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One district one factory policy of Ghana, a transition to a low-carbon habitable economy?

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Abstract
Ghana has proposed 'One district, one factory' policy which would bridge the income gap, improve standards of living, ease dependency ratio, and build up the economy. Based on the past trend of foreign direct investment (FDI) of Ghana, we examine the possible impact of this policy on its environment, validating the pollution haven or halo effect. We examined the validity of the environmental Kuznets curve (EKC) hypothesis. Augmented Dickey–Fuller and Phillips–Peron unit root tests were conducted to examine the presence of unit root among the variables. Johansen cointegration test was also used to examine the long-run relationship. The autoregressive distributed lag approach to cointegration, Granger causality test, and fully modified ordinary least square were the estimation methods employed. A unidirectional relationship was found between FDI and economic growth, FDI and energy consumption, and FDI and CO_2 emissions. We found that the EKC was not valid for Ghana, but the pollution haven hypothesis was confirmed for Ghana. We therefore conclude that 'One district one factory' policy would only be beneficial if Ghana attracts cleaner industries, environmental regulations get much stringent, and environmentally related taxes are elevated.

Keywords Pollution haven theory · Pollution halo effect · Economic growth · Foreign direct investment · Environmental pollution

Abbreviations

ARDL	The autoregressive distributed lag
FMOLS	Fully modified ordinary least square

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FDI	Foreign direct investment
PHH	Pollution haven hypothesis
EKC	Environmental Kuznets curve
GDP	Gross domestic product
ADF	Augmented Dickey–Fuller unit root test
PP test	Phillips–Peron unit root test
VECM	Vector error correction model

1 Introduction

In spite of abundance natural resource, the resource curse theory has been found in many developing economies (Boos and Holm-Müller 2016; Dam and Scholtens 2012). Countries rich in natural resource have experienced unsatisfactory growth. Some resource-rich countries experiencing resource curse therefore rely on foreign investors for economic growth without considering the environmental impact of their activities. Such nations with lax environmental regulations attract pollution intensive industries, turning them into pollution havens (Shen et al. 2019). Alternatively, the pollution halo effect happens when they attract labor-intensive sectors or industries with sophisticated technologies, better processes and better ways of doing things (Pazienza 2015; Zhu et al. 2016). This means that labor-intensive multinationals are much favorable to the environment of the host nation. However, much employment is created with the manufacturing industries hence the preference of developing countries.

Ghana has attracted foreign investors who have contributed positively to national building by improving human capital, creating jobs and contributing to the gross domestic product (Adams and Atsu 2014; Tang and Gyasi 2012; Tsamenyi et al. 2010). The detrimental impact of foreign investors on Ghana has also been revealed in the study of Solarin et al. (2017). However due to increasing unemployment rate in the country, 'One district, one factory' policy has been proposed to address unemployment issues, bridge income gap, boost the economy and reduce dependency ratio. The policy seeks to provide support for viable existing companies in various districts. The technical support team of the policy would also develop business plans for the establishment of the selected viable factories. One other provision of this policy is the creation of a secretariat to serve as a contact for investors who are interested in this policy (Daily 2017).

The country would therefore need foreign investors on board to accomplish this policy successfully. However, foreign investors do more harm than good to the environment especially in developing countries (Dou and Han 2019; Sarkodie and Strezov 2019; Zheng and Shi 2017). This is because developing economies mostly prioritize economic growth over habitable environment. Nonetheless, developing low-carbon economy is both an economic and political issue (Dou 2015) and achieving sustainable development means taking measures to deal with conceivable environmental impact (Gara 2019).

Economic growth on one hand, environmental quality on the other hand. Will Ghana walk into a low habitable carbon economy with its 'One district, one factory' policy? Our study aims at heightening the impact of the activities of multinationals on the growth and environmental quality of Ghana. A number of studies have been conducted on the impact of multinationals and other foreign investors on the environmental quality of host nations (Fotourehchi 2019; Shao et al. 2019; Shen et al. 2019; Solarin et al. 2017) including Ghana. However none of these studies specifically examined the environmental impact of foreign

investors in relation to the proposed 'One district one factory' policy of Ghana. Although this study is focused on Ghana, findings from this study would be useful to other developing nations who hope to create jobs with the help of foreign investors to resolve unemployment issues.

The remaining section of our paper is structured as follows: Sect. 2 discusses relevant related literature; Sect. 3 puts across data and methods employed; Sect. 4 presents results and discussion of our study; Sect. 5 draws the conclusion to the study, proposing likely policies to be instituted based on the findings.

2 Literature review

Many countries rich in natural resources have observed an unsatisfactory economic growth (Ben-Salha et al. 2018). Notwithstanding other factors help such economies to develop and these factors could have either negative or positive impact on the country. For instance, import has an impact on economic growth (Makun 2018; Tahir et al. 2015) and environmental quality (Cole 2004). This is because imports ranges from green products to electronic waste (Akormedi et al. 2013; Oteng-Ababio 2010). Export also influences economic growth (Quaicoe et al. 2017) and environmental quality (Shi and Xu 2018). Import, export, and other economic activities cause frequent movement of persons to the urban centers. Urbanization as well impact on economic growth (Solarin and Shahbaz 2013) due to expansion in urban facilities, increase in patronage of goods and service as well as increased industrial activities. On the other hand, urbanization affect the environment negatively due to increase in energy consumption associated with economic expansion (Zhao and Zhang 2018). High energy consumption is mostly associated with industrial activities.

Extensive research has therefore been carried out on the impact of industrial activities on the environment (Mensah et al. 2019b; Mirasgedis et al. 2008; Muñoz et al. 2019). These studies concluded that industrial activities pollute the environment and increase mortality rate. In the context of Ghana Abokyi et al. (2019) found a u-shaped relationship between industrial growth and environmental pollution. Pollution from these industries have been linked to the over-reliance on fossil fuels (Muñoz et al. 2019). However, environmental regulations control pollution from industrial activities and influence firms relocation decisions (Wang et al. 2019b). Notwithstanding, investors take advantage of nations quest to develop economically and the removal of economic barriers (Adom et al. 2019) to invest in other countries. These foreign investors help develop nations, however, when investors engage in pollution intensive activities, they turn host nations into pollution havens (Shen et al. 2019). For this reason, a number of studies have been conducted to examine the pollution haven hypothesis.

The pollution haven hypothesis purports that due to stringent environmental regulations, multinationals move their production activities to nations with lax environmental and social standards, making them pollution havens (Dam and Scholtens 2012). Developed economies institute stringent environmental regulations to discourage activities of dirty industries. This is also to discourage the movement of dirty industries into these countries as well as encourage innovation of green technologies, products, and processes to protect the environment and its inhabitants. Taxes levied on production activities in such countries make industries relocate to zones with lax environmental standards. They mostly move to developing countries who are seeking economic growth rather than environmental protection, creating pollution havens. Although the relocation of these industries alleviate emissions levels in developed economies, that of the developing nations worsen (Li and Wang 2019).

The reverse is found in situations where companies move into territories with high environmental standards (Wang et al. 2019a). These investors are forced to invest in cleaner production methods through clean technological innovation and clean energy use. The environment is therefore protected. This is referred to as the pollution halo effect. A country can move into low-carbon habitable economy depending on the kind of foreign investor it attracts. Much research has been carried out on impact of foreign investors on the environment of host nations examining both the pollution haven and pollution halo hypotheses.

In the context of Ghana, Solarin et al. (2017) investigated the PHH and the EKC for the period 1980–2012. They found that GDP, urban population, foreign direct investment, financial development, and international trade positively impact on CO_2 emission, an indication of existence of PHH. This means that foreign investors in Ghana do not promote a low-carbon habitable economy. Also, institutional quality enhances environmental quality in Ghana. This study proves that foreign investors create pollution havens rather than pollution halo effect in Ghana. However, this study did not consider other contributors to economic growth of Ghana in as much as the country opens its doors to foreign investors for economic growth. Other studies focused on the impact of foreign investors on the environment from the perspective of regional blocs.

Examining the impact of foreign investors on the host countries environment, Baek (2016) focused on the Association of Southeast Asian Nations (ASEAN) five. This researcher estimated the effects of FDI inflows, income, and energy consumption on CO_2 emissions employing a panel data over 1981–2010 and found that FDI negatively affect environmental quality in these countries, supporting PHH. This study justifies that the activities of foreign investors do not lead to low-carbon economy in the ASEAN five economies.

Similarly, Kim and Adilov (2012) investigated the relationship between FDI and CO_2 emissions. Their results reveal that, while lax environmental regulations could attract FDI, these companies employ less polluting technologies compared to local firms in low-income countries. They concluded that FDI does not necessarily worsen pollution levels in the host countries. Their findings confirm both pollution haven and the pollution halo hypotheses. This study suggests that, possibly in the face of lax environmental standards, nations could still attract pollution halo, however, this rarely happens. It does happen when nations attract sectors with labor-intensive activities.

In another study, Sapkota and Bastola (2017) probed into the effect of FDI and income on pollution emissions using time series data from 1980 to 2010 for 14 countries. Specifically, they tested for the validity of PHH and EKC hypothesis for this region. Results validated both the PHH and EKC hypothesis for both the high and low-income countries. This study shows that both the high- and low-income countries are capable of attracting pollution havens in the face of lower environmental standards. They also prove that economic growth can lead to environmental deterioration. Since foreign investors join different sectors and still impact on the environment. Other researchers looked at the sectorial pollution contribution from foreign investors.

Zugravu-Soilita (2017) explored the impact of FDIs on industrial pollution based on a panel data on manufacturing FDIs from Germany, France, Sweden, and the UK between 1995 and 2008. They found that FDI reduces pollution levels, an indication of the pollution halo effect. However, this hypothesis was confirmed for countries with low to average capital-to-labor ratio. These countries as well do not have very lax environmental regulations. Also, FDIs are found to increase pollution, confirming the PHH in countries with abundant capital, average capital endowment and lax environmental regulations. From this study, it can be inferred that FDI could yield the halo effect

where stringent environmental rules do not exist but ratio of labor to capital is high in manufacturing activities. This is to say, a low-carbon habitable economy resulting from the activities of foreign investors could occur when labor dominate manufacturing activities and stringent environmental policies are laid in place.

From the perspective of labor-intensive foreign investment, Pazienza (2015) investigated the impact FDI inflows in the 'agriculture and fishing' sector of OECD countries exert on CO_2 emissions level. This study focused on 30 OECD countries over a period of 25 years. They found that through technique, scale, and cumulative effects, FDI reduces CO_2 emissions, confirming the pollution halo effect. Although not studied in relation to any policy, this study proves that depending on the sector of attraction, FDI can be beneficial to the environment of the host country. A low-carbon habitable economy can be observed depending on the sector foreign investors decide to join.

Much said, there remain inconclusive findings on the activities of foreign investors on environmental quality, and no study has yet been carried out on the environmental impact of the proposed 'One district one factory' policy of Ghana. This study therefore seeks to contribute to existing literature by examining the role of foreign investors on both the economy and environment as well as examine the determinants of growth in the context of Ghana in relation to the proposed 'One district, one factory policy'.

3 Materials and methods

3.1 Data and source

Variables for our study were extracted from World Bank database, World Development Indicators (WDI). It covers the period 1976–2017 due to data availability. These variables are GDP, FDI, energy use, CO_2 emissions, natural resource rent, import, export, and urbanization. CO_2 emission is expressed in kilotons and a proxy for pollution. FDI inflow, import, export, and gross domestic product (GDP) are expressed as constant USD 2010. Information on data employed is reported in Table 1.

Figure 1 shows the trend of variables of this study. It is observed that Ghana has since 1976 experienced a growing trend in FDI. This increasing has been at a slower pace until beyond the year 2000 when it accelerated. Multinational companies and foreign investors have turned their attention to Ghana in the past decade. GDP, urbanization, energy consumption, import, and exports have also seen an increasing trend in the past years. The GDP of the country has since 1998 shot up at a much faster pace comparatively. Import and export trends have increased at a slower pace but beyond 1997, Ghana has imported more than it has exported. Energy consumption dropped sharply in 2014 and has since been stable, possibly due to limited supply of energy. CO_2 emissions and urbanization trend have both been stable since 1976. The growth trend of CO_2 emissions is an indication that the country experiences less pollution possibly due to their reliance on imports rather than domestic production and successful implementation of environmental policies of controlling greenhouse gases by the Environmental Protection Agency (EPA). The descriptive statistics of the study is presented in Table 2.

Table 1 Definition of variable of our study

Variable		Definition	Unit of measurement	Source
CO_2	Dependent	Carbon dioxide emission	kilotons	World Development Indicators
GDP	Dependent	Economic growth	constant USD 2010	World Development Indicators
FDI	Independent	Foreign direct investment	constant USD 2010	World Development Indicators
EC	Independent	Actual energy consumption	kilotons	World Development Indicators
URB	Control	The total urban population	total	World Development Indicators
EXP	Control	The total volume of export	constant USD 2010	World Development Indicators
IMP	Control	The total volume of import	constant USD 2010	World Development Indicators
NRR	Independent	Total natural resource rent	total	World Development Indicators

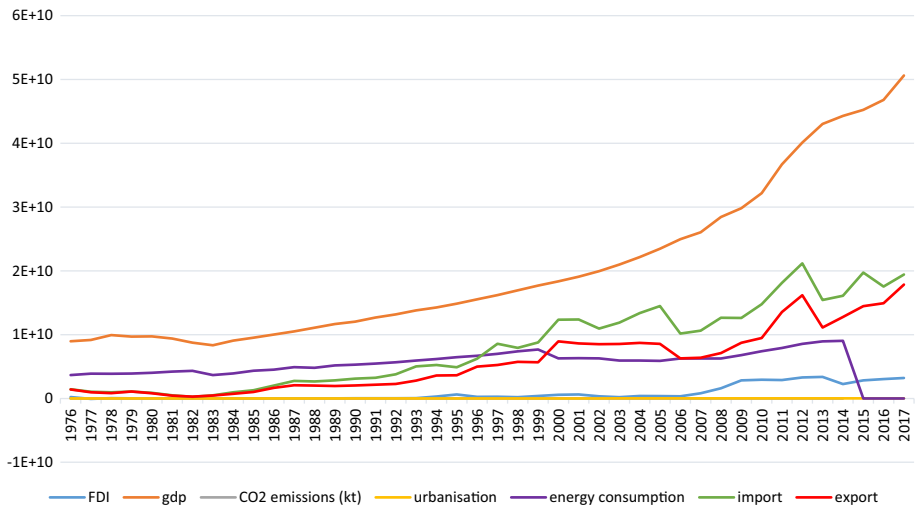

Fig. 1 Growth trend in polluting contributors of interest in Ghana

3.2 Materials and methods

Based on extant literature, FDI, economic growth, energy consumption, urbanization, export and import impact economic growth and the environment (Dauda et al. 2019; Hille et al. 2019; Mensah et al. 2019a; Salman et al. 2019; Wang et al. 2019c). Natural resource rent as well impact economic growth (Ben-Salha et al. 2018). These variables were therefore inculcated in this study. Three models were developed with the first model examining the impact of FDI on economic growth. The second model examines the pollution haven and pollution halo effects. The third model examines the validity of the EKC. The study

Table 2 Descriptive statistics

	CO_2	EC	EXP	FDI	GDP	IMP	NRR	URB
Mean	5980.407	5.82E+09	5.06E+09	6.53E+08	1.83E+10	7.26E+09	5.78E−08	7,373,884
Median	5276.813	5.94E+09	3.64E+09	2.26E+08	1.49E+10	5.25E+09	5.45E−08	6,727,651
Maximum	14,620.33	9.03E+09	1.62E+10	3.38E+09	4.43E+10	2.12E+10	9.94E−08	14,403,132
Minimum	2434.888	3.66E+09	2.92E+08	−60,509,835	8.34E+09	2.61E+08	3.20E−08	3,034,105
SD	3247.797	1.49E+09	4.19E+09	1.04E+09	1.01E+10	5.91E+09	1.66E−08	3,486,837
Skewness	1.026459	0.338316	0.759043	1.709623	1.179995	0.490992	0.6376	0.473726
Kurtosis	3.429113	2.400787	2.717481	4.359457	3.433538	2.050402	2.634251	1.995015
Jarque–Bera	7.147741	1.327442	3.874651	22.00146	9.355948	3.032298	2.859847	3.099951
Probability	0.028047	0.514932	0.144089	0.000017	0.009298	0.219556	0.239327	0.212253
Sum	233,235.9	2.27E+11	1.97E+11	2.55E+10	7.13E+11	2.83E+11	2.25E−06	2.88E+08
Sum Sq. Dev	4.01E+08	8.40E+19	6.67E+20	4.11E+19	3.89E+21	1.33E+21	1.05E−14	4.62E+14
Observations	39	39	39	39	39	39	39	39

considers the directional relations between the variables using vector error correction model (VECM) granger causality.

3.2.1 Description of variables

3.2.1.1 Pollution Our study proxy CO_2 emissions as pollution as done in many environmental pollution research (Dam and Scholtens 2012; Solarin et al. 2017). The unit for CO_2 emission is kilotons. CO_2 is recorded as the highest emitting greenhouse gas aggravating global warming, comparatively.

3.2.1.2 Foreign direct investment (FDI) FDI inflow is expressed as constant USD 2010. This variable was employed as an independent variable to examine its effect on the economic growth of Ghana as well as the environment. FDI could be detrimental or beneficial to the environment thus creating pollution haven or pollution halo effect. FDI has in history been considered a significant channel for international diffusion of technology (Peterson 2008).

3.2.2 Economic growth

GDP constant USD 2010 is an indicator for economic growth as used in many studies, Abdouli and Hammami (2017), Bakhsh et al. (2017) and the square of GDP is used for the EKC hypothesis testing. A negative and a significant coefficient value imply an improvement in environmental quality with economic growth. An inverted u-shaped curve is expected to this effect. Economic growth can be detrimental to the environment at the initial stage of development. At the stage of economic development where inhabitants are more conscious about their environment and pursue green life, economic growth becomes beneficial to the environment. The latter leads to validation of the environmental Kuznets curve.

3.2.2.1 Energy consumption Our study calculated for actual energy use from the data of energy use per capita in kg oil equivalent and population total, to eliminate the per capita element from energy use. We multiplied the two variables to obtain the actual figures for energy consumption.

3.2.2.2 Urbanization The data on urban population are employed as an indicator for urbanization. Increase in urbanization has an impact on economic growth (Solarin and Shahbaz 2013). This is due to expansion in facilities and increase in patronage of goods and service. On the other hand, the environment is negatively affected due to increase in energy consumption (Zhao and Zhang 2018) associated with economic expansion.

3.2.2.3 Import Data on import was calculated from the data on import of goods and services, a % percentage of GDP. The actual figure for import was calculated by multiplying the GDP constant USD 2010 by import divided by 100. Import has an impact on both economic growth (Makun 2018; Tahir et al. 2015) and environmental quality (Cole 2004). Much is imported than produced in the Ghana and imports range from green products to electronic waste (Akormedi et al. 2013; Oteng-Ababio 2010). Import in Ghana thus impact on both economy and the environment. We therefore consider import as one of our control variables.

3.2.2.4 Export Values for export were calculated from the data on exports of goods and service, a % percentage of GDP. Export was divided by 100 and multiplied by GDP. Export impacts economic growth (Quaicoe et al. 2017) and environmental quality (Shi and Xu 2018). Ghana exports minerals, cocoa, timber, among other resources, and hence the need to examine the impact of this variable on both the environment and economic growth.

3.2.2.5 Natural resource rent Research shows that many countries rich in natural resources have observed an unsatisfactory economic growth (Ben-Salha et al. 2018). Ghana is a resource-rich country, and hence the impact of natural resource rent is examined on economic growth using data on total natural resource rent and percentage of GDP. The actual figure for total natural resource rent was obtained by the same method used for the calculation of imports and exports.

3.3 Methods

3.3.1 Unit root test

The preliminary test conducted was the conventional unit root test. The study applied augmented Dickey–Fuller (ADF) and Phillips–Peron (PP) to test for the stationarity of the variables so as to avoid spurious regression results. Again, the order of cointegration is revealed through unit root test so that the appropriate estimation method can be applied to a set of data.

3.3.2 The ARDL bounds testing approach to cointegration

Our study employed the ARDL bounds test approach to cointegration to investigate the possible presence of cointegration among the variables of study. This technique aids in detecting the existence of long-run equilibrium relationship among variables in a study and

extracts the long-run and short-run dynamics. The advantages this method holds over the traditional cointegration testing are that; it is very flexible and allows analysis with $I(0)$ and/or $I(1)$ data, it is much conducive when study sample is small, it offers impartial estimation for long-run relationship and long-run parameters (Rahman and Kashem 2017).

Based on the ARDL approach to cointegration, our first model two models are presented as:

$$\begin{aligned}\Delta \ln \text{gdp}_t = \beta_0 &+ \sum_{i=1}^{k} \xi_1 \Delta \ln \text{gdp}_{2t-i} \sum_{i=1}^{k} \xi_2 \Delta \ln \text{fdi}_{t-i} + \sum_{i=1}^{k} \xi_3 \Delta \ln \text{urb}_{t-i} \\ &+ \sum_{i=1}^{k} \xi_4 \Delta \ln \text{ec}_{t-i} + \sum_{i=1}^{k} \xi_5 \Delta \ln \text{exp}_{t-i} + \sum_{i=1}^{k} \xi_6 \Delta \ln \text{imp}_{t-i} + \sum_{i=1}^{k} \xi_7 \Delta \ln \text{nrr}_{t-i} \\ &+ \lambda_1 \ln \text{gdp}_{2t-i} + \lambda_2 \ln \text{fdi}_{t-i} + \lambda_3 \ln \text{urb}_{t-i} + \lambda_4 \ln \text{ec}_{t-i} \\ &+ \lambda_5 \ln \text{exp}_{t-i} + \lambda_6 \ln \text{imp}_{t-i} + \lambda_7 \ln \text{nrr}_{t-i} + \cdots + U_t \end{aligned} \tag{1}$$

where gdp is the dependent variable and the independent variables are foreign direct investment (fdi), urbanization (urb), energy consumption (ec), export (exp), import (imp), and natural resource rent (nrr). Here, the constant terms in front of the variables are Xi (ξ) and lambda (λ). This is to differentiate the changing stage of the variables. The delta (Δ) symbols estimate the short-run relationship and the λ (lambda) estimates the long-run relationship. ln shows that variables for study are in the logarithm form.

$$\begin{aligned}\text{polt}_t = \alpha_t &+ \beta_1 \ln \text{fdi}_t + \beta_2 \ln \text{urb}_t + \beta_3 \ln \text{gdp}_t + \beta_4 \ln \text{gdp}_t^2 \\ &+ \beta_5 \ln \text{ec}_t + \beta_6 \ln \text{urb}_t + \beta_7 \ln \text{exp}_t + \beta_8 \ln \text{imp}_t + \cdots + e_t \end{aligned} \tag{2}$$

$$\begin{aligned}\text{polt}_t = \alpha_t &+ \beta_1 \ln \text{fdi}_t + \beta_2 \ln \text{urb}_t + \beta_3 \ln \text{gdp}_t + \beta_5 \ln \text{ec}_t \\ &+ \beta_6 \ln \text{urb}_t + \beta_7 \ln \text{exp}_t + \beta_8 \ln \text{imp}_t + \ldots .. + e_t \end{aligned} \tag{3}$$

In our third model, we introduce a new dependent variable *pollution,* representing environmental pollution and a new independent variable which is gdp.

3.3.3 VECM Granger causality

In investigating the direction of causality of environmental pollution, foreign direct investment, economic growth, urbanization, energy consumption, export and import, VECM Granger causality test was used. This is because it helps in determining whether another time series can be useful when forecasting the other. We adopted and modified the bootstrap Granger causality approach propounded by Granger (1986). Our fourth equation is modeled as:

$$
\begin{aligned}
(1-L)\begin{bmatrix} \text{polt}_t \\ \text{fdi}_t \\ \text{gdp}_t \\ \text{urb}_t \\ \text{ec}_t \\ \text{exp}_t \\ \text{imp}_t \end{bmatrix} &= \begin{bmatrix} \text{polt}_1 \\ \text{fdi}_2 \\ \text{gdp}_3 \\ \text{urb}_4 \\ \text{ec}_5 \\ \text{exp}_6 \\ \text{imp}_7 \end{bmatrix} \\
&+ \sum_{j=i}^{q} (1-F) \begin{bmatrix} c_{11i} & c_{12i} & c_{13i} & c_{14i} & c_{15i} & c_{16i} & c_{17i} \\ c_{21i} & c_{22i} & c_{23i} & c_{24i} & c_{25i} & c_{26i} & c_{27i} \\ c_{31i} & c_{32i} & c_{33i} & c_{34i} & c_{35i} & c_{36i} & c_{37i} \\ c_{41i} & c_{42i} & c_{43i} & c_{44i} & c_{45i} & c_{46i} & c_{47i} \\ c_{51i} & c_{52i} & c_{53i} & c_{54i} & c_{55i} & c_{56i} & c_{57i} \\ c_{61i} & c_{62i} & c_{63i} & c_{64i} & c_{65i} & c_{66i} & c_{67i} \\ c_{71i} & c_{72i} & c_{73i} & c_{74i} & c_{65i} & c_{76i} & c_{77i} \end{bmatrix} \begin{bmatrix} \text{polt}_{t-i} \\ \text{fdi}_{t-i} \\ \text{gdp}_{t-i} \\ \text{urb}_{t-i} \\ \text{ec}_{t-i} \\ \text{exp}_{t-i} \\ \text{imp}_{t-i} \end{bmatrix} + \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \\ \varphi_4 \\ \varphi_5 \\ \varphi_6 \\ \varphi_7 \end{bmatrix} \left[\text{ECT}_{t-i}\right]
\end{aligned} \tag{4}
$$

where $(1-L)$, is the lag operator, denoting the number of lags used in the model. The ECT_{t-i} represents the error correction term.

4 Results and discussion

4.1 Unit root test

Table 3 reports the findings for the unit root test and the order of integration. From the results, all variables except for FDI had unit root at level but all turned stationery at the first difference with regards to augmented Dickey–Fuller unit root test. Observed from the results for Philips–Perron test, all of the variables had unit root at level but turned stationery at first difference. The order of integration for all the variables under both test are integrated at $I(1)$.

Table 3 Unit root test results

Variables	ADF test at level	1st difference	PP test at level	1st difference	Order of integration
CO_2	−0.67 (0.84)	−6.36 (0.00)***	−0.73 (0.83)	−6.36 (0.00)***	$I(1)$
GDP	−1.98 (0.29)	−1.02 (0.04)**	−1.98 (0.29)	−6.58 (0.00)***	$I(1)$
EC	−0.34 (0.91)	−0.34 (0.03)**	−0.34 (0.91)	−6.39 (0.00)***	$I(1)$
EXP	−1.48 (0.53)	−1.48 (0.05)**	−1.48 (0.53)	−0.76 (0.02)**	$I(1)$
FDI	−3.27 (0.08)*	−3.27 (0.00)***	−1.28 (0.63)	−6.74 (0.00)***	$I(1)$
IMP	0.96 (0.99)	0.96 (0.03)**	−1.21 (0.66)	−1.75 (0.08)*	$I(1)$
NRR	−0.67 (0.97)	*−6.80 (0.00)***	−1.21 (0.66)	−1.75 (0.08)*	$I(1)$
URB	−3.02 (0.14)	−3.02 (0.01)***	1.52 (0.97)	−3.19 (0.00)***	$I(1)$

*,**,***Significance at the 10%, 5% and 1% levels respectively. *P*-values in parenthesis

4.2 ARDL long-run and short-run estimates of economic growth

The long-run relationship among the variables for economic growth was estimated using the ARDL model (4, 4, 3, 4, 4, 4, 4). From the findings reported in Table 4, urbanization, energy consumption, export and natural resource rent results would improve economic growth of Ghana, confirming (Goh et al. 2017; Sunde 2017). Foreign investors may stop improving economic growth in the long-run from the insignificant coefficient value. Import

Table 4 Estimated long-run coefficients using ARDL approach

Variables	Coefficient values	*t*-statistic	Prob
FDI	0.040156	1.129678	0.3218
URB	1.481459	19.93174	0.0000***
EC	0.303348	4.139944	0.0144***
EXP	1.019633	2.629801	0.0582*
IMP	− 1.294835	− 3.257486	0.0312**
NRR	0.523812	3.798891	0.0191**
C	9.064847	3.638438	0.022**
Estimated short-run coefficients			
D(GDP(− 1))	− 1.616401	− 5.705105	0.0047***
D(GDP(− 2))	− 1.53735	− 4.801997	0.0086***
D(GDP(− 3))	− 0.714169	− 2.460879	0.0696*
D(FDI)	− 0.012547	− 1.312863	0.2595
D(FDI(− 1))	0.055629	6.32877	0.0032***
D(FDI(− 2))	− 0.048363	− 6.791718	0.0025***
D(FDI(− 3))	− 0.050439	− 5.259221	0.0063***
D(URB)	− 4.318258	− 1.01942	0.3656
D(URB(− 1))	22.549589	3.359777	0.0283**
D(URB(− 2))	− 2.696849	− 0.565741	0.6018
D(*D*(EC)	0.002281	2.536363	0.0642
D(EC(− 1))	0.203847	8.571977	0.001***
D(EC(− 2))	− 0.115934	− 1.063251	0.3476
D(EC(− 3))	0.118658	1.304566	0.262
D(EXP)	0.347566	7.262005	0.0019***
D(EXP(− 1))	0.128721	1.893246	0.1313
D(*D*(EXP(− 2))	0.604754	7.180587	0.002***
D(EXP(− 3))	0.505681	7.035059	0.0022***
D(IMP)	− 0.370368	− 6.056573	0.0038***
D(IMP(− 1))	− 0.072959	− 1.938687	0.1246
D(IMP(− 2))	− 0.606649	− 8.586158	0.001***
D(IMP(− 3))	− 0.574046	− 6.622845	0.0027***
D(NRR)	− 0.267728	− 8.447289	0.0011***
D(NRR(− 1))	− 0.105214	− 6.546134	0.0028***
D(NRR(− 2))	− 0.048373	− 3.267654	0.0309**
D(NRR(− 3))	0.130807	6.123798	0.0036**
CointEq(− 1)	0.647478	3.194572	0.0331**

*, **,***Significance at the 10%, 5% and 1% levels respectively

negatively impact on economic growth confirming the findings of Pistoresi and Rinaldi (2012) but contrasts with the findings of Çetintaş and Barişik (2009) and Velnampy and Achchuthan (2013). Inference drawn from this result is that Ghana's growth is hampered by import hence continuous import would threaten the growth of her economy. Export enhances economic growth by 101%, which contradicts the findings of Quaicoe et al. (2017). Natural resource rent contributes to economic growth by 52%, endorsing the findings of Jović et al. (2016), and energy consumption enhances growth in Ghana by 30%. Urbanization has the highest impact on economic growth with a coefficient value of 148% at 1% significant value. The above findings point toward the fact that urbanization and exports have substantial positive role in increasing the GDP of Ghana, comparatively.

The lags of GDP, FDI, urbanization, energy consumption, import and natural resource rent significantly impact on economic growth in the short-run. This is reflected in the coefficient values of the present, immediate past, second, third, and fourth lagged values. However, the coefficient values of lags of GDP's first, second, and third are negatively related to economic growth. Also, FDI's lags 2 and 3 negatively impact on economic growth, but the FDI of the immediate past year had a significant positive impact on the current GDP. Lag 1 of urbanization significantly impact on economic growth. Energy consumption of the current and lag 1 has a significant positive effect on economic growth. All the lags and the first difference of export have significant positive effect on economic growth. It is also observed that the first difference as well as the lags of import negatively impact economic growth except for the lag 1 which has no significant relationship with economic growth. Natural resource rent of the current, lags 1 and 2 also has a negative significant relationship with economic growth, but its lag 3 is significantly positively related to economic growth.

4.3 The EKC hypothesis, pollution haven/halo results

Using the FMOLS estimation method, we examined the validity of the EKC hypothesis and the pollution haven/halo hypothesis. Results are reported in Table 5. The EKC hypothesis although not valid for Ghana, the gdp^2 exhibits a negative coefficient value which is quiet impressive. This means a little more environmental protection effort from Ghana

Table 5 The EKC, pollution haven, and halo hypothesis

Variables	EKC (model 2)	Pollution haven/halo (model 3)
FDI	0.03 (0.02)	0.04 (0.02)**
URB	0.75 (0.20)***	0.79 (0.18)***
GDP	5.18 (7.67)	0.10 (0.15)
GDP^2	−0.10 (0.16)	
EC	0.42 (0.00)***	0.42 (0.00)***
EXP	0.16 (0.16)	0.13 (0.27)
IMP	−0.26 (0.16)	−0.20 (0.13)
C	−75.38 (−0.80)	−15.06 (1.64)
R-squared value	0.99	0.99
Adjusted *R*-square	0.99	0.99

*, **,***Significance at the 10%, 5% and 1% levels respectively, () standard error, coefficient values on the left of parenthesis)

would validate the Kuznets curve. Adu and Denkyirah (2018), Ben Nasr et al. (2015), Lin et al. (2016) also found that the EKC hypothesis is not valid for some African countries. From the same model, no significant impact is witnessed of FDI, economic growth, export and import on environmental pollution, but increased urbanization trend and energy consumption negatively impact environmental quality by 75% and 42%, respectively.

As per the findings of our model 3, the pollution haven hypothesis is confirmed for Ghana where FDI leads to environmental deterioration but minimally. A unit attraction of FDI in Ghana results in a 4% increase in environmental pollution. From the coefficient value of FDI's impact on pollution in Ghana, it can be said that the country has not attracted much 'dirty industries' in the past. Most probably multinational companies are more into services, marketing, and/or distribution without production plants in the country. Few production plants installed by the foreign investors most likely employ cleaner production methods. Findings are an indication that the environmental laws governing Ghana, Ministry of Environment, Science and Technology, as well as the advisory National Committee in charge of Implementing Agenda 21, and a fully authorized administration for environment are working in the country (Hens and Boon 1999). Although it has not met the expectations of citizens yet, Ghana's environmental governance has been relatively effective (Darimani et al. 2013). Careful management could go long way to control the environmental impact of foreign investors. One of Ghana's climate change policy is to strengthen measures that would moderate greenhouse gas emissions from the industrial, energy and waste sectors (MESTI 2013). Should this climate change policy be affirmed, the nation's proposed 'One district, one factory' policy would not pose threat to the environment.

If the country should continue to attract cleaner industries, pollution levels would be controlled and the nation would move into a low-carbon habitable economy. A conscious effort to attract industries with cleaner technologies and methods of production would create the pollution halo effect for the nation's 'One district, one factory' policy as it has been established by Appiah et al. (2018) that pollution in Ghana has a bearing on infant mortality rate. Demand for energy usually surges with development, but when energy is used efficiently and users conserve energy, the growth of greenhouse gases would decline (MESTI 2013).

4.4 Granger causality test

We employed the Granger causality in determining the direction of causality among our variables of study. From the results reported in Table 6, a unidirectional relationship maps from FDI to economic growth, FDI to energy consumption, and FDI and CO_2 emissions. This means FDI enhance economic growth but through energy consumption which in turn pollutes the environment. We found a unidirectional relationship between energy consumption and CO_2 emissions, export and economic growth as well as economic growth and CO_2 emissions. This is consistent with the findings of Pinzón (2018). A feedback effect was found between economic growth and energy consumption consistent with the findings of Lu (2018). This is an indication that an attempt to decrease energy consumption will have a detrimental effect on economic growth. Interestingly, we observed a bidirectional relationship between urbanization and all the variables of our study. Import and export granger causes each other. There is a feedback effect between import and economic growth as well as import and FDI. The feedback effect between import and export was also established in the work of Pistoresi and Rinaldi (2012).

Table 6 Granger causality test results

	Short-run					Long-run		
	ΔCO_2	ΔEC	ΔEXP	ΔFDI	ΔGDP	ΔIMP	ΔURB	ECT
ΔCO_2	–	3.25 (0.20)	2.13 (0.34)	2.01 (0.36)	0.06 (0.97)	2.05 (0.35)	9.49 (0.01)***	− 0.03 [0.29] (0.91)
ΔEC	7.32 (0.03)**	–	1.95 (0.38)	2.04 (0.36)	0.03 (0.03)**	2.15 (0.34)	8.67 (0.01)***	− 0.10 [7.58] (0.89)
ΔEXP	1.03 (0.59)	0.04 (0.98)	–	4.24 (0.12)	7.22 (0.03)**	4.75 (0.09)*	5.57 (0.06)*	3.42 [0.05] (0.00)***
ΔFDI	19.22 (0.00)***	10.94 (0.00)***	4.26 (0.12)	–	6.40 (0.04)**	4.75 (0.09)*	5.57 (0.06)*	− 0.07 [0.10] (0.49)
ΔGDP	19.22 (0.00)***	10.94 (0.00)***	1.06 (0.59)	1.21 (0.55)	–	9.95 (0.01)***	10.74 (0.00)***	3.54 [0.05] (0.00)***
ΔIMP	1.34 (0.51)	0.55 (0.76)	13.26 (0.00)***	14.93 (0.00)***	8.03 (0.02)**	–	8.13 (0.02)**	3.44 [0.04] (0.00)***
ΔURRB	11.05 (0.00)***	7.70 (0.02)**	9.62 (0.01)***	3.05 (0.21)	20.36 (0.00)***	11.30 (0.00)***	–	− 0.00 [0.00] (0.08)*
ΔIMP	1.34 (0.51)	0.55 (0.76)	13.26 (0.00)***	14.93 (0.00)***	8.03 (0.02)**	–	8.13 (0.02)**	3.44 [0.04] (0.00)***
ΔURRB	11.05 (0.00)***	7.70 (0.02)**	9.62 (0.01)***	3.05 (0.21)	20.36 (0.00)***	11.30 (0.00)***	–	− 0.00 [0.00] (0.08)*

*,**,***Significance at the 10%, 5% and 1% levels, respectively

5 Conclusion and policy implication

Ghana has proposed numerous policies in the past nonetheless the much awaited is the 'One district one factory' policy which aims at creating jobs, bridging income gaps and boosting economic growth which would mean attracting more foreign investors. Stringent environmental regulations lead 'dirty industries' to zones with lax environmental rules, creating pollution havens. Other industries move with cleaner technologies and methods of production which in the end create pollution halo effect. This study therefore examines the environmental impact of foreign investors in relation to the proposed 'One district, one factory' policy of Ghana employing ARDL approach to cointegration, Granger causality, and fully modified least-square regression methods.

Findings reveal that foreign investors, urbanization, energy consumption, import, and natural resource rent enhance economic growth in Ghana in the short-run. A unidirectional relationship maps from FDI to economic growth, FDI to energy consumption and FDI and CO_2 emissions. This is an indication that FDI has both beneficial and detrimental impact on Ghana. The environmental Kuznets curve was not confirmed for Ghana, but the pollution haven hypothesis was confirmed, but with a minimal impact as per the coefficient value of FDI on environment in Ghana. This implies that Ghana would likely move into a low-carbon habitable economy should the appropriate measures be put in place. Based on our findings, we propose the following policies.

The implication of the finding on export on economic growth is an indication that Ghana is an export-led economy therefore the nation could rely on exports for growth in the future. This could be achieved through investment in sectors that are able to produce and export their products. The government and other private investors could support these sectors. Already, the government is helping the agriculture sector through mass spraying activities, agriculture mechanization among others. Needed help could be extended to other sectors that export to generate revenue for the nation. This would also be a way of easing the unemployment burden. Once there is support, the unemployed youth would be motivated to move into sectors that are able to export.

In as much as Ghana would like to create jobs to bridge income gap and boost economic growth to reduce her dependency ratio, it is necessary to focus on the environmental impact of the 'One district, one factory' policy to be implemented. There is no doubt that FDI is currently impacting positively on the economy of Ghana but negatively on the environment and many have suffered deteriorating health impact worldwide due to environmental pollution. The country would still need foreign investors to help boost up the economy. We therefore advocate for incentives such as tax exemption to attract labor-intensive industries. This is because capital intensive industries with no clean technologies tend to pollute more. Should Ghana attract cleaner firms and industries, the negative environmental impact would be controlled and the nation would move into a low-carbon habitable economy.

Developing nations as Ghana would want to grow economically and foreign firms would also want to expand their activities to other regions to enjoy economies of scale and scope. This should be a win–win situation for both investors and the host nation. We therefore advocate for the attraction of waste management and recycling companies as well to handle waste disposed. In as much as this would come at a cost, it would help reduce the negative impact of the proposed policy. The polluter pays principle where polluting firms would be responsible for the cost of managing their pollution so as to prevent the damage could also be instituted. This would be a way to improve the national greenhouse gas inventory mechanisms as per the climate change policy of Ghana.

Finally, already established high polluting industries should be controlled from expanding their activities to other regions. Expanding production activities across the nation means increasing pollution levels across the country. This could be controlled through elevation of environmental related taxes. Strengthening measures that would lessen emissions of greenhouse gas is a climate change policy of Ghana. Again the 1995 Environmental Policy of Ghana entitles all Ghanaians to a habitable environment. This infers that the environment of Ghana should be not harmful to the health and well-being of Ghanaians. Also the 1995 Environmental policy aims at protecting the environment to benefit of the current and future generations through reasonable legislative and administrative measures. Should the government and policy makers consider suggested policies, the tendency of attracting dirty industries for the nation's 'One district, one factory' policy could be controlled. This would be a way forward in achieving the climate change and environmental policies stated here.

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References

Abdouli, M., & Hammami, S. (2017). Economic growth, FDI inflows and their impact on the environment: An empirical study for the MENA countries. *Quality & Quantity, 51*, 121–146. https://doi.org/10.1007/s11135-015-0298-6.

Abokyi, E., Appiah-Konadu, P., Abokyi, F., & Oteng-Abayie, E. F. (2019). Industrial growth and emissions of CO_2 in Ghana: The role of financial development and fossil fuel consumption. *Energy Reports, 5*, 1339–1353. https://doi.org/10.1016/j.egyr.2019.09.002.

Adams, S., & Atsu, F. (2014). Aid dependence and economic growth in Ghana. *Economic Analysis and Policy, 44*, 233–242. https://doi.org/10.1016/j.eap.2014.05.001.

Adom, P. K., Opoku, E. E. O., & Yan, I. K.-M. (2019). Energy demand–FDI nexus in Africa: Do FDIs induce dichotomous paths? *Energy Economics, 81*, 928–941. https://doi.org/10.1016/j.eneco.2019.05.030.

Adu, D. T., & Denkyirah, E. K. (2018). Economic growth and environmental pollution in West Africa: Testing the environmental Kuznets curve hypothesis. *Kasetsart Journal of Social Sciences*. https://doi.org/10.1016/j.kjss.2017.12.008.

Akormedi, M., Asampong, E., & Fobil, J. N. (2013). Working conditions and environmental exposures among electronic waste workers in Ghana. *International Journal of Occupational and Environmental Health, 19*, 278–286.

Appiah, K., Du, J., & Appiah, R. (2018). Economic activity indicators, environmental pollution and infant mortality relations: Evidence from Ghana. *International Journal of Environmental Planning and Management, 4*, 7–15.

Baek, J. (2016). A new look at the FDI–income–energy–environment nexus: Dynamic panel data analysis of ASEAN. *Energy Policy, 91*, 22–27. https://doi.org/10.1016/j.enpol.2015.12.045.

Bakhsh, K., Rose, S., Ali, M. F., Ahmad, N., & Shahbaz, M. (2017). Economic growth, CO_2 emissions, renewable waste and FDI relation in Pakistan: New evidences from 3SLS. *Journal of Environmental Management, 196*, 627–632. https://doi.org/10.1016/j.jenvman.2017.03.029.

Ben Nasr, A., Gupta, R., & Sato, J. R. (2015). Is there an environmental Kuznets curve for South Africa? A co-summability approach using a century of data. *Energy Economics, 52*, 136–141. https://doi.org/10.1016/j.eneco.2015.10.005.

Ben-Salha, O., Dachraoui, H., & Sebri, M. (2018). Natural resource rents and economic growth in the top resource-abundant countries: A PMG estimation. *Resources Policy*. https://doi.org/10.1016/j.resourpol.2018.07.005.

Boos, A., & Holm-Müller, K. (2016). The Zambian Resource Curse and its influence on Genuine Savings as an indicator for "weak" sustainable development. *Environment Development and Sustainability, 18*, 881–919. https://doi.org/10.1007/s10668-015-9667-5.

Çetintaş, H., & Barişik, S. (2009). Export, import and economic growth: The case of transition economies. *Transition Studies Review, 15*, 636–649. https://doi.org/10.1007/s11300-008-0043-0.

Cole, M. A. (2004). Trade, the pollution haven hypothesis and the environmental Kuznets curve: examining the linkages. *Ecological Economics, 48*, 71–81. https://doi.org/10.1016/j.ecolecon.2003.09.007.

Daily, A. (2017). One district, one factory Action in 6 mths—Alan Kyerematen. *ADR Daily*. https://adrdaily.com/one-district-one-factory-action-6-mths-alan-kyerematen/. Reterived Wednesday, December 18, 2019.

Dam, L., & Scholtens, B. (2012). The curse of the haven: The impact of multinational enterprise on environmental regulation. *Ecological Economics, 78*, 148–156. https://doi.org/10.1016/j.ecolecon.2012.04.011.

Darimani, A., Akabzaa, T. M., & Attuquayefio, D. K. (2013). Effective environmental governance and outcomes for gold mining in Obuasi and Birim North Districts of Ghana. *Mineral Economics, 26*, 47–60. https://doi.org/10.1007/s13563-013-0036-2.

Dauda, L., Long, X., Mensah, C. N., & Salman, M. (2019). The effects of economic growth and innovation on CO_2 emissions in different regions. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-019-04891-y.

Dou, J., & Han, X. (2019). How does the industry mobility affect pollution industry transfer in China: Empirical test on Pollution Haven Hypothesis and Porter Hypothesis. *Journal of Cleaner Production, 217*, 105–115. https://doi.org/10.1016/j.jclepro.2019.01.147.

Dou, X. (2015). The essence, feature and role of low carbon economy. *Environment Development and Sustainability, 17*, 123–136. https://doi.org/10.1007/s10668-014-9542-9.

Fotourehchi, Z. (2019). Are UN and US economic sanctions a cause or cure for the environment: Empirical evidence from Iran. *Environment Development and Sustainability*. https://doi.org/10.1007/s10668-019-00434-0.

Gara, T. (2019). Sustainable development or environmental Kuznets curve model: Which route for Africa? *Environment, Development and Sustainability, 21*, 1341–1356. https://doi.org/10.1007/s10668-018-0084-4.

Goh, S. K., Sam, C. Y., & McNown, R. (2017). Re-examining foreign direct investment, exports, and economic growth in asian economies using a bootstrap ARDL test for cointegration. *Journal of Asian Economics, 51*, 12–22. https://doi.org/10.1016/j.asieco.2017.06.001.

Granger, C. J. (1986). Developments in the study of cointegrated economic variables. *Oxford Bulletin of economics and statistics, 48*, 213–228.

Hens, L., & Boon, E. K. (1999). Institutional, legal, and economic instruments in Ghana's environmental policy. *Environmental Management, 24*, 337–351. https://doi.org/10.1007/s002679900237.

Hille, E., Shahbaz, M., & Moosa, I. (2019). The impact of FDI on regional air pollution in the Republic of Korea: A way ahead to achieve the green growth strategy? *Energy Economics, 81*, 308–326. https://doi.org/10.1016/j.eneco.2019.04.004.

Jović, S., Maksimović, G., & Jovović, D. (2016). Appraisal of natural resources rents and economic development. *Resources Policy, 50*, 289–291. https://doi.org/10.1016/j.resourpol.2016.10.012.

Kim, M. H., & Adilov, N. (2012). The lesser of two evils: An empirical investigation of foreign direct investment-pollution tradeoff. *Applied Economics, 44*, 2597–2606. https://doi.org/10.1080/00036846.2011.566187.

Li, M., & Wang, Q. (2019). Does industrial relocation alleviate environmental pollution? A mathematical economics analysis. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-019-00403-7.

Lin, B., Omoju, O. E., Nwakeze, N. M., Okonkwo, J. U., & Megbowon, E. T. (2016). Is the environmental Kuznets curve hypothesis a sound basis for environmental policy in Africa? *Journal of Cleaner Production, 133*, 712–724. https://doi.org/10.1016/j.jclepro.2016.05.173.

Lu, W.-C. (2018). The impacts of information and communication technology, energy consumption, financial development, and economic growth on carbon dioxide emissions in 12 Asian countries. *Mitigation and Adaptation Strategies for Global Change, 23*, 1351–1365. https://doi.org/10.1007/s11027-018-9787-y.

Makun, K. K. (2018). Imports, remittances, direct foreign investment and economic growth in Republic of the Fiji Islands: An empirical analysis using ARDL approach. *Kasetsart Journal of Social Sciences, 39*, 439–447. https://doi.org/10.1016/j.kjss.2017.07.002.

Mensah, C. N., Long, X., Dauda, L., Boamah, K. B., & Salman, M. (2019a). Innovation and CO_2 emissions: The complimentary role of eco-patent and trademark in the OECD economies. *Environmental Science and Pollution Research, 26*, 22878–22891. https://doi.org/10.1007/s11356-019-05558-4.

Mensah, C. N., Long, X., Dauda, L., Boamah, K. B., Salman, M., Appiah-Twum, F., et al. (2019b). Technological innovation and green growth in the Organization for Economic Cooperation

and Development economies. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2019.118204.
MESTI. (2013). Ghana national climate change policy.
Mirasgedis, S., et al. (2008). Environmental damage costs from airborne pollution of industrial activities in the greater Athens, Greece area and the resulting benefits from the introduction of BAT. *Environmental Impact Assessment Review, 28*, 39–56. https://doi.org/10.1016/j.eiar.2007.03.006.
Muñoz, A. A., et al. (2019). Multidecadal environmental pollution in a mega-industrial area in central Chile registered by tree rings. *Science of the Total Environment, 696*, 133915. https://doi.org/10.1016/j.scitotenv.2019.133915.
Oteng-Ababio, M. (2010). E-waste: An emerging challenge to solid waste management in Ghana. *International Development Planning Review, 32*, 191–206.
Pazienza, P. (2015). The relationship between CO_2 and foreign direct investment in the agriculture and fishing sector of OECD countries: Evidence and policy considerations. *Intellectual Economics, 9*, 55–66. https://doi.org/10.1016/j.intele.2015.08.001.
Peterson, S. (2008). Greenhouse gas mitigation in developing countries through technology transfer? A survey of empirical evidence. *Mitigation and Adaptation Strategies for Global Change, 13*, 283–305. https://doi.org/10.1007/s11027-007-9111-8.
Pinzón, K. (2018). Dynamics between energy consumption and economic growth in Ecuador: A granger causality analysis. *Economic Analysis and Policy, 57*, 88–101. https://doi.org/10.1016/j.eap.2017.09.004.
Pistoresi, B., & Rinaldi, A. (2012). Exports, imports and growth: New evidence on Italy: 1863–2004. *Explorations in Economic History, 49*, 241–254. https://doi.org/10.1016/j.eeh.2011.11.003.
Quaicoe, A., Aboagye, A. Q. Q., & Bokpin, G. A. (2017). Assessing the impact of export processing zones on economic growth in Ghana. *Research in International Business and Finance, 42*, 1150–1163. https://doi.org/10.1016/j.ribaf.2017.07.052.
Rahman, M. M., & Kashem, M. A. (2017). Carbon emissions, energy consumption and industrial growth in Bangladesh: Empirical evidence from ARDL cointegration and Granger causality analysis. *Energy Policy, 110*, 600–608. https://doi.org/10.1016/j.enpol.2017.09.006.
Salman, M., Long, X., Dauda, L., & Mensah, C. N. (2019). The impact of institutional quality on economic growth and carbon emissions: Evidence from Indonesia, South Korea and Thailand. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2019.118331.
Sapkota, P., & Bastola, U. (2017). Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. *Energy Economics, 64*, 206–212. https://doi.org/10.1016/j.eneco.2017.04.001.
Sarkodie, S. A., & Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *Science of The Total Environment, 646*, 862–871. https://doi.org/10.1016/j.scitotenv.2018.07.365.
Shao, Q., Wang, X., Zhou, Q., & Balogh, L. (2019). Pollution haven hypothesis revisited: A comparison of the BRICS and MINT countries based on VECM approach. *Journal of Cleaner Production, 227*, 724–738. https://doi.org/10.1016/j.jclepro.2019.04.206.
Shen, J., Wang, S., Liu, W., & Chu, J. (2019). Does migration of pollution-intensive industries impact environmental efficiency? Evidence supporting "Pollution Haven Hypothesis". *Journal of Environmental Management, 242*, 142–152. https://doi.org/10.1016/j.jenvman.2019.04.072.
Shi, X., & Xu, Z. (2018). Environmental regulation and firm exports: Evidence from the eleventh Five-Year Plan in China. *Journal of Environmental Economics and Management, 89*, 187–200. https://doi.org/10.1016/j.jeem.2018.03.003.
Solarin, S. A., Al-Mulali, U., Musah, I., & Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: An empirical investigation. *Energy, 124*, 706–719. https://doi.org/10.1016/j.energy.2017.02.089.
Solarin, S. A., & Shahbaz, M. (2013). Trivariate causality between economic growth, urbanisation and electricity consumption in Angola: Cointegration and causality analysis. *Energy Policy, 60*, 876–884. https://doi.org/10.1016/j.enpol.2013.05.058.
Sunde, T. (2017). Foreign direct investment, exports and economic growth: ADRL and causality analysis for South Africa. *Research in International Business and Finance, 41*, 434–444. https://doi.org/10.1016/j.ribaf.2017.04.035.
Tahir, M., Khan, I., & Shah, A. M. (2015). Foreign remittances, foreign direct investment, foreign imports and economic growth in Pakistan: A time series analysis. *Arab Economic and Business Journal, 10*, 82–89. https://doi.org/10.1016/j.aebj.2015.06.001.
Tang, D., & Gyasi, K. B. (2012). China–Africa foreign trade policies: The impact of China's foreign direct investment (FDI) flow on employment of Ghana. *Energy Procedia, 16*, 553–557. https://doi.org/10.1016/j.egypro.2012.01.089.

Tsamenyi, M., Onumah, J., & Tetteh-Kumah, E. (2010). Post-privatization performance and organizational changes: Case studies from Ghana. *Critical Perspectives on Accounting, 21*, 428–442. https://doi.org/10.1016/j.cpa.2008.01.002.

Velnampy, T., & Achchuthan, S. (2013). *Export, import and economic growth: Evidence from Sri Lanka* (Vol. 4).

Wang, H., Dong, C., & Liu, Y. (2019a). Beijing direct investment to its neighbors: A pollution haven or pollution halo effect? *Journal of Cleaner Production, 239*, 118062. https://doi.org/10.1016/j.jclepro.2019.118062.

Wang, X., Zhang, C., & Zhang, Z. (2019b). Pollution haven or porter? The impact of environmental regulation on location choices of pollution-intensive firms in China. *Journal of Environmental Management, 248*, 109248. https://doi.org/10.1016/j.jenvman.2019.07.019.

Wang, Z., Sun, Y., & Wang, B. (2019c). How does the new-type urbanisation affect CO_2 emissions in China? An empirical analysis from the perspective of technological progress. *Energy Economics, 80*, 917–927. https://doi.org/10.1016/j.eneco.2019.02.017.

Zhao, P., & Zhang, M. (2018). The impact of urbanisation on energy consumption: A 30-year review in China. *Urban Climate, 24*, 940–953. https://doi.org/10.1016/j.uclim.2017.11.005.

Zheng, D., & Shi, M. (2017). Multiple environmental policies and pollution haven hypothesis: Evidence from China's polluting industries. *Journal of Cleaner Production, 141*, 295–304. https://doi.org/10.1016/j.jclepro.2016.09.091.

Zhu, H., Duan, L., Guo, Y., & Yu, K. (2016). The effects of FDI, economic growth and energy consumption on carbon emissions in ASEAN-5: Evidence from panel quantile regression. *Economic Modelling, 58*, 237–248. https://doi.org/10.1016/j.econmod.2016.05.003.

Zugravu-Soilita, N. (2017). How does foreign direct investment affect pollution? Toward a better understanding of the direct and conditional effects. *Environmental and Resource Economics, 66*, 293–338. https://doi.org/10.1007/s10640-015-9950-9.