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FINANCIAL DEVELOPMENT, INCOME, TRADE, AND URBANIZATION ON CO2 EMISSIONS: NEW EVIDENCE FROM KYOTO ANNEX COUNTRIES

Desenvolvimento Financeiro, Renda, Comércio e Urbanização Sobre as Emissões de CO_2: Novas Evidências dos Países do Anexo do Protocolo de Kyoto

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Abstract: This study attempts to empirically investigate the impact of financial development, income, trade openness, and urbanization on carbon dioxide (CO2) emissions for the 21 Kyoto Annex countries using a balance panel data and GMM system over the period of 1970-2016. The results show a positive relationship between income and CO2 emissions in long-run. All models support the EKC hypothesis which assumes an inverted U-shaped relationship among income and environmental degradation. Financial development has a long-run negative influence on CO2 emissions, indicating that financial development reduces the environmental degradation. This means that financial development can be used as an implement to keep the degradation environmental clean by presenting financial reforms. The urbanization declines the CO2 emissions; however, it is essential for the policymakers and urban planners in these countries to control the rapid increase in urbanization. The panel causality confirms that bi-directional causal relationship between financial development, CO2 emissions, income, trade openness, and Urbanization in short-run.
Key words: Financial development; CO2 emissions; EKC hypothesis; Urbanization; Panel data; GMM system; Kyoto Annex countries

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Resumo: Este estudo tenta investigar empiricamente o impacto do desenvolvimento financeiro, renda, abertura comercial e urbanização nas emissões de dióxido de carbono (CO2) para os 21 países do Anexo do Protocolo de Kyoto usando dados de um painel de balanço e sistema GMM durante o período de 1970-2016. Os resultados mostram uma relação positiva entre renda e emissões de CO2 no longo prazo. Todos os modelos suportam a hipótese EKC, que assume uma relação em U invertido entre a renda e a degradação ambiental. O desenvolvimento financeiro tem uma influência negativa de longo prazo nas emissões de CO2, indicando que o desenvolvimento financeiro reduz a degradação ambiental. Isso significa que o desenvolvimento financeiro pode ser usado como um instrumento para manter a degradação ambiental limpa, apresentando reformas financeiras. A urbanização diminui as emissões de CO2; no entanto, é essencial que os formuladores de políticas e planejadores urbanos desses países controlem o rápido aumento da urbanização. A causalidade do painel confirma essa relação causal bidirecional entre o desenvolvimento financeiro, as emissões de CO2, a renda, a abertura comercial e a urbanização no curto prazo.
Palavras-chave: Desenvolvimento Financeiro, Emissivos de CO2; Hipóteses EKC; Urbanização; Dados de Painel; Sistema GMM; Países do Anexo do Protocolo de Kyoto

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INTRODUCTION

The change of climate due to hazard of global warming is one of the important concern in the 21st century, eliminating and devastating climatic actions which preserve to demolish the whole planet. The concern of sustainable development has moved the consideration of the world from simple growth to environment friendly growth in the last decades. Consequently, economists and environmentalists are concerned about the environmental costs of economic growth. This matter could not fascinate much consideration of policy makers who consider that economic growth is explicit to environment and there would be no reaction from environmental descent to the economic development. Therefore, the injurious effects of environmental deterioration seemed in different practices, disturbing the economic actions of countries in a serious manners. The burn out of fire in Russia, the explosion of flood in China and Australia, the earthquake in Japan, and the tsunami in Northern Chile, Portugal and Spain are some of the main disaster detected in the past which might be the penalties of environmental dilapidation. These actions caused in damages to infrastructure, natural resources and also the human lives. These events were very astonishing for researchers in the field of economics and environment. The association among different element of environmental quality and the economy was described in the recent years by the environmental Kuznets curve, which is the hypothesis of an inverted U-relationship among CO2 emission and economic growth (Grossman and Krueger, 1993; Bruyn et al., 1998). The EKC hypothesis revealed a U-shaped relationship inverted between different elements of quality of the environment and income. In such circumstances, the CO2 emissions were generally explicated by means of linear polynomials or quadratic of income.

In the literature, the determinations have been made to determine the dynamic causal associations between the environmental quality and economic activity. However, the influence of economic activity on environmental degradation in a bivariate structure is still impending in the empirical literature, the relationship is important with the incorporating of more variables. The CO2 emissions in one particular country does not essentially depend on its trade openness, income, urbanization, and financial development might be other alternative source. Additionally, the influence of financial development on the eminence of the environment has established a little consideration by different ways might be effective on the environment: (a) financial development by creation the capital required for the industrial actions and then the industry can cause CO2 emissions (Sadorsky, 2010); financial development might be delivered better financial funds with a less financial charges, for example, exited to the environmental plans (Tamazian and Rao, 2010); financial mediators can get the new reverent of the environment, technology which can enhance the environment (Tamazian et al., 2009).

Generally, the sustainable economic growth and improvement has been the essential macroeconomic objective of all the governments in order to enhance the social welfare. Then, the problem for the policymakers is to perceive and advocate the main measures to accelerate a necessary level of economic growth. Perhaps, there are different techniques but the modern growth theory contends on that financial development influence on long-term growth through the technical progress and capital formation. A proficient and persistent financial sector confirms the accumulated capital formation, improves the procedure of investment, and alleviates in financial risk and borrowing costs and inconsistent clearness among creditors and borrowers. As a result, they enlarges saving, and portfolio, which subsequently more support the inward foreign capital and embolden technological development. It is believed that comprehensive financial structure rises social welfare and leads to alleviate poverty, condense income inequality, and activate savings and productive return on investment, therefore, enhance economic growth. Furthermore, extensive financial facilities increase income growth, extending financial services supply which can be benefit for the poor people and will substitute income growth for the poor, therefore having a direct influence on poverty mitigation. Consequently, financial development is one of the essential aspects which play a vital role in the progression of economic development. So, financial organizations are deliberated to be an enthusiastic implementer to the economic growth and development.

Kuznets (1955), the innovative study by Grossman and Krueger (1995), firstly modified the relationship regarding economic growth and environment degradation, later on different empirical researchers were fascinated by this research area. The EKC represents that environmental degradation initially rises with a rise in economic growth and then starts decreasing, once per capita income has touched to the benchmark point. Additional, rise in income at initial level of economic growth is augmented with acceleration of energy consumption that promotes the environmental degradation. The EKC hypothesis has been investigated for different economies (Pao and Tsai, 2010; Al-Mulali and Ozturk, 2015; Jamel and Maktouf, 2017; Anastacio, 2017). The EKC hypothesis has also been examined for Asia (Shahbaz, 2009; Lean andSmyth, 2010; Apergi and Ozturk, 2015), Africa (Orubu and Omotor, 2011; Osabuohien et al., 2013), USA (Day and Grafton, 2003; Zilio and Recalde, 2011), Europe (Ang, 2007; Acaravci and Ozturk, 2010; Esteve and Tamarit, 2012). All of these empirical studies accomplish with mixed results. This study extends the empirical work of Kasman and Duman (2015) by taking into account financial development on CO2 emissions with a different econometric techniques.

There are a number of expected contributions of this study to the social-financial development, environmental pollutants, and economic growth literature. This study provide new empirical results with respect to the dynamic association between CO2 emissions, financial development, income, trade, and urbanization in order to help policy makers to design suitable economic and environmental policies for the studied countries. The Kyoto Protocol is an international agreement which prolongs the 1992 United Nations Framework Conventions on Climate Change (UNFCCC) that obliges state parties to condense greenhouse gas emissions, based on the scientific agreement that (a) global warming is happening and (b) it is enormously likely that human-made CO2 emissions have mainly caused it. The Kyoto Protocol (Kyoto Annex countries) applied the aim of the UNFCCC to fight global warming by decreasing greenhouse gas attentions in the environment to a level that would preclude dangerous anthropogenic intervention with the system of climate. The Protocol is established on the principle of common but distinguished accountabilities: it situates the responsibility to decrease current CO2 emissions in developed countries on the basis that they are generally accountable for the current levels of greenhouse gases in the environment. The main objective of the Kyoto Protocol (Kyoto Annex countries) is to control emissions of the main anthropogenic (human-emitted) greenhouse gases (GHGs) in such techniques that replicate underlying national differences in GHG emissions, wealth, and capability to make the reductions. The agreement follows the main ideologies approved in the original 1992 UN Framework Convention. After all the objective of this research is to examine the influence of financial development, income, trade and urbanization on CO2 emissions for the Kyoto Annex countries.

To the best of our knowledge, this is the first study that empirically models the relationship between these variables in 21 Kyoto Annex countries, such as Australia, Austria, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Netherland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, and USA, as it applies the panel co-integration and GMM SYSTEM, Dumitrescu and Hurlin heterogeneous causality, and the innovative accounting approach and the impulse response function. However, this study investigates the impact of financial development, income, trade openness, and urbanization on CO2 emissions in 21 Kyoto economies over the period of 1990 to 2016.

We find that per capita of income has statistically significant and positive effect on CO2 emissions, this indicates that a rise in GDP per capita rises per capita CO2 emissions in the Kyoto Annex countries. Furthermore, the square term of GDP has a negative effect on CO2 emissions in all four models which is confirm the environmental Kuznets curve hypothesis specifying an inverted U-shaped curve. Additionally, trade openness does not significant on CO2 emissions in all three models. However, urbanization has a significant and negative effect in all models. This indicates that urbanization is not one of the key elements of the CO2 emissions. Finally, the coefficient of financial development is negative in all three models, which means that financial development has a negative influence on the CO2 emissions. In short-run, a bi-directional causality among financial development, per capita income, urbanization, trade openness, and CO2 emissions is observed.

The rest of the paper is organized as follows: Section 2 reviews the theoretical and empirical literature. Section 3 presents the methodology and data. Section 4 (Empirical Findings) focusses on the explanation of the findings and arguments including the statistical importance of the findings. Section 5 concludes the paper and provides recommendations for upcoming research.

LITERATURE REVIEW

The role of financial development, trade openness, urbanization, and income on the environmental dilapidation has been amassed consideration in the recent literature. Both of specific and cross-country empirical studies argued the prominence of these variables on the CO2 emissions. Halicioglu, (2009) used the time series data for the inspecting the causal association among CO2 emissions, trade openness, energy use, and economic growth in Turkey. Their results show that income is the statistically significant variable in explanation the CO2 emissions in Turkey, which is tracked by trade openness and energy consumption. Furthermore, there happens a steady function of CO2 emission. Sadorsky (2010) examined the effect of urbanization on CO2 emissions for a panel of emerging economies. The estimated coefficients on the energy concentration are positive and statistically significant using different estimation methodology. Though, the estimated contemporary coefficient on the urbanization variable is positive but insignificant. Hossain (2011) scrutinized the causal association among CO2 emissions, economic growth, trade openness, energy consumption, and urbanization using the time series data of newly industrialized countries. The Granger causality experiment outcomes show that there is no significant of long-run causal association, but there is a unidirectional short-run association from growth and openness to trade CO2 emission, from trade openness to economic growth, and from trade openness to urbanization. Shahbaz et al., (2011) analyzed the effects if financial development, coal consumption, trade openness, growth on environmental performance in South Africa. They endorsed the existing of a long-run association between the variables. The increase in economic growth increases the energy emissions whereas the financial development depresses it. The openness trade might develop the environmental eminence by depressing the growth of energy chemicals. Zhang (2011) used some econometric methods, to explore the impact of financial development on CO2 emissions in China. He indicated that the impact of financial development on CO2 emissions compensated that of other elements of financial development, but its competence influence seems by far weaker though it might origin the change of CO2 emissions statistically.

Ali et al., (2015) studied the causal association between financial development, power consumption, price, and GDP per capita. They showed that the financial development has a statistically significant and negative influence on consumption of fossil fuels in short-run. Though, the energy prices have a positive and statistically significant influence on the consumption of fossil fuels. Therefore, in the long-run, growth has a statistically negative influence on consumption energy, and financial development has a significant negative influence on consumption energy, whereas the energy prices have a statistically significant and positive influence on consumption of fossil fuels. In the long-term, financial interconnected relations and financial proficiency in China, Yang et al., (2015) revealed that there is a positive influence of the economic growth on the environment.

Wang et al., (2015a) investigated the causal relationship among consumption energy, urbanization, and CO2 emissions by using panel co-integration and Granger causality techniques. The empirical results indicate that the causal association from urbanization to consumption energy and from urbanization to CO2 emissions have found by Granger causality tests in short run. Also, the results evidently show that in the long-run, urbanization collected with consumption energy Granger cause CO2 emissions. Likewise, Wang et al., (2015b) scrutinized the causal relationship between the urbanization-CO2 emission-Environmental Kuznets curve for a panel of the OECD countries. The result exposed that the intensity of energy and economic growth have vibrant effects on per capita CO2 emissions. Additionally, the result indicate for an inverse U-shaped curve relationship among urbanization and CO2 emissions. Wang et al., (2016) examined the influence of economic growth and urbanization on sulfur dioxide emissions. The results indicated that there is a confirmation of an inverted U-shaped curve association among economic growth and sulfur dioxide emissions and between for emissions and urbanization.

Kohler (2013) studied the causal relationship among CO2 emissions, foreign trade, consumption energy, and economic growth in South Africa. The Granger causality tests indorse the presence of positive bidirectional causality among trade and income per capita and among trade and consumption energy. Muhammad and Fatima (2013) inspected the influence of financial development, consumption energy, economic growth, square term of economic growth, and openness on CO2 emissions. The result also exposed a statistically significant and positive coefficient for financial development, proposing that financial development has happened at the cost of environmental quality. Moreever, the trade openness has no significant impact on CO2 emissions in short and long run. Ozturk and Acaravci (2013) revealed that the dynamic relationship between financial development, consumption energy, economic growth and CO2 emissions in Turkey. The empirical result show that the increase of international trade to GDP clues to greater CO2 emissions and financial development has no statistically significant impact on CO2 emissions in long-run. Shahbaz et al., (2013a) examined the association between energy consumption and GDP per capita by containing trade openness and financial development. The Granger causality test revealed that bidirectional causality consumption energy and openness trade. The bidirectional relationship among openness trade and financial development. Bidirectional causality occurs among trade openness, financial development and economic growth. Additionally, Sbia et al., (2014) studied the association among openness trade, FDI, CO2 emissions, clean energy, and economic growth in UAE. The results indorse the presence of co-integration between the series. They confirm that trade openness, FDI, and carbon condense the energy demand.

Boutabba (2014) recommended that there is a dynamic relationship among financial development, trade openness, CO2 emissions, and economic growth. Additionally, it shows a long run unidirectional causality running from financial development to CO2 emissions. The evidence proposes that financial system should take into account the environment feature in their current procedures. Moghadam and Lotfalipour (2014) examined the influence of financial development on environment quality in Iran. The results indication that financial development accelerates the dilapidation of the environment; though, the rise in openness trade condenses the destruction to environment in Iran. Yazdi and Shakouri (2014) inspected the dynamics relationship among CO2 emissions, trade openness, consumption energy, financial development, urbanization, and economic growth in Iran. The result indicate that there is a statistically significant relationship among CO2 emissions, consumption energy, and income, square term of income, openness trade, and urbanization. The result also indorse the presence the EKC hypothesis in this particular economy. Additionally, the causality test also show that there was a unidirectional causality running from CO2 emissions, financial development, consumption energy, real income, and urbanization. Altaee and Al-Jafari (2015) scrutinized the causal relationship between financial development, trade openness, and economic growth using panel co-integration and Granger causality techniques. The result show that financial development and trade openness have statistically significant effect on economic growth, but economic growth is found to have no causal effect on financial development and trade openness. Also, the results indicate that a short-run causality from financial development to trade openness. Omri et al., (2015) studied the dynamic relationship among financial development, international trade, CO2 emissions, and income in MENA countries using panel data and simultaneous-equation. The results show that there is bidirectional causality between trade openness and economic growth, also a bidirectional causality between CO2 emissions and economic growth. Additionally, the neutrality hypothesis is found between CO2 emissions and financial development. Al-Mulali et al., (2016) and Bhattacharya et al., (2017) exposed that there is a long-run relationship between energy consumption, trade, output and CO2 emissions for all countries and explored that environmental concerns of economic growth are alarming for most of the countries in the panel and the renewable energy consumption is the important factor towards environmental deterioration.

According to the empirical studies cited above, the empirical evidence of this study is developed to scrutinize the influence of financial development, income, trade openness, and urbanization on CO2 emissions. The empirical investigation is explained for an annually panel data of 21 Kyoto Annex countries (Australia, Austria, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Netherland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, and USA) for the period of 1970 to 2016.

EMPIRICAL MODEL AND DATA

Empirical Model

In this study, we scrutinize the dynamic relationship between financial development (FDP), foreign trade (OPE), urbanization (URB), income (Y), square of income (Y2), and CO2 emissions (C) for 21 Kyoto Annex countries during the time period of 1990-2016 using system-GMM model.

$$lnC_{it} = \alpha_i lnC_{it-1} + \beta_{i1} lnFDP_{it} + \beta_{i2} lnY_{it} + \beta_{i3} lnY^2{}_{it} + \beta_{i4} lnOPE_{it} + \beta_{i5} lnURB_{it} + \varepsilon_t$$

Where i shows the countries and t shows the time period. LNC, LNFPD, LNY, LNY2, LNOPE, and LNURB represent the natural logarithms of CO2 emissions, financial development, and income, square term of income, foreign trade, and urbanization, respectively. In order to reveal the inverted U-shaped pattern of the EKC hypothesis, the negative sign is expected for β3. The Inverted U-shaped pattern of EKC indicates that per capita carbon emissions increase with an increase in per capita income up to a certain threshold level of per capita income, after which per capita carbon emissions decline. If β3 is statistically insignificant, then there is a monotonically increasing relationship between per capita CO2 emissions and per capita income.

The model (1) is a dynamic panel model that contains unobserved panel level effects. Accordingly, Arellano and Bond, (1991) explain a generalized method of moments (GMM) estimator that delivers estimations of coherent parameters for such type of models. Though, the (Arellano and Bond, 1991) methodology can, in some cases, deprived outcomes if the autoregressive parameters are too big or the ratio of the variance of error is too big. Furthermore, Blundell and Bond, (1998), construct on the work of Arellano and Bover (1995), improve a system GMM estimator which advanced these complications by incorporating the instruments list for the level equation. In this study, we use the system GMM methodology to evaluation our models.

Data Sources and Descriptive Statistics

The annual data for CO2 emission (metric tons per capita), financial development (domestic credit to private sector by financial institutions (% of GDP)), per capita real GDP (Y) (constant 2010US$), trade openness (OPE) (% of imports and exports of GDP), and urbanization (URB) (% urban population of total) are downloaded from the World Bank's Development Indicators. The data is used for the time period 1990-2016. The sample countries in this study include, Australia, Austria, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Netherland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, and USA. Table 1 explain the variable name, Acronym, description, and data source. The descriptive statistics of all variables for panel and individuals are given below in Table 2.

The highest means value of financial development (2293.633) is in UK, per capita CO2 emissions (19.4069) is in USA, per capita real GDP (47240.09) is in Denmark, trade openness (131.5794) is in Ireland, and urbanization (90.6699) is in Iceland. The lowest average value of financial development (25.0702) is in Turkey, per capita CO2 emissions (0.7549) is in Switzerland, per capita real GDP (2586.463) is in Switzerland, trade openness (19.9153) is in Japan, and urbanization (50.4786) is in Portugal.

Furthermore, the highest coefficient of variation (which is measured by the ratio of standard deviation to mean ratio) in the financial development (6.5073) is in UK, per capita CO2 emissions (0.3638) is in Turkey, per capita real GDP (0.5135) is in Ireland, trade openness (0.3963) is in Turkey, and urbanization (0.1973) is in Turkey. Correlation matrix between panel data variables are shown in Table 3, which shows there is no multicolinearity issue among the variables in the current study. All variables, C, FDP, Y, OPE, URB, are shown in natural logarithms. Also the figure 1 shows the trend of all the discussed variables.

Table 1: Variable name, Acronym, description, and data source

Variables	Acronym	Description	Source	Time span
CO_2 emission	C	CO_2 emissions (metric tons per capita	WDI	1970-2016
Financial development	FDP	Domestic credit to private sector by financial institutions (% of GDP)	WDI	1970-2016
Per capita income	Y	GDP real per capita growth	WDI	1970-2016
Per capita income Square	Y^2	(GDP real per capita growth)^2	WDI	1970-2016
Trade Openness	OPE	(% of imports and exports of GDP)	WDI	1970-2016
Urbanization	URB	(% urban population of total)	WDI	1970-2016

Note 1: WDI is the World Development Indicators.

Table 2: Descriptive statistics for the individuals and also for panel

Countries	Descriptive Statistics	C	FDP	Y	OPE	URB
Australia	Means	15.6323	64.8871	38963.35	35.0196	86.7390
	Std. dev.	1.8019	39.4028	9665.423	5.7754	1.3758
	CV	0.1153	0.6073	0.2480	0.1649	0.0158
Austria	Means	7.7046	72.3344	35730.12	76.0494	65.6673
	Std. dev.	0.6207	18.7499	9096.021	16.2817	0.2187
	CV	0.0805	0.2592	0.2545	0.2140	0.0033
Canada	Means	16.5043	99.6603	38345.33	58.6213	78.0239
	Std. dev.	0.8187	40.1286	7836.262	11.4563	2.1941
	CV	0.0496	0.4027	0.2044	0.1954	0.0281
Denmark	Means	10.3190	87.2897	47240.09	75.7014	84.6685
	Std. dev.	1.6444	62.1438	10150.13	15.6209	1.8848
	CV	0.1594	0.7119	0.2149	0.2063	0.0223
Finland	Means	10.5316	50.6097	34071.14	62.4671	77.6764
	Std. dev.	1.1463	24.3022	9516.706	11.8776	6.3011
	CV	0.1088	0.4802	0.2793	0.1901	0.0811
France	Means	6.8469	69.0311	33070.88	46.6067	75.1571
	Std. dev.	1.4007	16.9943	6844.890	8.0031	2.3188
	CV	0.2046	0.2462	0.2070	0.1717	0.0309
Greece	Means	6.6072	53.0855	21120.86	44.4188	71.8096
	Std. dev.	1.6635	31.6392	4089.262	10.7716	3.5739
	CV	0.2518	0.5960	0.1936	0.2425	0.0498
Iceland	Means	7.3446	79.1904	32677.01	75.5962	90.6699
	Std. dev.	0.7115	67.2683	8679.059	12.2713	2.7121
	CV	0.0969	0.8495	0.2656	0.1623	0.0299
Ireland	Means	8.5972	70.9188	32051.24	131.5794	57.7983
	Std. dev.	1.3296	35.5878	16458.08	41.1771	3.1736
	CV	0.1547	0.5018	0.5135	0.3129	0.0549
Italy	Means	6.9861	57.0744	29956.73	44.0988	67.0171
	Std. dev.	0.7605	19.9900	6295.500	7.5361	1.0741
	CV	0.1089	0.3502	0.2102	0.1709	0.0160
Japan	Means	8.6821	167.0820	35623.85	19.9153	80.5872
	Std. dev.	0.8430	30.2393	9295.732	5.7486	6.3328
	CV	0.0971	0.1810	0.2609	0.2886	0.0786
Netherland	Means	10.9992	86.9246	38585.64	112.8168	73.6409
	Std. dev.	0.8228	24.5919	9248.606	20.1437	9.4468
	CV	0.0748	0.2829	0.2397	0.1786	0.1283

New Zealand	Means	7.0722	76.5463	27936.13	56.2347	84.6480
	Std. dev.	1.0438	49.7207	4806.149	5.4683	1.4759
	CV	0.1476	0.6496	0.1720	0.0972	0.0174
Norway	Means	9.0008	70.3890	66500.64	71.9550	73.6354
	Std. dev.	1.3662	36.7907	19383.26	4.1104	4.2674
	CV	0.1518	0.5227	0.2915	0.0571	0.0580
Portugal	Means	4.1543	112.1901	16966.78	60.1255	50.4786
	Std. dev.	1.4218	19.7658	4667.813	10.5312	7.7482
	CV	0.3422	0.1762	0.2751	0.1752	0.1535
Spain	Means	5.8715	84.7228	23512.00	43.8710	74.8118
	Std. dev.	1.0747	46.4141	6001.772	12.0430	3.4708
	CV	0.1830	0.5478	0.2553	0.2745	0.0464
Sweden	Means	7.0083	84.9671	39808.88	68.1300	83.6874
	Std. dev.	1.9625	24.8557	9288.556	14.4204	1.0880
	CV	0.2800	0.2925	0.2333	0.2117	0.0130
Switzerland	Means	0.7549	135.1318	2586.463	96.9810	68.1513
	Std. dev.	0.2448	25.2330	888.5165	13.4132	7.0584
	CV	0.3243	0.1867	0.3435	0.1383	0.1036
Turkey	Means	2.8708	25.0702	7671.971	35.0561	57.8974
	Std. dev.	1.0444	14.9636	2710.886	13.8930	11.4247
	CV	0.3638	0.5969	0.3533	0.3963	0.1973
UK	Means	9.4338	2293.633	30217.87	51.4668	79.0618
	Std. dev.	1.3315	14925.26	7910.371	5.1201	1.5290
	CV	0.1411	6.5073	0.2618	0.0995	0.0193
USA	Means	19.4069	136.3961	38149.70	23.2203	76.9884
	Std. dev.	1.5157	40.7262	9239.344	5.3281	2.9368
	CV	0.0781	0.2986	0.2422	0.2294	0.0381
Panel	Means	15.6323	64.8871	38963.35	35.0196	86.7390
	Std. dev.	1.8019	39.4028	9665.423	5.7754	1.3758
	CV	0.1153	0.6073	0.2481	0.1649	0.0159

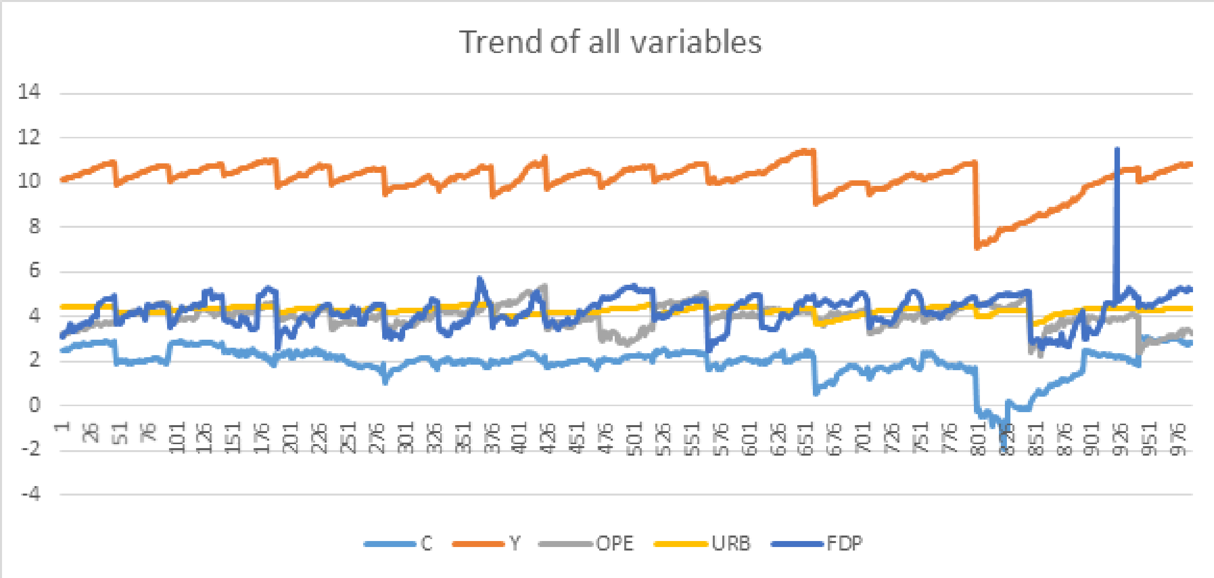
Note 2: Std. dev standard deviation, CV coefficient of variation, C show the per capita of CO_2 emissions, FDP indicate the Financial Development, Y is the per capita real income. OPE show the trade openness, and URB is the Urbanization.

Table 3: Corrleation Matrix

Variables	C	FDP	Y	OPE	URB
C	1.0000				
FDP	0.4576	1.0000			
Y	0.4811	0.0078	1.0000		
OPE	-0.1785	-0.0120	0.2210	1.0000	
URB	0.4014	0.0159	0.4895	-0.0655	1.0000

Note 3: C show the per capita of CO_2 emissions, FDP indicate the Financial Development, Y is the per capita real income. OPE show the trade openness, and URB is the Urbanization.

Figure 1: Trend of all the selected variables.



EMPIRICAL RESULTS AND DISCUSSIONS

Unit root tests

The unit root test of individual time series is the most important test, the panel unit root test becomes more prevalent due to its upper power and latest. There is a diversity of panel unit root tests which contain Levin et al., (2002) and Im et al., (2003) among others. Therefore, the following autoregressive specification:

$$Y_{it} = \alpha_i Y_{it-1} + \beta_i X_{it} + \varepsilon_{it} \quad (2)$$

Where i shows for each country in the panel; t shows to the time period; X it refers to the exogenous variables in the model containing individual time trend or fixed effects; αi are the autoregressive coefficients; and ε_{it} are the stationary error terms. If αi<1, Y_{it} is reflected weakly trend stationary; However if αi=1, then Y it has a unit root. The (Levin et al., 2002) panel unit root tests assume a homogenous autoregressive unit root under the alternative hypothesis; however Im et al., (2003) permits for a heterogenous autoreressive unit root under the alternative hypothesis.

Table 4, all the variables in level, the null hypothesis of unit root cannot be rejected for both unit root tests (LLC and IPS). By taking the first difference, the null hypothesis is rejected for both unit root tests at the 1 and 5 % significance level. All the series, the first difference provides convincing indication of panel unit root. However, it is conclude that LNC, LNFDP, LNY, LNOPE, and LNURB are integrated with order one I (1).

Table 4: Panel unit roor results for LNC, LNFDP, LNY, LNOPE, LNURB

Tests	Variables	LNC	LNFDP	LNY	LNOPE	LNURB
At level						
	Levin, Lin & Chu (LLC)	7.2474 (1.0000)	11.6688 (1.0000)	20.6786 (0.5490)	6.4269 (0.3409)	11.5093 (1.0000)
	Im, Pesaran and Shin (IPS) W-stat	-0.5050 (0.3068)	1.2601 (0.8962)	0.5789 (0.7178)	-0.4403 (0.3298)	14.8556 (1.0000)
At first difference						
	Levin, Lin & Chu (LLC)	-16.9681* (0.0000)	-20.5477* (0.0000)	-10.4878* (0.0000)	-24.2784** (0.0422)	-3.5050* (0.0002)
	Im, Pesaran and Shin (IPS) W-stat	-18.8949* (0.0000)	-18.1847* (0.0000)	-14.0987* (0.0000)	-21.3921* (0.0000)	-15.4609** (0.0151)

Note 4: * and ** represent significance at the 1% and 5% levels, respectively.

Panel Co-integration results

Granger (1988) involved the stationary tests of two series to introduce the idea of co-integration. Consequently, the first phase is to examine the stationary of each series, given that for each series to be co-integrated they would be stationary of the same order I (1) and be created by an error-correction model (ECM). The second phase includes examining the long-run association among CO2 emissions, financial development, trade, real GDP, and urbanization using the panel co-integration method (Kao, 1999; Pedroni, 2004). Pedroni's test recommends seven different statistics to examine for co-integration association in heterogeneous panel. All of these tests are modified for bias familiarized by potentially endogenous regressors. The seven test statistics of Pedroni are categorized into within-dimension and between-dimension statistics. Within-dimension statistics are discussed to as panel co-integration statistics, while between-dimension statistics are referred group mean panel co-integration statistics. This method allows for heterogeneity between different members of the panel and is thus an enhancement over classical co-integration tests. Table 4, there is a strong indication that each panel series is integrated I (1) at the first difference. Table 5 shows the findings concerning to the different methods applicable to (Kao, 1999; Pedroni, 2004). The results shows the existence of long-run relationship between all the variables.

Table 5: Pedroni residual cointegration test results

Methods	Series: LNC, LNFDP, LNY, LNOPE, LNURB					
Pedroni (2004)	Within dimension (panel statistics)			Between dimension (Individual statistics)		
	Test	Statistics	Prob.	Test	Statistics	Prob.
	Panel v-Statistic	-0.8155	0.7926	Group ρ-statistic	-2.5690*	0.0051
	Panel rho-Statistic	-4.0230*	0.0000	Group PP-Statistic	-7.3279*	0.0000
	Panel PP-Statistic	-7.1055*	0.0000	Group ADF-Statistic	-1.6858**	0.0450
	Panel ADF-Statistic	-2.5069*	0.0061			
	Weighted statistic					
	Panel v-Statistic	-0.8155	0.7926			
	Panel rho-Statistic	-4.0230*	0.0000			
	Panel PP-Statistic	-7.1055*	0.0000			
	Panel ADF-Statistic	-2.5069*	0.0059			
(Kao 1999)	ADF	-9.9661*	0.0000			

Note 5: the panel ADF statistic is analogous to the LLC panel unit root test. The group ADF statistics is analogous to the IPS panel unit root test. The PP statistics are panel versions of the Phillips-Perron (PP) t-statistics.

Note 6: Rejection of the null hypothesis of no co-integration at the 1% and 5% level of significance respectively.

Dumitrescu and Hurlin heterogeneous causality

Dumitrescu and Hurlin (2012) established a short-run causality analysis based on heterogeneous panels. This assessment is applied to find out the short-run causality between all the considered variables in this study. The results are showed in Table 6. The result show that CO2 emissions granger causes financial development, income, urbanization, and trade openness, whereas financial development and urbanization Grangr cause CO2 emissions, bi-directional causality between financial development, per capita income, trade openness, and urbanization is found in short-run. The outcomes show that increase in financial development and urbanization can boost up CO2 emissions which influence per capita income, financial development, trade openness and urbanization in short-run. The Dumitrescu and Hurlin causality indorses that there is relationship between CO2 emissions, financial development, per capita income, trade openness, and urbanization in short-run across Kyoto Annex countries.

Table 6: Pairwise Dumitrescu and Hurlin panel causality tests

Null hypothesis	W-Stat	Zbar-Stat	Prob.
FDP does not homogeneously cause C	2.2286	0.2547*	0.0009
C does not homogeneously cause FDP	0.9043	2.4799*	0.0001
OPE does not homogeneously cause C	4.2439	4.4165*	0.0000
C does not homogeneously cause OPE	2.2915	0.3846*	0.0001
URB does not homogeneously cause C	0.4283	3.4629*	0.0005
C does not homogeneously cause URB	11.7356	19.8869*	0.0000
Y does not homogeneously cause C	2.2115	0.2195*	0.0002
C does not homogeneously cause Y	1.8835	0.4578*	0.0031
OPE does not homogeneously cause FDP	5.4288	6.8633*	0.0000
FDP does not homogeneously cause OPE	5.0508	6.0826*	0.0000
URB does not homogeneously cause FDP	5.4121	6.8287*	0.0000
FDP does not homogeneously cause URB	14.7860	26.1860*	0.0001
Y does not homogeneously cause FDP	11.0361	18.4424*	0.0000
FDP does not homogeneously cause Y	1.0508	2.1774*	0.0002
URB does not homogeneously cause OPE	0.4031	3.5148*	0.0004
OPE does not homogeneously cause URB	14.7158	26.0410*	0.0000
Y does not homogeneously cause OPE	9.0487	14.3385*	0.0000
OPE does not homogeneously cause Y	3.0018	1.8514*	0.0005
Y does not homogeneously cause URB	23.1175	43.3907*	0.0000
URB does not homogeneously cause Y	4.5174	4.98117*	0.0000

Note 7: * indicates the 1% level of significance.

GMM-SYSTEM of panel data

The table 7 shows the estimation test for autocorrelation and the validity of the instrument. AR (1) and AR (2) are Arellano and Bond, (1991) investigations for first-order and second-order autocorrelation in the first differenced errors. The Sargan test is to check for over identifying restrictions (Arellano and Bond, 1991). A rejection from this experiment indications that instruments might be miss-specified. Table 7, each model the AR (2) tests indication of no autocorrelation at 1% and 5% significance level. The Sargan tests show that none of the models show confirmation of miss-specified at the 1% and 5% significance level.

The results indication that CO2 emissions in preceding period contribute to decline of environment in the coming period. If lag of CO2 emissions are positively interrelated with income and leads of CO2 emissions are negatively interrelated with income, this delivers a presence of an inverted U-shaped links. Therefore, model 1 indications that income has statistically significant and positive influence on CO2 emissions. It is noted that a 0.547% rise in CO2 emissions in allied with a 1 % rise in income. These results are different with the findings of (Ben Aissa et al., 2014).

Financial development influences CO2 emissions negatively and statistically significant. The results show that financial development has oppressed effect on contaminants. The findings indicate that a 1 % increase in financial development will leads to 0.078 % decreased in CO2 emissions. This findings is in line with Tamazian et al., (2009) and Jalil and Feridun, (2012). The empirical result indicates that influence of urbanization on CO2 emissions is positive and statistically significant. This denotes that a 1% increase in urbanization will ultimately decrease the per capita CO2 emissions by 0.144 %. This result is consistent with Martínez-Zarzoso and Maruotti, (2011) and Sharma, (2011). The coefficient of trade openness is positive but not statistically significant. This results in in line with Managi et al., (2009) and Naranpanawa, (2011).

Model 2 appearances that income has positive and statistically significant effect on CO2 emissions. This suggests that a 1% rise in income will ultimately rise the CO2 emissions by 0.565%. Additionally, urbanization has a negative and significant effect on CO2 emissions, it means that 1 % rise in urbanization decreases the environment pollution by 0.150%. Our findings is different with the (Hua-jun, 2012; Zhang et al., 2015). However, for all 21 Kyoto countries in this study, greater urbanization leads to decrease the CO2 emissions. In model 3, income has a statistically significant and positive influence on CO2 emissions. This findings indicate that a 1% rise in economic growth increases the dilapidation of the environment by 0.648%. This result is consistent with Mbarek et al., (2014). The coefficient of financial development is negative but insignificant on CO2 emissions.

Finally model 4, the income increases the CO2 emissions. We find that 1% rise in economic growth will ultimately rises the CO2 emissions by 0.541%. The positive and statistically significant association is found among income and CO2 emissions. This result is in line with Bozkurt and Akan, (2014). The influence of financial development on CO2 emissions is negative and significant. The results show that 1% rise in financial development would decreases CO2 emissions by 0.079%. This findings is consistent with Ali et al., (2015). The coefficient of urbanization is negative and statistically significant which means that urbanization progresses the environmental quality through decreases the CO2 emissions. The value of urbanization exposes that 1% rise in urbanization decreases the CO2 emissions by 0.159%. All of our four models, the coefficients of square income measured by Y2 is negative. Thus, the results support the environmental Kuznets curve hypothesis specifying an inverted U-shaped curve.

Table 7: System GMM panel estimation regression results

	Model 1	Model 2	Model 3	Model 4
LNC_{it-1}	0.804 (0.000)	0.854 (0.000)	0.812 (0.000)	0.901 (0.000)
LNY_{it}	0.547 (0.004)	0.565 (0.003)	0.648 (0.000)	0.541 (0.004)
LNY^2_{it}	-0.027 (0.003)	-0.031 (0.002)	-0.031 (0.001)	-0.026 (0.003)
$LNFDP_{it}$	-0.078 (0.032)	-	-0.085 (0.352)	-0.079 (0.001)
$LNURB_{it}$	-0.144 (0.09)	-0.150 (0.071)	-	-0.159 (0.061)
$LNOPE_{it}$	0.005 (0.823)	0.052 (0.841)	0.018 (0.455)	-
Constant	-2.964 (0.001)	-3.045 (0.001)	-3.009 (0.002)	-2.948 (0.001)
AR(1)	-6.761 (0.003)	-8.120 (0.002)	-8.020 (0.001)	-7.219 (0.000)
AR(2)	0.492 (0.751)	0.541 (0.698)	0.449 (0.510)	0.551 (0.690)
Sargan	98.091 (0.031)	80.460 (0.001)	106.460 (0.000)	110.98 (0.003)

Note 8: the table reports the t statistics beside estimated coefficients. The regression coefficients are estimated using the (Blundell and Bond 1998) and (Arellano and Bover 1995) system GMM estimation approach. The estimated coefficients on the time-dependent dummy variables are not reported. AR (1) and AR (2) are (Arellano and Bond 1991) tests for first-order and second-order autocorrelation in the first differenced errors. The Sargan test is a test for over identifying restrictions.
Note 9: the p-values are in parentheses.

The innovative accounting approach and the impulse response function

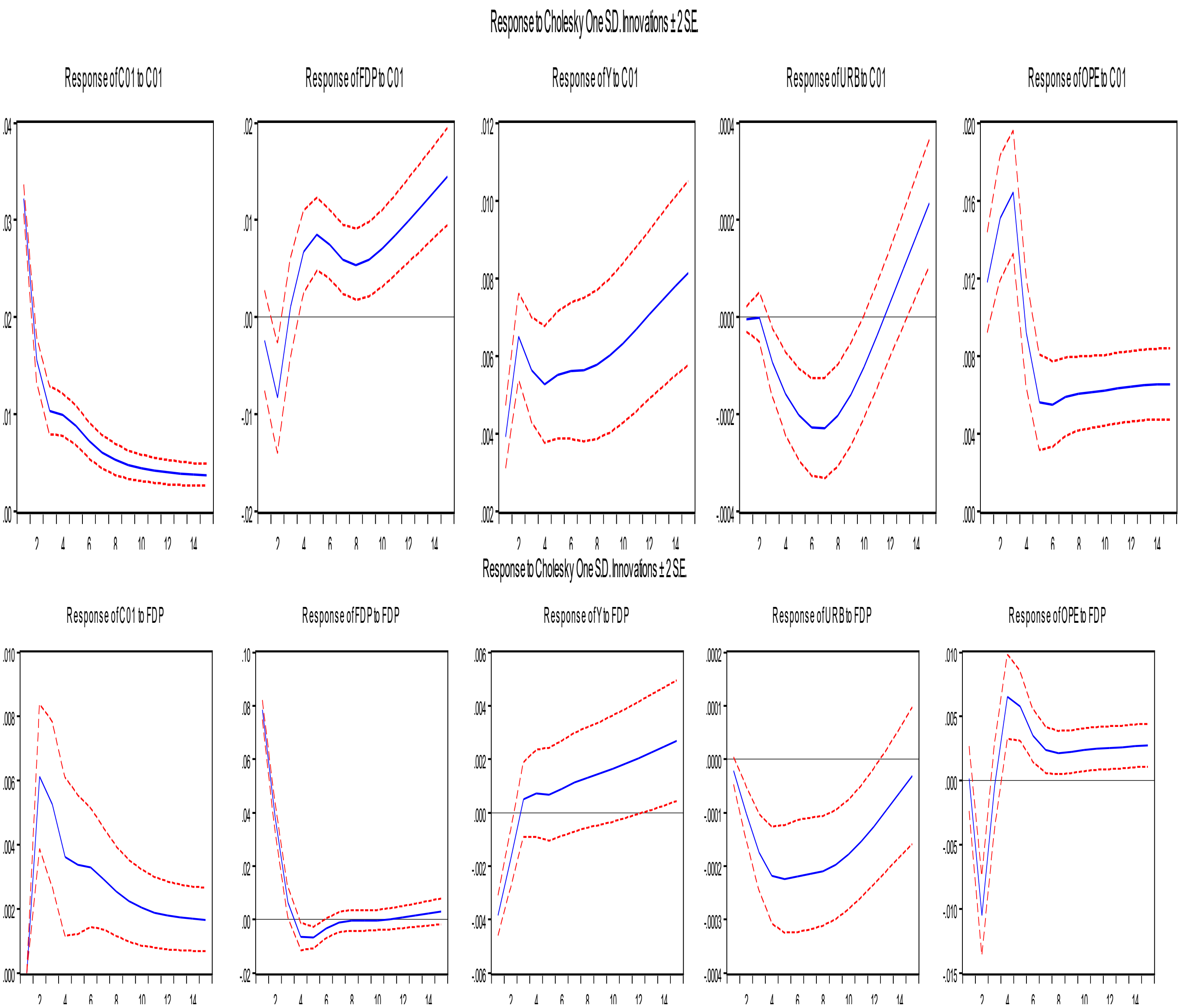
This study applied the innovative accounting approach (which is also known as variance decomposition analysis) to suspicious the intrinsic problem of the causality analysis of being incapable to detect the causal association between the variables beyond the current time period. Therefore, this research expects the dynamic causal association between CO2 emissions, financial development, per capita income, trade openness, and urbanization of Kyoto Annex countries for the next 15 years. The outcomes of the decomposition analysis as stated in Table 8 exposed that about 58% CO2 emissions is affected by its own standard innovation shock. CO2 emissions responds by 4.48 %, 21.37%, 5.26%, and 11.27% when one standard deviation variation is attributed in financial development, trade openness, urbanization, and per capita income respectively. The result is confirmed by the result of the impulse response function, which is also exposed that in the next 15 years, trade openness would be the main contributor of CO2 emissions.

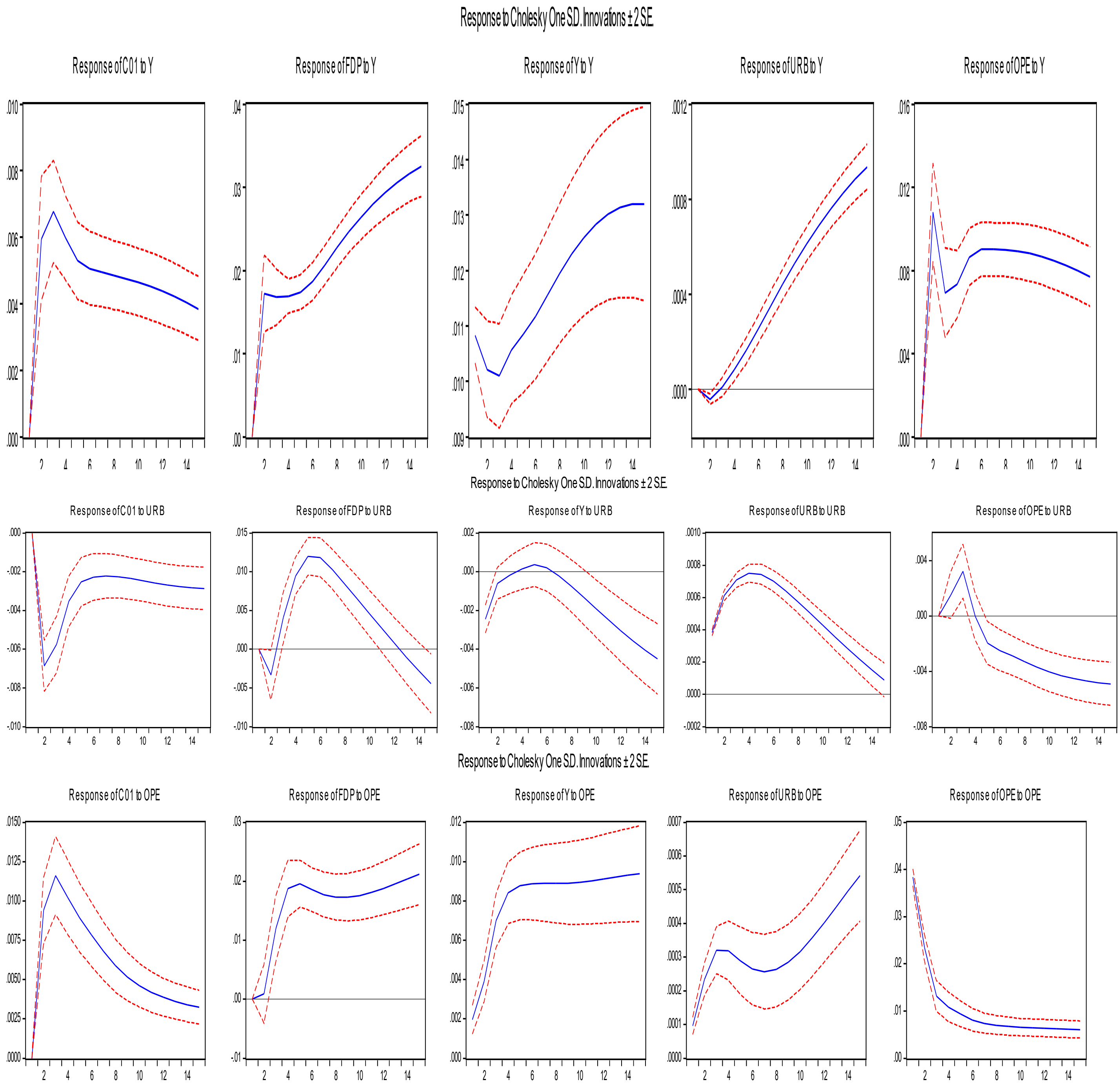
The impulse response function which is the substitute for variance decomposition exploration. The impulse response function describes the response of independent variables. The results of impulse response function expose that CO2 emissions increases due to prediction miscalculation curtailing from energy disasters. This indicates that CO2 emissions increases due to increasing the trade openness and per capita income. The response of urbanization in CO2 emissions rises with the passage of time. The response of urbanization due to CO2 emission, financial development, per capita income and trade openness are firstly decreasing then increasing with the passage of time. The response of financial development in CO2 emissions, trade openness, per capita income, and urbanization are increasing.

Table 8: Results of the variance decomposition analysis

Periods	S.E	C	FDP	Y	OPE	URB
Variance decomposition of C.						
1	0.0323	100.0000	0.0000	0.0000	0.0000	0.0000
2	0.0387	85.9568	2.5214	2.3812	5.9643	3.1759
3	0.0430	75.4689	3.5476	4.4351	12.1698	4.3784
4	0.0460	70.6472	3.7210	5.5771	15.6359	4.4188
5	0.0482	67.7835	3.8874	6.3009	17.7217	4.3062
6	0.0498	65.6247	4.0802	6.9440	19.1057	4.2452
7	0.0510	63.9662	4.2220	7.5720	20.0014	4.2381
8	0.0520	62.6733	4.3094	8.1772	20.5664	4.2734
9	0.0528	61.6188	4.3624	8.7518	20.9208	4.3459
10	0.0534	60.7235	4.3960	9.2900	21.1397	4.4505
11	0.0541	59.9434	4.4191	9.7856	21.2700	4.5817
12	0.0546	59.2528	4.4370	10.2339	21.3421	4.7339
13	0.0551	58.6368	4.4530	10.6325	21.3764	4.9015
14	0.0556	58.0845	4.4689	10.9809	21.3858	5.0796
15	0.0561	57.5913	4.4858	11.2798	21.3789	5.2640

Figure 2: Impulse response function





CONCLUSION

This study empirically examines the impact of income, financial development, trade openness, and urbanization on CO2 emissions in 21 Kyoto Annex countries (Australia, Austria, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Netherland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, and USA) for the period of 1970-2016. We employed the unit root test, co-integration test (Pedroni and Kao), Dumitrescu and Hurlin heterogeneous causality, the innovative accounting approach and the impulse response function and GMM-SYSTEM of panel data. The co-integration tests indicates that the existence of panel long-run equilibrium relationship between financial development (FDP), real income (Y), square term of real income (Y2), trade openness (OPE), urbanization (URB), and CO2 emissions (C), implication that all variables move together in the long-run.

The GMM-SYSTEM results indicate that per capita of GDP has statistically significant and positive effect on CO2 emissions, this indicates that a rise in GDP per capita rises per capita CO2 emissions in the particular country. Furthermore, the square term of GDP has a negative effect on CO2 emissions in all four model models which means that there is presence of environmental Kuznets curve hypothesis specifying an inverted U-shaped curve. Additionally, trade openness does not statistically significant on CO_2 emissions in all three models. However, urbanization has a significant and negative effect in all models. This indicate that urbanization is not one of the key elements of the CO_2 emissions. Finally, the coefficient of financial development is negative in all three models, which means that financial development has a negative influence on the CO_2 emissions. This suggests that financial development might be used as a tool to keep the degradation environmental clean through familiarizing the financial amendments. In Short-run, a bi-directional causality among financial development, per capita income, urbanization, trade openness, and CO_2 emissions is observed.

This study recommends the essential for policy makers to incorporate the regulation of CO_2 emissions with economic growth strategies. We also recommend that trade openness regulations should be secure about friendly environmental supplies. According the results of this study, due to bi-directional causality within Kyoto Annex countries, finance is a productive tool for environmental researcher and the regulator consultants to formulate the short-run sector strategies. In the long-run, the green financing method is a main answer for financing and environmental authorities. The carbon tax and tight monetary policy might be supportive to deterioration the environment hazards. Therefore, the main concern is given to environmental elements while making assessments about financial development.

In this study, 21 Kyoto Annex countries were investigated as a panel. Meanwhile, most of these countries are developed countries, therefore our results comprehensive for developed countries. However, one would examine a new data set and assessment the model for this study for developing countries as a further research. Then, the researcher should see the difference between developed and developing economies in terms of the association between financial development, per capita income, trade openness, urbanization, and CO_2 emissions.

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