to the limiting capacity of rebound effects on any potential decoupling, improved contribution of energy consumption to productivity, complimenting improved efficiency with an ethic of sufficiency, incompatibility of sustainability with increasing economic growth in advanced countries, and negative influence of a zero-growth economy with reserves in the banking system (Zhang et al., 2016; Gu et al., 2014; Sorrell, 2010).

Specifically, Sorrell (2010) study challenged the conventional theory and raised major concerns due to probable less expected improvements from any potential process of decoupling sustainability variables from economic growth (Zhang et al., 2016; Gu et al., 2014). That notwithstanding, based on the four research questions/ hypotheses in this study, the following are the specific conclusion from the four articles:

7.2.1 Conclusion: Article 1

This paper examined the influence of economic growth on socio-economic sustainability within the BRICS countries from 1990 to 2017. The paper utilizes Pesaran et al. (2001) cointegration as well as the Granger no-causality methodology developed by Toda and Yamamoto (1995) as estimation techniques. Our results confirmed the existence of co-integrating vectors in all the models of all the selected BRICS countries. Specifically, estimates from all the BRICS countries exhibit long-run equilibrium relationship with each other, however, while the models of Brazil, India and South Africa did the adjustment in the short-run via one established channels, variables in the models of Russia and China exhibit the same adjustment via three identified channels.

However, since the presence of cointegrating vectors in any system merely assumed the existence and/or nonexistence of causality, this, however, often failed to specify the route of causality among the systems (Hickel & Kallis, 2020). Consequently, the direction of causality was therefore established via Toda–Yamamoto causality analysis. The outcome of the estimated causality test detected both unidirectionally and bidirectionally causal effects in the short-run for all the variables.

Our study, therefore, concluded that the long-run equilibrium relationships between economic growth and socio-economic sustainability in the BRICS countries vary from one country to another, but were largely insignificant in the models of Russia and China during the study period. Also, the present study found that a common policy option may not be beneficial and that for the block to pursue its economic prosperity goals without compromising individual countries' needs for socio-economic sustainability, varied policy options were inevitable.

Furthermore, the insignificant influence of economic growth on socio-economic sustainability in the estimates from Russian and Chinese models could be seen as tacit support for the Kuznets hypothesis. The Kuznets hypothesis simply posits for an increase in income disparities arising from the first phase of economic growth, while the same economic growth in a later phase, given redistribution mechanisms, tends to contribute to the attainment of an egalitarian pattern of the income distribution (Fan & Zheng, 2013; Omer, 2008; Spangenberg, 2004). Lastly, our study also observed a unidirectional causality between economic growth and socio-economic sustainability in South Africa. This interesting result, however, differs from previous studies in the same bloc (Younsi & Bechtini, 2018; Javeria et al., 2017; Jamel & Maktouf, 2017).

7.2.2 Conclusion: Article 2

This study analyses the effect of economic growth on institutional fitness within the BRICS countries using a panel dataset from 1990 to 2017. The main focus of the present study was on contriving policy options that would emanate from the linkage between economic growth and institutional sustainability. With countries in BRICS having different levels of institutional development to support economic growth, the study was eager to produce evidence that would enable the proposition of policy options to assist individual countries or subgroups of countries to deal with their institutional issues whilst remaining prescribed to the overall goals of the bloc. After testing for panel Unit Root, the study estimates via the system-Generalised Method of Moments (GMM) were, however, supported by the Hausman specification test to know which effect (both the fixed and random effects estimates) is more significant.

Again, to compare the trends in the level, as well as, the capacity to generalise our panel results, the study conducted a Panel Data Cointegration Analysis, via PEDRONI'S Panel cointegration test on each panel data set of the BRICS block and also launched a cross-sectional dependence test, Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimations at individual and panel levels over the study period as robust checks.

Based on our findings, we can conclude the significant positive influence of economic growth on institutional fitness within the panel sample. This, however, differs from one country to another. Again, we also concluded that economic growth and institutional fitness are co-integrated at the panel level, indicating the presence of long-run equilibrium, with some exhibiting bi-directional relationships. Hence, the influence of economic growth on institutional fitness within the BRICS countries, though significant, was limited and varied.

Specifically, the study observed that China and Russia performed well among the five countries. Comparative findings from fixed effect Least Square Dummy Variable (LSDV), FMOLS and DOLS also observed that only China and Russia exhibited specific effects. Hence, our results can only be generalised within the two countries. The insignificance and sometimes negative results at both individual FMOLS and DOLS estimates for Brazil, India, and South Africa is an indication that economic growth has the potential to diminish institutional fitness in the three countries. Consequently, this study posits a more radical policy mix to enhance institutional sustainability in the three (Brazil, India, and South Africa) countries.

7.2.3 Conclusions: Article 3

To compare evidence on the influence of economic growth on environmental sustainability measured in terms of environmental degradation (C02 emissions), this study estimated the nexus between economic growth and environmental sustainability within the BRICS countries using data sets from 1990 to 2017. Again, to control for any likely cross-sectional dependency issues ARDL and CS-ARDL models were used as the estimation techniques (Lombardi et al., 2017). Our results conform to all robustness checks, including temporal and spatial changes. The study observed that C02 emission and economic growth share long-run relationships, with the possibility of both bidirectional causalities between C02 emission (environmental sustainability) and economic growth. Thus, the increase noted in the level of economic growth in the BRICS countries contributed to increasing C02 emission (environmental pollution) in the bloc.

Specifically, our study concluded that GDP growth exhibits a significant negative impact on C02 emissions in the short-run but reversed in the long-run estimates, tacit support for the EKC hypothesis. For example, we observed that GDP, GDP square, and GDP cube have a negative and significant impact on C02 emission in the short-run, although with declining trends. For example, a magnitude of 0.04657 indicates that a 1% increase in GDP growth increases C02 emission by 0.0446% in the short-run.

However, the major determinants identified in this study were economic growth, nature of technology usage, energy usage, and institutional fitness, while FDI, exchange rate, inflation, and infrastructural investments coefficients were not a significant determinant of C02 emission in the BRICS region during the study period. Presenting the evidence of the relationship between economic growth and environmental sustainability, findings from our study depict a favourable outcome in the present BRICS environmental sustainability policies. Therefore, this study believes that all the BRICS countries should continue with the present environmental policy mix, but the effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability in the bloc. This could be achieved via objective integration of energy sector policies and sustainable development strategies.

7.2.4 Conclusion: Article 4

This study investigates the long-run and short-run effect of the past three decades of economic growth on sustainable development using the novel CS-ARDL and CS-DL models proposed by Chudik et al. (2016) and Pesaran and Smith (1995). It uses panel data of BRICS, MINT, and G-7 countries from 1990 to 2017. Our results conform to all robustness checks, including temporal and spatial changes. Evidence from this paper depicts a positive impact of economic growth on the levels of sustainable development in both the BRICS sub-samples and BRICS blocs in the short run. However, the study observed a long run drag on sustainable development in sub-sample 1 (Brazil, India and South Africa). Also, since most long-run coefficients in our estimates for BRICS and MINT countries seem to cluster around –0.1, the study concluded that a 1 percentage increase in economic growth, in the long run, is associated with a 0.1% decline in sustainable development in the BRICS and MINT blocs. The study also concluded that economic growth and sustainable development are co-integrated at all the panel levels, indicating the presence of long-run equilibrium relationships. Hence, the influence of economic growth on sustainable developments within the blocs and sub-samples countries, though significant, was limited and varied. Specifically, all the coefficients on the first, second and third lags of the short-run part of the cointegrating equation are significant and positive at mostly 10% level but decreases in magnitude towards the third lags. The decreasing magnitude is an indication that the bulk of the pass-through of improving economic growth to sustainable development growth occurs within the first few years (Lombardi et al., 2017; Javeria et al., 2017).

7.3 Policy Implication and recommendations

7.3.1 Policy Implication and recommendations: Article 1

General Implication and recommendations

To improve socio-economic sustainability and also to positively improve economic growth in the BRIC countries, effort should be geared towards the promotion of enhanced social programmes, integration of existing policies, and creation of societal culture. This is based on the notion that an increase in economic growth by 1% will bring about an increase in socio-economic sustainability rates by 0.20% in Brazil, by 0.03% in Russia, by 0.19% in India, by 0.03% in China, and by 0.21% in South Africa. Subsequently, this instability is corrected every year between long and short-run socio-economic sustainability rates by 0.017% for Brazil, by 0.023% for Russia, by 0.019% for India, by 0.017% for China and by 0.022% for South Africa. This implies that fiscal policies in the BRICS countries could be aimed at improving socio-economic sustainability through short term inequality rates, which are often affected by expected growth rates (Younsi and Bechtini, 2018; Maktouf, 2017).

Additionally, based on the output of our findings, if economic growth is likely to decline socio-economic sustainability in the BRICS countries, then various policies to improve socio-economic sustainability could become necessary. Specifically, efforts should be made to improve the main causes of inequalities, like energy usage, institutional fitness, and financial development in the Bloc. Strategic adoption of a focused liberalization and financial openness policies to attract higher R&D-related foreign direct investment that is capable of reducing the increasing socio-economic inequality in BRICS countries is a necessity. It is through establishing the balance among socio-economic sustainability, financial development, and economic growth that sustainable and equitable growth can be achieved by all BRICS countries (Menon, 2017). Lastly, general policies should focus more on radical law reforms and the creation of independent organisations to assist poor people; population growth control, speedy poverty alleviation and basic education; market development. Overall, the impact of the aforementioned recommendations will be beneficial to policymakers in all the BRICS countries not only in estimating the achievement of many BRICS goals but also will serve as a "double-edged" tool for monitoring the BRICS' progress towards the attainment of the United Nations SDGs by the year 2030 (World Bank Group, 2018 Agrawal, 2015; Awan, 2013).

Policy Implication and recommendations for Brazil, India and South Africa

Our findings have shown that socio-economic sustainability has not been adequately supported, while there are variations in the impact of economic growth on socio-economic sustainability within the BRICS bloc. Consequently, this study posits a more radical policy mix to reduce the negative impact of economic growth on socio-economic sustainability, especially in the three most affected countries (namely Brazil, India, and South Africa). Improving socio-economic sustainability in Brazil, India, and South Africa can be achieved through radical legal basis for the transition from natural resource export, as well as sweeping regulation for the sustainable usage of natural resources protection, strict penalties on violations of environment-related laws and general country-wide support in the three countries. Also, there may be an urgent need to define the active role of NGOs and other independent institutions in improving socio-economic sustainability at both local and national levels. Specifically, in South Africa, adequate Corporate Social Responsibility (CSR) guidelines should be implemented as a veritable way of encouraging corporations to monitor their contributions to socio-economic sustainability at both local and national levels. Special enforcement mechanisms, such as "Green Scorpions," should be adequately empowered by the coordinating ministry (Ministry of Environment and Tourism) to step-up their monitoring, assessment, and enforcement roles. There is also a need to have a national standard for reporting CSR by corporations and civil society organisations (CSOs).

Also, the declining trends in socio-economic sustainability in Brazil, India, and South Africa require a radical policy mix on population growth control, inclusive and basic education for all citizens, as well as swift poverty alleviation programmes. There is an urgent need for improved transparency and participation of media organisations in this regard. The establishment and promotion of nationwide social standard and corporate social responsibility guidelines will also go a long way in improving the increasing level of socioeconomic sustainability in the three countries. Specifically, the three countries should prioritise the radical provision of social security and services to assist the poor. Specifically, in South Africa, this could be achieved via an improved implementation of the present accelerated growth strategy to encourage public redistribution of resources and investment in critical infrastructures. On education, content-related coordination for education policy should be encouraged by designing programmes that are capable of integrating learning methods and materials on socioeconomic sustainability into an agreed percentage of all classrooms curricula in all post-secondary schools in the three countries.

This study acknowledges the fact that economic growth alone cannot solve the declining socio-economic sustainability in Brazil, India, and South Africa. Hence, radical strategic policies should be formulated to demand better social standards from multinational companies operating in these countries. Specifically, to reduce income inequalities in Brazil, national government policies must shift from the present dominance of the "industrialist paradigm," which tends to prioritise mainly the economic dimension of sustainability. There is also an urgent need to invigorate the present income transfer programme, as well as transparent land reform, to increase the present level of disposable income needed by the poor and disadvantaged citizens in Brazil. Similar to the successful regional policies in Russia, Brazil may need to focus more on the creation of protected areas, indigenous people's settlements, as well as special economic zones. In India, there is a need for an objective and transparent poverty alleviation programme to improve the declining socio-economic sustainability during the study period. Unfortunately, due to the limited capacity of government to mobilise resources needed to accelerate the level of development, there is an urgent need to increase the level of cooperation with the organised private sector, via Public-Private Partnerships initiatives.

To assist the poor and improve the declining socio-economic sustainability in Brazil, India, and South Africa, there is an urgent need to reinvigorate reconstruction and development programmes. For example, to improve the declining level of socio-economic sustainability in South Africa, the Reconstruction and Development Programme (RDP) should be reinvigorated based on a long term framework that is efficient and coherent in addressing targeted socio-economic sustainability issues. There is also a need to prioritize the concept of nation-building, basic human needs, peace and security, and people-driven growth processes in many Reconstruction and Development Programme (RDP) initiatives.

Furthermore, to improve the declining level of socio-economic sustainability in Brazil, India, and South Africa countries, the government will have to create a societal culture that is favourable to socioeconomic sustainability in each country. However, to achieve this noble objective, the government institution must work harmoniously with both civil society and business sectors. The creation of a societal culture that is favourable to socio-economic sustainability can also be created through local level's promotion of best practices, increase in consumers' demand for sustainable clean services and products, transparent corporate reporting, as well as, required political will on the part of the government to provide the necessary funding, institutional support, and other incentives.

Policy Implication and recommendations for Russia and China

Despite the giant stride recorded by China and Russia in improving socio-economic sustainability over the study period, this study is unmindful of the necessity to improve the current challenges in the area of unemployment, uneven distribution of political and financial power, as well as, regional disparities, especially in China. This is on the premise that it is only through even development strategies and viable interactions between the private sector, general public, and government that can engender the formulation of transparent and equitable policies needed for the much desired sustainable economic growth in the BRICS bloc. On the social dimension, the more advanced group in the bloc (China and Russia) could also emulate Germany's "greying society" strategy of decoupling economic growth from socio-economic sustainability and environmental pollution due to the probable increase in average age and decrease in size. Also, China and Russia should move further by integrating socio-economic inequality interventions into their export/ trade policies. Most importantly, BRICS countries must understand that economic growth might not necessarily result in socio-economic sustainability; rather, it may lead to an unprecedented decline in socio-economic sustainability, financial, institutional, and market risks (Younsi & Bechtini, 2018; Javeria et al., 2017).

7.3.2 Policy Implications and Recommendations: Article 2

The focus on economic growth as a determinant of institutional fitness is intended to provide policy-makers and scholars with a framework for evaluating the association between economic growth and Institutional fitness. Evidence from paper 2 depicts a positive influence of economic growth on institutional fitness in the BRICS bloc. However, results from our FMOLS and DOLS cautioned on the capacity of economic growth to diminish institutional fitness in Brazil, India, and South Africa. Consequently, this study posits a more radical policy mix to enhance institutional sustainability in the three (Brazil, India, and South Africa) countries. The policies could focus on developing fundamental institutional development strategies, superior growth induced domestic investment and financial developments, as well as the creation of a circular economic model.

Superior growth induced domestic investment and financial developments can be achieved via radical interaction between the marketplace and extractive communities or regular contact between credit institutions and producers, to promote FDI that will increase the value of traditional knowledge, technology, capacity building, planting and replanting, social organization, aggregation of value, collection and quality of life. Radical institutional development (fitness) could also be enhanced in the three countries (Brazil, India, and South Africa) by strengthening the role of non-governmental organisations (NGOs). This could serve as a way of exerting better inspection, social control, monitoring, inspecting, as well as demanding action from the government (Santana et al., 2014). Additionally, NGOs, as true umpire, could be encouraged to participate in major growth and sustainability policy formulation by way of supporting the design of national strategies, plans, and programmes (Younsi & Bechtini, 2018). Specifically, NGOs and other stakeholders can play a veritable role, at the grassroots level, on many developmental processes on land resource management. Stakeholders and policymakers in the BRICS bloc should also understand that the key to institutional (fitness) sustainability and success in the bloc lies in the sincere enablement of citizens, especially women, via the promulgation of institutional policies that will create alternative rural livelihoods (Azevedo et al., 2018).

Due to its successful implementations in Germany and China, this study believes that Brazil, India and South Africa countries can adequately tackle the challenges of poor and ineffective institutions and institutional developments arising from citizen's lack of access to clean water, poverty, water pollution, corruption and increasing CO2emissions by adapting the "circular economy" model. Consequently, compulsory circular economy principles should be embedded in strategic government legislations in the three countries. Stiffer penalties should be gazette for defaulting companies by the government. However, the "circular economy" model must be done transparently and objectively, while effort must be made to reduce or eliminate the bureaucratic systems of government institutions in these countries. Each of the three countries could set-up circular economy zones that may be specifically targeting rural areas or provinces. The circular economy zones could be aimed at promoting institutional developments or renewable resources. This may also be integrated into their respective national development plans. Most importantly, the "circular economy" concept can be used to judge and monitor the performance of public/ civil servants, as well as the level of institutional developments in these countries after its implementations.

Furthermore, this study believes that the three "vulnerable countries" in the bloc (Brazil, India, and South Africa) should emulate the better performance of Russia and China in the bloc. Specifically, Russia's age-long tradition of sustainability could be traced to the promulgation of April 1996, Decree No 440 on the concept of Russia's "Transition to Sustainable Development." The Decree played a major role in influencing many newly established Russian public agencies, ministries, and institutions to grow "ministerial" tactics for sustainable development (Santana et al., 2014). There may be a need for better coordinated institutional sustainability-related strategies in different sectors, aimed at promoting growth and sustainability in the three countries. Targeted national committee (commission) and budget resources on growth and institutional sustainability could be allocated for these purposes in a national context.

Despite positive evidence in this study, to catch-up with more advanced countries, there may need to shift from sporadic to more systematic development and implementation of sustainability-related activities in both Russia and China, with a better target and coordination-oriented efforts from the regions, NGOs, experts, government, and local communities (Menon, 2017). Specifically, Russia still has a lot of work to be done in maintaining governance sustainability, reducing clientelism and political patronage, policy contradictions, and inadequate independent experts.

Also, Brazil, India, and South Africa may still undertake few peculiar transformational institutional and sustainable economic growth policies that will turn the tunnel of any probable institutional development constraints in the long-run. Additionally, due to a possibility that economic growth may diminish institutional fitness in Brazil, India and South Africa, the present study also suggests a radical policy stance on both Foreign Direct Investment (FDI) and inflationary risk, as well as, other positive determinants (economic growth, exchange rate, domestic investment, and financial development) of institutional fitness in the BRICS bloc to attain the much desired institutional sustainability and sustainable economic growth.

Specifically, policymakers may have to address shortcomings in their institutional development processes, based on the premise that any improvements in institutional quality will re-distribute the benefits of economic growth in the bloc. Again, due to the notion that better economic growth and institutional development could enhance the marginal product of capital and speed of adjustment in the bloc, an extension of the traditional neoclassical theory to capture any probable deviation in current institutional quality from the ideal level, the present study also believes that countries with better institutional quality in the bloc may be less exposed to the adverse influence of any structural or financial crises (Eslamloueyan & Jafari, 2019; Kandil, 2009). Consequently, more stringent policies aimed at fostering FDI, economic growth, domestic investments, financial developments, as well as, reducing inflation should be encouraged in the three vulnerable countries. For example, a probable policy mix to spur institutional development and economic growth in the three countries should target both monetary and fiscal policies (Fakoya, 2013; Santana et al., 2014).

Theoretically, the contrived model in this study provides predictive implications on improved institutional fitness in the BRICS countries, given the activities of critical variables manifesting its sustainability. This concurs with our theoretical framework (Institutional Fitness theory) for this study. The theory suggests that sustainability of economic growth is determined more by institutional variables (Anyanwu and Yameogo, 2015). Hence, the presupposition is that government policies should be executed within a sound institutional framework for the country to achieve the desired improvements in sustainable economic growth (Wilhelms, 1998). Consequently, national institutions, like education, markets, socio-cultural systems, and government, must be active and efficient in the process of transmitting various government policies to tangible derivatives (Ogasawara, 2018; Wilhelms, 1998).

7.3.3 Policy implication and recommendations: Article 3

Evidence from our paper 3 depicts a favourable outcome in the present BRICS's environmental policies. Specifically, the present study observed, although a significant negative impact of GDP growth on C02 emissions in the short run, however, it seems to have reversed in the long run (tacit support for the EKH hypothesis in the bloc). Therefore, this study believes that all the BRICS countries should continue with the present environmental policy mix in the bloc, but the effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability. This could be achieved via objective integration of energy sector policies and sustainable development strategies.

Based on our study, only the nature of technology use still exacts more impact on environmental pollution in the bloc. Consequently, radical policies are required to strengthen the present BRICS cooperation in energy, especially in moving to a robust environmentally sustainable energy system that arebeing supportive of the global agenda on universal energy access, energy affordability, energy security, environmental conservation and reduced pollution (Wanjuu & Le Roux, 2017; Fakoya, 2013). First, maybe to fast track the 2018 BRICS ministers of Energy’s agreement to establish a joint BRICS Energy Research Cooperation, as well, as the establishment of the BRICS Environmentally Sound Technology (BEST) cooperation platforms (Zha et al., 2019; Bindi, 2018). The two platforms are capable of providing practical, and results orientated information on how to improve the nature of technology usage in the bloc. To improve the nature of technology usage in the BRICS bloc, there may be an urgent need for diversification of energy supply sources to include low carbon energy sources and renewable. Emphases should be placed on investments in energy and energy infrastructure, market development, accelerating energy transition including in heating, transportation, and industry and intra-BRICS collaboration for access to primary energy sources (Santana et al., 2014). In addition to the probable reduction in the negative impact of nature of technology usage on environmental pollution, the above policy mix is capable of popularising the virtue of energy-efficient lifestyle, industrial competitiveness, job creation, emissions reduction, and sustainable economic growth in the BRICS bloc (Fakoya, 2013).

Although Brazil has demonstrated significant potentials in the area of alternative fuels, with major achievements in vegetable oil for biodiesel and sugarcane for ethanol in the past decades, policymakers in the country must shift from their skepticism on the possibility of developing a green economy. Many stakeholders also believe that a green economy would only benefit advanced countries and a general view that developing countries lack the competence to develop new technologies required to maintain a low carbon economy (Menon, 2017). Consequently, the "Brazil 3 Tempos" project, a long-term national strategic objective should be strengthened to probably interconnect with other planning initiatives with adequate inclusion of long term environmental criteria to promote the use of alternative energy sources such as wind energy, small hydropower plants, and biomass. This could be achieved via in-depth dialogue between the Brazilian industrial and environmental policy-makers. Also, a more objective oriented and transparent integration of environmental sustainability issues into the "Pluriannual Plan" (PPA) will not only invigorate Brazil's medium and long-term planning but also improve environmental sustainability in the country. Procurements of modern satellite technologies will go a long way in protecting forest and biodiversity by limiting illegal logging and clandestine activities in Brazil.

Although China’s contributions to Green House Gas (GHG) emissions in absolute terms have not reduced, the country has made substantial progress in the past three decades by growing emissions below GDP and also agreed to major carbon reduction targets. This bold move is capable of encouraging other nations to take the reduction of CO2 more seriously. Nonetheless, the present strategies of reducing China’s high CO2 emissions due to over-reliance on coal can be further strengthened via structural changes in energy supply. This can be done by the promotion of policies that will further encourage systematic investments in the development of new technologies in renewable energies, as well as increased energy efficiency. Also, blocking the conflicts of interest at both local and provincial levels should be matched with consistency in environmental sustainability strategies and actual policies in terms of water, power plants, coal, and infrastructure development planning.

Due to similarities in the generation (for example, coal is still the main source of generating electricity in China, South Africa, and India), limited capacities on distributions, as well as, probably limited value from large hydropower projects in many BRICS countries, development of nuclear power capacities will serve as a veritable way of generating the additional energy need, especially, in China and India. However, successful implementation of such a project may be problematic, especially in India and Brazil. Consequently, the India government may need to curb public resistance to similar projects, while Brazil may face a daunting task due to the country's acclaimed history of non-compensation and a dislocated population. Similarly, the promotion of sugar cane propelled biofuels in Brazil has always been resisted due to the negative impact on deforestation. Therefore, government policies may target public awareness and consensus by all stakeholders on the future benefits of nuclear power and biofuels in the country. Besides, policies should also target more research and development (R&D) initiatives in the area of renewable energy technologies and innovative energy efficiency.

India should also focus more on reducing the gaps between petroleum product consumption and local production. This can be achieved in the form of prudent and restrictive use of petroleum products to essential needs, or promotion of substitutes like compressed liquefied petroleum and natural gases. Due to her large population, the government can also protect the environment by investing more in research and development (R&D) for the efficient upgrade of fuel quality, as well as, development of biofuels. Coal gasification and washing, as well, policies to reduce environmental pollution to air, water, and land during extraction and mining of coal, should also be prioritised. The above will ensure energy security in India and other BRICS countries. Fiscal incentives, as a supplement to the market mechanism, could be given to encourage the use of fly-ash for both bridge and road construction in the three (Brazil, India, and South Africa) aspiring BRICS countries. Unlike Brazil and China, with a high level of utilisation, India, Russia, and South Africa should also shift priorities to judicious use of hydroelectricity to enhance energy security. Organisations like the Bureau of Energy Efficiency (BEE) in India should expedite the strengthening of strategies and policies to promote competition, market principles, and self-regulation to reduce the negative impact of high energy intensity in the country. BRICS countries could also emulate the Japanese strategies of reducing emissions in the early 1990s while generating twice its output of the 1970s. Lastly, the bloc could establish a common coordinating institutional body or matched environmental sustainability indicators as a means to engendering a clear link between environmental sustainability strategies and energy policies

Again, policies should aim at encouraging other strong determinants of C02 emissions, like the nature of technology usage, energy usage, and institutional fitness, which would, in turn, reduce the rate of environmental pollution in the BRICS countries. Existing policies on infrastructural development, financial development, FDI, exchange rate, and inflation should be sustained and strengthened, despite the above variables not adversely impacted environmental sustainability during the study period. Although, the influence of financial development on C02 emission was insignificant, which seem to be in line with Sorrell (2010) contradictions of the basic assumptions of decoupling environmental sustainability from economic growth in much empirical literature (Ichinose et al., 2015; Chen et al., 2014; Andersson & Karpestam, 2013; Sorrell, 2010), that notwithstanding, the role of the New Development Bank should remain consistent with the goal of sustainability. The above policies will not only contribute to significant improvements in sustainability, in the form of a reduction in pollution but also ensures that any increased income from economic growth in the bloc will engender (through a trickle-down effect) a declining environmental pollution and modification citizen’s ambitions, which may ultimately put further pressure on governments to implement sustainability policies.

7.3.4 Policy implications and recommendations: Article 4

The focus on economic growth as a determinant of sustainable development in the BRICS countries is intended to provide policy-makers and scholars with a framework for evaluating the nexus between economic growth and sustainable developments. Our findings have clearly shown that sustainable development has not been adequately supported and developed in all the BRICS countries. Although, evidence from our paper 4 depicts a positive impact of economic growth on the levels of sustainable development in all the BRICS bloc in the short-run, however, the study observed a long run drag on sustainable development in sub-sample 1 (Brazil, India and South Africa). Consequently, this study posits for a more radical policy mix to reduce the negative impact of economic growth on the level of sustainable development in Brazil, India, and South African countries. These policies should take the form of focused, sustainable development strategies and energy policies, creation of a “new economy,” improved education, and equal distribution of resources.

To achieve focused sustainability development strategies and energy policies, radical water management, and water supply, land, agriculture, and soil degradation, as well as, biodiversity and conservancies issues should be prioritised. For example, marine resource management should be a major concern in South Africa. The country should add more exploiters of marine resources to the established fund for marine resource management in addition to the fishing companies. In India, the government must urgently tackle the increasing pressure on soil resources (like biodiversity loss and deforestation) due to social deprivation in major rural areas. In Brazil, government efforts should be geared toward reducing the impact of domestic migration on environmental degradation. Similar to the local practice in Brazil, the three (Brazil, India and South Africa) countries could lead the present demand for compensation due to the increasing exploitation of natural resources and biodiversity by global corporations and developed countries.

Also, to improve the current decline in sustainable development in Brazil, India, and South Africa, the present study posits for the creation of a "New Economy". A "New Economy" can be created through macro-level inclusion of local and national environmental factors in strategic economic evaluations. There is also a need to develop strong ethics of financial markets, while the old-fashioned slogan of "first growth, then environment" should be replaced. This is on the premise that clever environmental policies also have the potential to contribute to growth in the bloc. Although continuity of the sustainable development process is vital, BRICS countries should understand that sustainability and sustainable development are two complex problems with no single solution. Therefore, efforts should be geared towards the development of objective measures of sustainable development in the bloc as a follow-up, while more dialogue could also help in sharing experiences among local and international stakeholders. The creation of a “New Economy” in Brazil, India, and South Africa is also possible through the establishment of strong targets and indicators of social and environmental sustainability. The targets must be jointly developed with the civil society and academia.

That notwithstanding, government commitment to sustainable development must be firm, and the general public should be bold enough to hold government accountable to any environmental and social targets. Objective sustainable development targets and guidelines will also enhance government facilitating roles. Therefore, multi-stakeholder processes should be encouraged to prevent the kind of stagnating growth rates experienced in Brazil, and the attendant regional migration and environmental problems. A strict top-down approach could be adopted by the political class to encourage grass-root participation in the decision-making process.

This study is also of the opinion that an improved and inclusive educational system, as well as, equal distribution of resources, will go a long way in reducing the declining level of sustainable development in the three BRICs countries (Brazil, India, and South Africa). Education and compromise are also required in the seemly conflicts of interest between the two triangles (socioeconomic, institutional, and environmental dimensions vs. society, business, and government) of “sustainable development” strategy/ policy implementation. Hence, to achieve any meaningful improvements in the level of sustainable development, there is an urgent need for the three “vulnerable” countries (Brazil, India, and South Africa) in the bloc to balance this divide.

Contrary to the negative sentiments on the implementation of foreign sustainable development models and unified strategies, this study believes that the acclaimed risks should not prevent the adoption of previous approaches/ solutions in other countries. Thus, the three countries could emulate the positive policy stance in both China and Russia. Specifically, the positive findings in our Russian models during the study period might be due to the active role of Russian NGOs and independent institutions in promoting sustainable development practices at both local and national level (Azevedo et al., 2018; Santana et al., 2014). However, care must be taken in the bloc to balance the interest of the various NGOs, media, and other independent organisations. Nowadays, many business and personal interests are usually concealed under the guise of 'civil society' interests and NGO status. Also, Russian scientific organisations were deemed to have shown more interest in sustainable development by creating a more prognostic system for the country. Similarly, to reduce the negative impact of economic growth on the level of sustainable development in our sub-sample 1 (Brazil, India, and South Africa countries), the three countries could adopt a similar radical strategy. The strategy must be based on sustainable development principles, as well as tight state control over land use (Javeria et al., 2017). For example, the strict adoption of an ecology-oriented land policy could enhance land preservation and productive usage of natural resources at both regional and municipal levels.

There is also a need for special focus on probable (innovative) methods to advance sustainable development across sectors in the three countries making up our sub-sample 1 (Brazil, India, and South Africa countries). However, many of the general strategies/ approaches could be placed in the realm of public financial policy. This could be in the form of an “outcome versus outlay budgets”, where various outcomes of each scheme/ programme can easily be defined in the context of sustainable development imperatives of each country (Fakoya, 2013). Consequently, to improve sustainable development outcomes, the budgeting process in each country could be designed to integrate sustainable development principles into specific sectoral strategies and policies. On the other hand, the revenue side of the budget may witness a shift in tax burdens from labour to resource exploiters.

To improve the declining level of sustainable development in Brazil, India and South Africa countries, government must create a societal culture that is favourable to sustainable developments in each country. Government institutions must work harmoniously with both civil society and business sectors. Also, the creation of a societal culture that is favourable to sustainable development can be created through local level's promotion of best practices, increase in consumers' demand for environmentally clean services and products, corporate reporting, as well as, the required political will on the part of the government to provide the necessary funding, institutional support, and other incentives. A societal culture could also be created through consumer and media awareness. Although strengthening consumer awareness may be difficult since businesses are deemed too strong, while the media are practically being controlled by businesses in many BRICS countries. That notwithstanding, countries like China and Brazil could build on their past successes in sustainable development initiatives; for example, the "26 degrees" campaign on various media platforms by the Beijing Global Village

Organisation to encourage citizens to lower their air-conditioners in summer was a veritable example of successful sustainable development initiatives aimed at saving energy. Also, the Brazilian sustainable development initiative initiated by the NGO "Acatu" was successful in encouraging manufacturers to upload sustainability information of their production methods on the website of selected consumer interest groups. The initiative was aimed at encouraging superior consumption decisions by consumers. Consequently, the development of public awareness initiatives about sustainable development in the BRICS countries should be prioritized by all stakeholders. This is on the premise that policies can only succeed when they can respond to citizen's real needs (Javeria et al., 2017).

Finally, since environmental sustainability crusade seems to be more popular in the BRICS bloc, this study is of the view that communicating the three-dimensional concept (socioeconomic, institutional and environmental dimensions) of sustainable development (similar to the German sustainable development strategy) in the BRICS bloc will go a long way in reaching out to wider audiences than just the environmental stakeholders. Finally, the present study believes that for economic growth to increases the level of sustainable developments in the BRICS countries, Russia and China could adopt similar policies (similar to G-7 countries) while Brazil, India and South Africa could also adopt same policies (similar to MINT group of countries).

7.4 Contributions to Knowledge

Being a disparate group of countries with different levels of development and different priorities in various aspects of sustainability (socioeconomic, environmental and institutional), policy options that would make it possible for the cooperation of BRICS countries on the bloc goals whilst pursuing individual sustainable priorities in economic activities (growth) become difficult to devise. This thesis produces evidence that sheds light on how these policy options should be devised. The overall contribution of this thesis lies in the fact that no study to date has produced an evidence of the linkage between economic growth and sustainability to devise possible policy options that would take care of priority needs of individual countries (or subgroup of countries) in aspects of socioeconomic, environmental and institutional sustainability in the BRICS bloc.

The contribution of the thesis also lies on its comprehensiveness. The overall contribution of the thesis to the literature was made through 4 papers.

In the first paper, the question was to produce evidence that would inform policy options for the socioeconomic sustainability in BRICS. Presenting the evidence of the relationship between economic growth and socioeconomic sustainability, the paper found that a common policy option was not possible and that for the block to pursue its economic prosperity goals without compromising individual countries' needs for socioeconomic sustainability, varied policy options were inevitable. Specifically, our findings were a tacit support for the "Kuznets hypothesis" in both China and Russia only. Consequently, this study posits for a more radical policy mix to reduce the negative impact of economic growth on socioeconomic inequalities in the three "vulnerable" countries, namely, Brazil, India, and South Africa. This could be in the form of an underlying legal basis for transition from natural resource export, as well as, sweeping regulation for the sustainable usage of natural resources protection, strict penalties on violations of environment-related laws and policies to enhance general country-wide support. Also, there may be an urgent need to define the active role of NGOs and other independent institutions in promoting socioeconomic sustainability practices and concepts at both local and national levels, enhanced social programmes; market development, Integration of existing policies and creation of societal culture. Consequently, to the best of the researcher's knowledge, no study has investigated comprehensibly (along with multiple determinants) the sustainability of growth policy options within BRICS with an aim to proposing socioeconomic sustainability and growth policy options. Moreover, due to the strategic importance of BRICS countries in enhancing global economic growth and socioeconomic sustainability, the paucity of studies on a trending issue, like the nexus between economic growth and socioeconomic sustainability, in the bloc has been described as a major concern in the literature (Younsi & Bechtini, 2018). Consequently, the present study has been able to provide new empirical evidence concerning the aforementioned relationships. Additionally, in a deviation from previous studies that used a singular measure of socioeconomic sustainability, part of the novelty of this paper was the development of an aggregated composite index of socioeconomic inequality of several socioeconomic sustainability variables that have been used in the literature. Constructing the index comprising variables depicting various dimensions of socioeconomic sustainability was crucial as a single index might not give a strong measure of socioeconomic sustainability in the bloc, as well as its capacity to correct past contradictory results in the literature. To the best of the researcher’s knowledge, there has not been any study using an index whilst investigating sustainability in BRICS.

In the second paper, the focus was on policy options that would emanate from the linkage between economic growth and institutional sustainability. With countries in BRICS having different levels of institutional development to support economic growth, the study was eager to produce evidence that would enable the proposition of policy options to assist individual countries or subgroups of countries to deal with their institutional issues whilst remaining prescribed to the overall goals of the bloc. Specifically, evidence from our study cautioned on the capacity of economic growth to diminish institutional fitness in Brazil, India, and South Africa; consequently, this study posits for a more radical policy mix to enhance institutional sustainability in the three (Brazil, India and South Africa) countries. The recommended policy mix include superior growth induced domestic investment and financial developments, via radical interaction between the marketplace and extractive communities or regular contact between credit institutions and producers, to promote FDI that will increase the value of traditional knowledge, technology, capacity building, social organization, aggregation of value, collection and quality of life. Also, radical institutional development (fitness) could be enhanced in the three countries (Brazil, India, and South Africa) by strengthening the role of non-governmental organisations (NGOs).

Despite positive evidence in this study, to catch-up with more advanced countries, there may need to shift from "sporadic" to a more "systematic" development and implementation of sustainability-related activities in both Russia and China, with a better target and coordination-oriented efforts from the regions, NGOs, experts, government, and local communities. Consequently, to the best of the researcher’s knowledge, no study has investigated comprehensibly the institutional sustainability of growth policy options within BRICS with an aim of proposing institutional sustainability and growth policy options. Paper two (2) was also a novel way of extending the present literature on economic growth- sustainability debates from the present concentrations on socioeconomic and environmental dimensions, by giving due recognition to the role of institutions (institutional sustainability) via institutional economics. In addition to the validation of the institutional fitness theory, another novelty of the present study is the development of an aggregated composite index of institutional fitness based on the dictates of institutional economics, by looking at risk assessment factors of all the BRICS countries over time. Development of an aggregate composite index of institutions and evaluating the effect of economic growth on institutional variables in an attempt to predicting the sustainability of economic growth in a group of developing countries and possibly using a mixture of methodologies has been positioned as a way out of the present contradictory findings in the literature (Tendetnik et al., 2018).

In the third paper, the question was to produce evidence that would inform policy options for environmental sustainability in BRICS. Presenting the evidence of the relationship between economic growth and environmental sustainability, findings from our study depict a favourable outcome in the present BRICS environmental sustainability policies. Specifically, our findings supported a significant negative impact of GDP growth on C02 emissions in the short-run; however, it seems to have reversed in the long run. This was tacit support for the EKH hypothesis in the BRICS bloc.

Therefore, this study believes that all the BRICS countries should continue with the present environmental policy mix, but the effort should be made to improve the nature of technology usage, which is still a major hindrance to environmental sustainability in the bloc. This could be achieved via objective integration of energy sector policies and sustainable development strategies. For example, the "Brazil 3 Tempos" project, a long-term national strategic objective, could be strengthened to probably interconnect with other planning initiatives with adequate inclusion of long term environmental criteria to promote the use of alternative energy sources such as wind energy, small hydropower plants, and biomass. This could be achieved via an in-depth dialogue between the Brazilian industrial and environmental policy-makers. To the best of the researcher's knowledge, there seems not to be any study that has investigated these issues comprehensibly in the BRICS bloc. Additionally, confirmation of the EKC hypothesis in the Bloc is another way of extending current debates on economic growth-environmental sustainability nexus and by testing existing knowledge originally in solving trending issues.

In the fourth paper, the question was that any policy options formulation in BRICS would not be just contextual and not founded on the evidence of the relationship between sustainability and economic growth. The contribution of the thesis in this respect consisted of an attempt to validate this evidence. With BRICS being made by countries with different levels of development, the validation consisted of comparing sustainability evidence in BRICS by splitting BRICS countries into emerging countries (Brazil, India and South Africa) and developed counties (China and Russia) to recognize that the latter two countries are on the verge of becoming developed countries with different level of development. Comparing the evidence to the evidence in MINT and G7 provided an opportunity to validate the policy options based on the evidence in BRICS alone. Evidence from this paper depicts a positive impact of economic growth on the levels of sustainable development in both the BRICS sub-samples and BRICS blocs in the short run. However, the study observed a long run drag on sustainable development in sub-sample 1 (Brazil, India and South Africa). Consequently, the paper posits a confirmation of another radical policy mix to reduce the negative impact of economic growth on the level of sustainable development in the three countries (Brazil, India, and South Africa) in sub-sample 1. To achieve this, various policy mix may include giving an active role to NGOs and independent institutions in promoting sustainable development practices at both local and national level, creation of a more prognostic system in each of the three countries, adoption of a radical strategy, based on sustainable development principles, as well as, tight state control over land use. Specifically, the strict adoption of an ecology-oriented land policy could enhance land preservation and productive usage of natural resources at both regional and municipal levels. The contribution of this paper to the literature lies in the fact that policy options arising from the previous paper must take into account the different levels of development. Whilst it is recognized that policy in a developed country setting might not work in developing countries, most research conducted in BRICS have ignored the fact that deep contrast in the level of development among the BRICS member might require policy adjustment to the varying level of developments. To the best of the researcher's knowledge, the analysis of sustainability in BRICS for the sake of policymaking has not contemplated levels of development in their conceptualization. Similarly, no study has investigated the economic growth-sustainable development nexus comprehensibly within BRICS and similar blocs of developing and developed countries with an aim to proposing sustainability, sustainable development and growth policy options. Also, due to the blurred line between growth and developments, Huang and Ulanowicz (2014) posit the quantification of growth and development as a necessary prerequisite to any treatment of sustainable development. Hence, the construction of a composite index to measure sustainable development in this study was a novel contribution in an attempt to quantify sustainable development. Constructing the index comprising variables depicting various dimensions of sustainable developments was crucial as a single index might not give a strong measure of sustainable development in the BRICS bloc, as well as its capacity to correcting past contradictory results in the literature. To the best of the researcher's knowledge, there has not been any study using an index whilst investigating sustainability in BRICS. Aside from contriving separate meanings of economic growth and sustainable development, the combined action of economic growth and sustainable development in the BRICS bloc was quantified with a single index that is robust to cross-sectional biases and small sample size.

In conclusion, the validation of "resource course" hypothesis in the relationship between economic growth and socio-economic sustainability in the BRICS bloc, as attested by the empirical validation of probable EKC arguments due to the varying levels of sustainable developments depicts the necessity for a more radical sustainability policy mix by the three "vulnerable" countries (Brazil, India and South Africa) when compared with the two more advanced countries (China and Russia), for the much-desired goal of sustainable economic growth to be realized. Methodologically, our corrections for cross-sectional dependence issues, via CS-ARDL and CS-DL, are important since all the BRICS countries may be exposed to common shocks. Besides, CS-ARDL and CS-DL estimation techniques are robust to small sample bias. Moreover, using different estimation techniques is another novel way of correcting the plethora of contradictory findings in the literature, as well as any probable homogeneity or heterogeneity that may exist between the BRICS countries. The novelty of our estimation techniques is, therefore, the adoption of a standard method of estimating a long-run relationship, which in addition to tackling the problems of endogeneity, also provides a veritable tool to disentangle the short- and long-run role of economic growth. To the best of the researcher's knowledge, no study has investigated these issues comprehensibly in sustainable development literature. All results conform to all robustness checks, including temporal and spatial changes.

7.5 Limitation and Suggestions for further studies

However, the results of this study should be adopted with care due to some inherent limitations. The first limitation, peculiar to most empirical studies on the economic growth-sustainability nexus using cross-country data from most developing countries, is the probable presence of periods and country-specific omitted variables (Azevedo et al., 2018; Menon, 2017). This is usually due to poor data collection by relevant agencies (World Bank Group, 2018; Pereira et al., 2018).

Secondly, another “inevitable” flaw in many regression results are the constructs/ specifications used to measure our variables (Menon, 2017). Also, there may be problems of endogeneity, which may lead to biases from simultaneous or reverse causation (Anyanwu, 2012; Hailu, 2010). This is on the premise that most of the explanatory variables may probably be jointly endogenous with sustainability dimensions variables (Agrawal, 2015; Younsi & Bechtini, 2018). However, the use of CS-ARDL, CS-DL, ARDL, and GMM approaches was a deliberate attempt to address any potential endogeneity; moreover, our well-designed study using longitudinal or panel data can also address the issue of causality (El-Wassal, 2012).

Again, it could be argued that grouping some determinants that have been identified in the literature as prerequisites to improved sustainable development in one set and treating them equally may be misleading because they are not of equal importance (Anyanwu and Yameogo, 2015). Consequently, the main "inevitable" weakness of our estimated models is the items used to measure the determinants of sustainable development, which might not include several other relevant variables. Further studies might consider the inclusion of these variables; chiefly among the variable are nature of technology usage, Human capital development, resource endowments, agglomeration effects, and the degree of diversification of the economy (Anyanwu & Yameogo, 2015; El-Wassal, 2012).

BIBLIOGRAPHY

Ac, M., Ja, F., & Pa, L. (2018) "The impact of economic growth on CO_2 emissions in Australia: The environmental Kuznets curve and the decoupling index", *Env and sc pollute Res Int,* 25(27), 27283-27296

Adelakun, O.J. (2011). 'Human capital development and economic growth in Nigeria, European Journal of Business and Management, 3(9), 29-38.

Adelowokan, O. A. (2012). "Growth effect of Education and Health Expenditure in Nigeria (1970-2010)", *African Journal of Scientific Research*, 10(1), 510-528.

Adibe, J. (2014). MINT, re-based GDP and poverty: a commentary on the identity crisis in Africa's. *African Journal of Business and Economic Research,* 9(1)**,** 119-134.

Agrawal, G. (2015). 'Foreign Direct Investment and Economic Growth in BRICS Economies: A Panel Data Analysis', *Journal of Economics, Business and Management,* 3(4): 421-424

Agarwal, G., and Khan, M.A. (2011).Impact of FDI on GDP: A comparative study of China and India, *International Journal of Business and Management*, 6(10), 71-79.

Agnello, L., Sousa, R. M. (2012). How do banking crises impact on income inequality? *Applied Economics Letters* 19(15): 1425-1429.

Agrawal, G. (2015). 'Foreign Direct Investment and Economic Growth in BRICS Economies: A Panel Data Analysis', *Journal of Economics, Business and Management,* 3(4): 421-424

Ahenkan, A. & Osei-Kojo, A. (2014) "Achieving sustainable development in Africa: Progress, challenges and prospects", *International Journal of Development and Sustainability*, 3(1), 162-176

Ahmad, S. and Schroeder, R.G. (2003). The impact of human resource management practices on operational performance: Recognising country and industry differences, *Journal of Operations Management,* 21 (2): 19–43.

Ahmed, A. D. (2007). Potential impact of financial reforms on savings in Botswana: an empirical analysis using a VECM approach. *The Journal of Developing Areas* 41(1): 203-220.

Aiglepierre, R. & Bauer, A. (2018). "The choice of Arab-Islamic education in sub-Saharan Africa: Findings from a comparative study", *International Journal of Educational Development*, 62 (4), 47–61.

Ajide, K. & Raheem, I.D. (2016). "Institutions-FDI Nexus in ECOWAS Countries", *Journal of African Business*, 34(2), 231-245.

Akadiri, S.S., Bekun, F.V. & Sarkodie, S.A. (2019), "Contemporaneous interaction between energy consumption, economic growth and environmental sustainability in South Africa: What drives what?", *Science of The Total Environment*, 686(1), 468-475

Akaike, H. (1974). "A new look at statistical model identification". *IEEE Transactionson Automatic Control,* Vol. 19, pp. 716-723.

Akinlo, A. E. (2004). Foreign direct investment and growth in Nigeria An empirical investigation, *Journal of Policy Modeling*, 26(3): 627-639.

Akinola G. W. & Bokana K. G. (2017). "Human Capital, Higher Education Enrolment and Economic Growth in the SSA Countries (Panel Model Approach)", *Journal of Economics and Behavioral Studies*, 9(6), 215-226.

Akintunde, T. S. & Satope, B. F. (2013). "Effect of Health Investment on Economic Growth in Nigeria", *IOSR Journal of Economics and Finance,* 1(2): 39-47.

Al-mulali, U., Fereidouni, H.G. & Lee, J.Y. (2014). "Electricity consumption from renewable and non-renewable sources and economic growth: Evidence from Latin American countries", *Renewable and Sustainable Energy Reviews* 30(1), ; 290-298.

Alzoubi, W.K.A., Khasawneh, S.N.D. & Zoubi, O.M.A. (2020) 'The Relationship between Public Debt and Economic Growth in Jordan for the Period (1990-2018)", *Journal of Economics and Sustainable Development*, 11(12), 62-71

Amigun, B., Musango, J.K. & Stafford, W. (2011), "Biofuels and sustainability in Africa", *Renewable and Sustainable Energy Reviews,* 15(2), 1360-1372

Andersson, F.N.G. & Karpestam, P. (2013). "CO2 emissions and economic activity: Short- and long-run economic determinants of scale, energy intensity and carbon intensity", *Energy Policy*, 61, :1285-1294.

Andreoni, V. & Galmarini, S. (2012). "Decoupling economic growth from carbon dioxide emissions: A decomposition analysis of Italian energy consumption", *Energy*, 44, pp.682–691.

Ang, J.B. (2013). "Institutions and the long-run impact of early development", *Journal of Development Economics,* 105(1), : 1-18.

Ang, J. B. (2010). Finance and inequality: the case of India. *Southern Economic Journal* 76(3): 738-761.

Anyanwu, J.C. (2011), Determinants of foreign direct investment inflows to Africa, 1980-2007, Working Paper No. 136, African Development Bank, Tunis.

Anyanwu, J.C. (2012). Why does foreign direct investment go where it goes?: New evidence from African countries*, Annals of Economics and Finance,* 13(2): 433-470.

Anyanwu, J.C. and Yameogo, N.D. (2015).What drives foreign direct investments into West Africa? An Empirical investigation, *African Development Review*, 27(3): 199-215.

Aoki-Suzuki, C. (2016). "Exploring potential policy motivation and approaches to improve resource efficiency in emerging Asia", *J. Mater. Cycles Waste Manag*., 18, 57–71.

Appleton S. and Teal, F. (1998): Human capital and economic development. ADB Economic Research paper, 39 (4): 1-17.

Aregbesola, A.R. (2014). Foreign direct investment and institutional adequacy: New Granger causality evidence from African countries, *South African Journal of Economic and Management Sciences*, 17(5): 557-568.

Arellano, M., Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies* 58(2): 277-297.

Asheghian, P. (2004). Determinants of economic growth in the United States: The role of foreign direct Investment. *The International Trade Journal*, 18(1), : 63-83.

Asiedu, E. (2002). "On the determinant of foreign direct investment to developing countries: Is Africa different?" *World Development*, 30(1), : 107-119.

Asongu, S.A., Agboola, M.O., Alola, A.A. & Bekun, F.V. (2020), "The criticality of growth, urbanization, electricity and fossil fuel consumption to environment sustainability in Africa", *Science of The Total Environment*, 712(1), 136-176

Asongu, B. & Nwachukwu, J. (2015). "Revolution empirics: predicting the Arab spring", Empirical Economics, 49(3), 1-44.

Asteriou, D. and Hall, S. G. (2007). *Applied Econometrics: A Modern approach*(revised ed.), NY: Palmgrave Macmillan.

Awan, A.G. (2013). Diverging trends of human capital in BRICS countries, *International Journal of Asian Social Science*,2(12): 2195-2219.

Ayres, R.U., Turton, H. & Casten, T. (2007). "Energy efficiency, sustainability and economic growth", *Energy*, 32(5) : 634-648.

Azevedo, V.G., Sartori, S. & Campos, L.M. (2018). "CO2 emissions: A quantitative analysis among the BRICS nations", *Renewable and Sustainable Energy Reviews*, 81: 107-115

Bahmani, O. M., Zhang, R. (2015). On the impact of financial development on income distribution: time-series evidence. *Applied Economics* 47(12): 1248-1271.

Bakare, A.S and Olubokun, S. (2011). "Health Care Expenditure and Economic Growth in Nigeria: An Empirical Study", *Journal of Emerging Trends in Economics and Management Sciences*, 2(2): 83-87.

Barro, R.J. (2013). "Health and Economic Growth", *Annals of economics and finance*, 14(2) : 305-342.

Barro, R.J. (1990). 'Government spending in a simple model of endogenous growth', *Journal of Political Economy*, 98(5): S103-S125.

Barro, R.J. and Lee J.W. (1993). International comparisons of educational attainment, *Journal of Monetary Economics*, 32(3): 363-394.

Barro, R.J. and Sala-i-Martin, X. (1995). *Economic growth.* New York: McGraw-Hill.

Bartelmus, P. (2013). "The future we want: Green growth or sustainable development?", *Environmental Development*, 7(1): 165-170.

Bartelmus, P. (1999). Economic growth and patterns of sustainability, Wuppertal Papers, No. 98, Wuppertal Institut für Klima, Umwelt, Energie, Wupperta.

Bartniczak, B. & Raszkowski, A. (2019) "Sustainable Development in African Countries: An Indicator-Based Approach and Recommendations for the Future", *Sustainability,* 11(22), 1-23

Batuo, M., Mlambo, K., Guidi, F. (2010). Financial development and income inequality: Evidence from African Countries. MPRA Paper No. 25658. http://mpra.ub.uni-muenchen.de/25658

Beck, T., Demirguç-Kunt, A., Levine, R. (2007). Finance, inequality and the poor. *Journal of Economic Growth* 12(1): 27-49.

Becken, S. (2011). A critical review of tourism and oil. *Annals of Tourism Research*, *38*(2): 359–379.

Beckerman W. (1972). "Economists, Scientists, and Environmental Catastrophe", *Oxford Economic Papers*, 24(3) : 327-344.

Beckerman W. (1992). "Economic Growth and the Environment: whose Growth? Whose Environment?", *World Development*, 20(4), pp.481-496.

Behera, J. & Mishra, A.K. (2016). "Inflation and economic growth nexus in BRICS: evidence from ARDL bound testing approach", Asian Journal of Economic Modelling, 4(1), pp.1-17

Benhabib J.and Spiegel, M.M (1994). The role of human capital in economic development. Evidence from aggregate cross-country time, *Journal of Monetary Economics*, 34(3): 143-173.

Bese, E. & Kalayci, S. (2019) "Testing the environmental KuznetsCurve hypothesis: Evidence from Egypt, Kenya and Turkey", *International journal of energy economics and policy*, 9(6), 479-491

Bhagwati, J.N. (1978). *Anatomy and consequences of exchange control regimes*. New York: Balinger Publishing.

Bhagwati, J.N. (1985). *Investing abroad*: *Esmée Fairbairn Lecture*. Lancaster: Lancaster University Press.

Bhagwati, J.N. (1994). Free trade: Old and new challenges, *Economic Journal*, 104(3): 231-246.

Bilgili, F., Koçak, E. and Bulut, U. (2016). "The dynamic impact of renewable energy consumption on CO2 emissions: A revisited Environmental Kuznets Curve approach", *Renewable and Sustainable Energy Reviews,* 54(1): 838–845.

Bindi, G. (2018). The resource curse hypothesis: an empirical investigation, a thesis submitted for the Master's Programme in Economics, School of Economics and Management, Lund University

Bittencourt, M. (2010). Financial development and inequality: Brazil 1985-99. *Economic Change and Restructuring* 43(2): 113-130

Błazejowski, M., Kwiatkowski, J. & Gazda, J. (2019). "Sources of Economic Growth: A Global Perspective", *Sustainability*, 11(1): 275-288

Blomstrom, M. and Kokko A. (1998). Multinational corporations and spill overs, *Journal of Economic Surveys*, 12(3): 247-277.

Blomstrom, M., Lipsey, R.E. and Zejan, M. (1996). Is fixed investment the key to economic growth, *Quarterly Journal of Economics*, 111(3): 269-276.

Blundell, R. and Bond, S. (1998). "Initial conditions and moment restrictions in dynamic panel data models". *Journal of Econometrics*87(4): 115-143.

Boesler, M. (2013). "The Economist Who Invented The BRICs Just Invented A Whole New Group Of Countries: The MINTs". Business Insider, 13 November. Retrieved 7 January 2014.

Bond, P. (2016). "BRICS Banking and the Debate over Subimperialism." *Third World Quarterly*, 37(4): 611-629

Bond, P. & Garcia, A. (2015). *BRICS: An Anti-Capitalist Critique* (Eds), London : Pluto Press.

Bond, P. (2014). "Theory and Practice in Challenging Eextractive-Oriented Infrastructure in South Africa." *Research in Political Economy*, 29(1), 97-132

Boutrolle, C. (2003). "Education, CroissanceetDéveloppement: UneApproche Comparative du BassinMéditerranéenet du Sud-Est Asiatique." Unpublished Ph.D. dissertation, Universite de la Mediterranee, Faculte des Sciences Economiques, Centre d'Economieet Finances Internationales

Bovenberg, A. L. & Smulders, S. (1995). "Environmental quality and pollution-augmenting technological change in a two-sector endogenous growth model", *Journal of Public Economics*, 57(1): 369–391.

Bowen, A., Cochrane, S. & Fankhauser, S. (2012). "Climate change, adaptation and economic growth", *Climatic Change*, 113(1): 95–106.

Brecher, R.A. and Findlay, R.(1983). Tariff, foreign capital and national welfare with sector specific factors, *Journal of International Economics*, 14(3): 277-288.

Breitenbach, M.C., Tipoy, C.K. and Zerihun, M.F. (2017). "Equilibrium Exchange Rates and Misalignments: The Case of Homogenous Emerging Countries', Economic Research Southern Africa (ERSA) working paper 713.

Bryman, A. and Bell, E. (2011). *Business research methods*. (3rd ed.). Oxford: Oxford University

Bryman, A. (2012). Social research methods (4thed.). New York, NY: Oxford University Bundell, R., Dearden, L., Meghir, C., and Barbara, S. (1999). Human capital investment: The returns from education and training to the individual, the firm and the economy, *Fiscal Studies*, 20(1): 1-23.

Burgess R., Rohini, P. (2005). Do Rural Banks Matter? Evidence from the Indian Social Banking Experiment. *American Economic Review* 95(3): 780-795.

Cadarso, M. Á., Gómez, N., López, L. A., & Tobarra, M. Á. (2016). Calculating tourism's carbon footprint: Measuring the impact of investments. *Journal of Cleaner Production*, *111(1)* : 529–537.

Carnoy, M. (2006). Higher education and economic development: India, China, and the 21st Century, working paper no. 297 presented at the Pan Asia Conference: Focus on Economic Challenges, Stanford Center for International Development May 31- June 3.

Carnoy, M., Loyalka, P., Androushchak, G. & Proudnikova, A. (2012). The economic returns to higher education in the BRIC countries and their implications for higher education expansion, basic esearch program working papers series: Education WP BRP 02/EDU/2012, the National Research University Higher School of Economics (HSE).

Cashin, P., K. Mohaddes, and M. Raissi (2017). China's Slowdown and Global Financial Market Volatility: Is World Growth Losing Out?, *Emerging Markets Review*, 31, 164-175.

Chang, M. C. (2015). Room for improvement in low carbon economies of G7 and BRICS countries based on the analysis of energy efficiency and environmental Kuznets curves. Journal of Cleaner Production, 99, 140-151

Chen, S. (2018). "Education and transition to work: Evidence from Vietnam, Cambodia and Nepal", *International Journal of Educational Development*, 61 (1): 92-105.

Chen, X.P., Pang, J.X., Zhang, Z.L. & Li, H.J. (2014). "Sustainability assessment of solid waste management in China: A decoupling and decomposition analysis", *Sustainability*, 6, pp.9268–9281

Chen, B. and Fang, Y. (2000). "Determinants of Economic Growth in China: Private Enterprise, Education, and Openness." *China Economic Review*, 11 (1): 1-15.

Chiu, C. L., & Chang, T. H. (2009). What proportion of renewable energy supplies is needed to initially mitigate CO2 emissions in OECD member countries? *Renewable and Sustainable Energy Reviews*, 13(1): 1669-1674.

Chudik, A., Mohaddes, K., Pesaran, M. and Raissi, M. (2016): "Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors", in Hill, Gonzalez-Rivera, and Lee (eds), *Advances in Econometrics (Volume 36): Essays in Honour of Aman Ullah*, 85-135, Emerald Publishing.

Chudik, A., Mohaddes, K., Pesaran, M.H. and Raissi, M. (2015). "Long-Run Effects in Large Heterogenous Panel Data Models with Cross-Sectionally Correlated Errors", Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute, Working Paper No. 223.

Chudik, A and Pesaran, M. (2015): "Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors", *Journal of Econometrics*, 188(2) : 393–420.

Clarke, G. R., Xu, L. C., Zou, H-F. (2006). Finance and Income Inequality: What Do the Data Tell Us? *Southern Economic Journal* 72(3): 578-596.

Clarke, G., Xu. L. C., Zou, H-F. (2013). Finance and Income Inequality: Test of Alternative Theories. *Annals of Economics and Finance* 14-2(A): 493-510.

Coe, D.T. and Helpman, E. (1995). International R&D spill overs, *European Economic Review,*39(**5):** 859-887.

Colantonio, E., Marianacci, R. & Mattoscio, N. (2010). "On human capital and economic development: some results for Africa", *Procedia-Social and Behavioral Sciences*, 9(1) : 266–272.

Constantine, C. & Khemraj, T. (2019). "Geography, economic structures and institutions: A synthesis Structural Change and Economic Dynamics, Structural Change and Economic Dynamics, 24(2) : 23-45.

Craig, J.C. (2001). "Japanese Foreign Direct Investment in Thailand", *Mid-Atlantic Journal of Business*, 1(3): 564.

Creswell, J.W. (2009). *Research Designs: Qualitative, quantitative and mixed methods approaches.* (3rd ed.). Los Angeles, CA: Sage.

Creswell, J.W. (2014). *Research design: qualitative, quantitative and mixed methods approaches.* Los Angeles, CA: Sage.

Cuma, B. and Akan, Y. (2014), "Economic Growth, CO2 Emissions and Energy Consumption: The Turkish Case", International journal of energy economics and policy, 4(3): 484-494.

Cuthbertson, K.; Hall, S. G. and Taylor, M. P. (1992). *Applied econometric techniques*, NY: Simon and Schuster.

Cuthill, M. (2010). "Strengthening the 'Social' in Sustainable Development: Developing a Conceptual Framework for Social Sustainability in a Rapid Urban Growth Region in Australia", *Sustainable Development*, 18(1): 362-373.

David E., Bloom, D.E. & Canning, D. (2008). Population Health and Economic Growth, Working Paper no. 24: The International Bank for Reconstruction and Development / The World Bank On behalf of the Commission on Growth and Development, 1-27.

Daisaka, H., Furusawa, T., Yanagawa, N. (2014). Globalization, Financial Development and Income Inequality. *Pacific Economic Review* 19(5): 612-633.

D'Alessandro, S., Luzzati, T. & Morroni, M. (2010). "Energy transition towards economic and environmental sustainability: feasible paths and policy implications", *Journal of Cleaner Production*, 18 (1): 532–539.

Daly H.E. (1990). "Toward Some Operational Principles of Sustainable Development", *Ecological Economics*, 2(1): 1-6.

Daly, H.E. & Cobb, J.B. (1990). *For the Common Good*. Boston: Beacon Press.

Dasgupta, P.S. & Heal, G.M.. (1974). "The optimal depletion of exhaustible resources", *Review of Economic Studies*, 41(1):.3-28.

Dawson, J., Stewart, E. J., Lemelin, H., & Scott, D. (2010). The carbon cost of polar bear viewing tourism in Churchill, Canada. *Journal of Sustainable Tourism*, *18*(3): 319-336.

De Bruyn, S.M., Van den Bergh, J.C. and Opschoor, J.B. (1998). "Economic growth and emissions: reconsidering the empirical basis of environmental Kuznets curves", *Ecological Economics*, 25 (1): 161-175.

De La Fuente, Á and Domenéch, A. (2000). Human capital in growth regressions: how much difference does data quality make?, Economic Department Working Paper No262, Paris: OECD 35.

De La Fuente, Á and Domenéch, A. (2006). Human capital in growth regressions: how Much difference does data quality make?, *Journal of the European Economic Association*, 4(1): 1-36.

De Mello, L.R. (1996). *Foreign direct investment, international knowledge transfers, endogenous growth: Time series evidence*. Department of Economics, University of Kent, pp. 234-240.

De Mello, L.R. (1997). Foreign direct investment in developing countries and growth: A selective survey, *Journal of Development Studies*, 34(3): 1-34.

De Mello, L.R. (1999). Foreign direct investment-led growth: Evidence from time series and panel data, *Oxford Economic Papers*, 51(2): 133-151.

Demurger, S. (2001). "Infrastructure and Economic Growth: An Explanation for Regional Disparities in china." *Journal of Comparative Economics*, 29(3): 95-117.

Diao, X., McMillan, M. & Wangwe, S. (2018). "Agricultural Labour Productivity and Industrialisation: Lessons for Africa", *Journal of African Economies*, 27(1): 28-65.

Diesendorf, M. (2000). 'Sustainability and sustainable development', in Dunphy, D, Benveniste, J, Griffiths, A and Sutton, P (eds) *Sustainability: The corporate challenge of the 21st century*, Sydney: Allen & Unwin, chap. 2, 19-37.

Domfeh, K.A., Ahenkan, A. & Bawole, J.N. (2012), "Is sustainable development achievable in Ghana? An analysis of Ghana's development policy achievements and challenges", *International Journal of Environment and Sustainable Development*, 11(3), 304-317

Dupasquier C. and Osakwe P.N. (2006). "Foreign direct investment in Africa: Performance, challenges, and responsibilities". *Journal of Asian Economics*, 17: 241-260.

Durham, B. (2004). Absorptive capacity and the effects of foreign direct investment and equity foreign portfolio investment on economic growth, *European Economic Review*, 48(2): 285-306.

Eaton, J. and Kortum, S. (1999). International technology diffusion: Theory and Measurement, *International Economic Review*, 40(3): 537-570.

Effiong, E. L. (2016). "Financial Development, Institutions and Economic Growth: Evidence from Sub-Saharan Africa", Proceedings of the Centre for the Study of African Economies (CSAE) 2016 Conference on Economic Development in Africa, March 20-22, 2016, St. Catherine's College, Oxford University, United Kingdom.

Eggoh, J., Houeninvo, H. & Sossou, G. (2015). Education, Health and Economic Growth in African Countries, Journal of Economic Development, 40(1): 93-111

El-Wassal, K.A. (2012). Foreign direct investment and economic growth in Arab Countries (1970-2008): An inquiry into determinants of growth benefits, *Journal of Economic Development*, 37(4): 79-100.

Elliott, R.W. & Paton, V.O. (2018). "U.S. higher education reform: Origins and impact of student curricular choice", *International Journal of Educational Development*, 61 (3): 1-4.

Eslamloueyan, K. & Jafari, M. (2019). "Do better institutions offset the adverse effect of a financial crisis on investment? Evidence from East Asia", *Economic Modelling*, 79(1): 154-172.

Esseghir, A. and Khouni, L.H. (2014). **"**Economic growth, energy consumption and sustainable development: The case of the Union for the Mediterranean countries**",** *Energy*, 71(1): 218-225.

Fan C. & Zheng, X. (2013). 'An empirical study of the environmental Kuznets curve in Sichuan Province, China', Environmental *Pollution*, 2(3): 107.

Fakoya, M.B. (2013). Economic growth, sustainability and sustainable development: challenges facing the BRICS economic nation of South Africa. Environmental Economics, 4(3), 72-80.

Fedderke, J. and Romm, A.T. (2005). Growth impact and determinants of foreign direct investment into South Africa, 1956-2003. *Economic Modelling*, 23(2):738-760.

Felipe, J. (1997). *Total factor productivity growth in East Asia: A critical survey*, Economics and Development Research Center Report Series No. 65, Asian Development Bank: 233-235.

Filmer, D. and Pritchett, L.H. (2001). Estimating wealth effects without expenditure data or tears: An application to educational enrolments of India, *Demography*, 38 (1): 115-132.

Fosu, A.K. (2018). "Economic Structure, Growth, and Evolution of Inequality and Poverty in Africa: An Overview", *Journal of African Economies*, 27(1): 1-9.

Fosu, A. K. (2018b). "The Recent Growth Resurgence in Africa and Poverty Reduction: The Context and Evidence", *Journal of African Economies*, 27(1): 92-107.

Franck-Dominique, V. (2008). "Sustainable development: An overview of economic proposals", *Surveys and Perspectives Integrating Environment and Society*, 1(2): 1-8.

Fraser, I.(2011). "Fidelity is confident its MINTs won't suck". Bloomsbury Information QFINANCE, 10 May. Retrieved 7 January 2014.

Frenkel, M., Funke, K., and Stadtmann, G. (2004). A panel analysis of bilateral FDI flows to emerging economies, *Economic System*, 28(3):L 281-300.

Friedl, B., & Getzner, M. (2003). Determinants of CO2 emissions in a small open economy. *Ecological Economics, 45*, pp. 133–148. https://doi.org/10.1016/S0921-8009(03)00008-9

Gaspar, J.D., Marques, A.C. and Fuinhas, J.A. (2017). "The traditional energy-growth nexus: A comparison between sustainable development and economic growth approaches", *Ecological Indicators*, 75(1), pp. 286-296

Giri, A. K., Sehrawat, M. (2015). Financial development and income inequality in India: An application of ARDL approach. *International Journal of Social Economics* 42(1): 64-81

Gokmen, G., Vermeulen, W.N. & Vézina, P. (2020), "The imperial roots of global trade", *Journal of Economic Growth*, **25(1),** 87–145

Goldman Sachs (2001). *Building better global economic BRICs.* Accessed from http://www.goldmansachs.com/our-thinking/topics/brics/brics-reports-pdfs/build-better-brics.pdf as at 18th December, 2014

Granger, C.W.J. (1988). Some recent developments in the concept of causality. *Journal of Econometrics*, 39(3):199-211.

Granger, C. W. J. (1969). "Investigating causal relations by econometric models and cross spectral methods", *Econometrica*, Vol. 35, pp. 424-438.

Greyson, J. (2007). "An economic instrument for zero waste, economic growth and sustainability", *Journal of Cleaner Production*, 15(13/14), pp. 1382-1390

Grossman, G., & Krueger, A. (1991) *Environmental impacts of a North American free trade agreement* (National Bureau of Economics Research Working Paper No. 3194). Cambridge: NBER. https://doi.org/10.3386/w3914

Grossman G.M. & A.B. Krueger (1993). "Environmental Impacts of a North American Free Trade Agreement", in P.M. Garber (ed.), The Mexico-U.S. Free Trade Agreement, Cambridge (Mass.)., The MIT Press: 13-56.

Grossman G.M. & A.B. Krueger (1995). "Economic Growth and the Environment", Quarterly *Journal of Economics*, 2, 353-377.

Grossman, G.M. and Helpman, E. (1990), Trade, innovation, and growth, *The American Economic Review*, 80(2): 86-91.

Gu, A., Teng, F. & Wang, Y. (2014). "China energy-water nexus: Assessing the water-saving synergy effects of energy-saving policies during the eleventh Five-year Plan", *Energy Convers. Manag*., 85, 630-637.

Gur, B. (2015). "An Analysis of Unemployment Determinants in BRIC Countries", *International Journal of Business and Social Science,* 6(1): 192-198.

Gustav, R. and Stewart, F. (2001): Growth and human development; comparative Latin American Experience*, Center Discussion Paper*, No826.

Hailu, Z.A. (2010), Demand side factors affecting the inflow of foreign direct investment to African Countries: Does capital market matter?, *International Journal of Business and Management*, 5(5): 104-116.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1998). *Multivariate analysis*, 5th ed. Englewood Cliffs, NJ: Prentice-Hall.

Hall, C. M., Scott, D., & Gössling, S. (2013). The primacy of climate change for sustainable international tourism. *Sustainable Development*, *21*(2): 112-121.

Hamilton, K. (2015). Sustainable development, the Hartwick rule and optimal growth, *Environmental and Resource Economics*, 21(1): 393-411.

Hanushek, E.A. and Kimko, D.D. (2000), Schooling, labour force quality, and the growth of nations, *American Economic Review*,90(5): 1184-1208.

Hanushek, E.A. and Shultz, G.P. (2012). Education is the key to a healthy economy, *The Wall Street Journal*, 30 April.

Hanushek, E.A. and Woessmann, L. (2007). The role of education quality for economic growth, *World Bank Policy Research Working Paper*, No. 4122, February.

Hapenciuc, C. V. & Neamtu, D. M. (2016). “Comparative analysis of the geographical disparities regarding the level of education of the population and the level of economic development in Romania and in the regional profile*”, Ecoforum Journal*, 5(2) : 213-234.

Hartwick, J.M. (1977). “Intergenerational equity and the investing of rents from exhaustible resources”, American Economic Review, 67(5): 972-974.

Hasan, H. (2011). Leadership styles, decision making styles, and teacher job satisfaction: an Indonesian school context. PhD Thesis. James Cook University

Hayek, F.A. (1960). *The constitution of liberty*.London: Routledge.

Hayek, F.A. (1973). Law, legislation and liberty, vol 1. London: Routledge.

He, J. & Richard, P. (2010). “Environmental Kuznets curve for CO2 in Canada”, *Ecological Economics*, 69 (1), 1083-1093.

Hediger, W. (2000). Sustainable development and social welfare. Ecological Economics, 32: 481-492.

Hickel, J. & Kallis, G. (2020) “Is Green Growth Possible?”, *New Political Economy*, 25(4), 469-486

Hochestler, K. (2014). *Infrastructure and sustainable development goals in the BRICS-Led New development bank*, Policy Brief No. 46, Centre for International Governance Innovation: NY

Hofkes, M.W. (1996).”Modelling sustainable development: an economy-ecology integrated model”, *Economic modelling*, 13(1): 333-353.

Hoi, L. Q., Hoi, C. M. (2013). Financial Sector Development and Income Inequality in Vietnam: Evidence at the Provincial Level. *Journal of Southeast Asian Economies* 30(3): 263-277.

Hoi, L. Q., Hoi, C. H. (2016). Credit Market Depth and Income Inequality in Vietnam: A Panel-Data Analysis. *Journal of Economics and Development* 18(2): 5-18.

Horwitz, F. (2005). Human resources and competitiveness, *Executive Business Brief*, 10(3): 50-52.

Huang, J. & Ulanowicz, R.E. (2014). “Ecological Network Analysis for Economic Systems: Growth and Development and Implications for Sustainable Development”, *PLoS ONE*, 9(6): 1-8.

Hudson, J. & Minea, A. (2013). “Innovation, Intellectual Property Rights, and Economic Development: A Unified Empirical Investigation”, *World Development*, 46(1), 66-78.

Hussin, M.Y.M., Muhammad, F., Abu, M.F., & Awang, S.A. (2012). “Macroeconomic Variables and Malaysian Islamic Stock Market: A Time Series Analysis”, Journal *of Business Studies Quarterly*, 3(4): 1-13.

Hye, Q. M. A. (2011). Financial development index and economic growth: empirical evidence from India. *The Journal of Risk Finance* 12(2): 98-111.

Hye, Q. M. A., Islam, F. (2013). Does financial development hamper economic growth: empirical evidence from Bangladesh. *Journal of Business Economics and Management* 14(3): 558-582.

Ichinose, D., Yamamoto, M. & Yoshida, Y. (2015). "The decoupling of affluence and waste discharge under spatial correlation: Do richer communities discharge more waste?", *Environ. Dev. Econ*., 20, 161-184.

Islam, S.M., Munasinghe, M. and Clarke, M. (2004). "Making long-term economic growth more sustainable: evaluating the costs and benefits'', Ecological Economics, 47(2/3) : 149-166.

Islam, N. (1995). Growth empirics: A panel data approach, *Quarterly Journal of Economics*, 110(3): 1127-1170.

ISSA (2017). *BRICS countries: Sustainability challenges for social security systems*, International Social Security Association: NY

Jalil, A., Feridun, M. (2011). Long-run relationship between income inequality and financial development in China. *Journal of the Asia Pacific Economy* 16(2): 202-214.

Javeria, M., Ashok, M. & Vishal, S. (2017). "C02 Emissions, Energy Consumption and Economic growth in BRICS: An empirical analysis", *IOSR Journal of humanities and social science*, 22(2): 53-58.

Jamel, L. & Maktouf, S. *(2017). "*The nexus between economic growth, financial development, trade openness, and CO2 emissions in European countries*", Cogent Economics & Finance* 5(1): 134-145.

Johansen, S. and Juselius, K. (1990). 'Maximum likelihood estimation and inference on Cointegration – with application to the demand for money', *Oxford Bulletin of Economics and Statistics*, 52 (2): 169-210.

Johnson, A. (2006). The Effects of FDI inflows on host country economic growth. Downloaded from http://www.infra.kth.se/cesis/documents/WP58.pdf as at 31 May 2008.

Jorgenson, A.K. & Clark, B. (2012). "Are the Economy and the Environment Decoupling? A Comparative International Study, 1960–2005", *Am. J. Sociol*., 118: 1-44.

Kandil, M. (2009), "Determinants of institutional quality and their impact on economic growth in the MENA region", *International Journal of Development Issues*, 8(2): 134-167.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics* 90(1): 1-44.

Kappel, V. (2010). The effects of financial development on income inequality and poverty. Working Paper, 10/127, CER-ETH-Center of Economic Research at ETH Zurich

Katircioglu, S. T., Feridun, M., & Kilinc, C. (2014). Estimating tourism induced energy consumption and CO2 emissions: The case of Cyprus. *Renewable and Sustainable Energy Reviews*, 29(1): 634-640.

Keller, W. (2001). The geography and channels of diffusion at the world's technology frontier, NBER Working Paper 8150, NBER, MA: Cambridge.

Keller, W. (2002). Trade and the transmission of technology, *Journal of Economic Growth*, 7(3): 5-21.

Khembo, F. (2013). "The Impact of Human Capital on Economic Growth in the SADC Region", *Developing Country Studies*, 3(4) : 144-152.

Kim, D. H., Lin., S. C. (2011). Nonlinearity in the financial development and income inequality nexus. *Journal of Comparative Economics* 39(3): 310-325.

Kimura, H and Todo, Y. (2010). "Is foreign aid a vanguard of foreign direct investment? A gravity-equation approach". *World Development*, 38(4): 482-497.

Knight, S.A. and Cross, D. (2012). Using contextual constructs model to frame doctoral research methodology. *International Journal of Doctoral Studies*, 7:39-62.

Krauss, S.E. (2005). Research Paradigms and meaning making: A primer. *The Qualitative Report*, 10(4):758-770.

Kurt, S. (2015). "Government Health Expenditures and Economic Growth: A Feder–Ram Approach for the Case of Turkey", *International Journal of Economics and Financial Issues*, 5(2), 441-447

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y., [KPSS], (1992), 'Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root', *Journal of Econometrics*, 54(1) : 159-178

Lau, L., Jamison, D., and Louat, F. (1991), 'Education and productivity in developing countries: an aggregate production function approach', *World Bank, WPS 612.*

Law, S. H., Azman-Saini, W. N., Tan, H. B. (2014). Financial Development and Income Inequality at Different Levels of Institutional Quality. *Emerging Markets Finance and Trade* 50(1): 21-33.

Lee, H. H. and Tan, H. B. (2006). "Technology transfer, FDI and economic growth in the ASEAN Region", *Journal of the Asia Pacific Economy,* 11(4): 394–410.

Levin, A., Lin, C. & Chu, C.J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, 108(3):1-24.

Levine, R., Beck, T., Loayza, N. (2000). Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics* 46(1): 31-77.

Levinson, A. (2009). Technology, international trade, and pollution from US manufacturing, *American Economic Review*, *99*(5) : 2177-2192.

Li, M. (2010). Decomposing the change of CO2 emissions in China: A distance function approach. *Ecological Economics*, 70(1) :77-85.

Li, H., Squire, L., Zou, H. F. (1998). Explaining International and Intertemporal Variations in Income Inequality. *The Economic Journal* 108(446): 26-43.

Liang, Z. (2006). Financial development and income distribution: A system GMM panel analysis with application to urban China. *Journal of Economic Development* 31(2): 1-21.

Licumba, E.A., Dzator, J. & Zhang, X. (2016). "Health and economic growth: are there gendered effects?: Evidence from selected southern Africa development community Region", *The Journal of Developing Areas*, 50(5): 215-227.

Licumba, E.A., Dzator, J. & Zhang, J.X. (2015). Gender equality in education and economic growth in selected Southern African countries, Proceedings of the Australasian Conference on Business and Social Sciences 2015, Sydney (in partnership with The Journal of Developing Areas) ISBN 978-0-9925622-1-2.

Liu, H. T., Xi, Y. M., Guo, J., & Li, X. (2010). Energy embodied in the international trade of China: An energy input–output analysis. *Energy Policy*, 38(8), 3957-3964.

Liu, J., Chen, X. P., & Zhang, Z. L. (2017). Features and factors decomposition of carbon dioxide emission of China's tourism industry. *Resources and Industries*, *19*(3), pp.67–76

Liu, J., Feng, T. T., & Yang, X. (2011). The energy requirements and carbon dioxide emissions of tourism industry of Western China: A case of Chengdu City. *Renewable and Sustainable Energy Reviews*, *15(1)*, 2887-2894.

Lombardi, M., Mohanty, M. and Shim, L. (2017). "The real effects of household debt in the short and long run", Bank for International Settlements Working Paper No. 607

Lucas, R. (1988). On the mechanics of economic development, *Journal of Monetary Economics*, 22(3): 30-42.

Madsen, J.B. (2007). Technology spill over through trade and TFP convergence: 135 years of evidence for the OECD countries, *Journal of International Economics*, 72(3): 464-480.

Magalhaes, L. (2013). "O'Neill, Man Who Coined 'BRICs,' Still Likes BRICs, But Likes MINTs, Too". The Wall Street Journal, 9 December. Retrieved 7 January 2014.

Mahe, S.A. (2005). Is globalisation capable of raising living standards, through international trade in Nigeria?, Downloaded from http://www.hollerafrica.com/showArticle.php?artId=143&catId=2 on 21 July 2008.

Mankiw, N.G, Romer, D. and Weil, D.N. (1992). Contribution to the empirics of economic growth, *The Quarterly Journal of Economics*, 107(2):407-437.

Mansur, M., Azleen, R. (2017). What is the link between financial development and income inequality? Evidence from Malaysia. MPRA Paper No. 79416. http://mpra.ub.uni-muenchen.de/79416

McCowan, T. (2018). "Quality of higher education in Kenya: Addressing the conundrum", *International Journal of Educational Development*, 60 (2): 128-137.

McMahon, W. (1998), 'Education and growth in East Asia', Economics of Education Review, 17(2), pp 159-172

Meagher, K. & Lindell, I. (2013), "Engaging with African Informal Economies: Social Inclusion or Adverse Incorporation? Introduction", *Afr. Stud. Rev.*, 56(1), 57–76.

Meng, W. Q., Xu, L. Y., Hu, B. B., Zhou, J., & Wang, Z. L. (2016). Quantifying direct and indirect carbon dioxide emissions of the Chinese tourism industry. *Journal of Cleaner Production, 126(1)* : 586–594.

Menon, A.A. (2017). "Performance of Economic Growth in BRICS Countries", *International Journal of Informative & Futuristic Research,* 4(5): 6200-6203.

Mesagan, E.P., Isola, W.A. & Ajide, K.B. (2019) "The capital investment channel of environmental improvement: evidence from BRICS", *Environmental Development and Sustainability*, 21(1), 1561–1582

Mikulewicz, M. & Taylor, M. (2020) "Getting the Resilience Right: Climate Change and Development Policy in the 'African Age'", *New Political Economy*, 25(4), 626-641

Mohaddes K and Raissi M. (2017). Do sovereign wealth funds dampen the negative effects of commodity price volatility, 18-27.

Mosteanu, N.R. (2019). "Regional development and economic growth approach in Europe and GCC countries", ECOFORUM, 8(2-19) 1-12.

Moşteanu, N.R. (2019b). *Intelligent Foreign Direct Investments to boost economic development – UAE case study*. Proceedings of *8th* International Conference on Business & Economic Development *(ICBED)*, 8-9 April, 2019, NY, SUA .

Moşteanu, N.R. and AlGhaddaf, C. (2019). *Smart economic development by Using Foreign Direct Investments – UAE case study*. Journal of Information Systems & Operations. 13(1) : 34-54.

Mookherjee, D., Ray, D. (2003). Persistent Inequality. *The Review of Economic Studies* 70(2): 369-393

Moyo, C. & Khobai, H. (2018). Trade openness and economic growth in SADC countries, MPRA Paper No. 84254, Nelson Mandela University, South Africa. Available at Online at https://mpra.ub.uni-muenchen.de/84254/

Murthy, N.R. and Chien I.S. (1997). The empirics of economic growth for OECD countries: Some new findings, *Economic Letters*, 55(3):425-429.

Nassani, A. A., Aldakhil, A. M., Abro, M. M. Q., & Zaman, K. (2017). Environmental Kuznets curve among BRICS countries: spot lightening finance, transport, energy and growth factors. Journal of Cleaner Production, 154(1), pp.474-487

Ncube, M. (1999). Is human capital important for economic growth in Zimbabwe?, *African Journal of Economic Policy*, 7(3): 1-14.

Neamtu, D.M. (2015). "Education, the economic development pillar", *Procedia - Social and Behavioral Sciences*, 180 (1): 413-420.

Newey, W.K.. & West, K.D. (1994), Automatic lag selection in covariance matrix estimation. Review of Economic Studies, 61, 631-653

Nikoloski, Z. (2013). Financial sector development and inequality: is there a financial Kuznets curve? *Journal of International Development* 25(7): 897-911.

Nkoro, E. & Uko, A.K. (2016). " Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation", *Journal of Statistical and Econometric Methods*, 5(4) : 63-91.

Nonneman, V. and Vandhoult, P. (1996). A further augmentation of the Solow model and the empirics of economic growth for OECD countries, *Quarterly Journal of Economics*, 111 (3): 943-953.

North, D. C. (1971). "Institutional change and economic growth", *Journal of Economic History*, 31(1):118-125.

North, D.C. (1989). "Institutions and economic growth: an historical introduction", *World Development*, 17(9):1319-1332.

North, D.C. (2005) Understanding the process of economic change. Princeton University Press, Princeton

Nosheen, M., Iqbal, J. & Hassan, S.A. (2019) "Economic growth, financial development, and trade in nexuses of CO2 emissions for Southeast Asia", *Environ Sci Pollut Res*, 26(1), 36274–36286

Odhiambo, N. M. (2010). Finance-investment-growth nexus in South Africa: an ARDL bounds testing procedure. *Economic Change and Reconstructing* 43(3): 205-219.

Odusola, A.F. (1998). Human investment and the empirics of economic growth, *Selected papers for the NES Annual Conference*, Ibadan.

OECD. (2010). *The high cost of low educational performance*. Paris: OECD Publishing.

Ogasawara, K. (2018). "Health and education during industrialisation: Evidence from early twentieth century Japan", *International Journal of Educational Development*, 61 (1), pp. 40–54

Ogutcu, M. (2002). Foreign direct investment and regional development: Sharing experiences from Brazil, China, Russia and Turkey. *OECD Paper*, Paris.

Okojie C.E.E. (1995). Human capital formation for productivity growth in Nigeria, *The Nigerian Economic and Financial Review*, 32(3): 44-54.

Oladipo, O.S. (2008). "Foreign direct investment flow: Determinants and growth effects in a small open economy", Proceedings of the Northeast Business & Economics Association, Northeast Business & Economics Association 35th Annual Conference, Long Island, New York, 6-8 November.

Omar, M.A. & Inaba, K. (2020), "Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis, *Journal of Economic Structures*, **9(1),** 37-65

Omer, A M. (2008). 'Energy, Environment and Sustainable Development, *Renewable and Sustainable Energy Reviews*, 12(9): 2265-2300.

Onisanwa, I.D. (2014). "The Impact of Health on Economic Growth in Nigeria", *Journal of Economics and Sustainable Development*, 5(19): 159-166.

Onuonga, S. M. (2020) "The Impact of Financial Development and Economic Growth on Environmental Quality of Kenya", Journal of Economics and Sustainable Development, 11(12), 15-26

Ostrom, E. (1995), 'Self-organisation and social capital', *Industrial and Corporate Change*, 4(1): 131–159.

Ostrom, E. and Basurto, X. (2011), 'Crafting analytical tools to study institutional change', *Journal of Institutional Economics*, 7(3), 317-343.

Özokcu, S. & Özdemir, Ö. (2017). "Economic growth, energy, and environmental Kuznets curve", Renewable and Sustainable Energy Reviews, 72 (1): 639-647.

Ozturk, I. (2007). Foreign direct investment-growth nexus: A review of the recent literature, *International Journal of Applied Econometrics and Quantitative Studies*, 4(2): 79-98.

Pao, H. T., & Tsai, C. M. (2010). CO2 emissions, energy consumption and economic growth in BRIC countries. Energy policy, 38(12), pp.7850-7860

Pearce, D.W., Hamilton, K. & Atkinson, G. (2014). 'Measuring Sustainable Development: progress on indicators, *Environment and Development Economics*, 1(1): 85-101.

Pearce, D.W. & Atkinson, G. (1993). Capital theory and the measurement of sustainable development: an indicator of weak sustainability. Ecological Economics, 8(1): 103-108.

Pedroni, P. (1999). "Critical Values for Cointegration tests in heterogeneous panels with multiple regressors", *Oxford Bulletin of Economics and Statistics*, 61: 653-670.

Pelinescu, E. (2015). The impact of human capital on economic growth, *Procedia Economics and Finance*, 22(1): 184-190.

Perch-Nielsen, S., Sesartic, A., & Stucki, M. (2010). The greenhouse gas intensity of the tourism sector: The case of Switzerland. *Environmental Science and Policy*, *13*(2), 131-140.

Pereira, C.A., Ferraz, J.F., Araujo, E. & Machado-Taylor, M. (2018). “The Brazilian higher education evaluation model: “SINAES” sui generis”, *International Journal of Educational Development*, 61 (3): 128-137.

Perrings, C. and Ansuategi, A. (2000), "Sustainability, growth and development", *Journal of Economic Studies*, 27(1/2) 19-54.

Pesaran, M.H. & Shin, Y. (1995), An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. Cambridge: Cambridge University, Department of Applied Economics, DP No. 9514.

Pesaran, M.H., Shin, Y. & Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationship. Journal of Applied Economics, 16, 289-326.
.

Pesaran M. H. (2003), A Simple Panel Unit Root Test in the Presence of Cross Section Dependence.

Pesaran M.H (2004) General diagnostics tests for cross section dependence in panels, CWPE 0435.

Pesaran, M.H and Smith, R. (1995): “Estimating long-run relationships from dynamic heterogeneous panels”, *Journal of Econometrics*, 68(1), : 79-113.

Phillips, P.C. & Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75, 335-346

Phong, L.H. (2019) “Globalization, financial development and environmental degradation in the presence of environmental Kuznets curve: Evidence from ASEAN-5 countries”, *International journal of Energy Economics and Policy*, 9(2), 40-50

Pillay, D. (2013). The relationship between financial market development and economic growth in the Southern Africa Development Community, A MBA research project submitted to the Gordon Institute of Business Science, University of Pretoria, South Africa.

Pillay, P. (2011). Higher Education and Economic Development: literature review, Published by the Centre for Higher Education Transformation (CHET): Wynberg

Pistorius, C. (2004).The competitiveness and innovation, *Elektron*, 2(3): 234-245.

Pritchett, L. (1996), ‘Where has all the education gone*?’, World Bank working paper*, n°1581.

Polasky, S, Kling, C.L., Levin, S.A., Carpenter, S.R., Daily, G.C., Ehrlich, P.R., Heal, G.M. & Lubchenco, J. (2019). “Role of economics in analysing the environment and sustainable development”, *Colloquium Introduction*, 116(12): 5233-5238.

Richmond, A. K., & Kaufmann, R. K. (2006). Is there a turning point in the relationship between income and energy use and/or carbon emissions? *Ecological Economics*, 56, 176-189. https://doi.org/10.1016/j.ecolecon.2005.01.011.

Riley, G. (2012). Economic growth - the role of human & social capital, competition & innovation. Accessed from http://www.tutor2u.net/economics/revisionnotes/a2-macro-economic-growth-capital.html, 16 April 2014.

Robaina-Alves, M., Moutinho, V., & Costa, R. (2016). Change in energy-related CO2 (carbon dioxide) emissions in Portuguese tourism: A decomposition analysis from 2000 to 2008. *Journal of Cleaner Production*, 111(1), 520-528.

Rodrik, D. (2016). "An African Growth Miracle?", *Journal of African Economies*, 25(1), 1-18.

Romer, P. (1986). Increasing returns and long-run growth, *Journal of Political Economy*, 94(3): 1002-1037.

Romer, P. (1990). Human capital and growth: Theory and evidence, *Carnegie Rochester Conference Series on Public Policy*, 32(3): 251-286.

Rostow W. (1960). The Stages of Economic Growth: A Non-Communist Manifesto. Cambridge: Cambridge University Press.

RSA. (2013). South Africa's positions in BRICS, Quarterly Bulletin- January to March, 2013. Gauteng Provincial Treasury, Republic of South Africa.

Saggi, K. (2002). Trade, foreign direct investment and international technology transfer: A survey, *The World Bank Research Observer*, 17(2): 191-235.

Santana, N.B., Rebelatto, D.A., Périco, A.E. & Mariano, E.B. (2014). "Sustainable development in the BRICS countries: an efficiency analysis by data envelopment", *International Journal of Sustainable Development & World Ecology*, 21(3) : 259-272, DOI: 10.1080/13504509.2014.900831.

Schumacher, I. & Strobl, E. (2011). "Economic development and losses due to natural disasters: The role of hazard exposure", *Ecological Economics*, 72(1): 97-105.

Selden, T. M., & Song, D. (1994). Environmental quality and development: Is there a Kuznets curve for air pollution emissions? *Journal of Environmental Economics and Management, 27(3)* : 147-162. https://doi.org/10.1006/jeem.1994.1031.

Serena, M. and Freire, J. (2001). Human capital accumulation and economic growth, *Investigaciones Económicas*, XXV(3): 585-602.

Sesay, B., Yulin, Z. & Wang, F. (2018), 'Does the national innovation system spur economic growth in Brazil, Russia, India, China and South Africa economies? Evidence from panel data', *South African Journal of Economic and Management Sciences* 21(1) : 16-47.

Shahbaz, M., Lean, H.H. & Farooq, A. (2013). "Natural gas consumption and economic growth in Pakistan", *Renewable and Sustainable Energy Reviews*, 18(1) : 87-94.

Sharma, S.S. (2010). “The relationship between energy and economic growth: Empirical evidence from 66 countries”, Applied Energy, 87(1) : 3565-3574.

Shebaya, M.P. (2011). Leadership development: the role of developmental readiness, personality dispositions and individual values. PhD Thesis. Birmingham: Aston.

Shimeles, A. & Nabassaga, T. (2018). “Why Is Inequality High in Africa?”, *Journal of African Economies*, 27(1) :108-126.

Siggel, E.(2000). Uganda's policy reforms, competitiveness and regional integration industry: A comparison with Kenya. *African Economic Policy, Discussion paper 24*. Washington: United States Agency for International Development: Bureau for Africa.

Siggel, E. (2001). India's trade policy reforms and competitiveness industry in the 1980s, *World Economy*, 322(3):159-183;

Smulders S. (1995). “Entropy, environment and endogenous economic growth”, Journal of International Tax and Public Finance, 2(1) : 317-338.

Smulders, S. (1999). Endogenous growth theory and the environment. In: Van den Bergh J, editor. Handbook of environmental and resource economics. Cheltenham, UK: Edward Elgar. 610-21.

Solow, R.M. (1974). “Intergenerational equity and exhaustible resources”, *Review of Economic Studies*, 41(1) : 29-46.

Sorrell, S. (2010). “Energy, Economic Growth and Environmental Sustainability: Five Propositions”, *Sustainability,* 2: 1784-1809.

Spangenberg, J.H. (2010). “The growth discourse, growth policy and sustainable development: two thought experiments”, Journal of Cleaner Production, 18 (1): 561-566.

Spangenberg, J.H. (2004). “Reconciling Sustainability and growth: Criteria, Indicators, Policies”, *Sustainable Development,* 12, 74-86.

Stern, D.I., Common, M.S. and Barbier, E.B. (1996). “Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development”, World Development, 24(7): 1151-1160.

Stefan, G. (2012). “Considerations on the theory of economic growth and development”, *Procedia-Social Behavioral Sciences*, 62(1) : 280-284.

Stiglitz, J. E. (1974). “Growth with exhaustible natural resources”, *Review of Economic Studies*, 41(1) : 123-137.

Strittmatter, A. & Sunde, U. (2011). “Health and Economic Development: Evidence from the Introduction of Public Health Care”, Discussion Paper No. 5901: The Institute for the Study of Labor (IZA), 1-53.

Tahvonen, O. and Kuuluvainen, J. (1993). Economic growth, pollution and renewable resources, Journal of Environmental Economics and Management, 24(1): 101-118

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. Energy policy, 37(1), pp.246-253

Tekabe, L.F. (2018). Health and Economic Growth in selected low income countries of African south of the Sahara: Cross Country Evidence, Södertörns University, Department of Social Sciences, Economics.

Temple, J. (1999). A positive effect of human capital on growth, *Economics Letters,* 65(3): 131-134.

Tendetnik, P., Clayton, G. & Cathcart, K, (2018). "Education and nation-state fragility: Evidence from panel data analysis", *International Journal of Educational Development*, 62 (1): 17-26.

Toda, H.Y. & Yamamoto, T. (1995). Statistical inference in vector auto regressions with possibly integrated processes. Journal of Econometrics, 66, 225-250.

Tsaurai, K.(2019) "Impact of Financial development on CO2 in Africa", *International Journal of Energy Economics and Policy*, 93(1), 144-153

Tsaurai, K. (2017). "The Dynamics of Foreign Direct Investment in BRICS Countries", *Journal of Economics and Behavioral Studies,* 9(3): 101-112.

Tsur, Y. & Zemel, A. (2003). "Optimal transition to backstop substitutes for non-renewable resources", *Journal of Economic Dynamics and Control*, 27(1) : 551-72.

Tsur, Y. & Zemel, A. (2005). "Scarcity, growth and R&D', *Journal of Environmental Economics and Management*, 49(3) : 484-99.

Ugur, S. and Sari, R. (2003) "Energy consumption and GDP: Causality relationship in G-7 countries and emerging markets", *Energy Economics,* (25): 33-37.

United Nations (2013). *Sustainable Development Challenges*, World Economic and Social Survey, 2013; World Economic and Social Survey, The Department of Economic and Social Affairs of the United Nations, United Nations publication: NewYork.

UNCSD, (2012). The future we want, outcome document of the 2012 United Nations Conference on Sustainable Development, Geneva: United Nations. .

UNCTAD. (2013). *World investment report: Global value chains: Investment and trade for development.* New York and Geneva: The United Nations Conference and Trade and Development: United Nations.

UNCTAD. (2014). *World investment report 2014*. United Nations Conference on Trade and Development. New York: United Nations.

UNCTAD. (2015). *World Investment Report 2015*. By United Nations Conference on Trade and Development, New York: United Nations.

UNDP. (2014). United Nations Development Programme, *Human Development Report (2014).*

Valentin, A. & Spangenberg, J.H. (2000). A guide to community sustainability indicators. Environmental Impact Assessment Review, 20: 381-392.

Walter, M. (2006). The nature of social science research. In M. Walter (Ed). Social research methods: an Australian perspective. Melbourne: Oxford University, 167-168.

Wang, H., & Zhou, P. (2018). Multi-country comparisons of CO2 emission intensity: The production–theoretical decomposition analysis approach. *Energy Economics*, *74(1)* : 310-320.

Wang, K., Shao, H. Q., Zhou, T. T., & Liu, H. L. (2017). Analysing impact factors of CO2 emissions from tourism in China: Based on STIRPAT model. *Acta Scientiae Circumstantiae, 37*(3): 1185-1192.

Wang, M., & Feng, C. (2017). Decomposition of energy-related CO2 emissions in China: An empirical analysis based on provincial panel data of three sectors. *Applied Energy*, 190 (1) : 772-787.

Wang, R. (2018). Energy efficiency in China's industry sectors: A nonparametric production frontier approach analysis. *Journal of Cleaner Production*, *200(1)* : 880-889.

Wang, K.M. (2013). "The relationship between carbon dioxide emissions and economic growth: Quantile panel-type analysis", *Qual. Quant*., 47: 1337-1366.

Wang, W.W., Liu, R., Zhang, M. & Li, H.A. (2013). "Decomposing the decoupling of energy-related CO2 emissions and economic growth in Jiangsu Province', *Energy Sustain. Dev*., 17: 62-71.

Wang, W., Liu, R., Zhang, M. & Li, H. (2013). "Decomposing the decoupling of energy related CO2 emissions and economic growth in Jiangsu Province", *Energy for Sustainable Development,* 17(1): 62-71.

Wanjuu, L. & Le Roux, P. (2017) Wanjuu & Le Roux, (2017) Effiong, E. L. (2016. "Economic institutions and economic growth: Empirical evidence from the Economic Community of West African States", *South African Journal of Economic and Management Sciences* 20(1): 1-10.

Webersik, C. & Wilson, C. (2009), "Achieving environmental sustainability and growth in Africa: the role of science, technology and innovation", *Sustainable Development*, 17(6), 400-413

Welle-Strand, A., Ball, G., Hval, M.V. & Vlaicu, M. (2012). “Electrifying solutions: Can power sector aid boost economic growth and development?”, *Energy for Sustainable Development,* 16(1) : 26-34.

WDI. (2016). World Development Indicators. World Bank. http://data.worldbank.org/indicator

Weil, D.N. (2013). “Health and Economic Growth”, *Handbook of Economic Growth*, 2(3) : 23-64.

Westerlund, J. (2007) Testing for Error Correction in Panel Data, Oxford bulletin of economics and statistics.

Wilhelms, S. K.S. (1998). Foreign Direct Investment and its determinants in emerging economies, African Economic Policy Paper Discussion Paper Number 9, July.

World Bank Group (2018). Global Economic prospects: Broad-Based Upturn, but for How Long? A World Bank Group flagship report: NW, Washington.

World Commission on Environment and Development (WCED) (1987). Our Common Future. Oxford: Oxford University Press.

Wright, C. (2014). "After The BRICS Are The MINTs, But Can You Make Any Money From Them?". forbes.com. 6 January. Retrieved 7 January 2014.

Wu, B., & Flynn, A. (2010). Sustainable development in China: Seeking a balance between economic growth and environmental protection. *Sustainable Development, 3*(1), pp.1–8.

Wyk, J.V. and Lal, A.K. (2008). Risk and FDI flows to developing countries, *South African Journal of Economic and Management Sciences,* NS 11(4): 511-528.

Xu, B., Sun, Q., Wennersten, R., & Brandt, N. (2014). An analysis of China's carbon dioxide mitigation target. *Sustainable Development*, 22(1). : 113-121.

Young, A. (1991). Learning by doing and the dynamic effects of international trade, *The Quarterly Journal of Economics*, 106(2): 369-405.

Younsi, M. & Bechtini, M. (2018). Economic Growth, Financial Development and Income Inequality in BRICS Countries: Evidence from Panel Granger Causality Tests, Munich Personal RePEc Archive (MPRA) Paper No. 85249.

Zanin, L. & Marra, G. (2012). “Assessing the functional relationship between CO2 emissions and economic development using an additive mixed model approach”, *Economic Modelling*, 29(1) : 1328-1337.

Zha, J., Tan, T., Yuan, W., Yang, X. & Zhu, Y. (2019). "Decomposition analysis of tourism CO2 emissions for sustainable development: A case study of China", *Sustainable Development*,10(1), : 1-18.

Zha, J. P. (2016). Reducing carbon emissions in China's tourism industry. *Tourism Tribune, 31*(9) : 101-112.

Zha, J. P., & Li, Z. Y. (2017). Drivers of tourism growth: Evidence from China. *Tourism Economics*, *23*(5) : 941-962.

Zhang, N., & Choi, Y. (2013). Total-factor carbon emission performance of fossil fuel power plants in China: A metafrontier non-radial Malmquist index analysis. *Energy Economics*, *40*(2) : 549-559.

Zhang, Z., Xue, B., Pang, J. & Chen, X. (2016). "The Decoupling of Resource Consumption and Environmental Impact from Economic Growth in China: Spatial Pattern and Temporal Trend", *Sustainability*, 8(1) : 222-235.

Zhang, N., Lior, N. & Jin, H.G. (2011). "The energy situation and its sustainable development strategy in China", *Energy*, 36: 3639-3649.

Zhang, Y., Liu, X., Xu, J. & Wang, R. (2016). Does military spending promote social welfare? A comparative analysis of the BRICS and G7 countries. *Defence and peace economics***,** 1-17.

Zhang, Y., Shen, L., Shuai, C., Tan, Y., Ren, Y., & Wu, Y. (2019). Is the low carbon economy efficient in terms of sustainable development? A global perspective. *Sustainable Development*, *27*(1), 130–152.

Zhang, J. K., & Zhang, Y. (2018). Carbon tax, tourism CO2 emissions and economic welfare. *Annals of Tourism Research*, *69(1)* : 18-30.

Zondi, S. (2009). "Governance and social policy in the SADC region: An issues analysis", Development Planning Division Working Paper Series No. 2: 1-26.

Zuo, B. (2011). An empirical study of the factors influencing the tourism economic growth in China. *Journal of Business Economics*, 10(1) : 82-90.

Zuo, H. & Ai, D. (2011). "Environment, energy and sustainable economic growth", *Procedia Engineering*, 21(1), 513-519.

APPENDIX 1

Appendix 1: The Measure of Constructs

Variable	Measure	Author	Source of Data
INQ	Composite socio-economic inequality index	Author's own construction	World Bank's World Development Indicators; International Monetary Fund
GDP	Real level of GDP per capita (constant 2005 US$) (proxy for economic growth)	Agrawal, 2015; Akintunde & Satope, 2013	World Bank's World Development Indicator Database
Health	Total government expenditure on Health	Eggoh et al., 2015; Adelowokan,2012	World Bank's World Development Indicator Database
EDU	Weighted average of government expenditure in primary and secondary and tertiary education	Younsi & Bechtini, 2018; Jamel & Maktouf, 2017	World Bank's World Development Indicators
FIN	Domestic credit to private sector to GDP ratio	Younsi & Bechtini, 2018; Jamel & Maktouf, 2017	International Monetary Fund; World Bank's World Development Indicators; Transparency International Database
INSTFIT	Aggregations of economic, political and institutional indexes (proxy for institutional fitness)	Author's own construction	International Monetary Fund, International Financial Statistics and data files; World Bank's World Development Indicators
TO	Total Trade (% of GDP)	Jamel & Maktouf, 2017; Eggoh et al., 2015	World Bank's World Development Indicators; OECD National Accounts data files
CO_2	CO2 emissions (metric tons per capita)	Jamel & Maktouf, 2017;	World Bank's World Development Indicators
EN	Energy consumption (in kilotons)	Jamel & Maktouf, 2017	World Bank's World Development Indicators
FDI	FDI inflow, expressed as a percentage of GDP (a proxy for Foreign Direct Investment)	Akinola & Bokana, 2017; Ajide and Raheem, 2016	World Bank Databases (the World Development Indicators- WDI).
DI	Gross fixed capital formation (a proxy for domestic investment)	Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
EXR	Number of local currency unit to 1 US$ (for exchange rate)	Akinola & Bokana, 2017	World Bank Databases (the World Development Indicators- WDI).

INF	Log of Consumer price index-CPI (a proxy for inflation)	Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	International financial statistics (IFS); World Bank Databases (the World Development Indicators- WDI).
IINV	Total Infrastructure Investment **(US$ bn)**	Dupasquier and Osakwe (2006)	World Bank's World Development Indicator Database
NTECH	High-technology exports (current US$) (proxy for nature of technology usage)	Jamel & Maktouf, 2017; Eggoh et al., 2015	World Bank's World Development Indicators
EN	Energy consumption (in kilotons)	Jamel & Maktouf, 2017	World Bank's World Development Indicators
DEV	Composite sustainable development index	Author's own construction	International Financial Statistics and data files; World Bank's World Development Indicators
HCAP	Weighted average of government expenditure in primary and secondary and tertiary education	Younsi & Bechtini, 2018; Jamel & Maktouf, 2017	World Bank's World Development Indicators
POP	Population Growth (annual %)	Younsi & Bechtini, 2018	World Bank's World Development Indicators

APPENDIX 2

Appendix 2A: Construction of Socio-economic Sustainability Index for BRICS Countries

Brazil				Eigenvalues (Sum = 5, Average = 1)				Eigenvectors (loadings			
Number	**Value**	**Difference**	**Proportion**	**Cumulative value**	**Cumulative proportion**	**Variable**	**PC 1**	**PC 2**	**PC3**	**PC4**	**PC5**
1	2.77777	1.43211	0.5556	2.77777	0.5813	GCII	0.68345	-0.04443	-0.4564	-0.86536	0.04537
2	1.34566	0.86131	0.2691	4.12343	0.8122	AI	0.79835	0.04542	0.56455	-0.62663	0.05675
3	0.48435	0.29875	0.0968	4.60778	0.9311	RFMLF	0.43576	0.74344	0.56356	0.03785	0.08645
4	0.29875	0.20528	0.0597	4.90653	0.9889	UNEMP	0.43833	0.63457	0.65334	0.04765	0.05675
5	0.09347	--------	0.0188	5.00000	1.0000	RPOP	0.33430	-0.56401	0.60340	0.07797	0.05697
Russia											
1	2.86754	1.52187	0.5734	2.86754	0.5734	GCII	0.63484	-0.04501	-0.43434	0.65279	0.65649
2	1.34567	1.05229	0.2691	4.21321	0.8425	AI	0.63589	0.07561	-0.24508	-0.74739	-0.56789
3	0.29338	0.00995	0.0587	4.50659	0.9012	RFMLF	0.2605	0.76561	0.53348	0.10851	0.15661
4	0.28343	0.07345	0.0566	4.79002	0.9578	UNEMP	0.34453	0.85344	0.65657	0.26543	0.27873
5	0.20998	--------	0.0422	5.00000	1.0000	RPOP	0.43456	-0.73568	0.65769	0.05896	0.07636
India											
1	3.02145	1.99689	0.6042	3.02145	0.6042	GCII	0.58455	-0.03408	-0.65636	0.53063	0.57873
2	1.02456	0.56809	0.2049	4.04601	0.8091	AI	0.58342	0.03340	-0.18721	-0.79893	-0.67753
3	0.45647	0.20462	0.0913	4.50248	0.9004	RFMLF	0.37230	0.75234	0.51988	0.20355	0.26745
4	0.25185	0.00618	0.0504	4.75433	0.9504	UNEMP	0.39565	0.86654	0.67875	0.35542	0.37665
5	0.24567	---	0.0492	5.00000	1.0000	RPOP	0.41454	-0.64515	0.57872	0.19673	0.16743
China											
1	3.23457	2.28894	0.6469	3.23457	0.6469	GCII	0.54453	-0.04583	-0.58793	-0.59194	-0.56654
2	0.94563	0.58020	0.1891	4.1802	0.8360	AI	0.54665	-0.24625	-0.2739	0.77066	0.76566
3	0.36543	0.08907	0.0731	4.54563	0.9091	RFMLF	0.35673	0.96342	0.28732	0.06213	0.06783
4	0.27636	0.09835	0.0553	4.82199	0.9644	UNEMP	0.41785	0.97452	0.35677	0.12364	0.06983
5	0.17801	-------	0.0356	5.00000	1.0000	RPOP	0.51679	-0.34537	0.74104	-0.22765	-0.27755
South Africa											
1	3.54654	2.28875	0.7093	3.54654	0.7093	GCII	0.54563	-0.07600	-0.73404	-0.24157	-0.34787
2	1.28875	1.21230	0.2578	4.83529	0.9671	AI	0.56541	-0.14567	0.59452	-0.56175	-0.45755
3	0.07645	0.02002	0.0153	4.91174	0.9824	RFMLF	0.54561	-0.13471	0.15420	0.79106	0.74576
4	0.05643	0.02460	0.0113	4.96817	0.9937	UNEMP	0.63453	0.17654	0.25647	0.83453	-0.23864
5	0.03183	--------	0.0063	5.00000	1.0000	RPOP	0.17650	0.93454	0.06787	0.01725	0.02355

Note: GCII= Gini coefficient-income inequality; AI= Atkinson index; RFMLF= Ratio of female to male labor force participation rate; UNEMP= Unemployment, total; RPOP= Refugee population by country or territory of origin

Appendix 2B1: ADF, PP and KPSS Test Results

Variables	ADF		P-P		KPSS	
	Const	Const, trend	Const	Const, trend	Const	Const, trend
Level						
INQB	−1.352 (1)	−3.342 (1)***	−1.432 [6]	−2.113 [5]	1.765 [12]	0.223 [12]
INQR	−1.736 (3)	−3.323 (3)***	−1.776 [6]	−2.876 [5]	1.754 [12]	0.231 [12]
INQI	−1.473 (0)	−2.435 (0)	−1.423 [5]	−2.867 [5]	1.978 [12]	0.2155 [12]
INQC	−1.637 (3)	−3.342 (3)***	−3.756 [6]	−2.845 [5]	1.756 [13]	0.256 [12]
INQS	−2.374 (0)	−2.654 (0)	−3.432 [5]	−2.857 [5]	1.754 [11]	0.264 [12]
GDPB	−2.237 (1)**	−3.121 (1)	−18.75 [12]*	−18.66 [12]*	0.134 [19]*	0.134 [18]*
GDPR	−2.536 (12)	−2.423 (12)	−16.11 [13]*	−14.67 [14]*	0.324 [14]*	0.254 [15]**
GDPI	−2.847 (11)**	−3.534(11)**	−13.76 [56]*	−14.34 [56]*	0.543 [77]*	0.254 [41]**
GDPC	−4.563 (12)	−2.432 (12)	−16.86 [13]*	−15.45 [14]*	0.345 [14]*	0.215 [14]**
GDPS	−3.746 (11)**	−3.543 (11)**	−13.76 [77]*	−14.23 [56]*	0.523 [77]*	0.321 [54]**
First differences						
ΔINQB	−9.44 (0)*	−9.21 (0)*	−10.43 [4]*	−12.21 [4]*	0.129 [6]*	0.143 [5]*
ΔINQR	−7.234 (2)*	−7.321 (2)*	−12.11 [5]*	−13.12 [5]*	0.132 [6]*	0.125 [5]*
ΔINQI	−13.44 (0)*	−14.33 (0)*	−14.54 [4]*	−15.65 [4]*	0.123 [5]*	0.164 [5]*
ΔINQC	−7.231 (2)*	−7.324 (2)*	−12.34 [5]*	−12.12 [5]*	0.212 [6]*	0.231 [5]*
ΔINQS	−14.56 (0)*	−14.53 (0)*	−14.45 [4]*	−14.65 [4]*	0.123 [5]*	0.156 [5]*
ΔGDPB	−13.43 (10)*	−13.23 (10)*	−19.38 [53]*	−51.11[53]*	0.132 [36]*	0.231 [34]*
ΔGDPR	−8.743 (11)*	−8.76 (11)*	−61.54 [33]*	−71.34 [33]*	0.432 [34]*	0.124 [34]*
ΔGDPI	−10.77 (10)*	−10.23(10)*	−51.65 [26]*	−51.43 [26]*	0.342 [41]*	0.241 [44]**
ΔGDPC	−8.734 (11)*	−8.76 (11)*	−61.55 [33]*	−61.32 [33]*	0.144 [34]*	0.143 [34]*
ΔGDPS	−10.675 (10)*	−11.38 (10)*	−41.64 [16]*	−51.64 [46]*	0.334 [41]*	0.278 [42]**

Note: INQB, INQR, INQI, INQC, INQS show the Socio-economic inequality rates for Brazil, Russia, India, China, and South Africa respectively; GDPB, GDP, GDPI, GDPC, GDPS show the GDP per capita growth for Brazil, Russia, India, China, and South Africa respectively; Δ denotes on first differences of series; *, ** and *** implies 1%, 5% and 10% levels of significance respectively; ADF: Augmented Dickey-Fuller, PP: Phillips-Perron, KPSS: Kwiatkowski, Phillips, Schmidt, and Shin

Appendix 2B2: Cross sectional dependence test on y-variable (ln_INQ)

Variable	CD-Test	p-value	Corr	Abs(corr)
ln_INQB	221.11	0.3010	0.006	0.433
ln_INQR	312.78	0.1200	0.037	0.443
ln_INQI	234.25	0.2060	0.072	0.324
ln_INQC	221.73	0.1004	0.027	0.122
ln_INQS	233.72	0.2003	0.004	0.234

Under the H_0 of cross-section independence CD ~ N(0,1)

Appendix 2C1: VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SBC	HQC
Brazil						
0	99.11	NA	0.0367	−0.8736	−0.8112	−0.8365
1	118.77	12.133*	0.0354	−0.8443	−0.7765*	−0.8536*
2	123.50	2.5433	0.0345	−0.8440	−0.7637	−0.8357
3	124.28	4.2332	0.0324*	−0.8266*	−0.7352	−0.8123
4	126.33	0.0433	0.0231	−0.8391	−0.7435	−0.8328
Russia						
0	81.115	NA	0.0443	−0.6604	−0.6873	−0.6321
1	84.156	10.637	0.0432	−0.6713	−0.6923	−0.6432
2	87.233	5.3224	0.0427	−0.7028	−0.6963	−0.6546
3	91.322	9.3432*	0.0312*	−0.7359*	−0.6998*	−0.6734*
4	94.336	0.5431	0.0332	−0.7233	−0.6738	−0.6574
India						
0	134.18	NA	0.0257	−0.9845	−0.8765	−0.9345
1	136.11	1.9384*	0.0255*	−0.9765*	−0.8893*	−0.9435*
2	138.38	1.3643	0.0254	−0.9632	−0.8637	−0.9234
3	141.33	0.0844	0.0254	−0.9427	−0.8435	−0.9112
4	142.11	0.0023	0.0257	−0.9604	−0.8123	−0.9332
China						
0	81.221	NA	0.0445	−0.6764	−0.5895	−0.6345
1	84.956	9.2332	0.0442	−0.6944	−0.5983	−0.6500
2	86.103	3.2344	0.0435	−0.7021	−0.6237	−0.6500
3	87.316	12.342*	0.0412*	−0.7239*	−0.6425*	−0.6890*
4	89.233	0.6541	0.0430	−0.7123	−0.6111	−0.6703
South Africa						
0	112.73	NA	0.0357	−0.9837	−0.8795	−0.9342
1	113.72	2.3249*	0.0354*	−0.9736*	−0.8930*	−0.9456*
2	114.38	1.4532	0.0349	−0.9526	−0.8659	−0.9201
3	121.33	0.0845	0.0349	−0.9435	−0.8467	−0.9112
4	122.11	0.0023	0.0253	−0.9534	−0.8234	−0.9023

Note: *Denotes the optimal lag selection; FPE: Final prediction error; HQC: Hannan-Quinn criteria; AIC: Akaike Information Criterion,

Appendix 2C2: Results of F bounds test (Wald test)

Test statistic	Optimal lag	Value	df	P
Brazil				
F-statistic	ARDL (1,0)	3.99*	(3.322)	0.013
Chi-square		8.02	(2)	0.015
Russia				
F-statistic	ARDL (1,2)	10.02	(6.232)	0.012
Chi-square		21.734	(2)	0.016
India				
F-statistic	ARDL (1,0)	6.071**	(3.123)	0.011
Chi-square		12.102	(2)	0.012
China				
F-statistic	ARDL (1,2)	11.16	(6.237)	0.011
Chi-square		23.111	(2)	0.016
South Africa				
F-statistic	ARDL (1,0)	5.123**	(3.231)	0.003
Chi-square		11.023	(2)	0.003

Note: *, ** and *** show significant at 1%, 5% and 10% levels respectively, ARDL: Autoregressive distributed lag

Appendix 2C3: Estimation from the unrestricted error correction model (bounds test model)

Dependent variable = ΔINQ_t								
Unrestricted error correction model (short-run analysis)								
Brazil			**Russia**			**India**		
Variable	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**
Const.	−0.031	−0.075	Const.	0.045	0.845	Const.	0.034	0.874
ΔINQ_{t-1}	0.435	5.273	ΔINQ_{t-1}	0.438	5.635	ΔINQ_{t-1}	0.035	4.536
ΔGDP_t	0.072	3.363	ΔGDP_t	0.045	2.345	ΔGDP_t	0.098	3.453
			ΔGDP_{t-1}	0.014	1.443			
			ΔGDP_{t-2}	0.053	1.345			
INQ_{t-1}	−0.025	−1.834	INQ_{t-1}	−0.088	−1.983	INQ_{t-1}	−0.011	−1.738
GDP_{t-1}	0.0051	2.736	GDP_{t-1}	0.0020	3.784	GDP_{t-1}	0.0021	4.352
R2	0.334		R2	0.382		R2	0.348	
F-stat	6.536		F-stat	4.223		F-stat	4.363	
D-W	2.043		D-W	2.110		D-W	1.989	
Diagnostic	**$\chi2$**	**P**	**Diagnostic**	**$\chi2$**	**P**	**Diagnostic**	**$\chi2$**	**P**
Normal	2.31 (2)	0.553	Normal	2.66 (2)	0.647	Normal	1.733 (2)	0.733
Serial	0.42 (1)	0.887	Serial	1.93 (1)	0.153	Serial	0.023 (1)	0.883
ARCH	0.12 (1)	0.856	ARCH	1.34 (1)	0.432	ARCH	0.453 (1)	0.774

China			**South Africa**		
Variable	**Coefficients**	**t-stat.**	**Variable**	**Coefficients**	**t-stat.**
Const.	0.437	0.977	Const.	0.134	0.733
ΔINQ_{t-1}	0.463	4.256	ΔINQ_{t-1}	0.045	4.328
ΔGDP_t	0.045	1.883	ΔGDP_t	0.078	3.883
ΔGDP_{t-1}	0.013	1.345			
ΔGDP_{t-2}	0.054	3.453			
INQ_{t-1}	−0.071	−1.875	INQ_{t-1}	−0.010	−1.923
GDP_{t-1}	0.0019	2.739	GDP_{t-1}	0.0020	4.473
R2	0.488		R2	0.355	
F-stat	4.833		F-stat	5.512	
D-W	1.998		D-W	2.023	
Diagnostic	**$\chi2$**	**P**	**Diagnostic**	**$\chi2$**	**P**
Normal	3.23 (2)	0.388	Normal	2.12 (2)	0.594
Serial	3.56 (1)	0.144	Serial	0.014 (1)	0.992
ARCH	1.78 (1)	0.463	ARCH	0.394 (1)	0.734

Note: Δ Denotes the first difference operator; ***,** and * show significant at 1%, 5% and 10% levels respectively.; $\chi2$ Serial for LM serial correlation test; $\chi2$ Normal is for normality test, $\chi2$ ARCH for autoregressive conditional heteroskedasticity, ( ) is the order of diagnostic tests

Appendix 2D1: Spartial Robustness checks: Results of F bounds test (Wald test)

Test statistic	**Optimal lag**	**Value**	**df**	**P**
BRICS sub-sample 1: Brazil, India and South Africa				
Brazil				
F-statistic	ARDL (1,0)	4.11*	(4.344)	0.014
Chi-square		7.03	(2)	0.013
India				
F-statistic	ARDL (1,0)	5.034**	(4.353)	0.012
Chi-square		11.232	(2)	0.013
South Africa				
F-statistic	ARDL (1,0)	4.435**	(3.102)	0.003
Chi-square		10.213	(2)	0.003
BRICS sub-sample 2: Russia and China				
Russia				
F-statistic	ARDL (1,2)	11.33	(7.112)	0.013
Chi-square		23.111	(2)	0.015
China				
F-statistic	ARDL (1,2)	12.22	(7.453)	0.012
Chi-square		24.341	(2)	0.015

Note: *, ** and *** show significant at 1%, 5% and 10% levels respectively, ARDL: Autoregressive distributed lag

Appendix 2D2: Robustness check: POLS and GMM

Variables	dependent Variable: INQ					
	POLS			GMM		
	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value
ln_GDP	0.14283	2.537	.0132457**	0.52435	3.86	.032453**
ln_INST	0.72539	13.62	.0562535	0.56257	9.33	.097649
ln_C02	0.86353	10.97	-.012552	-12.453	1.56	-.164746
ln_FIN	0.62452	11.43	.153363	0.65743	2.67	.1863635
ln_HEALTH	0.46252	15.33	-.001636	0.76533	5.62	-.012536
ln_EDU	-0.63539	-7.67	-.043525**	-0.17654	-14.41	-.076363**
ln_TO	-0.15353	5.73	.0065363	-0.16543	-6.67	.0156373***
ln_EC	0.85363	11.34	.166333	0.77543	12.64	.1673353
ln_EXR	-0.43353	-3.66	-.187636	0.43554	5.34	-.103425
ln_INF	-0.13852	-5.54	-.001236**	-0.65749	-7.36	-.0015262**
Constant	5.25257	6.73	0.00101*	4.43573	4.17	0.00102*
Obs.	140			140		
R^2	0.7386			0.6833		
Adj. R^2	0.7963			0.7154		
F Statistics	0.001**					
AR(2)	-------			0.301		
Hansen Test	-------			0.169		

Note: * and ** denotes statistical significance at 1% and 5% respectively.
Source: Authors Computation

Appendix 2E: The Measure of Constructs (Dependent and Explanatory Variable)

Variable	**Measure**	**Author**	**Source of Data**
INQ	Composite social-economic sustainability index	**Author's construction**	World Bank's World Development Indicators; International Monetary Fund, International Financial Statistics and data files
GDP	The real level of GDP per capita (constant 2005 US$) (a proxy for economic growth)	Agrawal, 2015; Akintunde & Satope, 2013; Kurt, 2015;	World Bank's World Development Indicator Database
Health	Total government expenditure on Health	Eggoh et al., 2015; Adelowokan, 2012; Strittmatter & Sunde, 2011	World Bank's World Development Indicator Database
EDU	Weighted average of government expenditure in primary and secondary and tertiary education	Younsi & Bechtini, 2018; Jamel & Maktouf, 2017	World Bank's World Development Indicators
FIN	composite financial sector development index	Younsi & Bechtini, 2018; Maryam et al., 2017	International Monetary Fund, International Financial Statistics and data files; World Bank's World Development Indicators
INSTFIT	Aggregations of economic, political and institutional indexes (a proxy for institutional fitness)	Eggoh, Houeninvo & Sossou, 2015; Adelowokan, 2012; David., Bloom, & Canning, 2008; Strittmatter & Sunde, 2011; Licumba., Dzator & Zhang, 2016	World Bank Databases (World Governance Index-WGI-).
TO	Total Trade (% of GDP)	Jamel & Maktouf, 2017; Eggoh et al., 2015	World Bank's World Development Indicators; OECD National Accounts data files
CO_2	CO2 emissions (metric tons per capita)	Jamel & Maktouf, 2017; Maryam et al., 2017; Eggoh et al., 2015	World Bank's World Development Indicators
EN	Energy consumption (in kilotons)	Jamel & Maktouf, 2017; Maryam et al., 2017; Eggoh et al., 2015	World Bank's World Development Indicators

APPENDIX 3

Appendix 3A: Construction of Institutional Fitness Index for BRICS Countries

Brazil				Eigenvalues (Sum = 6, Average = 1)				Eigenvectors (loadings)			
Number	**Value**	**Difference**	**proportion**	**Cumulative value**	**Cumulative proportion**	**Variable**	**PC 1**	**PC 2**	**PC3**	**PC4**	**PC5**	**PC6**
1	2.82436	1.61525	0.4707	2.82436	0.4707	MIS	0.71095	-0.0334	-0.4664	-0.8653	0.06537	0.02536
2	1.20911	0.21476	0.2015	4.03347	0.6722	S&P	0.69076	0.04652	0.56625	-0.6266	0.07875	0.07633
3	0.99435	0.39560	0.1657	5.02782	0.8389	FR	0.37256	0.74734	0.56406	0.03785	0.03785	0.03737
4	0.78875	0.20560	0.1315	5.81657	0.9704	ECRS	0.41992	0.65747	0.65434	0.04765	0.04875	0.04367
5	0.09765	0.01187	0.0163	5.91422	0.9857	WDGI	0.42536	-0.6473	0.48570	0.05474	0.07464	0.07729
6	0.08578	--------	0.0143	6.00000	1.0000	CPI	0.25630	-0.7750	0.60740	0.07797	0.08797	0.07829
Russia												
1	2.23454	0.28887	0.37242	2.23454	0.37242	MIS	0.60084	-0.0050	-0.4613	0.65279	0.67279	0.45379
2	1.94567	1.18229	0.32428	4.18021	0.69670	S&P	0.60189	0.07321	-0.2740	-0.7473	-0.7473	-0.8976
3	0.76338	0.27973	0.12723	4.94359	0.82393	FR	0.29405	0.76701	0.53138	0.10851	0.15851	0.14537
4	0.48365	0.16367	0.08063	5.42724	0.90456	ECRS	0.32453	0.85654	0.65657	0.26543	0.28753	0.25643
5	0.31998	0.06720	0.05333	5.74722	0.95789	WDGI	0.43616	-0.7136	0.65549	0.05896	0.05896	0.05643
6	0.25278	--------	0.04211	6.00000	1.0000	CPI	0.56746	-0.6547	0.34569	0.04567	0.07654	0.05226
India												
1	3.12528	1.38072	0.52088	3.12528	0.52088	MIS	0.58385	-0.0108	-0.6143	0.53063	0.55063	0.55063
2	1.74456	1.29079	0.29076	4.86984	0.81164	S&P	0.58622	0.03730	-0.1332	-0.7989	-0.7989	-0.7989
3	0.45377	0.09692	0.07563	5.32361	0.88727	FR	0.37330	0.75194	0.51838	0.20355	0.24355	0.24355
4	0.35685	0.18298	0.05948	5.68046	0.94675	ECRS	0.39075	0.86654	0.67875	0.35542	0.32345	0.32345
5	0.17387	0.02820	0.02898	5.85433	0.97573	WDGI	0.41964	-0.6501	0.57972	0.19673	0.18673	0.18673
6	0.14567	---	0.02427	6.00000	1.0000	CPI	0.35764	-0.5464	0.43252	0.16543	0.12343	0.15543
China												
1	3.12301	1.99368	0.52050	3.12301	0.52050	MIS	0.54963	-0.0428	-0.5879	-0.5919	-0.5619	-0.4325
2	1.12933	0.50830	0.18822	4.25234	0.70872	S&P	0.54665	-0.2622	-0.2493	0.77066	0.79066	0.67543
3	0.62103	0.04472	0.10351	4.87337	0.81223	FR	0.35943	0.96772	0.20732	0.06213	0.07213	0.06578
4	0.57631	0.20400	0.09605	5.44968	0.90828	ECRS	0.41235	0.97432	0.35577	0.12364	0.08653	0.07654
5	0.37231	0.19430	0.06205	5.82199	0.97033	WDGI	0.51949	-0.3693	0.74104	-0.2276	-0.2376	-0.4356
6	0.17801	-------	0.02967	6.00000	1.0000	CPI	0.34547	-0.4536	0.56437	-0.4532	-0.4532	-0.3432
South Africa												
1	2.93415	1.64540	0.48903	2.93415	0.48903	MIS	0.56543	-0.0850	-0.7850	-0.2415	-0.2515	-0.3453
2	1.28875	0.42835	0.21479	4.22290	0.70382	S&P	0.56821	-0.1346	0.59212	-0.5617	-0.5517	-0.4536
3	0.86040	0.40737	0.14340	5.08330	0.84722	FR	0.57241	-0.1287	0.18020	0.79106	0.78106	0.67536
4	0.45303	0.12170	0.07551	5.53633	0.92273	ECRS	0.67533	0.13324	0.26547	0.83453	-0.8553	-0.7543
5	0.33133	0.19899	0.05522	5.86766	0.97795	WDGI	0.17250	0.92454	0.02487	0.01725	0.02725	0.03435
6	0.13234	--------	0.02205	6.00000	1.0000	CPI	0.16453	0.87654	0.01034	0.01342	0.01254	0.07564

Note: MIS= Moody's Investors services; S&P= Standard & Poor'r financial services; FR= Fitch ratings Inc.; ECRS= Euromoney country risk survey; WDGI= World Bank decomposed governance indices; CPI= Corruption Perception Index

Appendix 3B: The Measure of Constructs

Variable	Measure	Author	Source of Data
INSTFIT	Aggregations of economic, political and institutional indexes (proxy for institutional fitness)	**Author's own construction**	International Monetary Fund, International Financial Statistics and data files; World Bank's World Development Indicators
GDP	Real level of GDP per capita (proxy for economic growth)	Agrawal, 2015; Akintunde & Satope, 2013; Kurt, 2015;	World Bank Databases (the World Development Indicators- WDI).
FDI	FDI inflow, expressed as a percentage of GDP (a proxy for Foreign Direct Investment)	Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
DI	Gross fixed capital formation (a proxy for domestic investment)	Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015; Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017	World Bank Databases (the World Development Indicators- WDI).
FINDEV	Private sector credit (this is a proxy for financial development)	Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015; Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017	World Bank Databases (the World Development Indicators- WDI).
EXR	Number of local currency unit to 1 US$ (a proxy for exchange rate)	Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
INF	Log of Consumer price index-CPI (a proxy for inflation)	Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	International financial statistics (IFS); World Bank Databases (the World Development Indicators- WDI).

Appendix 3C: Panel unit root tests results

Variables	**Levin, Lin and Chu test**				**Im, Pesaran & Shin test**			
	Level		**First difference**		**Level**		**First difference**	
	t-tatistics	**p-value**	**t-tatistics**	**p-value**	**t-tatistics**	**p-value**	**t-tatistics**	**p-value**
INSTFIT	-19.7867	0.0000*	-22.5467	0.0000*	-21.7865	0.0000*	-28.3459	0.0000*
GDP	-23.5643	0.0000*	-30.6543	0.0000*	-24.5533	0.0000*	-26.5642	0.0000*
GDP^2	-16.2343	0.0000*	-24.6543	0.0000*	-20.8743	0.0000*	-20.2349	0.0000*
FDI	-8.5436	0.0000*	-16.6487	0.0000*	-14.8936	0.0000*	-28.8736	0.0000*
DI	-13.4532	0.0000*	-7.3276	0.0000*	-19.4587	0.0000*	-23.4872	0.0000*
FINDEV	-9.43527	0.0000*	-10.3523	0.0000*	-20.4327	0.0000*	-19.4527	0.0000*
EXR	-24.4539	0.0000*	-26.4564	0.0000*	-23.4749	0.0000*	-22.4587	0.0000*
INF	-27.4532	0.0000*	-20.4762	0.0000*	-17.4539	0.0000*	-29.4234	0.0000*

Note: *, **, * denotes the level of significance at 10%, 5%, & 1% levels respectively**
Source: Author's computation

Appendix 3D: Cross Sectional Dependence Test on y-variable (ln_INSTFIT)

Variable	CD-Test	p-value	Corr	Abs(corr)
ln_INSTFIT	24.94	0.1010	0.016	0.067

Note: Under the H_0 of cross-section independence CD ~ N(0,1)

Appendix 3E: Fixed Effects Estimation Results

Variables	Dependent Variable: INSTFIT											
	FE (Full period (1990-2017))			FE (Pre-Asian financial Crisis era (1990-1996))			FE (Asian financial Crisis era (1997-2006))			FE (Global financial crisis era (2007-2017))		
	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value
lnGDP	0.21564	3.54	0.013*	0.35624	4.34	0.021*	0.32664	7.26	0.029*	0.315644	4.34	0.044*
$lnGDP^2$	0.39087	3.32	0.004*	0.436744	4.03	0.035*	0.49347	16.34	0.014*	0.24087	3.72	0.022*
lnFDI	0.00756	0.67	0.645	-0.23646	0.87	0.356	-0.00576	0.89	0.864	0.23756	1.67	0.778
lnDI	0.73453	10.65	0.022*	0.273457	12.34	0.022*	0.79563	11.63	0.022*	0.866453	11.65	0.035
lnFINDEV	0.40653	4.56	0.000*	0.426733	5.67	0.000*	0.46543	7.33	0.000*	0.55653	3.54	0.045
lnEXR	-0.12543	-8.34	0.000*	-0.3748	-7.32	0.000*	-0.27658	-8.77	0.000*	-0.21254	-9.33	0.011*
lnINF	-0.13245	-4.67	0.143	0.26243	-7.69	0.078***	-0.17653	-9.23	0.083***	-0.24524	-5.57	0.134
Constant	2.43567	5.76	0.000*	4.36646	9.27	0.000*	2.76575	7.73	0.000*	4.23567	6.66	0.001
Obs.	140			140			140			140		
R^2	0.9676			0.8783			0.7497			0.9345		
Adj. R^2	0.9611			0.8435			0.7454			0.9237		
DF	97			91			92			96		
Prob>F	0.0000			0.0000			0.0000			0.0000		
Prob>χ^2	0.0000			0.0000			0.0000			0.0000		

Appendix 3F: Robustness Check: POLS

Variables		dependent Variable: INSTFIT							
	FE			POLS			GMM		
	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value	Coeff.	t-stats.	p-value
lnGDP	0.21564	3.54	0.013**	0.22734	4.33	0.011*	0.245664	6.22	0.017**
$lnGDP^2$	0.39087	3.32	0.004*	0.43733	5.23	0.002*	0.497587	17.34	0.009*
lnFDI	0.00756	0.67	0.645	-0.00798	0.69	0.637	-0.00576	0.89	0.864
lnDI	0.73453	10.65	0.022**	0.73737	15.63	0.022*	0.79563	11.63	0.032**
lnFINDEV	0.40653	4.56	0.000*	0.48373	5.34	0.000*	0.46543	7.33	0.000*
lnEXR	-0.12543	-8.34	0.000*	-0.14542	-9.32	0.000*	-0.27658	-8.77	0.000*
lnINF	-0.13245	-4.67	0.143	-0.15367	-1.67	0.167	-0.17653	-1.23	0.183
Constant	2.43567	5.76	0.000*	2.58373	3.01	0.000*	2.76575	7.73	0.000*
Obs.	140			140			140		
R^2	0.8676			0.7567			0.7497		
Adj. R^2	0.8611			0.7499			0.7454		
F Statistics	0.001**			0.001**					
AR(2)	-------						0.311		
Hansen Test	-------						0.176		

Note: * and ** denotes statistical significance at 1% and 5% respectively.
Source: Authors Computation

APPENDIX 4

Appendix 4A: Construction of Financial Development Index for BRICS Countries

Brazil				Eigenvalues (Sum = 5, Average = 1)				Eigenvectors (loadings			
Number	**Value**	**Difference**	**Proportion**	**Cumulative value**	**Cumulative proportion**	**Variable**	**PC 1**	**PC 2**	**PC3**	**PC4**	**PC5**
1	2.13546	0.9108	0.5339	2.13546	0.5339	DCB	0.71253	-0.03267	-0.3535	0.73922	0.06326
2	1.22466	0.74112	0.3062	3.36012	0.8401	DCP	0.67378	0.03273	0.46363	-0.6337	-0.07372
3	0.48354	0.3272	0.1209	3.84366	0.9610	SMC	0.35373	0.63723	0.56406	-0.03636	0.04737
4	0.15634	--------	0.0390	4.00000	1.0000	MS	0.42774	-0.6373	0.53373	-0.08373	0.07383
Russia											
1	1.86757	0.52190	0.46689	1.86757	0.46689	DCB	0.60084	-0.00501	-0.46134	0.65279	0.67279
2	1.34567	0.84889	0.33642	3.21324	0.80331	DCP	0.60189	0.07321	-0.27408	-0.74739	-0.74739
3	0.49678	0.20680	0.12419	3.71002	0.92750	SMC	0.29405	0.76701	0.53138	0.10851	0.15851
4	0.28998	--------	0.07250	4.00000	1.0000	MS	0.43616	-0.71368	0.65549	0.05896	0.05896
India											
1	1.82145	0.69689	0.45536	1.82145	0.45536	DCB	0.58385	-0.01008	-0.61436	0.53063	0.55063
2	1.12456	0.51209	0.28114	2.94601	0.73650	DCP	0.58622	0.03730	-0.13321	-0.79893	-0.79893
3	0.61247	0.17095	0.15311	3.55848	0.88961	SMC	0.37330	0.75194	0.51838	0.20355	0.24355
4	0.44152	---	0.11039	4.00000	1.0000	MS	0.41964	-0.65015	0.57972	0.19673	0.18673
China											
1	1.53457	0.18894	0.38364	1.53457	0.38364	DCB	0.54963	-0.04283	-0.58793	-0.59194	-0.56194
2	1.34563	0.48020	0.33640	2.88020	0.72004	DCP	0.54665	-0.26225	-0.24939	0.77066	0.79066
3	0.86543	0.61106	0.21636	3.74563	0.93640	SMC	0.35943	0.96772	0.20732	0.06213	0.07213
4	0.25437	-------	0.06360	4.00000	1.0000	MS	0.51949	-0.36937	0.74104	-0.22765	-0.23765
South Africa											
1	1.54654	0.25779	0.38663	1.54654	0.38663	DCB	0.56543	-0.08500	-0.78504	-0.24157	-0.25157
2	1.28875	0.41230	0.32219	2.83529	0.70882	DCP	0.56821	-0.13467	0.59212	-0.56175	-0.55175
3	0.87645	0.58819	0.21911	3.71174	0.92793	SMC	0.57241	-0.12871	0.18020	0.79106	0.78106
4	0.28826	--------	0.07207	4.00000	1.0000	MS	0.17250	0.92454	0.02487	0.01725	0.02725

Note: DCB= Domestic credit given by banks sector to GDP ratio; DCP= Domestic credit to private sector to GDP ratio; SMC= Stock market capitalisation to GDP ratio, and MS= Money Supply-M2/GDP

Appendix 4B: Cross Sectional Dependence Test on y-variable (ln_C02)

Variable	CD-Test	p-value	Corr	Abs(corr)
ln_C02	24.94	0.000	0.106	0.206

Under the H_0 of cross-section independence CD ~ N(0,1)

Appendix 4C: CADF Unit Root Test

Variable	0 lag	0 lag and trend	1 lag	1 lag and trend
ln_C02	.130	.000**	.000	.000
ln_GDP	0.17	0.121	.000***	.000
ln_GDP^2	.004**	0.102	0.096	0.3
ln_GDP^3	0.51	0.016**	0.274	.000***
ln_IINV	.004***	0.000	0.52	0.87
ln_FIN	.120	.000**	.000	.000
ln_NTECH	0.027**	0.836	.007***	.97
ln_EC	.324	0.634	.047**	0.112
Ln_FDI	.110	.000***	.000	.000
Ln_EXR	0.043**	0.772	.006***	.89
ln_INF	.343	0.822	.049**	0.107
ln_NSTFIT	.214	0.645	.055**	0.122

Note: *** p<0.01, ** p<0.05, * p<0.10; only P-values are reported; HO:the process has a unit root

Appendix 4D: The Measure of Constructs- Article 3

Variable	Measure	Author	Source of Data
CO_2	CO2 emissions (metric tons per capita)	Jamel & Maktouf, 2017; Maryam et al., 2017; Eggoh et al., 2015	World Bank's World Development Indicators
GDP	Real level of GDP per capita (proxy for economic growth)	Agrawal, 2015; Akintunde & Satope, 2013; Kurt, 2015;	World Bank Databases (the World Development Indicators- WDI).
IINV	Total Infrastructure Investment **(US$ bn)**	Dupasquier and Osakwe (2006); Nnadozie and Osili (2004)	World Bank's World Development Indicator Database
FIN	Composite financial sector development Index	**Author's own Construction**	International Monetary Fund; World Bank's World Development Indicators; Transparency International Database; International Financial Statistics and data files
NTECH	High-technology exports (current US$) (proxy for nature of technology usage)	Jamel & Maktouf, 2017; Maryam et al., 2017; Eggoh et al., 2015	World Bank's World Development Indicators
EN	Energy consumption (in kilotons)	Jamel & Maktouf, 2017; Maryam et al., 2017; Eggoh et al., 2015	World Bank's World Development Indicators
FDI	FDI inflow, expressed as a percentage of GDP (a proxy for Foreign Direct Investment)	Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
EXR	Number of local currency unit to 1 US$ (a proxy for exchange rate)	Aggarwal., Demirgue-Kunt & Martinez-Peria, 2006; Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
INF	Log of Consumer price index-CPI (a proxy for inflation)	Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	International financial statistics (IFS); World Bank Databases (the World Development Indicators- WDI).
INSTFIT	Aggregations of economic, political and institutional indexes (proxy for institutional fitness)	Eggoh., Houeninvo, & Sossou, 2015; Adelowokan, 2012; David., Bloom, & Canning, 2008; Strittmatter & Sunde, 2011	World Bank Databases (World Governance Index-WGI-).

Appendix 4E: Westerlund Cointegration Test

Statistic	Test values (0 lag)	Test values (1 lag)
Gt	-0.365	-4.601***
Ga	2.617	-4.861**
Pt	-6.788***	-19.504***
Pa	-6.472***	-17.684***

Appendix 4F: ARDL and CS-ARDL Results for C02 Emission (with two lags)

Variables	**CS-ARDL** SR (short run)	**CS-ARDL** LR (long run)	**ARDL** SR (short run)	**ARDL** LR (long run)
D.ln_GDP	-.0677261 ** (.0349956)	.0005962** (.0003144)	-.056345*** (.0211213)	.0013789*** (.0002894)
D.ln_GDP2	-.0302732 ** (.0149128)	.0069844*** (.0005323)	-.0202538 (.0095034)	.0052051*** (.0008638)
D.ln_GDP3	-.0210584** (.1073766)	-.0196302*** (.0064335)	-.013405 (.0455726)	.010633** (.0062237)
D.ln_IINV	-2.039684 (2.243424)	-3.033347*** (.2727519)	1.963577** (1.95267)	1.090707*** (.2544404)
D.ln_FIN	-.0000552 (.0005075)	-0.0000036 (.000038)	.0003994** (.000288)	-.0000863** (.000039)
D.ln_NTECH	-.0654613 (.014536)	-.01341*** (.0011275)	.0020868 (.0036227)	-.0099415*** (.001532)
D.ln_EN	.0064338*** (.0012578)	-.0002171 (.0001442)	.0060859*** (.0007528)	.0002279*** (.0002028)
D.ln_FDI	-2.039684 (2.243424)	-3.033347*** (.2727519)	1.963577 (1.95267)	1.090707 (.2544404)
D.ln_EXR	-.0000552 (.0005075)	-0.0000036 (.000038)	.0003994 (.000288)	-.238863 (.239039)
D.ln_INF	-.005013 (.0103549)	-.0134134 (.0511275)	.0020868 (.0036227)	-.389415 (.112532)
D.ln_INSFIT	.0064338*** (.0012578)	-.0002171 (.0001442)	.0060859*** (.0007528)	.0002279** (.0002028)
Constant	1.344861*** (.1385227)		-.5219269*** (.042604)	
EC	-.6271135*** (.0647128)		-.6754753*** (.0538939)	

Note: D.ln_C02 is the dependent variable, *** p<0.01, ** p<0.05, * p<0.10, SE in parenthesis; D. indicates first difference, EC is the error correction coefficient

Appendix 4G: CS-ARDL Results for Institutional Fitness (with two lags)

Variables	SR (short run)	LR (long run)
D.ln_C02	.0099276 (.0622472)	-.0391918 (.0535653)
D.ln_IINV	.0024643 (.0220736)	-.0186877*** (.0016181)
D.ln_FIN	-.0004745 (.0151168)	.0021218 (.0041241)
D.ln_NTECH	-1.189329 (2.748665)	2.695453*** (.9785773)
D.ln_EN	-.0007527* (.0004088)	.0003634*** (.0001011)
D.ln_FDI	.0024643 (.0220736)	-.0186877*** (.0016181)
D.ln_EXR	-.0004745 (.0151168)	.0021218 (.0041241)
D.ln_INF	-1.189329 (2.748665)	2.695453*** (.9785773)
D.ln_GDP	-.0007527* (.0004088)	.0003634*** (.0001011)
Constant	-.1453364*** (.0372692)	
EC	-.1293467 *** (.0310769)	

Note: D.ln_INSFIT is the dependent variable, *** p<0.01, ** p<0.05, * p<0.10, SE in parenthesis
D. indicates first difference, EC is the error correction coefficient

Appendix 4H: Robustness check: CS-ARDL Results for C02 Emission (with two lags)

	Sub-sample 1 (Brazil, India and South Africa)		Sub-sample 2 (Russia and China)	
Variables	**CS-ARDL** SR (short run)	**CS-ARDL** LR (long run)	**CS-ARDL** SR (short run)	**CS-ARDL** LR (long run)
D.ln_GDP	-.0366334** (.035363)	.04636363*** (.0012929)	-.0536336** (.0384747)	.00536353*** (.0012828)
D.ln_GDP2	-.0136464** (.0636364)	.00728833** (.00073636)	-.0073839 ** (.0068837)	.0053838*** (.00088383)
D.ln_GDP3	-.0173636** (.0633674)	.0183838** (.0066363)	-.023888 ** (.029393)	.023933*** (.0064949)
D.ln_IINV	.1373737 (.373737)	.837373*** (.273737)	-.38484*** (.08939)	.4774748 (.248848)
D.ln_FIN	-.0003533 (.00033748)	-.3773738 (.193939)	.193933 (.59393)	-.00023738*** (.0002939)
D.ln_NTECH	-.0683737** (.0063847)	-.00048383** (.000683838)	-.0000483** (.0017474)	-.0013939** (.0007393)
D.ln_EN	.0063883*** (.00067338)	.00002939 (.0001887)	.0063938*** (.0007373)	.0006383*** (.00010494)
D.ln_FDI	.1338843 (.3374748)	.73381*** (.238383)	-.283833 (.893938)	.007848484** (.0000138)
D.ln_EXR	-.00037744 (.00023884)	-.00018938 (.00003393)	.0148585 (.0438747)	-.23945 (.23737)
D.ln_INF	-.00183737 (.0054737)	-.0004939 (.00069393)	-.00004885 (.00178484)	-.336633 (.17848)
D.ln_INSFIT	-.006337*** (.00078383)	.000039393 (.0001838)	-.0064884*** (.0007884)	-.00067737*** (.0001131)
Constant	-.536364*** (.023837)		-.247474*** (.013773)	
EC	-.733738*** (.0473737)		-.73636*** (.038337)	

Note: d.ln_C02 is the dependent variable, *** p<0.01, ** p<0.05, * p<0.10, SE in parenthesis; D. indicates first difference; EC is the error correction coefficient

Appendix 4I: Robustness Check-CS-ARDL Results for C02 Emission (with two lags)

	Main Sample (BRICS)		**BRICS + seven (7) emerging countries sample**	
Variables	**CS-ARDL SR (short run)**	**CS-ARDL LR (long run)**	**CS-ARDL SR (short run)**	**CS-ARDL LR (long run)**
D.ln_GDP	-.04657402** (.0435644)	.002374*** (.00063774)	-.052537** (.042534)	.0045635*** (.0005635)
D.ln_GDP2	-.0135644** (.067874)	.00738744** (.0007448)	-.0062425** (.0064553)	.0063572** (.00086364)
D.ln_GDP3	-.0136647** (.0526379)	.0138484** (.00637474)	-.054684 ** (.035646)	.036353** (.0066633)
D.ln_IINV	.1366443 (.384473)	.837474*** (.238474)	-.495855*** (.075676)	.4254398 (.263276)
D.ln_FIN	-.0000354 (.0003546)	-.173737 (.137474)	.345894 (.645474)	-.0001635*** (.0001320)
D.ln_NTECH	-.06374746** (.00637446)	-.00053747** (.000635646)	-.00045334 (.0015479)	-.0014532** (.0006725)
D.ln_EN	.00634848*** (.000738474)	.000023646 (.0001364)	.0052334*** (.000976)	.0008663*** (.0001763)
D.ln_FDI	.1384843 (.3747483)	.8374641*** (.223644)	-.243538 (.64549)	.0066373** (.0001352)
D.ln_EXR	-.0000674 (.00023848)	-.00013746 (.0000395)	.0154689 (.065356)	-.286343 (.263737)
D.ln_INF	-.00138474 (.0063848)	-.00053747 (.0006347)	-.0001655 (.0016545)	-.636369 (.263535)
D.ln_INSFIT	-.0063748*** (.000738484)	.00003447 (.0001447)	-.007453*** (.000644)	-.0006536*** (.000154)
Constant	-.4374748*** (.0248575)		-.36576*** (.024539)	
EC	-.7958581*** (.0436674)		-.75432*** (.054377)	

Note: d.ln_C02 is the dependent variable, *** p<0.01, ** p<0.05, * p<0.10, SE in parenthesis; D. indicates first difference; EC is the error correction coefficient

Appendix 4J: Robustness Check: POLS and GMM

Variables	Dependent Variable: C02 emission					
	POLS			GMM		
	Coeff.	**t-stats.**	**p-value**	**Coeff.**	**t-stats.**	**p-value**
ln_GDP	0.32469	4.63	-.055262**	0.22734	6.45	-.053637**
ln_GDP2	0.42567	4.32	-.014773**	0.43733	4.53	-.015363**
ln_GDP3	0.02778	6.98	-.013597**	-14.263	4.69	-.153537**
ln_IINV	0.62526	13.45	.1478343	0.75353	1.69	.1947473
ln_FIN	0.47272	5.35	-.0018274**	0.73838	5.34	-.0098374**
ln_NTECH	-0.26393	-7.67	-.0387446**	-0.13362	-10.44	-.0736373**
ln_EN	-0.12775	-5.73	.0074646***	-0.18337	-7.68	.0174646***
ln_FDI	0.833823	11.34	.1363773	0.73773	15.63	.1473633
ln_EXR	0.437283	4.88	-.0018294	0.46363	6.35	-.0025363
ln_INF	-0.13827	-6.74	-.0014875	-0.58484	-8.43	-.0014536
ln_INSFIT	-0.13883	-4.33	-.005884**	-0.12373	-1.55	-.007363***
Constant	4.26267	7.78	0.0001*	2.11173	3.11	0.000*
Obs.	140			140		
R^2	0.7226			0.6927		
Adj. R^2	0.7622			0.7237		
F Statistics	0.001**					
AR(2)	-------			0.299		
Hansen Test	-------			0.166		

Note: *, ** and ***denotes statistical significance at 1%, 5% and 10% respectively.
Source: Authors Computation

APPENDIX 5

Appendix 5A: Sustainable Development Index for BRICS Countries

Brazil				Eigenvalues (Sum = 5, Average = 1)				Eigenvectors (loadings			
Number	**Value**	**Difference**	**Proportion**	**Cumulative value**	**Cumulative proportion**	**Variable**	**PC 1**	**PC 2**	**PC3**	**PC4**	**PC5**
1	3.15262	1.40082	0.6305	3.15262	0.6305	ACAW	0.62728	0.04536	-0.35364	-0.73633	0.05363
2	1.22462	0.81448	0.2449	4.37724	0.8754	ACFT	0.58263	-0.06474	0.64377	-0.53337	0.06383
3	0.41014	0.29764	0.0820	4.78738	0.9574	NID	0.33774	0.63737	0.57388	0.04353	0.04352
4	0.11250	0.01238	0.0225	4.89988	0.9799	NMD	0.37333	-0.53638	0.68282	0.05266	0.05644
5	0.10012	--------	0.0201	5.00000	1.0000	COM	0.42839	-0.73626	0.83732	0.08337	0.07363
Russia											
1	2.62674	1.06111	0.52534	2.62674	0.52534	ACAW	0.72626	-0.00501	-0.46134	0.65569	0.62627
2	1.56563	1.23109	0.31312	4.19237	0.83846	ACFT	0.73837	0.07321	-0.23608	-0.74459	-0.7373
3	0.33454	0.06112	0.06691	4.52691	0.90537	NID	0.23839	0.76701	0.53138	0.10341	-0.63636
4	0.27342	0.07375	0.05468	4.80033	0.96005	NMD	0.32893	0.85654	0.63357	0.26543	0.28676
5	0.19967	--------	0.03995	5.00000	1.0000	COM	0.30393	-0.71368	0.65503	0.05236	0.05783
India											
1	3.05217	1.88391	0.61043	3.05217	0.61043	ACAW	0.53839	-0.01008	-0.6139	0.53123	0.53893
2	1.16826	0.84068	0.23365	4.22043	0.84408	ACFT	0.58339	0.03730	-0.13931	-0.79213	-0.7383
3	0.32758	0.08211	0.06552	4.54801	0.90960	NID	0.33839	0.75194	0.51838	0.20435	0.26373
4	0.24547	0.03895	0.04909	4.79348	0.95869	NMD	0.33929	0.86654	0.67949	0.35652	0.37383
5	0.20652	---	0.04131	5.00000	1.0000	COM	0.47383	-0.65015	0.57972	0.19873	0.18738
China											
1	3.23872	2.30175	0.64774	3.23872	0.64774	ACAW	0.53823	-0.04283	-0.58933	-0.59094	-0.5483
2	0.93697	0.55801	0.18739	4.17569	0.83513	ACFT	0.53393	-0.26225	-0.24469	0.77906	0.79738
3	0.37896	0.10104	0.07579	4.55465	0.91092	NID	0.33829	0.96772	0.23632	0.06893	0.07389
4	0.27792	0.11049	0.05558	4.83257	0.96650	NMD	0.37327	0.97432	0.34777	0.12784	0.08738
5	0.16743	-------	0.03350	5.00000	1.0000	COM	0.37382	-0.36937	0.74604	-0.22895	-0.23637
South Africa											
1	3.11672	1.99790	0.62334	3.11672	0.62334	ACAW	0.72828	-0.08500	-0.73704	-0.24787	-0.23673
2	1.11882	0.83495	0.22376	4.23554	0.84710	ACFT	0.56278	-0.13467	0.53712	-0.56675	0.73638
3	0.28387	0.01890	0.05677	4.51941	0.90387	NID	0.57866	-0.12871	0.13820	0.79566	0.78106
4	0.26497	0.04935	0.05299	4.78438	0.95686	NMD	0.67299	0.13324	0.23747	0.83343	-0.63737
5	0.21562	--------	0.04314	5.00000	1.0000	COM	0.17378	0.92454	0.03887	0.05365	0.03636

Note: ACAW= Access to clean air and water; ACFT=Access to clean fuels and technologies for cooking-% of population; NID=Number of infant deaths; NMD=Number of maternal deaths; COM=Compulsory education, duration.

Appendix 5B: The Measure of Constructs-Article 4

Variable	Measure	Author	Source of Data
DEV	Aggregations of Aggregation of ACAW, ACFT, NID, NMD, & COM (proxy for sustainable development)	**Author's own construction**	International Monetary Fund, International Financial Statistics and data files; World Bank's World Development Indicators
GDP	Real level of GDP per capita (proxy for economic growth)	Agrawal, 2015; Akintunde & Satope, 2013	World Bank Databases (the World Development Indicators- WDI).
INSTFIT	Aggregations of economic, political and institutional indexes (proxy for institutional fitness)	Eggoh., Houeninvo & Sossou, 2015; Adelowokan, 2012; David., Bloom, & Canning, 2008; Strittmatter & Sunde, 2011	World Bank Databases (World Governance Index-WGI-).
FDI	FDI inflow, expressed as a percentage of GDP (a proxy for Foreign Direct Investment)	Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
DI	Gross fixed capital formation (a proxy for domestic investment)	Asongu and Nwachukwu, 2015; Akinola & Bokana, 2017	World Bank Databases (the World Development Indicators- WDI).
FIN	Domestic credit to private sector to GDP ratio (this is a proxy for financial development)	Asongu and Nwachukwu, 2015; Akinola & Bokana, 2017	World Bank Databases (the World Development Indicators- WDI).
EXR	Number of local currency unit to 1 US$ (a proxy for exchange rate)	Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	World Bank Databases (the World Development Indicators- WDI).
INF	Log of Consumer price index-CPI (a proxy for inflation)	Akinola & Bokana, 2017; Ajide and Raheem, 2016; Asongu and Nwachukwu, 2015	International financial statistics (IFS); World Bank Databases (the World Development Indicators- WDI).

Appendix 5C: CADF Unit Root Test

Panel	Variable	0 lag	0 lag and trend	1 lag	1 lag and trend
BRICS	ln_DEV	.151	.000**	.001	.000
	ln_GDP	0.18	0.156	.001***	.000
	ln_INQ	0.59	0.016**	0.223	.000**
	ln_INSTFIT	.005***	0.000	0.34	0.66
	ln_C02	.211	.000**	.000	.000
	ln_FIN	0.032**	0.834	.005***	.752
	ln_INF	.364	0.645	.043**	0.155
	Ln_EXR	.124	.000***	.000	.000
	Ln_FDI	0.032**	0.734	.004***	.66
	ln_DI	.327	0.877	.041**	0.183
MINT	ln_DEV	.130	.000**	.000	.000
	ln_GDP	0.27	0.134	.000***	.000
	ln_INQ	.003**	0.155	0.086	0.55
	ln_INSTFIT	0.5	0.012**	0.223	.000***
	ln_C02	.002***	0.023	0.56	0.86
	ln_FIN	.138	.000**	.000	.000
	ln_INF	0.023**	0.839	.004***	.92
	Ln_EXR	.378	0.624	.045**	0.17
	Ln_FDI	.110	.000**	.000	.000
	ln_DI	0.023**	0.673	.005***	.88
G-7	ln_DEV	0.23	0.121	.000***	.001
	ln_GDP	.003**	0.127	0.086	0.322
	ln_INQ	0.55	0.011**	0.211	.000***
	ln_INSTFIT	.003***	0.043	0.78	0.81
	ln_C02	.134	.000***	.000	.000
	ln_FIN	0.023**	0.374	.003***	.91
	ln_INF	.323	0.763	.040**	0.122
	Ln_EXR	.198	.000**	.000	.001**
	Ln_FDI	0.032**	0.723	.003***	.78
	ln_DI	.323	0.833	.039**	0.327

Note: *** p<0.01, ** p<0.05, * p<0.10; only P-values are reported; HO: the process has a unit root

Appendix 5D: Westerlund Cointegration Test

Panel	Statistic	Test values (0 lag)	Test values (1 lag)
BRICS	Gt	1.453	-5.341***
	Ga	3.477	-5.861**
	Pt	-7.563***	-15.601***
	Pa	-8.354***	-16.861***
MINT	Gt	-5.723***	-12.504***
	Ga	2.617	-6.861**
	Pt	-8.788***	-17.504***
	Pa	-8.365**	-18.601***
G-7	Gt	3.7784	-5.891**
	Ga	-6.3788***	-6.478**
	Pt	-9.348***	-17.594***
	Pa	-9.378***	-18.694***

Appendix 5D(1): Robustness Check Results under CS-ARDL with Additional Explanatory Variables

Growth in Sustainable Development										
Panel		Baseline	INQ	INSTFIT	C02	FIN	INF	EXR	FDI	DI
BRICS	Theta	-0.062** (0.022)	0.088** (0.033)	0.132** (0.045)	-0.125** (0.045)	0.122** (0.044)	-0.167** (0.045)	-0.134** (0.039)	0.123** (0.065)	0.178** (0.078)
	Zeta		0.124** (0.045)	0.103** (0.035)	-0.145** (0.045)	0.145** (0.038)	-0.763** (0.035)	-0.156** (0.024)	0.135** (0.033)	0.133** (0.044)
	CSD test	1.86**	1.91**	3.66***	6.55*	4.71**	3.99***	5.44*	7.67**	8.63**
BRICS sub-sample 1: Brazil, India and South Africa)	Theta	-0.082** (0.031)	-0.081** (0.047)	0.111** (0.051)	-0.156** (0.049)	0.132** (0.032)	0.139** (0.041)	-0.142** (0.039)	0.139** (0.037)	0.148** (0.038)
	Zeta		-0.144** (0.049)	0.096** (0.041)	-0.141** (0.038)	0.137** (0.036)	0.132** (0.034)	-0.123** (0.031)	0.122** (0.034)	0.129** (0.039)
	CSD test	1.82**	1.93**	6.11***	7.22*	6.44**	5.59***	4.44*	2.11**	3.44***
BRICS sub-sample 2: Russia and China)	Theta	-0.071** (0.039)	0.087** (0.036)	0.153** (0.043)	-0.151** (0.037)	0.129** (0.031)	0.133** (0.037)	-0.133** (0.039)	0.139** (0.043)	0.130** (0.042)
	Zeta		0.141** (0.032)	0.122** (0.027)	-0.144** (0.034)	0.113** (0.029)	0.123** (0.038)	-0.132** (0.037)	0.127** (0.036)	0.111** (0.033)
	CSD test	1.92**	1.81**	5.11***	7.22*	4.32**	3.44***	6.77*	4.45**	4.22***
MINT	Theta	-0.092** (0.022)	-0.078** (0.045)	0.102** (0.049)	-0.145** (0.055)	0.123** (0.029)	0.141** (0.039)	-0.133** (0.034)	0.145** (0.034)	0.152** (0.037)
	Zeta		-0.134** (0.056)	0.099** (0.031)	-0.135** (0.033)	0.131** (0.038)	0.129** (0.031)	-0.120** (0.038)	0.111** (0.038)	0.133** (0.045)
	CSD test	1.76**	1.99**	5.67***	7.11*	5.23**	4.61***	5.51*	1.88**	3.69***
G-7	Theta	-0.062** (0.042)	0.084** (0.038)	0.145** (0.049)	-0.143** (0.035)	0.122** (0.028)	0.122** (0.038)	-0.102** (0.035)	0.124** (0.035)	0.112** (0.033)
	Zeta		0.134** (0.029)	0.111** (0.028)	-0.155** (0.039)	0.102** (0.026)	0.112** (0.029)	-0.125** (0.033)	0.121** (0.039)	0.103** (0.039)
	CSD test	1.99**	1.71**	4.63***	8.33*	3.21**	3.63***	7.59*	3.37**	3.33***

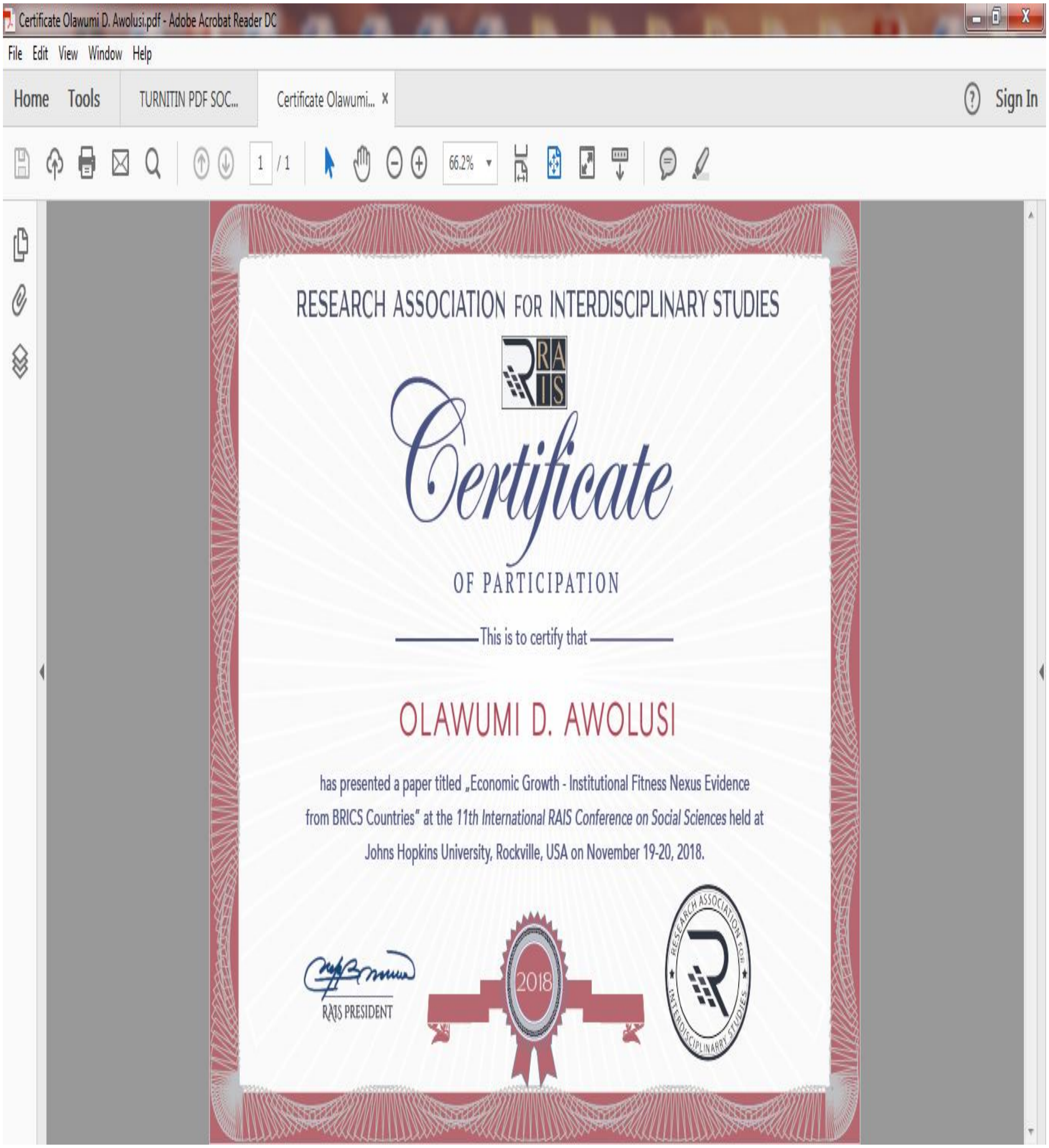
Note: CSD= Cross sectional dependence; ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent level respectively; ARDL= Autoregressive distributed lag; CS-ARDL= Cross-section augmented Autoregressive distributed lag; CS-DL= Cross-section augmented distributed lag; Standard errors are in parentheses.

Appendix 5E: Robustness Check Results under CS-ARDL with Additional Seven Emerging Countries Sample

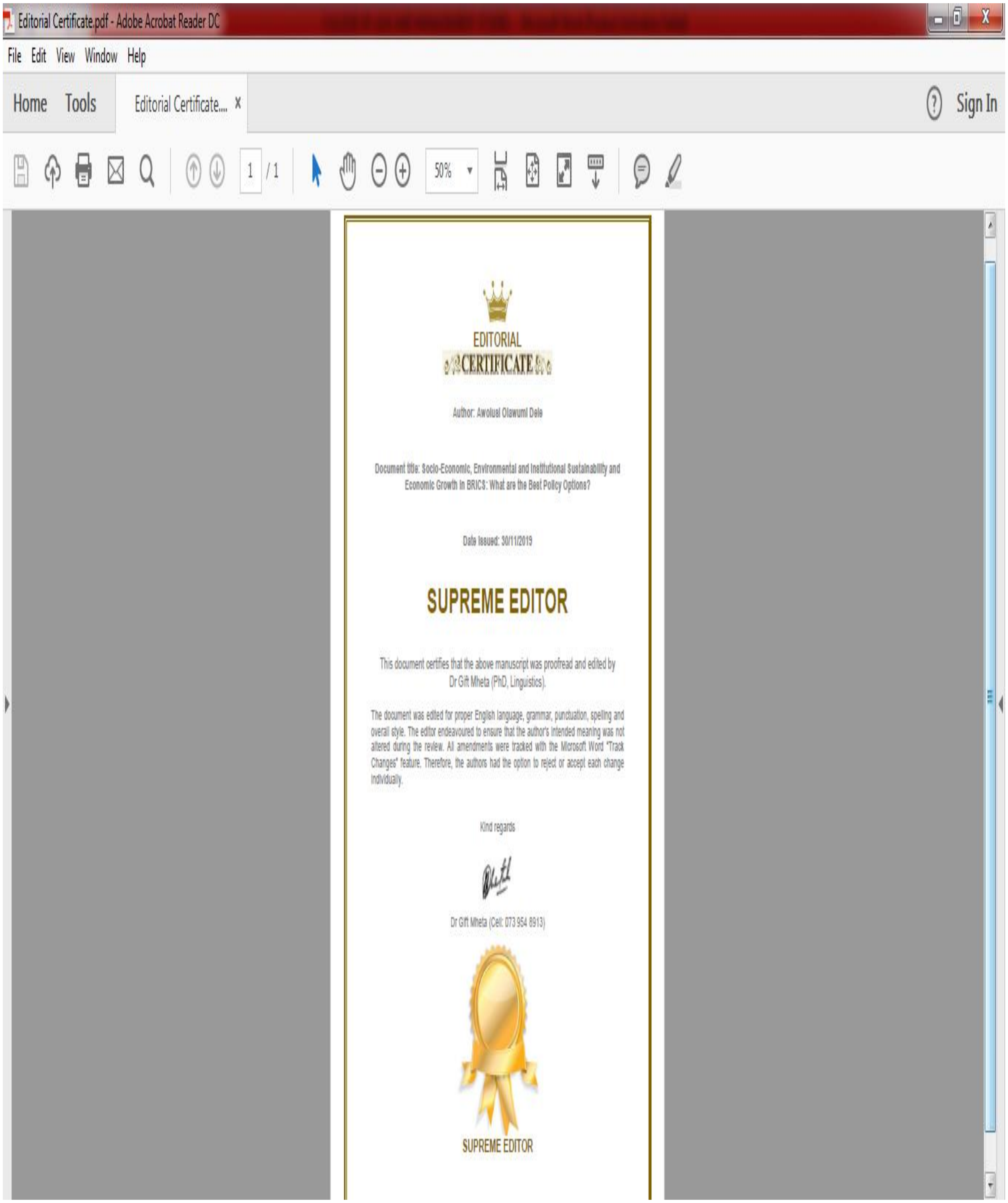
PANEL		Sustainable Development		
		ARDL	CS-ARDL	CS-DL
		1 lag		
	Theta	-0.086** (0.031)	-0.075** (0.023)	-0.051** (0.019)
	CSD test	131.27**	1.68**	0.94
		2 lag		
	Theta	-103*** (0.039)	-0.113** (0.29)	-0.073** (0.023)
	CSD test	122.12**	1.71*	0.79
		3 lag		
	Theta	-0.146 (0.078)	-0.133** (0.031)	-0.086** (0.020)
BRICS + Seven (7) emerging Countries	CSD test	109.22***	1.97**	0.97*
		ARDL	CS-ARDL	CS-DL
		1 lag		
	Theta	-0.091*** (0.041)	-0.069** (0.027)	-0.061* (0.021)
	CSD test	141.23**	1.71**	0.88
		2 lag		
	Theta	-111*** (0.042)	-0.102** (0.31)	-0.075** (0.027)
	CSD test	132.13**	1.68*	0.81
		3 lag		
	Theta	-0.151** (0.081)	-0.122** (0.043)	-0.079** (0.025)
BRICS sub-sample 1(Brazil, India and South Africa) **+ Seven (7) emerging Countries**	CSD test	111.33***	1.89**	0.96*
		ARDL	CS-ARDL	CS-DL
		1 lag		
	Theta	-0.091* (0.042)	-0.077** (0.021)	-0.059** (0.017)
	CSD test	142.21**	1.71**	0.88
		2 lag		
	Theta	-111*** (0.041)	-0.121** (0.31)	-0.082** (0.025)
	CSD test	132.11**	1.82*	0.71
		3 lag		
	Theta	-0.139 (0.081)	-0.129** (0.041)	-0.084** (0.029)
BRICS sub-sample 2 (Russia and China) **+ Seven (7) emerging Countries**	CSD test	113.28***	1.89**	0.93*

Note: CSD= Cross sectional dependence; ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent level respectively; ARDL= Autoregressive distributed lag; CS-ARDL= Cross-section augmented Autoregressive distributed lag; CS-DL= Cross-section augmented distributed lag; Standard errors are in parentheses.

Appendix 6A: Conference Certificates



Appendix 6B: Editorial Certificate



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CERTIFICATE

Author: Awolusi Olawumi Dele

Document title: Socio-Economic, Environmental and Institutional Sustainability and Economic Growth in BRICS: What are the Best Policy Options?

Date issued: 30/11/2019

SUPREME EDITOR

This document certifies that the above manuscript was proofread and edited by Dr Gift Mheta (PhD, Linguistics).

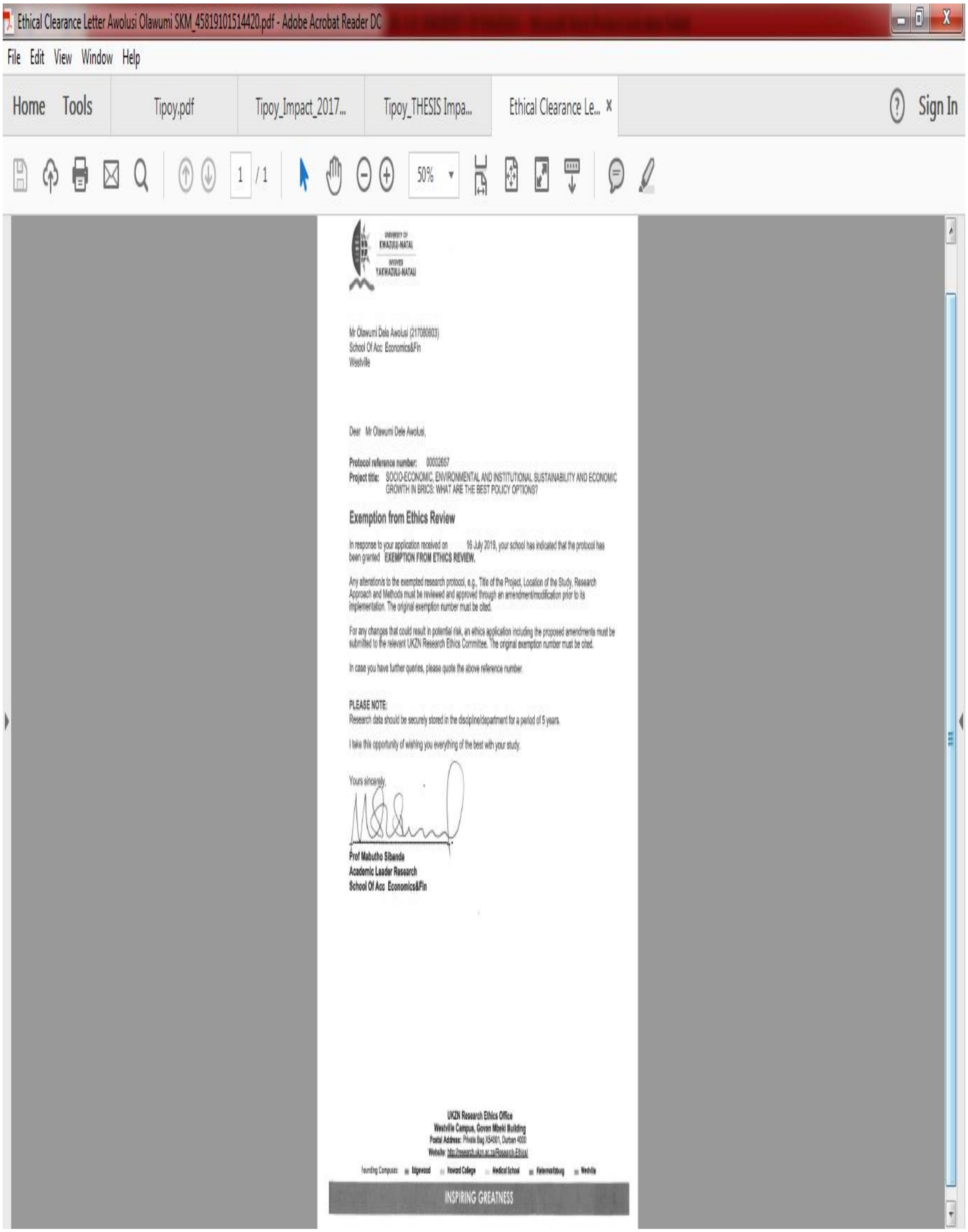
The document was edited for proper English language, grammar, punctuation, spelling and overall style. The editor endeavoured to ensure that the author's intended meaning was not altered during the review. All amendments were tracked with the Microsoft Word "Track Changes" feature. Therefore, the authors had the option to reject or accept each change individually.

Kind regards

Dr Gift Mheta (Cell: 073 954 8913)

SUPREME EDITOR

Appendix 6C: Ethical Clearance Certificate



UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Mr Olawumi Dele Awolusi (217080603)
School Of Acc Economics&Fin
Westville

Dear Mr Olawumi Dele Awolusi,

Protocol reference number: 00002657
Project title: SOCIO-ECONOMIC, ENVIRONMENTAL AND INSTITUTIONAL SUSTAINABILITY AND ECONOMIC GROWTH IN BRICS: WHAT ARE THE BEST POLICY OPTIONS?

Exemption from Ethics Review

In response to your application received on 16 July 2019, your school has indicated that the protocol has been granted **EXEMPTION FROM ETHICS REVIEW.**

Any alteration/s to the exempted research protocol, e.g., Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through an amendment/modification prior to its implementation. The original exemption number must be cited.

For any changes that could result in potential risk, an ethics application including the proposed amendments must be submitted to the relevant UKZN Research Ethics Committee. The original exemption number must be cited.

In case you have further queries, please quote the above reference number.

PLEASE NOTE:
Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours sincerely,

Prof Mabutho Sibanda
Academic Leader Research
School Of Acc Economics&Fin

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Appendix 6D: Turnitin Report