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Energy consumption, environmental degradation, economic growth and financial development in globe: Dynamic simultaneous equations panel analysis

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Research paper

Energy consumption, environmental degradation, economic growth and financial development in globe: Dynamic simultaneous equations panel analysis

ABSTRACT

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1. Introduction

We use a panel data set of 193 countries over 1990-2017 period, by employ the Seemingly unrelated regression (SUR), three stage least squares regression (3SLS), dynamic model two-step generalized method of moments and two-step system generalized method of moments approach to investigate the impacts of financial development, economic growth, energy consumption, and carbon emission on each other. The empirical results suggested that financial development, economic growth, energy consumption, and carbon emissions are affected one another but with high pollution spread, except for consumption of energy which decreases financial development. All models confirm the Environmental Kuznets Curve for the global panel. The implications of all results for carbon emissions, financial development, economic growth, and energy policy are discussed.

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The subject of consumption of energy, environmental degradation, financial development and economic growth has been well documented in literatures in the last two decenniums for many countries and regions by utilizing different economics, environmental and sociological indicators, as well as approaches to examine the relationship of consumption of energy and economic growth on CO2 emissions and financial development or emission of carbon, financial development on economic growth and consumption of energy (Oh and Lee, 2004; Acheampong, 2018; Lee and Lee, 2009; Soytas et al., 2007; Muhammad, 2019; Saidi and Hammami, 2015a,b; Apergis and Payne, 2009; Wang et al., 2011; Kahouli, 2017; Shahbaz and Lean, 2012; Acheampong, 2018; Zhang, 2011; Kasman and Duman, 2015; Omri, 2013; Wang et al., 2011; Sadorsky, 2011; Acaravci and Ozturk, 2012; Almulali and Sab, 2012; Islam et al., 2013; Karanfil, 2009; Dinda and Coondoo, 2006; Akbostancı et al., 2009; Pao and Tsai, 2010; Sharma, 2010; Halicioglu, 2009; Zhang and Cheng, 2009; Wang et al., 2018). However, less consideration has been given on the effect of financial development, CO2 emissions, consumption of energy and economic growth on one another altogether or energy consumption, emissions in carbon and economic growth on financial development. The main motivation of the study is

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to fixate on energy consumption, financial development and CO2 emissions which played crucial role in the present discussion on the sustainable development and environmental aegis. Similarly, economic growth and energy consumptions are positive cognate to one another, the higher the energy consumption, the more preponderant is out per capita (Islam et al., 2013; Saidi and Hammami, 2015a,b). In integrations, economic growth and financial development are positively affects one another and the linkage of financial development for economic growth is greatly consequential for assiduous economic development.

There are four kinds of studies in the literature on the linkage between financial development, consumption of energy, CO2 emissions and economics amplification observed in the last two decenniums. The first kind of studies fixated on financial development with consumption of energy and emission of CO2. Sadorsky (2010) argued that higher financial development rise the demand of consumption in energy in case of Emerging countries. Consumption of energy played a crucial role to increment financial development and out per capita in Africa (Al-Mulali and Normee, 2012). Islam et al. (2013) argue that due to well utilization of energy, the financial development reduce the utilization of energy consumption. Conversely, Shahbaz and Lean (2012) and Jalil and Mahmud (2009) argue that financial development increases the utilization of energy in China. Boutabba (2014) contend that in long run finical development is direct relationship with CO2 emissions; designate that financial development reduce CO2 emissions.

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The second type of study is focused bi-directional long term and short term relationship between environmental degradation and economic growth, as mainly tested the environmental Kuznets curve and the direct and inverse U-Shaped linkage between economic growth and emissions of CO2 and proven in many regions and countries by Arouri et al. (2012), Odhiambo (2012), Soytas and Sari (2009), Dinda (2004) and Richmond and Kaufmann (2006). The third type of study has carried out on the relationship between energy consumptions and CO2 emissions, as higher CO2 emissions is associated with the higher consumption of energy (Ozturk, 2010), but the utilization of efficient technology might decrease carbon emission (Chang 2010; Omri, 2013). The fourth type of study is concern about the relationship between consumption of energy and economic progression. Most of the studies (Kraft and Kraft, 1978; Al-Mulali, 2011; Al-mulali and Sab, 2012; Bildirici et al., 2012; Lee and Chang, 2008; Odhiambo, 2009; Warr and Ayres, 2010) have found long run and short run, as well as positive affect of consumption of energy on economic growth.

Given the prevailing debate on the connection between consumption of energy, financial development, emissions of CO2 and economic growth, we contribute further by examine the impact of energy consumption, financial development, CO2 emissions and economic growth on each other for 193 countries over the period 1990 to 2017. Best to our erudition, no paper has been published on the relationship between above mentioned designators effects on one another by utilizing Seemingly unrelated regression (SUR), three stages least squares regressions (3SLS), two step GMM and two step system GMM approach in dynamic context. Another novelty in the paper is the utilization of economic growth, CO2 emissions and consumption of energy effect on financial development first time by quantified utilizing private credit sectors. Third, and perhaps more importantly, we contend that the seemingly unrelated regression (SUR), three stage least squares (3SLSS) and GMM estimation reduces the quandary of omitted variables and solve the endogeneity issue. Furthermore, we additionally argue that any country-specific effect could be quantified by utilizing GMM estimators. Determinately, in our sample data most of the countries have richness in natural resources, and massive consumption of energy and emission of carbon dioxide. Section 2 provides a brief overview of the empirical literatures analyzing the relationship among energy consumption, economic growth, financial development and carbon emission. Section 3 designates the data and method with regards to different approaches. Section 4, composed of result, discussions findings and precise summaries. Concluding remarks and policy implicative insinuations are given in Section 5

2. Literature review

Based on the past studies, we separate research studies in four sub-sections. First section comprise on the studies related to economic growth and energy consumption, second section consist of financial development and others three indicators (economic growth, emissions of CO2 and energy consumptions). Third sections composed of economic growth and emissions of CO2. Last section consists of study related to energy consumption, CO2 emissions and another related variables.

2.1. Economic growth and consumption of energy

The connection between and economic growth has been one of the sultry topics from many years and carried out on many regions of the worlds by employ different methods and getting different results for different regions due to regional factors and utilizations of energy. In emerging, developing and Middle-East and North-African region, Muhammad (2019) found positive association between consumption of energy and out per capita. Wang et al. (2018) examined the linkage of urbanization, economic growth, emissions of CO2 and economic development for 170 countries predicated one the income level and find that all variables have positive linkage with one another in long run. In 12 sub-Saharan countries, Esso and Keho (2016) found that in longrun economic growth and consumption of energy are connected with carbon emissions. In ninety five economies, Farhani and Ben Rejeb (2012) found that for low and high income countries, the long run causality consecutively from economic progression to energy consumption, while for lower-middle and upper-middle income countries, the two way Granger causality running between economic magnification and energy consumption. In Malaysia, Ang (2008) showed that in long-run energy and pollutions are positively cognate with gross domestic product. The association between consumption of energy and economic growth investigated by Akinlo (2008) for 11 sub-Sahara African economies and came with evidence that unidirectional causality running from economic magnification to consumption of energy for two African countries Sudan and Zimbabwe. Moreover, Lee and Chang (2008) found long run integrations sodality between consumption of energy and GDP while for short run this relationship is found to be week which implicatively insinuates that diminish energy consumptions only affect output in Longrun. The unidirectional relationship from consumption of energy to economic development is proven by Tsani (2010) for Greec. Moreover, in Vietnam, Binh (2011) has found that unidirectional causality running from LPCGDP to CEC. Moreover, for USA, Warr and Ayres (2010) find a one side causal association from consumption of energy to economic magnification, while there was no evidence found with regard to economic growth to energy consumption. For nine African countries another study conducted by Bildirici et al. (2012) and found bidirectional connections between consumption of energy and per capita GDP.

2.2. Energy consumption, CO2 emissions and financial development

The effects of financial development utilizing as a dependent or explanatory variables have been utilized in several research papers for different purposes by utilizing different financial designators for different countries. In Sub Sahara African countries, the effects of carbon emission and energy utilization on financial development and economic magnification is investigate by Almulali and Sab (2012) and found that consumption of energy increase the financial development and economic magnification but this incrimination is the cause of high emission of CO2 gas. Other researcher investigates the relationship of consumption of energy and financial development and suggested that financial development is the cause of high economic development (Jalil and Feridun, 2011; Goldsmith, 1969). Another study, for BRICKS countries (Tamazian and Rao, 2010) found negative effects of financial development on carbon emission. Homogeneous findings were found by Jalil and Feridun (2011) for China, Islam et al. (2013) for Malaysia and Boutabba (2014) for India. In Central and Eastern Europe, Sadorsky (2010) employ the bank and capital market variables and came with results that financial development elevate energy consumptions. On the other hand, Zhang (2011) find that due to financial development Carbon emission increases in China. Kindred results were found by Boutabba (2014) in India, whereas Acaravci and Ozturk (2012) found no effect of financial development on CO2 emissions in Turkey.

2.3. Economic growth and CO2 emissions

The linkage between economic growth and consumption of energy has been one of the negotiable matters in literatures from the last two decenniums. Most recent study, Muhammad (2019) founds the positive link of economic magnification and emissions of CO2 in developed and MENA countries while negative relationship was found in emerging countries. Utilizing a data from 116 countries and categories the countries into five categories, Acheampong (2018) found commix results on the causes of one another of energy consumption, economic growth and CO2 emissions and for ecumenical panel proven the environmental Kuznets curve. Another recent study. Salahuddin et al. (2018) investigate the carbon emission relationship with electricity consumption, financial development, peregrine direct investment and economic growth in Kuwait. The empirical results show that electricity consumption, peregrine direct investment, financial development and consumption of energy have boosted up carbon emission in long and short run. In twelve MENA regions countries, Arouri et al. (2012) address the EKC and came with conclusions that authentic GDP denotes a quadratic sodality with the CO2 emissions for the county holistically, as well as found positive relationship between energy consumptions and CO2 emissions. In Turkey, Soytas and Sari (2009) shows that there is two-way causality between Carbon emission and income for both short and long run while in developing countries, Sari and Soytas (2007) found a unidirectional causality. Another study had carried out in Turkey by Soytas and Sari (2009) by including the consumption of energy and concluded that there is no long-run relationship between CO2 emissions and income. Furthermore, a study had carried out on 36 nations by Richmond and Kaufmann (2006) and came with results that there is no causal relationship between CO2 emissions and economic growth. Moreover, another related study conducted by Dinda (2004) to examine the causal relationship between consumption of energy and CO2 emissions for OECD countries and non-OECD region countries and found that for OECD countries there is causal relationship between CO2 emissions and GDP per capita while for non OECD countries this relationship is found to be inverted

2.4. Consumption of energy and CO2 emissions

Consumption of energy and carbon emission has been discussed in several published paper for different regions and countries. Most recently, Muhammad (2019) found a positive linkage between economic growth and consumption of energy in developed, MENA and emerging countries. Another, most recent study, Saidi and Hammami (2015a,b) examine the casual relationship between energy consumption, CO2 emissions and economic in Latin America, North Asia and Europe and Caribbean and came with results that there is a bidirectional relationship between consumption of energy and out per capita for all three regions and 58 countries and abnegated the neo classical postulation. Moreover, Yang and Lin (2016) investigated the relationship carbon emission, consumption of energy and economic magnification in China (Shanghai). He found a bidirectional causality sodality among authentic GDP, carbon emission, and energy consumption. Furthermore, Niu et al. (2011) explored the same effects and argue that this effect is more astronomically immense in developed countries than developing countries but the energy use per capita is higher in developed countries. In India, the relationship between primary energy, CO2 and economic development is examined by Tiwari (2011) and found long run relationship among variables. In Japan, Hossain (2012) found the unidirectional relationship for all variables such is EC, CO2, EC and EC and trade opens respectively. In prevalence independent states, Apergis and Payne (2010) found a bi-directional relationship for long run between CO2 emissions and consumption of energy and in short run CO2 emissions is the cause of magnification. Moreover, in ASEAN countries, Lean and Smyth (2010) examined causal relationship and found that causality running from CO2 emissions and electricity consumption to economic magnification, as well as two way relationship between consumption of energy and CO2 emissions and identically tantamount results were found by Ozturk and Acaravci (2010) for Turkey. For Bricks countries, Pao and Tsai (2010) investigate the causal links between CO2 emissions and consumption of energy and their study empirical results betokens the ease of robust bidirectional causality between these designators. On the other hand, In China, Jalil and Mahmud (2009) studied the long-run relationship between income, carbon emissions, peregrine trade and energy consumption, and found evidence of an EKC relationship. They furthered argue that carbon emission is largely determined by economic growth and income in long run.

3. Empirical models and data

3.1. Empirical models

The study is concerned mainly with examining the association among financial development, CO2 emissions, economic growth, and energy consumption. We argue that difference GMM and system GMM are best estimators but System GMM method have some advantage over difference GMM approach and below given equations step by step process of difference GMM and System GMM and difference between these two techniques.

$$GDPPC_{it} = a_0 + a_1GDPPC_{i,t-1} + a_2EC_{it} + a_3CO_{it} + a_4FDPVT_{it} + a_5FDB_{it} + a_6CAP_{it} + a_7LF_{it} + a_8X_{it} + \varepsilon_{it}$$
(1)
$$EC_{it} = a_0 + a_1EC_{i,t-1} + a_2GDPPC_{it} + a_3CO2_{it} + a_4FDPVT_{it} + a_5POP_{it} + a_6X_{it} + \varepsilon_{it}$$
(2)

$$CO2_{it} = a_0 + a_1 CO2_{i,t-1} + a_2 GDPPC_{it} + a_3 EC_{it} + a_4 FDPVT_{it} + a_5 FDB_{it} + a_6 GDP^2_{it} + a_7 TO_{it} + a_8 X_{it} + \varepsilon_{it}$$
(3)

$$FDPVT_{it} = a_0 + a_1 FDPVT_{it-1} + a_2 GDPPC_{it} + a_3 EC_{it} + a_4 CO2_{it} + a_5 CAP_{it} + a_6 NE_{it} + a_7 LF_{it} + a_8 X_{it} + \varepsilon_{it}$$
(4)

GMM include two ways of estimator, difference GMM and system GMM. For difference GMM, it must Eq. (1) can be written as:

$$GDPPC_{it} - GDPPC_{i,t-1} = a_1(GDPPC_{i,t-1} - GDPPC_{i,t-2}) + a_2(EC_{it} - EC_{i,t-1}) + a_3(CO2_{it} - CO2_{i,t-1}) + a_4(FDPVT_{it} - FDPVT_{i,t-1}) + a_5(FDB_{it} - FDB_{i,t-1}) + a_6(CAP_{it} - CAP_{i,t-1}) + a_7(LF_{it} - LF_{i,t-1}) + a_8(X_{it} - X_{i,t-1}) + (\varepsilon_{it} - \varepsilon_{i,t-1})$$
(5)

Difference GMM moment condition for Eq. (5) are set as below:

$$E[GDPPC_{i,t-s} * \varepsilon_{i,t}] = 0$$
, for $s \ge 1991 t = 1990, 1991, \dots, 2017$

$$E[EC_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0$$
, for $s \ge 1991$

(6)

$$t = 1990, 1991, \dots, 2017 \tag{7}$$

$$E[CO2_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } s \ge 1991$$

$$t = 1990, 1991, \dots, 2017$$

$$E[FDPVT_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } s \ge 1991$$
(8)

$$t = 1990, 1991, \dots, 2017$$
 (9)

$$E[FDB_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } s \ge 1991$$

$$t = 1990, 1991, \dots, 2017$$
(10)

$$E[CAP_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } s \ge 1991$$

$$t = 1990, 1991, \dots, 2017$$

$$E[LF_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } s \ge 1991$$
(11)

$$t = 1990, 1991, \dots, 2017 \tag{12}$$

$$E[X_{i,t-s} * (\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0, \text{ for } s \ge 1991$$

$$t = 1990, 1991, \dots, 2017$$
(13)

Although, this strategy can control the basis instigated by country specific effect and endogenous of explanatory variables, Difference GMM could lead to biased parameter estimations in small samples and larger variance asymptotically. So alternative approach is system GMM to overcome the problem. The system difference GMM moment condition for Eq. (5) is set as follow:

$$E[(GDPPC_{i,t-s} - GDPPC_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1,$$

$$t = 1992 \dots 2017 \tag{14}$$

$$E[(EC_{i,t-s} - EC_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1, t = 1992...2017$$
(15)

$$E[(CO2_{i,t-s} - CO2_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1, t = 1992...2017$$
(16)

$$E[(FDPVT_{i,t-s} - FDPVT_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1,$$

$$t = 1992, \dots, 2017 \tag{17}$$

$$E[(FDB_{i,t-s} - FDB_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1, t = 1992...2017$$
(18)

$$E[(CAP_{i,t-s} - CAP_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1, t = 1992...2017$$
(19)

$$E[(LF_{i,t-s} - LF_{i,t-s-1}) * \varepsilon_{it}] = 0 \quad \text{For } s = 1, t = 1992...2017$$
(20)

 $E[(X_{i,t-s} - X_{i,t-s-1}) * \varepsilon_{it}] = 0$ For s = 1, t = 1992...2017 (21) The same to Eqs. (2) (3) (4)

In the above given Eqs. (1)–(4), GDPPC, EC, CO2 and FDPVT represents the economic growth, consumption of energy, Carbon dioxide emissions and financial development by private sector credit respectively. GDP_{it-1} , EC_{it-1} , $CO2_{it-1}$ and $FDPVT_{it-1}$ are the first lag of all left hand side variables given in Eqs. (1) to (4) are used as an explanatory variable to measure the effect of the previous year's on the current year. FDB is the financial develop-

ment bank, CAP is fixed capital formation, LF is labor force, POP is the total populations of country and GDP2 is GDP per capita squares used for environmental Kuznets curve, NE is government national expenditure, and X_{it} is the vector of control variables that potentially affects our left hand side variables. It includes urban population, merchandise trade, infrastructures, merchandise trade, gross saving, government expenditure on educations, whereas i and t time and country index respectively.

In literature there are two variants of GMM approach, the on-step and two-step estimators. Most researchers such as Law and Azman-Saini (2012) preferred to use two-step-estimators because theoretically one step estimators is not efficient as compare to two-step estimators. It is therefore the two-step estimators employ optimal weighting matrices. Nevertheless, it should be noted that its use in small cross-sections dimension can lead to biased estimators parameters (Law and Azman-Saini, 2012; Windmeijer, 2005). However, in our case we have used large cross-section dimension which the mentioned problem may not be exist in our data set. This paper employed the two-step system GMM estimator to investigate the effects of economic growth, financial development, and consumption of energy and CO2 emissions on one other. Following Roodman (2009), the dimensionality of the instrumental variable ground was abridged. The consistency or reliability of the GMM methods depends on specification

| Table 1 | |
|-------------|------------|
| Descriptive | statistics |

| Variables | Mean | St-Dev | CV |
|----------------------------------|-----------|-----------|-------|
| GDP per capita | 12 053.26 | 17 547.07 | 1.456 |
| Consumption of energyper Capita | 2355.892 | 2806.682 | 1.191 |
| Carbon emission per capita | 4.595 | 6.59 | 1.434 |
| Financial development (Fd_Pvt) | 46.094 | 81.832 | 1.775 |
| Bank financial development(Fd_b) | 42.189 | 38.91 | 0.922 |
| Fixed capital | 22.526 | 10.237 | 0.454 |
| Labor force | 0.001 | 0.001 | 4.052 |
| Gross national expenditure | 105.824 | 19.375 | 0.183 |
| Squares of GDP per capita | 0.001 | 0.0001 | 2.655 |
| Population | 0.001 | 0.000 | 3.827 |
| Trade open | 86.26 | 52.201 | 0.605 |
| Rural population | 0.001 | 0.0001 | 4.680 |
| Merchandise trade | 66.033 | 44.852 | 0.679 |
| Infrastructure | 45.742 | 50.886 | 1.112 |
| Saving | 22.027 | 13.992 | 0.635 |

Notes: Mean denotes average, Std. Dev denotes standard deviation, CV represents coefficient of variation.

test, Sargan test of over-identifying restrictions. In Sargan test the Null hypothesis should be not fail to reject which indicates that the instruments are valid and the model is correctly specified.

3.2. Data and descriptive statistics

This paper explore the impact of economic growth, financial development, CO2 emissions and consumption of energy on each other for a period 1990-2017 by employing the dynamic one and two-step dynamic GMM and one and two-step System GMM model, as well as 3 stage least squares regressions and Seemingly unrelated regression (SUR). The variables included in this paper is authentic carbon dioxide emissions (metric tons per capita), consumption of energy (kg of oil equipollent per capita), GDP per capita (constant 2010 US\$), financial development (Private sector credit), financial development (Credit provide by bank), Labor force (total labor force of populations), merchandise trade (sum of merchandise exports and imports divided by the value of GDP) trade openness (% of exports and imports of GDP), capital stock (fine-tuned capital formation as a quota of GDP), urbanization (% of total population), expenditure (gross national expenditure or domestic absorption), Infrastructure (Mobile cellular subscription per 100) total population (in thousands), saving (Gross saving), and GDP2 is the square of per capita GDP for 193 countries. The data for all variables are retrieved from the World Bank (2017). Only few countries are not included due to missing data for main variables and the starting periods is predicated on the data availability.

Table 1; demonstrate the means, standard and coefficient of variation (CV) value for whole worlds. The value given in Table 1 indicates that financial development (FD-Pvt) is more volatile than the GDP per capita, Carbon emission, consumption of energy and capital stock according to the value of coefficient of variation (CV), while financial development by bank (Fd_B) is less so. Moreover, in other variables the labor force coefficient of variation is 4.052 which indicate higher volatility while the gross national expenditure is lowest coefficient of variation.

4. Results, discussion and findings

In this section, we discuss the estimation results of the present study. First, we estimate the dynamic models for a panel of 193 countries utilizing the one step GMM Arellano-Bond (AB, 1991) and System dynamic panel-data estimation Arellano and Bover (1995). The estimation results are presented in Table 2 from model 1a to 4d. We commence our discussion by culling the best model. We estimated the one-step difference and onestep system GMM model and found that all coefficients have the correct signs and statistically significant at the 1 and 5 percent level. However, the Sargan test for one-step dynamic GMM and System GMM estimation rejects the null hypothesis of overidentifying restrictions. Hence, we found that the one-step GMM and system GMM may not be right in this context and we perpetuate to estimate our dynamic model employing the two-step GMM and two-System GMM approach. We find that Sargan test fail to accept the alternative hypothesis of over identification restrictions at 1 and 5 percent level and we conclude that twostep GMM and two-system GMM is robust method and standard error are consistent and impartial. Hence, the analysis can be done predicated upon the GMM estimations results (Tang and Abosedra, 2014).

Secondly, we estimate the Seemingly unrelated regressions (SUR) and three stage least square regressions. The estimation results are presented in Tables 6 and 7 respectively. We find that most of coefficients have the correct signs of SUR models and consistent with two step System GMM except only one sign, while in 3SLS only two main variables and few others are have correct signs but frivolous which may be inefficient but acceptable results. For the robust, efficient and consistent results we are only presenting two steps GMM and two steps system GMM results and the parameters estimates two-step GMM and SUR remained same in magnitude and sign with two-step system GMM and we compare SUR results in summary and findings section as well.

4.1. The influence of energy consumption, CO2 emissions and financial development on economic growth

Table 2, the model (1a), (2b), (3c) and (4d) represent the dynamic GMM model (GMM), Two-step dynamic GMM model (2SGMM), system GMM (Sys GMM) and two-step dynamic system GMM (Sys2Step) model respectively. Here we explain the results of all models but in later part we will make a one tables and present the results of two-step GMM models due to efficient, robust and unbiased results. Secondly, similar to the results of one-step dynamic GMM approach and SUR, we are only presenting the two-step system GMM approach. The lagged value of GDP per capita from model (1a) to (4d) is highly significant, which indicates that GMM model and system GMM is an appropriate estimator and the empirical results could be reliable to carry out analysis or inferences. In addition, the Sargan statistic is constantly associated with a p-value higher than 10% level of significant. The two-step GMM and two-step system GMM outcomes confirm the validity of the two-step GMM and system GMM approach for undertaking the empirical analysis.

Table 2, model (1a) exhibits that consumption of energy positively and significantly influence GDP per capita which designates that economic development (growth) will rise by 0.901, if the there is one percent increase in consumption of energy in Globe. These findings reveal that consumption of energy cause to increases economic growth in 193 countries of the globe and this findings corroborated with the findings procured by Muhammad (2019), Shahbaz and Lean (2012) and Saidi and Hammami (2015a,b). Since power consumption is a main element for economic magnification (growth), solid energy strategies and policies are essential to procure perpetuate economic growth (Apergis and Payne, 2010). Similarly, The CO2 emissions is positively and significantly effects on economic growth at 1% level. This betokens that one 1% increase in carbon emission cause to increases economic growth by 53.75. The results revealed that CO2 emissions raise the economic development growth in globe and this result is in line with the findings (See, Saidi and Hammami,

Table 2

The effects of financial development, consumption of energy and CO2 emissions on economic growth in 193 countries of global panel.

| Dependent variable: EG | (GMM) Model (1a) | (2SGMM) Model (2b) | (Sys GMM) Model (3c) | (Sys2Step) Model (4d) |
|---|--|---|--|---|
| Lngdppc _{it-1} | 0.901*** | 0.901*** | 0.998*** | 0.998*** |
| | (0.008) | (0.001) | (0.001) | (0.001) |
| Energy consumption | 0.089*** | 0.088*** | 0.101*** | 0.101*** |
| | (0.032) | (0.000) | (0.000) | (0.000) |
| Carbon dioxide | 53.75*** | 53.68*** | 36.78*** | 36.78*** |
| | (17.85) | (0.053) | (0.111) | (0.111) |
| Financial development (Pvt) | 26.98*** | 26.99*** | 17.28*** | 17.28*** |
| | (5.600) | (0.025) | (0.096) | (0.096) |
| Financial development (B) | -33.71*** | -33.70*** | -23.74*** | -23.74*** |
| | (5.649) | (0.026) | (0.093) | (0.093) |
| Capital | 28.97*** | 28.98*** | 57.61*** | 57.61*** |
| | (4.831) | (0.054) | (0.077) | (0.077) |
| Population | | | | |
| - | 0.001 | 0.001*** | -0.001^{***} | -0.001^{***} |
| | 0.001 (0.001) | 0.001*** (0.001) | -0.001*** (0.001) | -0.001*** (0.001) |
| Labor force | 0.001 (0.001) 0.001 | 0.001*** (0.001) 0.001*** | -0.001*** (0.001) 0.001*** | -0.001*** (0.001) 0.001*** |
| Labor force | 0.001 (0.001) 0.001 (0.001) | 0.001*** (0.001) 0.001*** (0.001) | -0.001*** (0.001) 0.001*** (0.001) | -0.001*** (0.001) 0.001*** (0.001) |
| Labor force National expenditure | 0.001 (0.001) 0.001 (0.001) -0.001*** | 0.001*** (0.001) 0.001*** (0.001) -0.001*** | -0.001*** (0.001) 0.001*** (0.001) -0.001*** | -0.001*** (0.001) 0.001*** (0.001) -0.001*** |
| Labor force National expenditure | 0.001 (0.001) 0.001 (0.001) -0.001*** (2.964) | 0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.0147) | $\begin{array}{c} -0.001^{***} \\ (0.001) \\ 0.001^{***} \\ (0.001) \\ -0.001^{***} \\ (0.040) \end{array}$ | $\begin{array}{c} -0.001^{***} \\ (0.001) \\ 0.001^{***} \\ (0.001) \\ -0.001^{***} \\ (0.040) \end{array}$ |
| Labor force National expenditure Constant | 0.001 (0.001) 0.001 (0.001) -0.001*** (2.964) 1646*** | 0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.0147) 1612*** | -0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.040) 1240*** | -0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.040) 1240*** |
| Labor force National expenditure Constant | 0.001 (0.001) 0.001 (0.001) -0.001*** (2.964) 1646*** (333.3) | 0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.0147) 1612*** (20.47) | -0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.040) 1240*** (4.970) | -0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.040) 1240*** (4.970) |
| Labor force National expenditure Constant Observations | 0.001 (0.001) 0.001 (0.001) -0.001*** (2.964) 1646*** (333.3) 2387 | 0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.0147) 1612*** (20.47) 2387 | $\begin{array}{c} -0.001^{***} \\ (0.001) \\ 0.001^{***} \\ (0.001) \\ -0.001^{***} \\ (0.040) \\ 1240^{***} \\ (4.970) \\ 2534 \end{array}$ | -0.001*** (0.001) 0.001*** (0.001) -0.001*** (0.040) 1240*** (4.970) 2534 |

Notes: *, **, *** Indicate significance at the 1%, 5%, 10% level respectively. 2SGMM, Sys GMM, and Sys2Step are two-steps GMM, System GMM and two-step systems GMM respectively. Values in parenthesis are the standard errors. Sargan-test refers to the over-identification test for the restrictions in GMM estimation.

2015a,b; Muhammad, 2019). Similarly, The coefficient of financial development (PVT) is positive and statistically significant which denotes that 1% increase in financial development raises economic growth by 26.98 which denote that financial development increases economic growth, Whereas another financial indicator (Bank) is negatively affect GDP per capita which is in line with the anterior studies Al-mulali and Sab (2012). Subsequently, the Capital formation is positively and significantly affects economic growth. We argue that if there is one unit change in capital or domestic investment will raise the economic magnification by 28.97. The findings are in line with the findings of (Saidi and Hammami, 2015a,b; Shahbaz and Lean, 2012). Furthermore, population and labor force is positively and significantly GDP per capita which designates if there is 1% increase in population and labor force cause to increase economic growth in countries, while national govt expenditure negatively effects economic growth which denotes that due to no efficient and efficacious utilization of national government expenditure, the economic had raisen in globe.

4.2. Energy consumptions relationship with other three main variables (GDPPC, EC, FD)

Table 3 represents the results with regard to the effect of financial development, economic growth and CO2 emissions effects on energy consumption. The second, third, fourth and fifth column displays the results of GMM, two-step GMM model (2SGMM), System GMM and two-step system GMM (Sys2Step) results respectively.

The influence of economic growth, financial development and CO2 emission on economic growth for Global panel is described in Table 3. The lag coefficient value of consumption of energy(0.741) signifies that consumption of energy is corrected by 74% percent each year. The coefficient of economic growth is significantly

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 Table 3

 The effect of financial development, economic growth and CO2 emissions on consumption of energy in 193 countries of Globe.

| Dependent variable: EC | (GMM) Model (1a) | (2SGMM) Model (2b) | (Sys GMM) Model (3c) | (Sys2Step) Model (4d) |
|------------------------|---------------------|-----------------------|-------------------------|--------------------------|
| EC _{it-1} | 0.741*** | 0.741*** | 0.854*** | 0.854*** |
| | (0.013) | (0.001) | (0.010) | (0.001) |
| Loggdppc | 108.1* | 107.8*** | 126.9*** | 126.3*** |
| | (56.71) | (0.433) | (28.50) | (0.456) |
| Carbon dioxide | 65.32*** | 65.36*** | 38.30*** | 38.30*** |
| | (4.529) | (0.026) | (3.394) | (0.026) |
| Financial development | 1.008** | 1.012*** | 2.780*** | 2.791*** |
| (PVT) | | | | |
| | (0.479) | (0.004) | (0.479) | (0.008) |
| Labor force | 0.001 | 0.001*** | 0.001 | 0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Urban pop | -0.001 | -0.001^{***} | -0.001^{**} | -0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Trade open | 0.612 | 0.581*** | -4.724*** | -4.725*** |
| | (0.733) | (0.022) | (0.666) | (0.005) |
| National expenditure | -1.009 | -0.996^{***} | 0.295 | 0.290*** |
| | (0.989) | (0.012) | (1.034) | (0.005) |
| Population | -0.001 | -0.001^{*} | -0.001 | -0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Merchandise trade | 0.384 | 0.412*** | 3.569*** | 3.561*** |
| | (0.815) | (0.018) | (0.792) | (0.008) |
| Constant | -700.9 | -700.7*** | -821.5*** | -816.1*** |
| | (483.9) | (5.389) | (275.4) | (4.005) |
| Observations | 2395 | 2395 | 2543 | 2543 |
| Sargan test | 1842.938*** | 128.289 | 2007.138*** | 127.369 |

Notes *, **, *** Indicate significance at the 1%, 5%, 10% level respectively. 2SGMM, Sys GMM, and Sys2Step are two-steps GMM, System GMM and two-step systems GMM respectively. Values in parenthesis are the standard errors. Sargan-test refers to the over-identification test for the restrictions in GMM estimation.

and positively effects consumption of energy in all four models (GMM, two-step GMM, system GMM and two-step system) respectively. The positive relationship between energy consumptions and economic growth were in line with the previous finds (Muhammad, 2019; Saidi and Hammami, 2015a,b; Omri, 2013; Shahbaz and Lean. 2012: Odhiambo. 2009: Belloumi. 2009: Ang. 2008; Oh and Lee, 2004; Ghosh, 2002; Ageel and Butt, 2001). In all four models, the CO2 emissions is positive relationship with consumption of energy which implies if there is one unit increase in CO2 emission, will increase the consumption of energy by 65.32, 65.36, 38.30 and 38.30 respectively. Our results indicate that financial development has positive and statistically significant effects at 1% level of significant on energy consumptions. The coefficient of financial development (Pvt) of GMM, two step GMM, system GMM and two step system GMM are 1.008, 1.012, 2.780 and 2.791 respectively, which implies that a 1% increase in financial development cause to increase the consumption of energy by 1.008, 1.012, 2.780 and 2.791 percent respectively in 193 countries of globe. The urban populations, trade openness and total population is negatively effects consumption of energy per capita in all four models, while in GMM model trade openness is statistically show non-significant results but positive and significant in two step GMM models. On the other hand, Labor force is insignificant in GMM and system GMM models but positive and significant in two step GMM and system GMM model, which effect consumption of energy positively. Merchandise trade is statistically non-significant in GMM model while it have positive impact on consumption of energy in other three models, whereas for national expenditure, the results of GMM and system GMM show non-significant effect, while positive and significant effect on consumption of energy in two-step GMM and System GMM models which reveal that if there is 1% increases in government expenditure cause to increase consumption of energy in 193 countries.

Table 4

| The | effect | of | growth, | financial | development | and | consumption | of | energy | on |
|------|--------|------|----------|------------|--------------|-----|-------------|----|--------|----|
| carb | on em | issi | on in 19 | 3 countrie | es of globe. | | | | | |

| Dependent variable: CO2 | (GMM) Model (1a) | (2SGMM) Model (2b) | (Sys GMM) Model (3c) | (Sys2Step) Model (4d) |
|-------------------------|---------------------|-----------------------|-------------------------|--------------------------|
| CO2it-1 | 0.529*** | 0.529*** | 0.594*** | 0.594*** |
| | (0.015) | (0.001) | (0.013) | (0.001) |
| Loggdppc | 1.114*** | 1.111*** | 0.567*** | 0.567*** |
| | (0.197) | (0.002) | (0.106) | (0.001) |
| Energy consumption | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Financial develop (PVT) | -0.006 | -0.006^{***} | -0.020^{***} | -0.020*** |
| | (0.007) | (0.001) | (0.007) | (0.001) |
| Financial develop (B) | -0.002 | -0.002^{***} | 0.008 | 0.008*** |
| | (0.007) | (0.001) | (0.007) | (0.001) |
| Trade open | 0.000 | 0.000*** | 0.000 | 0.000*** |
| | (0.002) | (0.001) | (0.001) | (0.001) |
| Cgdppc2 | -0.001^{***} | -0.001^{***} | -0.001^{***} | -0.001^{***} |
| | (0.001) | (0.001) | (0.001) | (0.000) |
| Labor force | -0.001 | -0.001*** | 0.001** | 0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Urban pop | -0.001 | -0.001*** | -0.001^{***} | -0.001^{***} |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Constant | -8.679^{***} | -8.568*** | -4.426^{***} | -4.428^{***} |
| | (1.585) | (0.046) | (0.832) | (0.007) |
| Observations | 2457 | 2457 | 2607 | 2607 |
| Sargan test | 1954.05*** | 135.049 | 2214.711*** | 139.849 |

Notes: *, **, *** Indicate significance at the 1%, 5%, 10% level respectively. 2SGMM, Sys GMM, and Sys2Step are two-steps GMM, System GMM and two-step systems GMM respectively. Values in interpolation are the standard errors. Sargan-test refers to the over-identification test for the limitations in GMM estimation.

4.3. Carbon emission relationships with other three main variables (EC, GDPPC, FD)

The relationship of Carbon emission with three main variable economic growth, financial development and energy consumptions are presented in Table 4.

The estimates reported in column [2, 3, 4, and 5] of Table 4 suggest that economic growth positively and significantly effects CO2 emissions. This betokens that CO2 emissions increases by 1.114 when GDP per capita elevate by 1%. These results is corroborated with precedent findings which have revealed that a decline in carbon emissions would drop ecumenical GDP per capita (See; Menyah and Wolde-Rufael, 2010; Hourcade et al., 1996; Fan et al., 2010; Acheampong, 2018). Additionally, consumption of energy effects CO2 emissions and the relationship is positive. Consequently, CO2 emissions increase by 0.001 accordingly, when consumption of energy increases by 1%. These results stress that raises in consumption of energy deteriorate the environment. Moreover, coefficient of both financial developments variables is negative and consequential which show negative cognations with CO2 emissions. The economic growth per capita squares is negative and statistically significant which proof the existience of inverted U-Shaped relationship of environmental Kuznets curve for global panel. Results concerning others variables suggest that trade openness are positively and significantly effects CO2 emissions in both two-step GMM and two step different model. The urban population negatively effects the CO2 emissions in all models except in one-step GMM, while labor force exert significant negative impact on CO2 emissions in One-step and two-step GMM model, but paramount positive effect in one step and two step GMM. It corroborates that trade opens; GDP per capita square, labor force and urban populations is the consequential determinants of CO2 emissions.

Table 5

The effects of carbon emission, economic growth and consumption of energy on financial developments in 193 countries of globe.

| | (GMM) Model (1a) | (2SGMM) Model (2b) | (Sys GMM) Model (3c) | (Sys2Step) Model (4d) |
|--|---------------------|-----------------------|-------------------------|--------------------------|
| Dependent variable: FD FD _{it-1} | 0.751*** | 0.752*** | 0.889*** | 0.889*** |
| | (0.016) | (0.001) | (0.012) | (0.002) |
| Cgdppc | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.000) | (0.001) | (0.001) | (0.001) |
| Energy consumption | -0.005^{***} | -0.005^{***} | -0.003*** | -0.003*** |
| | (0.001) | (0.001) | (0.000) | (0.001) |
| Carbon dioxide | 1.105*** | 1.100*** | 0.662*** | 0.680*** |
| | (0.214) | (0.0319) | (0.165) | (0.0245) |
| Capital | 0.350*** | 0.339*** | 0.551*** | 0.546*** |
| | (0.062) | (0.007) | (0.066) | (0.010) |
| Population | -0.001 | -0.001*** | -0.001*** | -0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Labor force | 0.001*** | 0.001*** | 0.001* | 0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| National expenditure | 0.204*** | 0.202*** | 0.338*** | 0.340*** |
| | (0.045) | (0.004) | (0.045) | (0.006) |
| Saving | -0.121*** | -0.123*** | -0.031 | -0.036*** |
| | (0.042) | (0.005) | (0.044) | (0.004) |
| Infrastructure | 0.013* | 0.014*** | 0.002 | 0.002** |
| | (0.007) | (0.001) | (0.005) | (0.001) |
| Constant | -21.97^{***} | -21.49*** | -43.80*** | -43.95*** |
| | (4.876) | (0.443) | (4.622) | (0.480) |
| Observations | 2150 | 2150 | 2300 | 2300 |
| Sargan test | 860.163*** | 130.739 | 1320.269*** | 138.224 |

Notes: *, **, *** Indicate significance at the 1%, 5%, 10% level respectively. 2SGMM, Sys GMM, and Sys2Step are two-steps GMM, System GMM and two-step systems GMM respectively. Values in parenthesis are the standard errors. Sargan-test states to the over-identification test for the restrictions in GMM estimation.

4.4. Financial development relationships with other three main variables (EC, GDPPC, CO2)

Table 5 represents the results with regard to the effect of energy consumption, economic growth and CO2 emissions effects on financial development. The model(1a), model(2b), model(3c) and model(4d) represents the results of GMM, two step GMM model(2SGMM), System GMM and two step system GMM model (Sys2Step) results respectively.

The estimated coefficient of lagged financial development is highly positive and statistically significant at 1% level exhibiting that financial development in 1 year is heavily effected by financial development in the anterior years. The coefficient value of GDP per capita is positive in all models (One-step and twosteps GMM, one-step and two step system GMM) which reveal that economic growth increases financial development. The estimated coefficient of the consumption of energy is negative and highly significant in all models which denote the consumption of energy decreases financial developments in samples countries which are an incipient contribution to current literatures with regard to sample panel's countries. Sadorsky (2011) argue that financial development is positively effects energy consumptions by utilizing the stock markets variables such as stock market capitalizations and stock market value traded, but in our case I have utilized the private sectors credit as dependent variables. On the other hand, the estimated coefficient of CO2 emissions is positive and statistically significant in both models (two-step GMM and system GMM) which represents that CO2 emissions is the causes to increases the financial development by utilizing the financial credit provide by bank. Similarly, the estimated coefficient of fixed capital formation, Labor force, govt expenditure and infrastructures is positive and significant in all models except Infrastructure is non-significant in one step System GMM model, which designates that these all variables positively effects financial development, as well as all these variables are

4.5. Seemingly unrelated regression

We are presenting the results of seemingly unrelated regression (SUR) and compare with our baseline model (Two step system GMM model). Here we will not explain the results with details because in later part we will organize and summaries all the finding with details.

saving is negative relationship with financial development except in one step GMM and system GMM models respectively.

Table 6, second column, Model (1- SUR) shows the relationship of economic growth with financial development, consumption of energy and CO2 emissions. The estimated coefficient value of energy consumption, CO2 emissions, financial development by private credit sector is positive and significant, which imply that these three main variables are cause of increasing GDP per capita. These three variables have also positive and statistically highly significant in our baseline model two step system estimator results given in Table 8, which confirm the results validity. The same results were found by Muhammad (2019), Jalil and Mahmud (2009), Saidi and Hammami (2015a,b), Shahbaz et al. (2012), Omri (2013), Shahbaz and Lean (2012), Lean and Smyth (2010) and Bowden and Payne (2009). The financial development by bank (B) is positively effects economic growth while this variable in two step system GMM (Table 8) is negatively affect economic growth. The other variables e.g. Capital formation and labor force is positively effects economic growth, while in twostep System GMM negatively affect economic growth. Conversely, populations are positive and significant effects while in two step System GMM given in Table 8, this effect is negative, whereas national expenditure in both models (SUR & System GMM) has negative effects on economic growth which confirm the results validity.

The consumption of energy relationship with three main variables, economic growth, carbon emission and financial development are reported in third column, Model (2- SUR). The three main variables financial development, economic growth and CO2 emissions are positively effects consumption of energy which indicates that due to these three variables the use of consumption of energy has been increased. These three variables results are same with our baseline models (two-step system GMM model) which confirmed the result validity. The financial development by bank positively affects consumption of energy while this effect is found negative in two system GMM model (Table 8). The population and national expenditure are same results in both models and negatively effects energy consumption, merchandise trade is statistically insignificant and shows no effect in SUR model but in system GMM model given in (Table 8) show positive and significant impact on energy consumptions.

Fourth column (SUR-3), show the relationship of Carbon emission with financial development, energy consumptions and economic growth which indicates that economic growth and consumption of energy positively and significantly effects CO2 emissions while financial development by private sectors is negatively effects carbon emissions and these results are in line with the findings of Boutabba (2014). The effect of financial development, economic growth and energy consumptions on CO2 emissions is similar to the results of system GMM given in Table 7 which verified the results validity, except for urban populations is negative effects on CO2 emissions while in SUR model the coefficient value is non-significant which show no effect on CO2 emissions (See Table 8 results for details explanations) because both models results are same. Finally, Table 6 Column fifth (Sur-5) shows the effect of economic growth, CO2 emissions and consumption

Table 6

Seemingly unrelated Regression results for the all four independent variables effects on one another's.

| Variables | (1-SUR) | (2-SUR) | (3-SUR) | (4-SUR) |
|-----------------------|-----------|----------------|----------------|-----------|
| | Cgdppc | energy_consump | carbon_dioxide | FD |
| GDP per capita | | 0.031*** | 0.001*** | 0.002*** |
| | | (0.002) | (0.001) | (0.001) |
| Carbon dioxide | 225.0*** | 382.3*** | | -2.345*** |
| | (79.26) | (4.728) | | (0.235) |
| Energy consumption | 2.876*** | | 0.002*** | 0.000 |
| | (0.174) | | (0.001) | (0.000) |
| Financial develop (B) | 242.9*** | 9.564*** | -0.040^{***} | |
| | (14.11) | (1.716) | (0.004) | |
| Fin development (Pvt) | 28.00** | -9.272*** | 0.022*** | |
| | (13.22) | (1.577) | (0.004) | |
| Population | 0.001*** | -0.001 | | -0.001*** |
| | (0.001) | (0.001) | | (0.001) |
| Labor force | -0.001*** | 0.001 | 0.001* | 0.001*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Capital | -222.8*** | | | 0.929*** |
| National ann addama | (36.44) | 2 005*** | | (0.116) |
| National expenditure | -130.6 | 3.895 | | 0.226 |
| Trada anan | (18.55) | (1.340) | 0.007*** | (0.060) |
| frade open | | -2.407 | 0.007 | |
| Morchandisa trada | | 0.028) | (0.001) | |
| Werchandise trade | | (0.660) | | |
| cadppc? | | (0.000) | 0.001*** | |
| eguppez | | | (0.001) | |
| Urban non | | | 0.005 | |
| orban pop | | | (0.005) | |
| Saving | | | (01000) | -0.151** |
| Saving | | | | (0.064) |
| Infrastructure | | | | 0.103*** |
| | | | | (0.011) |
| Constant | 11,503*** | -374.7** | 0.164 | -16.51** |
| | (2026) | (150.6) | (0.109) | (6.585) |
| Observations | 2393 | 2393 | 2393 | 2393 ´ |
| R-squared | 0.635 | 0.783 | 0.765 | 0.450 |

Notes: standard errors are in parenthesis (). *, **, *** Indicate significance at 1%, 5%, 10% respectively.

of energy on financial development, which all results are same with two step system GMM results given below in Table 8, which no need to explain again here thoroughly, except here we find positive relationship of consumption of energy with financial development which indicates if there is 1% increase in energy consumptions raise the financial development by 0.0103%, which is new contributions to the current literatures and same results were found by Al-mulali and Sab (2012). Similarly, we also find negative relationship of CO2 emissions with financial development but in system GMM this relationship is positive.

4.6. Three stage least squares regression (3SLS)

We are presenting the results of 3SLS model; and compare with our baseline model (Two step system GMM model). Here we will only compare and not explain the results with details because in later part we will organize and summaries all the finding with details.

Table 7, column second, Model ((1-3SLS)) shows the relationship of economic growth with financial development, consumption of energy and CO2 emissions. The estimated coefficient value of consumption of energy is positive and highly significant, while the Carbon emission and financial development by (Bank) is negatively and significantly effects financial development which imply that these three main variables are cause of increasing and decreasing GDP per capita respectively, where financial development private credit sectors (Pvt) is statistically insignificant and show no effects on economic growth. This consumption of energy has also positive and statistically highly significant in our baseline model two step system GMM given in Table 8, which confirm the results validity while the results of CO2 emissions and financial development contradict to 3SLS model. The same results were found by with regard to consumption of energy and CO2 emissions effect on GDP per capita by Jalil and Mahmud (2009), Saidi and Hammami (2015a,b), Islam et al. (2013), Omri (2013), Shahbaz and Lean (2012), Lean and Smyth (2010) and Bowden and Payne (2009). The results of population, labor force, capital and national expenditure are significant effect economic growth but these results are contraindicate the two-step System GMM results given in Table 8, which not confirm the results validity.

Table 7, the consumption of energy relationship with three main variables, economic growth, carbon emission and financial development are reported in third column, Model (2.3SLS). The two main indicators (economic growth and CO2 emissions) are positively effects consumption of energy which indicates that due to these two variables the use of consumption of energy is increasing in globe, which confirm the results validity of twostep system GMM results given Table 8. Conversely, the estimated of both financial development variables are statistically non-significant which show no effects on energy consumption. Furthermore, The population are same results with our baseline models which confirm the results validity, while national expenditure and urban population estimated coefficient sign is positive which indicates if there is 1% increase causes to decrease energy consumption, Whereas merchandise trade and trade openness is statistically insignificant and shows no effect on consumption of energy but in two-step system GMM model given in (Table 8) show negative and positive and significant impact on energy consumptions respectively which contradict the results validity of two-step system GMM model.

If we look at Table 7 of fourth column (3-3SLS), the economic growth and consumption of energy positively and significantly

| Variables | (1-3SLS) | (2.3SLS) | (3.3SLS) | (4.3SLS) |
|-------------------------|--------------------|---------------------|----------------|----------------|
| | Cgdppc | energy_consump | carbon_dioxide | FD |
| GDP per capita | | 0.036*** | 0.000*** | -0.004^{***} |
| | 1001*** | (0.004) | (0.000) | (0.000) |
| Carbon dioxide | -4791*** | 170.2*** | | -24.25^{***} |
| Energy concumption | (1041) 27.00*** | (33.30) | 0 002*** | (4.335) |
| Energy consumption | (2,000) | | (0.002) | (0.010) |
| Financial develop (B) | -134.3** | 4.933 | 0.0107 | (0.010) |
| r () | (53.31) | (4.424) | (0.039) | |
| Financial develop (Pvt) | -79.94 | 3.648 | -0.059* | |
| | (49.87) | (4.106) | (0.0332) | |
| Population | 0.001*** | -0.001*** | | 0.000*** |
| | (0.001) | (0.001) | | (0.001) |
| Labor force | -0.005** | 0.001** | -0.001 | -0.001^{*} |
| Capital | (0.001) | (U.UUI) 8 202*** | (0.001) | (0.001) |
| Capital | (77.20) | 6.202 (3.056) | | -0.439 |
| National expenditure | 531 2*** | -19 60*** | | 1915*** |
| Rutional expenditure | (68.45) | (4,394) | | (0.295) |
| Trade open | () | 0.388 | 0.007*** | () |
| I I I | | (0.686) | (0.002) | |
| Merchandise trade | | 0.0209 | . , | |
| | | (0.861) | | |
| cgdppc2 | | | -0.001^{***} | |
| | | | (0.001) | |
| Urban pop | | 0.001*** | 0.001** | |
| Carriera | | (0.001) | (0.001) | 0.020 |
| Saving | | | | (0.029) |
| Infrastructure | | | | 0.0340 |
| linustracture | | | | (0.0340) |
| Constant | -61.749*** | 2214*** | -0.131 | -225.1*** |
| | (7341) | (486.6) | (0.198) | (32.15) |
| Observations | 2393 | 2393 | 2393 | 2393 |
| R-squared | -2.311 | 0.732 | 0.683 | -10.014 |

 Table 7

 Results of 3SLS for the all four independent variables effects on each other

Notes: Values in parenthesis are the standard errors. *, **, *** Indicate significance at the 1%, 5%, 10% level respectively.

effects CO2 emissions while financial development by private sectors credit are negatively effects carbon emissions. The effect of financial development, economic growth and energy consumptions on CO2 emissions is similar to the results of two step system GMM given in Table 8 which confirm the results validity, except for urban population is positive effects on CO2 emissions while this effects in two step systems GMM is negative, whereas financial development by bank is statistically non-significant while this effects is positive in system GMM model. See Table 8 for details explanations results, because both models results are same and verify the results validity for most of the variables.

Finally, Table 7 Column fifth (3-3SLS-5) shows the effect of economic growth, CO2 emissions and consumption of energy on financial development, which all results are not matching with two step system GMM results given below in Table 8, column five (Model (4d), except here we find positive relationship of consumption of energy with financial development which indicates if there is 1% increase in energy consumptions cause to raise the financial development in globe, which is new contributions to the current literatures and same results were found by Al-mulali and Sab (2012). Similarly, we also find negative relationship of CO2 emissions with financial development but in two step system GMM this relationship is positive. The Infrastructure, gross saving and capital formation is statistically insignificant which show no effects on financial development but these variables have shown effects on financial development in two-step system GMM model. The national expenditure results in both model are positive and statistically significant which increase financial developments, whereas labor force is negative effect financial development in SUR model but this effects is positive in two step system GMM models.

4.7. Two-step system GMM results for global panel of 193 countries

Table 8 presents the empirical results of our baseline dynamic model (1a, 2b, 3c, 4d) using the two-step system GMM approach. In this table we examine the effects among economic growth, energy consumption, CO2 emissions and financial development by Private sector credit effect on each other.

Table 8, model (1a) exhibits that consumption of energy positively and significantly influence GDP per capita which designates that economic growth will increase by 0.101, if the there is one percent increase in consumption of energy in Globe. These findings reveal that consumption of energy cause to increases GDP per capita in 193 countries of the globe and this findings corroborated with the findings procured by (See Muhammad, 2019; Shahbaz and Lean, 2012; Saidi and Hammami, 2015a,b; Al-mulali and Sab, 2012; Omri, 2013; Islam et al., 2013). Since power consumption is a main element for economic growth, solid energy strategies and efficient utilization are obligatory to get perpetuated economic growth (Islam et al., 2013; Apergis and Payne, 2010). The estimated coefficient value of two-step system GMM (Model (1a)) revealed that CO2 emissions have positive effects on economic growth. The results betoken that a 1% elevate in the CO2 emissions increases the economic growth in globe by 53.75 and SUR model verified the results validity that CO2 emissions is the cause of increasing economic growth. This result is in line with the findings (Islam et al., 2013). Similarly, The coefficient of financial development (Pvt) is positive and statistically consequential which designates that 1% increase in financial development decreases economic growth by 26.98 and SUR model results verified the results validity that financial development is the cause of surge economic growth, likewise, this results are

| Variables | GDPPC | EC per capita | CO emission | FD |
|-------------------------------------|----------------|---------------|----------------|------------|
| | Model (1a) | Model (2b) | Model (3c) | Model (4d) |
| Dependent variables _{it-a} | 0.998*** | 0.854*** | 0.594*** | 0.889*** |
| | (0.001) | (0.001) | (0.001) | (0.002) |
| GDPPC (EG) | | 126.3*** | 0.567*** | 0.001*** |
| | | (0.456) | (0.001) | (0.001) |
| Energy consumption (EC) | 0.101*** | | 0.001*** | -0.003*** |
| | (0.000) | | (0.001) | (0.001) |
| CO2 emissions | 36.78*** | 38.30*** | | 0.680*** |
| | (0.111) | (0.026) | | (0.025) |
| Financial develop (Pvt) | 17.28*** | 0.001*** | -0.020^{***} | |
| | (0.096) | (0.001) | (0.001) | |
| Financial develop (B) | -23.74*** | 2.791*** | 0.008*** | |
| | (0.093) | (0.008) | (0.001) | |
| Capital | 57.61*** | | | 0.546*** |
| | (0.077) | | | (0.010) |
| Population | -0.001^{***} | -0.001*** | | -0.001*** |
| | (0.001) | (0.001) | | (0.001) |
| Labor force | 0.001*** | | 0.001*** | 0.001*** |
| | (0.001) | | (0.001) | (0.001) |
| National expenditure | -20.60*** | 0.290*** | | 0.340*** |
| | (0.040) | (0.005) | | (0.006) |
| Saving | | | | -0.036*** |
| | | | | (0.004) |
| Urban population | | -0.001*** | -0.001*** | |
| | | (0.001) | (0.001) | |
| Trade openness | | -4.725*** | 0.000*** | |
| | | (0.005) | (0.001) | |
| Merchandise Trade | | 3.561*** | | |
| | | (0.008) | | |
| GDPPC2 | | | -0.001*** | |
| | | | (0.000) | |
| Infrastructures | | | | 0.002** |
| | | | | (0.001) |
| Constant | 1240*** | -816.1*** | -4.428*** | -43.95*** |
| | (4.970) | (4.005) | (0.00746) | (0.480) |
| Sargan test | 135.467 | 127.369 | 139.849 | 138.224 |

| Tabl | e 8 | |
|------|-----|--|
|------|-----|--|

Results of two-step System GMM models for the all four independent variables effects on each other.

Notes: *, **, *** Indicate significance at the 1%, 5%, 10% level respectively. Values in parenthesis are standard error. Sargan-test refers to the over-identification test for the restrictions in GMM estimation.

withal matching with anterior findings of Goldsmith (1969) and Jalil and Feridun (2011), Whereas another financial by bank (B) is negatively affect economic magnification(growth) which is in line with the precedent studies Al-mulali and Sab (2012). Afterward, the Capital formation is positively and consequential effect economic growth which is in line with the antecedent studies of Saidi and Hammami (2015a,b) and Shahbaz and Lean (2012). We argue that if there is one unit change in Capital or domestic investment will raise the economic magnification by 0.28. Furthermore, other variables, populations and national government expenditure are negatively and significantly economic growth while labor force positively effects economic growth and government expenditure results additionally verified by the results of SUR model, which betokens these are consequential determinants of economic growth.

Table 8, the Model (2b) demonstrate that economic growth positively and significantly effects energy consumptions, which designate that a 1 percent raise in GDP per capita is increase the utilization of energy by 126.3 in globe and these results are matching with the antecedent papers (Saidi and Hammami, 2015a,b). Furthermore, this results validity withal attested by SUR model that economic growth is the cause of incrementing energy consumption. Similarly, the estimated coefficient value of two-step system GMM (Model (2b)) revealed that Carbon dioxide emission has positive effects on energy consumption. The results designate that a 1% rise in the CO2 emissions increases the utilization of energy in globe by 38.30 and SUR model verified the results validity that CO2 emissions is the cause of increasing energy consumption. This result is corroborated with findings of Muhammad (2019) and Saidi and Hammami (2015a,b).

Moreover, the coefficient of financial development (Pvt) and financial development by bank (B) is positive and statistically significant at 1% level, which denotes that a one 1% increase in both financial development variables raises consumption of energy by 2.25 and 2.79 respectively. Our results with regard to financial development is in line with the Sadorsky (2010, 2011) who found positive relationship for 22 emerging and central and eastern Europe countries. Islam et al. (2013) and Shahbaz and Lean (2012) additionally argue that financial development bring raise in energy consumptions. This suggests that financial development is one of paramount be speakers of financials developments. The results validity of financial development by bank is withal verified by SUR model. The other variables regime national expenditure and merchandise trade is positive relationship with consumption of energy which denotes that 1% increase in merchandise trade and national expenditure cause to increment consumption of energy in globe, while population, trade openness and urban population is negatively effects energy consumptions which causes to decline consumption of energy in globe. This betokens that these are consequential determinants of energy consumptions.

Table 8, Model (3c), the estimated value of CO2 emissions is (0.594) denote that each year, carbon emissions is redressed by 0.594% percent. Table 8, Model (3c) shows that global CO2 emissions increase by 0.567 when economic growth elevate by 1%. This revealed that due to output per capita CO2 emissions have been increased in globe. This results are father substantiated by SUR model, as well as, withal corroborated with precedent findings which have discovered that a decline in carbon emissions would drop global GDP per capita (See; Hourcade et al., 1996;

Fan et al., 2010; Acheampong, 2018). This findings additionally matching with anterior recent studies (Muhammad, 2019; Saidi and Hammami, 2015a,b; Menyah and Wolde-Rufael, 2010) who shown that due to carbon emission economic growth have been increased in different regions of the world, as well as, in globe. Likewise, consumption of energy is significantly effects on CO2 emissions and the relationship is positive therefore CO2 emissions increase by 0.001, when consumption of energy increases by 1%. These results accentuation that elevates in consumption of energy deteriorate the environment. These result withal verified by the SUR model that due to consumption of energy carbon emission has increasing in world. Moreover, the coefficient of financial development (Private Sector Credit) and financial development by bank (Bank) is negative and positive and statistically significant at 1% level respectively, which betokens that a one 1% decrease and increment in the both financial development variables raises and decrement consumption of CO2 emission by -0.020 and 0.008 respectively. These results validity are father verified by the SUR model that financial development by private sectors credit and bank are causes to decrease or increase in globe. Our results with regard to financial development by bank and private sector credit is in line with the India, Zhang (2011) for China, Boutabba (2014) for India, Sadorsky (2010) for emerging economies, Jalil and Feridun (2011) for China, Tamazian and Rao (2010) for 24 transitions economies, Al-mulali and Sab (2012) for Sub Sahara African economies. This suggests that financial development is one of consequential be speakers of carbon emissions. The economic growth per capita squares is negative and statistically high significant which proof the inverted U-shaped relationship of environmental Kuznets curve for global panel in all three models. This implicatively insinuates that increase in GDP per capita firstly would increases carbon emissions and then decreases as economic growth increases. The other variables labor force and trade opens is positive relationship with CO2 emissions while urban population is negatively effects CO2 emissions which implicatively insinuates that due to labor force and trade openness carbon emission has incremented, while due to urban population has decremented the carbon emission in globe.

Table 8, Model (4d), the estimated coefficient of GDP per capita is positive and significant at 1% level which implicatively insinuated that 1% percent increase in GDP per capita will increases financial development by .0655. The estimated results revealed that a 1% increase in economic growth cause to increment the consumption of energy in globe. The estimated coefficient of the consumption of energy is negative and highly significant which betokens that a 1% increase in consumption of energy cause to increase the financial development in globe, which are an incipient contribution to current literatures with regard to global panel's countries. Sadorsky (2011) argue that financial development is positively effects energy consumptions by utilizing the stock markets variables such as stock market capitalizations and stock market value traded, but our cases we have utilized the financial sectors credit provide to as dependent variables. On the other hand, the estimated coefficient of CO2 emissions is positive and statistically significant which betoken that CO2 emissions positively effects financial development by utilizing the financial credit provide by bank proxy and these are corroborated with the finding of Al-mulali and Sab (2012). Similarly, the coefficient value of fixed capital formation, Labor force, Regime expenditure and infrastructures is positive and paramount, which denotes that these all variables increases financial development, as well as all these variables are paramount determines which fosters and promote the financial development of a countries. On the other hand, Population and preserving is negative relationship with financial development, which betokens that these two variables decrease financial development when we used private sector credit financial indicator.

4.8. Summary and findings

Table 9 summarized the results and findings about the fourways linkages or effect on one another among financial development, economic growth, and CO2 emissions and consumption of energy in 193 countries of the global.

Firstly, We find that energy consumption, carbon dioxide emission and financial development is positive impact on economic growth and these results are corroborated with the findings of Muhammad (2019), Saidi and Hammami (2015a,b), Omri (2013), Shahbaz and Lean (2012), Lean and Smyth (2010) Bowden and Payne (2009), Jalil and Mahmud (2009) and Ang (2008).

Secondly we find economic growth, carbon dioxide emission and financial development is positive and significant impact on consumption of energy which signifies that these three indicators increase energy consumption. Consumption of energy generates economic growth Al-mulali and Sab (2012) and great cause to stimulate economic growth (Saidi and Hammami, 2015a,b), although, it may the causes of environmental degradations. Energy is the important factors to financial development and economic development, as well as strong polices related to energy and financial development might stimulate the financial and economic development of countries. Our results with regard to energy are corroborated with the findings of Saidi and Hammami (2015a,b) and Apergis and Payne (2010), Sadorsky (2010, 2011), Islam et al. (2013) and Shahbaz and Lean (2012).

Thirdly, The findings of our analysis with regard to the effect of economic growth, consumption of energy and financial development is positively and significantly impact on CO2 emissions. which reveals that these three determinants (energy consumption, economic growth and financial development) has fairly important determinants and great cause of pollutions. These three factors is the cause to increase CO2 emissions which in turn becomes the cause of environmental degradation. Al-mulali and Sab (2012) argue that increase in CO2 emissions is due to fossil fuel consumptions which is 75% energy are using from burning of fossil fuel for economic and financial growth. Therefore, we suggest that all those countries of globe who use fossil fuel in bulk should adopt clean energy from all energy consumptions and adopt strong energy protection policies. Moreover, the economic growth per capita squares is negative and statistically significant which confirm the inverted U-shaped relationship of environmental Kuznets curve for global panel. These are corroborated with the finding of Saidi and Hammami (2015a,b) for 58 countries, Boutabba (2014) for India, Zhang (2011) for China, Boutabba (2014) for India, Sadorsky (2010) for emerging economies, Jalil and Feridun (2011) for China, Tamazian and Rao (2010) for 24 transitions economies, Al-mulali and Sab (2012) sub-Sahara Africa and Muhammad (2019) for Sub-Sahara-Africa, developing and emerging countries.

Finally, as you can see in Table 8, economic growth, consumption of energy is positively associated with financial developments (Pvt) for all countries, signifying that these two variables is increase financial development of countries while the SUR model results did not verify the results validity with regard to consumption of energy as a dependent variable. These findings suggest that due to consumption of energy and economic growth financial development has increased in globe. Moreover, we find that financial development has decreased due to CO2 emissions in globe and SUR model results also verify the results validity. On the other hand, financial developments (B) results indicates that energy consumption, CO2 emissions is positively affects financial development while we find that economic growth decrease financial development. These findings are further verified by SUR model that consumption of energy and CO2 emissions have been increased in our sample countries but economics growth has Effects of economic growth, energy consumption, CO2 emissions and financial development on each other.

| Variables | Global panel GDPPC | | Global panel | Global panel EC | | Global panel CO2 emissions | | Global panel FD | |
|-----------------------|--------------------|--------|--------------|-----------------|------------|----------------------------|------------|-----------------|--|
| | (Sys2Step) | SUR | (Sys2Step) | SUR | (Sys2Step) | SUR | (Sys2Step) | SUR | |
| GDPPC | | | Sig(+) | Sig(+) | Sig(+) | Sig(+) | Sig(+) | Sig(+) | |
| Energy consumption | Sig(+) | Sig(+) | | | Sig(+) | Sig(+) | Sig(-) | Sig(+) | |
| CO2 emissions | Sig(+) | Sig(+) | Sig(+) | Sig(+) | | | Sig(+) | Sig(-) | |
| Fin development (PVT) | Sig(+) | Sig(+) | Sig(+) | Sig(-) | Sig(-) | Sig(-) | | | |
| Fin development (B) | Sig(-) | Sig(+) | Sig(+) | Sig(+) | Sig(+) | Sig(+) | | | |
| Fixed cap formation | Sig(+) | Sig(-) | Sig(+) | InSig(+) | | | Sig(+) | Sig(+) | |
| Population | Sig(-) | Sig(+) | Sig(-) | InSig(-) | | | Sig(-) | Sig(-) | |
| Labor force | Sig(+) | Sig(-) | Sig(+) | InSig(-) | Sig(+) | Sig(+) | Sig(+) | Sig(+) | |
| National expenditure | Sig(-) | Sig(-) | Sig(+) | InSig(-) | | | Sig(+) | Sig(+) | |
| Saving | | | | | | | Sig(-) | Sig(-) | |
| Urban population | | | Sig(-) | | Sig(+) | InSig(+) | | | |
| Trade openness | | | Sig(-) | Sig(-) | Sig(+) | Sig(+) | | | |
| Merchandise Trade | Sig(+) | | InSig(+) | | | | | | |
| GDPPC2 | | | | | Sig(-) | Sig(-) | | | |
| Infrastructures | | | | | | | Sig(+) | Sig(+) | |

Note: SGMM and SUR stand for System GMM and Seemingly unrelated regression respectively, Sig and Insig' stand for significance and insignificant and (+)/(-) stand for positive and negative relationship with dependent variable.

decreased when we used financial development by bank indicator but economic growth and consumption of energy is increased when we used financial development by private sectors credit indicator. Few variables results with regard to financial development are in line with the previous study Al-mulali and Sab (2012).

Fig. 1 shows precise and clear pictures of the effect of four indicators on one another's. We finds that all indicators is positively effects one another, except consumption of energy and Carbon emission decreases the financial development and these all results are corroborated with the previous studies findings of Muhammad (2019), Kahouli (2017), Chaabouni and Saidi (2017). Saidi and Hammami (2015a,b), Acheampong (2018), Boutabba (2014), Saboori and Sulaiman (2013), Zhang (2011), Boutabba (2014), Sadorsky (2010, 2011), Jalil and Feridun (2011), Tamazian and Rao (2010), Al-mulali and Sab (2012), Apergis and Payne (2010), Islam et al. (2013), Shahbaz and Lean (2012), Omri (2013), Ghosh (2010), Lean and Smyth (2010), Bowden and Payne (2009), Jalil and Mahmud (2009), Coondoo and Dinda (2008). Ang (2007, 2008), Yingzi and Yuying (2011), Acaravci and Ozturk (2012) and Altinay and Karagol (2004).

5. Conclusions and policy implications

To date, best to our erudition no paper has been published on the relationship between energy consumption, economic growth, financial development and energy consumptions effects on each other by utilizing Seemingly unrelated regression (SUR), three stages least squares regression and two step GMM and two step system GMM approach altogether. Another novelty in the paper is this first time we are utilizing the economic growth, CO2 emissions and consumption of energy effects on financial development by utilizing bank predicated financial development. The results with regard to economic growth as a dependent variable show that a rise in energy consumption, financial development and carbon emission increases the economic growth in 193 countries. Likewise, financial development, carbon emission and growth increases consumption of energy when we used consumption of energy as dependent variables. Similarly, two variable's (consumption of energy and economic growth) increases the CO2 emissions when we used CO2 emissions as a dependent variable's, while financial development decrease the carbon emission when we used financial development as a private credit sectors but increased when we used financial development by bank variable. In addition, the results with regard to financial development as dependent variables show that increase in economic growth and carbon emission raises financial development while consumption of energy decreases financial development. This study offers the first set of findings on how carbon emission, environmental degradation and economic growth affect financial development in 193 economies. The overall results conclude that financial development, economic growth, consumption of energy and carbon emission is positively affecting one another but with high pollutions spread, except for consumption of energy which decreases financial development. Predicated on our findings our key policy implicative insinuations are as follow.

Firstly, we have found that economic growth, consumption of energy and financial development is increasing the carbon emissions. So we suggest that majority of developing countries and few developed countries should sit together and make vigorous efficacious and efficient energy mechanism and policy, as well as their implementations in order to diminish carbon emissions.

The second suggestion on the substratum of results obtained from our findings that majority of the countries should focus to amend financial development in order to reduce the caliber of CO2 emissions. The third suggestion is this as we have found that carbon emission, energy consumption and financial development are the main stimulator of economic growth. There four all countries, specially developing and few astronomically immense developed countries should establish one best methods or techniques to alleviate the environmental pressure resultant financial and economic development. Moreover, the developed countries should transfer the advanced technology to developing and least development countries to curb carbon emission. Furthermore, developed and developing countries should utilize the alternative resource of energy such as renewable energies and reduce the utilization of fossil fuels particularly United states, China and India. Conclusively, the climate change has been occurred due to extreme greenhouse gas emission which impacts the sustainable magnification of economies of many countries. Hence, it is compulsory to diminish CO2 emissions, which requires active participation of countries ecumenically. We hope that other researcher can utilize our methodology and findings of our paper to acquire better insights into finance, economic, environmental and energy nexus in emerging and developing economies because these countries currently contribute 63% with regard to carbon emissions.

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Two dimension arrows indicate two way negative effects and vice versa

Fig. 1. Four way Linkage or relationship among four indicators (FD, EG, CO2 & EC).

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