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Renewable and Nonrenewable Energy Consumption, Government Expenditure, Institution Quality, Financial Development, Trade Openness, and Sustainable Development in Latin America and Caribbean Emerging Market and Developing Economies

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ABSTRACT

This study investigates the role of non-renewable and renewable energy consumption in the sustainable development in 16 Latin America and Caribbean Emerging Market and Developing Economies (EMDEs) incorporating capital, government expenditure, institution quality, financial development, and trade openness by a multivariate framework using annual data from 1990 to 2014. We apply second-generation techniques for heterogeneous panel data as the presence of cross-sectional dependence and slope heterogeneity is detected. Accordingly, CADF and CIPS unit root tests show that all variables are integrated at order 1. Westerlund cointegration test acknowledges the long-run relationship among the variables. The long-run estimation is conducted by the Augmented Mean Group (AMG), MG and Common Correlated Effects MG (CCEMG) estimators. The findings indicate that, in the long run, renewable and non-renewable energy use, along with other factors including government expenditure, gross fixed capital formation, trade openness and financial development, positively affects the economic growth in the selected countries. The empirical results imply that the EMDEs in Latin America and the Caribbean should appropriately implement fiscal policies for macroeconomic stabilization in combination with finance and international trade policies as well as effective energy strategies to attain their sustainable development objectives.

Keywords: Sustainable Development, Renewable and Non-renewable Energy Use; Heterogeneous Panel Data, Economic Growth, Emerging Market and Developing Economies, Latin America and the Caribbean
JEL Classifications: C01, E02, H72, O11, Q01, Q43

1. INTRODUCTION

Energy consumption is deemed a main factor boosting economic growth because it directly contributes to the input of the manufacturing industry for producing goods and services and comprises a large proportion of household consumption (Stern, 2000). Despite this beneficial effect, energy consumption is one of the major culprits of pollution (Phong et al., 2018; Phong, 2019). Thus, the use of renewable energy or the one that minimally influences the environment in economic development process is an important objective (Dong et al., 2017). This indicates the more important role and effectiveness of renewable energy compared to its non-renewable counterpart in the economic growth of many countries, especially when they strive for sustainable development.

Hence, the better understanding about the impacts of renewable and non-renewable energy consumption patterns on economic growth is especially useful for policy-makers to design effective policies promoting sustainable development. This research will provide the assessment on the nexus between renewable and non-renewable energy consumption, along with other factors, and economic growth for emerging market and developing economies (EMDEs) in Latin America and the Caribbean.

This study contributes to the literature in two facets. First, regarding econometric technique, we consider the heterogeneity and cross-sectional dependence that possibly exist within cross countries, thus employing second-generation panel data methods that are free from the inconsistent and biased problems encountered by the first-generation techniques (Pesaran, 2004; Bilgili and Ulucak, 2018; Sharif et al., 2019). Besides, we utilize three computation methods including the Augmented Mean Group (AMG) estimator (Eberhardt and Bond, 2009; Eberhardt and Teal, 2010), the MG estimator of Pesaran and Smith (1995), and Pesaran (2006) Common Correlated Effects MG (CCEMG) estimator to ensure robustness. Second, to avoid inconsistent and biased estimation stemming from omitted variables (Lütkepohl, 1982), we expand the production function by adding renewable and nonrenewable energy consumption together with institution, government expenditure, gross fixed capital formation, financial development and trade openness as explanatory variables, which has not been done in any prior studies about the EMDEs in Latin America and the Caribbean.

The remaining contents follow this structure: Section 2 provides the review of notable studies; Section 3 explains the Model, Data, and Methodology; Section 4 shows the empirical results; Section 5 gives essential summary of this paper as well as recommendations for policy-makers grounded in the empirical findings.

2. LITERATURE REVIEW

The existing literature concerning the classical and modern economic growth models acknowledges the vital importance of fundamental factors such as capital, labour, financial development, trade openness and government's roles in public expenditure and institutional quality. An appropriate financial system can foster technological advancement and efficiently allocate resources to the manufacturing sector, which is deemed a crucial basis for sustainable development (Schumpeter, 1911; Demirgüç-Kunt, 2006). Besides, trade openness plays a not inconsiderable role in facilitating the economy through different ways such as achieving high efficiency of resources allocation due to export-orientation policies, attracting foreign direct investment, gaining access to advanced technology for promoting domestic production, creating financial and economic integration and improving total factor productivity (Romer, 1994; Shahbaz, 2012). Economists also contemplate if the public sector with the financial-institutional role of the government has any effect on the economic growth of a nation. According to endogenous growth theory, government expenditure can stimulate economic growth via education and medical subsidies together with social transfer and legal-framework research and design, which in turns increases human capital (Romer, 1986; Barro, 1990; López et al., 2011). Concurrently, the higher institutional quality of a nation will contribute to a better economy thanks to the reduction of transaction costs and risks (Cohen et al., 1983; Fredriksson et al., 2004; Fosu, 2014). Besides, energy is a vital input of economic growth (Kraft and Kraft, 1978; Apergis and Payne, 2009; Ozturk, 2010, 2017; Solarin and Ozturk, 2015).

Empirical evidences with regard to the impacts of the aforementioned factors on economic growth are very different depending on the researched countries, data and econometric methods. While many studies utilize individual elements, the others combine factors in a multivariate framework. Specifically, Shahbaz (2012) investigated the influences of financial development and trade openness on the economic growth of Pakistan. The findings showed that the stable long-run economic growth was encouraged by capital formation, labour, financial development and trade openness.

Shahbaz et al. (2013) examined the roles of energy consumption, capital, financial development, international trade and capital in the economic growth of China from 1971 to 2011 and indicated that all the variables had positive and significant effects. This article substantially contributed to the energy economics discipline and opened new directions for policy-makers to take advantage of the renewable energy sources to meet the increasing energy demand in the sustainable development process.

Kumar and Kumar (2013) scrutinized the long-run effects of energy consumption per capita embodying gross fixed capital formation per capita on the GDP per capita of Kenya in the period 1978–2009 and South Africa in the period 1971–2009. The empirical results estimated by ARDL approach demonstrated that in the short run and long run energy consumption and capital ameliorated the growth of the two countries. Also, using ARDL method for time-series analyses, Kumar et al. (2014) inspected the nexus between capital formation per capita, energy consumption per capita and GDP per capita in Albania (1980–2012), Bulgaria (1970–2012), Hungary (1980–2012) and Romania (1980–2012). They found that capital formation per capita stimulated the economic growth of all researched countries in both the short run and long run. Meanwhile, energy consumption per capita improved GDP per capita of all countries in the short run, but the long run effects only happened in Bulgaria and Romania. In addition, Kumar et al. (2015) employed ARDL technique to analyse the determinants of South Africa's economic growth from 1971 to 2011 and reported that energy, capital and trade openness facilitated economic growth in both the short run and long run while financial development had negative impacts.

Recently, Maji and Sulaiman (2019) studied the influences of renewable energy use, capital and labour on the economic growth of 15 West African countries by employing panel dynamic ordinary least squares method and annual data from 1995 to 2014. They showed that while capital and labour fostered economic growth, renewable energy consumption slowed down the economies of those countries. Besides, Zafar et al. (2019) evaluated the links between non-renewable and renewable energy consumption, capital formation, trade openness and research and development expenditures and the economic growth of Asia-Pacific Economic Cooperation (APEC) countries in the period 1990–2015 by CUP-FMOLS method. The findings indicated that all the factors enhanced the economic growth of APEC countries in the long run.

3. MODEL, METHODOLOGY, AND DATA

3.1. Empirical Model

This study examines the role of non-renewable and renewable energy consumption and other factors in the sustainable development in 16 Latin America and Caribbean EMDEs. The empirical model of this research is based on the extended Cobb-Douglas production function employed by Shahbaz et al. (2013), Kumar and Kumar (2013) and Kumar et al. (2014), which is written as follows:

$$GDP_{it} = f\left(GCF_{it}, RE_{it}, NRE_{it}, GC_{it}, INS_{it}, FD_{it}, TO_{it}\right) \quad (1)$$

In equation (1), *GDP* is the real gross domestic product per capita, *GCF* represents capital, *RE* is renewable energy consumption, *NRE* stands for non-renewable energy consumption, *GC* indicates general government final consumption expenditure, *INS* denotes institution quality, *FD* is financial development, and *TO* is trade openness. The notations *i* and *t* respectively demonstrate country and year, and ε_{it} is the error term.

All variables are changed into natural logarithm; thus, equation (1) can be rewritten as:

$$\begin{aligned} \ln GDP_{it} &= \alpha_{it} + \beta_1 \ln GCF_{it} + \beta_2 \ln RE_{it} + \beta_3 \ln \mathrm{NRE}_{it} \\ &+ \beta_4 \ln \mathrm{GC}_{it} + \beta_5 \ln \mathrm{INS}_{it} + \beta_6 \ln \mathrm{FD}_{it} + \beta_7 \ln TO_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

Where α_{it} is the constant, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ respectively show the elasticity coefficients of gross fixed capital formation (ln*GCF*), renewable energy consumption (ln*RE*), non-renewable energy consumption (ln*NRE*), general government final consumption expenditure (ln*GC*), institution quality (ln*INS*), financial development (ln*FD*) and trade openness (ln*TO*) and ε_{it} is the error term. All variables are under per capita terms except institution quality.

3.2. Estimation Techniques

3.2.1. Cross-sectional dependence test

Checking for cross-sectional dependence is deemed an important issue in panel data analysis because it can produce inconsistent estimates and misleading information (Grossman and Krueger, 1995; Pesaran, 2004; Bilgili and Ulucak, 2018).

As a result, Breusch and Pagan (1980) developed Lagrange Multiplier (LM) statistics to detect cross-sectional dependence in the panel data:

$$\mathrm{LM} = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T_{ij} \hat{\rho}_{ij} \rightarrow \chi^2 \frac{N(N-1)}{2} \quad (3)$$

Nevertheless, according to Pesaran (2004), the Breusch-Pagan LM test might be inconsistent. Thus, Pesaran (2004) introduced CD test to adjust the bias in LM test as follows:

$$\mathrm{CD} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \frac{(T-k)\hat{\rho}_{ij}^2 - E\left[(T-k)\hat{\rho}_{ij}^2\right]}{var\left[(T-k)\hat{\rho}_{ij}^2\right]} \quad (4)$$

Where *N* is the sample size, *T* displays the time period, $\hat{\rho}_{ij}$ indicates the coefficient of pair-wise correlation obtained from OLS estimation for each cross-section dimension *i*.

3.2.2. Slope homogeneity test

According to Breitung (2005), assuming slope homogeneity can cause misleading and untrustworthy estimates if the panel data is heterogeneous. Pesaran and Yamagata (2008) developed the method of Swamy (1970) to test for the slope homogeneity phenomenon, as described in equations (5), (6) and (7):

$$\bar{\Delta} = \sqrt{N}\left(\frac{N^{-1}\tilde{S} - k}{\sqrt{2k}}\right) \quad (5)$$

$$\bar{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}\tilde{S} - \mathrm{k}}{\sqrt{\frac{2k(T-k-1)}{T+1}}}\right) \quad (6)$$

$$\tilde{S} = \sum_{i=1}^{N}\left(\hat{\beta}_i - \tilde{\beta}_{WFE}\right)' \frac{X_i' M_\tau X_i}{\tilde{\sigma}_i^2}\left(\hat{\beta}_i - \tilde{\beta}_{WFE}\right) \quad (7)$$

$\bar{\Delta}$ and $\bar{\Delta}_{adj}$ are the standardized dispersion and the biased-adjusted statistics. $\hat{\beta}_i$ indicates the pooled OLS regression coefficients for each individual *i* ranging from 1 to N, and $\tilde{\beta}_{WFE}$ represents the weighted fixed effect (WFE) pooled estimator. Besides, M_τ, $\tilde{\sigma}_i^2$ and *k* are respectively the identity matrix, estimate of σ_i^2 and the number of independent variables.

3.2.3. Panel unit root test

Under the influence of cross-sectional dependence, first-generation panel unit root tests, for example Levin-Lin Chu (LLC), Im-Pesaran-Shin (IPS), augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), are not valid (Pesaran, 2007). Consequently, Pesaran (2007) developed the second-generation panel unit tests including the cross-sectionally augmented Dickey-Fuller (CADF) and the cross-sectionally augmented Im-Pesaran-Shin (CIPS), which is reliable in the presence of cross-sectional dependence. The CADF statistic can be calculated as follows:

$$\Delta y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + \gamma_i \bar{y}_{t-1} + \delta_i \Delta\bar{y}_{i,t} + \varepsilon_{it} \quad (8)$$

Where $\bar{y}_{t-1}$ and $\Delta\bar{y}_{i,t}$ are the cross-sectional averages of lagged levels and first differences of individual series, respectively.

$$\bar{y}_{t-1} = \frac{1}{N}\sum_{i=1}^{N} y_{i,t-1} \quad (9)$$

$$\Delta\bar{y}_{i,t} = \frac{1}{N}\sum_{i=1}^{N} \Delta y_{i,t} \quad (10)$$

The CADF statistic can be computed by averaging the $CADF_i$ as follows:

$$\mathrm{CIPS} = \frac{1}{N}\sum_{i=1}^{N} CADF_i \quad (11)$$

Where $CADF_i$ is the t-statistics in the CADF regression defined by equation (8).

3.2.4. Panel cointegration test

Westerlund (2007) proposed the test for panel cointegration in the presence of cross-sectional dependence, which is based on the following error-correction model:

$$\Delta Y_{i,t} = \delta_i^{'} d_t + \rho_i \left(Y_{i,t-1} - \beta_i^{'} X_{i,t-1} \right) + \sum_{j=1}^{K} \varphi_{ij} Y_{i,t-j} + \sum_{j=0}^{K} \varphi_{ij} X_{i,t-j} + \mu_{i,t} \quad (12)$$

In equation (12), ρ_i is the adjustment term that determines the speed by which the system adjusts back to equilibrium.

Westerlund (2007) test is built on the least squares estimates of ρ_i with the null hypothesis assuming no cointegration. Accordingly, the group mean statistics can be computed as:

$$G_\tau = \frac{1}{N} \sum_{i=1}^{N} \frac{\rho_i}{Se(\hat{\rho}_i)} \quad (13)$$

$$G_\alpha = \frac{1}{N} \sum_{i=1}^{N} \frac{T \rho_i}{\rho_i^{'}(1)} \quad (14)$$

When G_τ and G_α statistics reject the null hypothesis, it can be concluded that cointegration exists in at least one cross-sectional unit of the panel.

Meanwhile, the panel statistics are retrieved from these formulas:

$$P_\tau = \frac{\hat{\rho}_i}{Se(\hat{\rho}_i)} \quad (15)$$

$$P_\alpha = T \hat{\rho} \quad (16)$$

If the null hypothesis is rejected, it can be concluded that cointegration exists in the whole panel.

3.2.5. Panel long-run estimates

Under the influence of cross-sectional dependence, traditional panel regression methods might be biased and inconsistent (Pesaran and Smith, 1995; Phillips and Sul, 2003; Sarafidis and Robertson, 2009; Paramati et al., 2017). Pesaran and Smith (1995) proposed MG approach that allows all slope coefficients and error variances to vary across the panel or countries. The MG approach applies OLS technique to each panel or country to get panel-specific slope coefficients and then averages the panel-specific coefficients. Nonetheless, the MG estimator does not include any information about possible common factors that may occur in the panel data.

Pesaran (2006) introduced the CCEMG estimator which is robust to cross-sectional dependence and slope homogeneity. It includes the averages of independent and dependent variables along with the unobserved common effects f_t:

$$y_{it} = \alpha_i + \beta_i x_{it} + \gamma_i \bar{y}_{it} + \delta_i \bar{x}_{it} + c_i f_t + \varepsilon_{it} \quad (17)$$

Where y_{it} and x_{it} are variables; β_i represents the country-specific slope; f_t stands for the unobserved common factor with heterogeneous factor; α_i and ε_{it} are the intercept and error term respectively.

Besides CCEMG, AMG estimator introduced by Eberhardt and Bond (2009) and Eberhardt and Teal (2010) is highly robust regardless of cross-sectional dependence and slope heterogeneity. AMG estimator captures the unobservable common factors f_t specified in equation (17) by the common dynamic effect parameter. To describe the AMG estimator, consider this first-difference OLS equation:

$$\Delta y_{it} = \alpha_i + \beta_i \Delta x_{it} + \sum_{t=1}^{T} \theta_t D_t + \varphi_i f_t + \varepsilon_{it} \quad (20)$$

Δ denotes the first-difference operator, β_i indicates the country-specific coefficients and θ_t describes the coefficients of the time dummies.

The AMG estimator is then obtained from the across-panel averaged group-specific parameters:

$$\text{AMG} = \frac{1}{N} \sum_{i=1}^{N} \tilde{\beta}_i \quad (21)$$

In equation (21), $\tilde{\beta}_i$ are the estimates of β_i in equation (20).

As the performance of the AMG method in Monte Carlo simulation are unbiased and efficient for different N (number of observations) and T (time) settings (Bond and Eberhardt, 2013), this study employs the AMG method to evaluate the long-run parameters. Besides, the MG and CCEMG estimators are also used for robustness check.

3.3. Data and Variables

This study uses annual data in the period 1990–2014 of 16 EMDEs in Latin America and the Caribbean defined by Morgan Stanley Capital Income including Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru and Uruguay.

The variables are listed as follows: GDP (The real gross domestic product, measured in constant 2010 US dollars, per capita), GCF (Gross fixed capital formation, measured in constant 2010 US dollars, per capita), RE (Renewable energy consumption: Energy consumption from renewable sources includes hydropower, solar, wind power, modern biofuels, geothermal, wave & tidal; measured in millions of kilowatt-hours, per capita), NRE (Energy consumption from non-renewable sources includes coal, oil, and gas; measured in millions of kilowatt-hours, per capita), GC (General government final consumption expenditure, measured in constant 2010 US dollars, per capita), INS (Institution quality Index: The mean value of the ICRG variables "Corruption", "Law and Order" and "Bureaucracy Quality"; measured in Index from 0 to 1, higher values indicate higher quality of government), FD (Financial development: The domestic credit to the private sector, measured in constant 2010 US dollars, per capita) and TO (Trade openness: Trade openness measured by export plus import of goods and services, measured in constant 2010 US dollars, per capita).

The data for the variables *GDP*, *GCF*, *GC*, *FD* and *TO* are collected and calculated from the World Development Indicators database provided by the World Bank. The data concerning *RE* and *NRE* are obtained from Energy Information Administration. The data of *INS* is retrieved from The Quality of Government Institute, University of Gothenburg, Sweden. All variables are transformed into natural logarithm.

4. RESULTS

First, we use Pesaran (2004) CD test to examine the presence of cross-sectional dependence in the panel data. The outcomes shown in Table 1 reject the null hypothesis of no cross-sectional dependence at 1% significance level. In other words, we have strong evidence for the occurrence of cross-sectional dependence.

Next, we inspect the slope homogeneity phenomenon by Pesaran and Yamagata (2008) test. All the test statistics in Table 2 are significant at 1% level, thus signifying the existence of slope heterogeneity in our panel data.

As the presence of cross-sectional dependence and slope heterogeneity is confirmed by the aforementioned tests, first-generation unit root tests are not appropriate. Rather, we employ the second-generation unit root tests including CADF and CIPS to check for the stationarity of the variables. It can be observed in Table 3 that all variables are stationary at first difference. In other words, they are integrated at order 1 and can be referred to as I(1).

Next, we investigate the long-run relationship among the variables by Westerlund (2007) cointegration test whose outcomes are displayed in Table 4, which acknowledges the cointegration among GDP, gross fixed capital formation, renewable and non-renewable energy use, government expenditure, financial development and trade openness.

After having found the occurrence of cross-sectional dependence and slope heterogeneity as well as verified the stationarity and the cointegration properties of the variables, we now estimate the long-run coefficients of the heterogeneous panel data by the AMG estimator together with the CCEMG and MG ones for robustness check.

Table 5 demonstrates that gross fixed capital formation (GCF), renewable (RE) and non-renewable (NRE) energy use, government expenditure (GC), financial development (FD) and trade openness (TO) have positive and significant impacts on the economic growth of the EMDEs in Latin America and the Caribbean. Meanwhile, the effect of institutional quality is trivial. Specifically, in the long run, 1% increases of renewable and non-renewable energy use boost GDP by 0.119% and 0.099% respectively. In addition, when gross fixed capital formation per capita rises by 1%, GDP is enhanced by 0.148%. Moreover, when general government final consumption expenditure per capita goes up by 1%, GDP per capita is promoted by 0.109%. Besides, the results also validate the finance-led growth and trade-led growth hypotheses when GDP per capita grows by 0.058% and 0.076% due to 1% increases of domestic credit to private sector per capita and trade openness per capita respectively. Obviously, the estimation outcomes of the 3 estimators AMG, CCEMG and MG are similar in terms of coefficient signs and magnitude, which indicates the robustness of our empirical findings.

Table 1: Results of cross-sectional dependence test

Variable	CD-test	P-value
ln*GDP*	49.923***	0.000
ln*GCF*	38.538***	0.000
ln*RE*	22.699***	0.000
ln*NRE*	28.788***	0.000
ln*GC*	38.692***	0.000
ln*INS*	7.686***	0.000
ln*FD*	28.25***	0.000
ln*TO*	37.95***	0.000

***indicates significance at 1% level. Source: Authors' calculations.

Table 2: Results of slope homogeneity analysis

Variable	$\bar{\Delta}$	$\bar{\Delta}_{adj}$
ln*GDP*	66.002***	204.37***
ln*GCF*	30.341***	104.21***
ln*RE*	115.100***	177.75***
ln*NRE*	97.431***	167.89***
ln*GC*	40.295***	108.67***
ln*INS*	100.129***	172.83***
ln*FD*	94.296***	171.10***
ln*TO*	99.861***	267.50***

***indicates significance at 1% level. Source: Authors' calculations.

Table 3: Panel unit root tests results

Variables	CADF test Statistic		CIPS test Statistic	
	Level	First difference	Level	First difference
ln*GDP*	–1.517	–3.125***	–1.874	–3.709***
ln*GCF*	–1.747	–3.533***	–1.889	–4.791***
ln*RE*	–1.251	–3.885***	–1.901	–4.931***
ln*NRE*	–1.315	–3.381***	–1.855	–4.600***
ln*GC*	–1.638	–2.802***	–1.818	–4.199***
ln*INS*	–1.803	–3.793***	–1.784	–4.469***
ln*FD*	–1.912	–3.923***	–1.929	–5.486***
ln*TO*	–1.773	–3.080***	–1.846	–4.423***

***indicates significance at 1% level. The null hypothesis is non-stationarity.
Source: Authors' calculations.

Table 4: Westerlund (2007) cointegration test results

Statistics	Value	Z-value	Robust P-value
G_τ	–7.522***	–6.094	0.006
G_α	–13.603***	–4.080	0.000
P_τ	–16.515***	–2.324	0.001
P_α	–8.285***	–1.773	0.003

***indicates significance at 1% level. The null hypothesis is no cointegration.
Source: Authors' calculations.

Table 5: Heterogeneous parameter estimates using AMG, CCEMG, and MG estimators

Regressors	AMG estimator		CCEMG estimator		MG estimator	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
ln*GCF*	0.148***	6.38	0.156***	7.79	0.163***	7.01
ln*RE*	0.119***	2.81	0.116***	3.32	0.117***	5.92
ln*NRE*	0.099**	2.15	0.096**	2.00	0.095***	6.60
ln*GC*	0.109***	4.24	0.092***	2.94	0.090***	2.66
ln*INS*	0.028	1.22	0.015	1.62	0.024	0.95
ln*FD*	0.058***	3.13	0.047***	5.08	0.042**	2.17
ln*TO*	0.076**	2.51	0.073***	2.59	0.083***	5.98

,* indicate significance at the 5% and 1% significance levels. Source: Authors' calculations.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

This study examines the determinants of economic growth in EMDEs in Latin America and the Caribbean. Also, we consider the role of energy consumption in the sustainable growth objective of the aforementioned countries by employing second-generation panel data techniques on the annual data between 1990 and 2014. Our estimation methods are appropriate for the presence of cross-sectional dependence and slope heterogeneity in the panel data. CADF and CIPS unit root tests indicate that all variables are stationary at first difference, thus enabling the Westerlund panel cointegration test based on error correction. We detect the long-run relationship among the variables and evaluate the long-run coefficients by the AMG estimator. We also use the Common Correlated Effects MG (CCEMG) and MG estimators for robustness check.

The empirical findings show that renewable and non-renewable energy use, gross fixed capital formation, government expenditure, financial development and trade openness positively and significantly impact the economic growth in the selected EMDEs. Namely, 1% increases of renewable energy use, non-renewable energy use, gross fixed capital formation, general government final consumption expenditure, financial development and trade openness enhance GDP per capita by respectively 0.119%, 0.099%, 0.148%, 0.109%, 0.058% and 0.076%.

From the aforesaid results, we recommend that the policy-makers of the EMDEs in Latin America and the Caribbean should consider fiscal policies for macroeconomic stabilization, improve institutional quality and implement suitable finance-led and trade-led strategies. It is also important to develop energy policies in order to foster the shift from non-renewable energy consumption to the renewable one.

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