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RESEARCH ARTICLE

Exploring the existence of environmental Kuznets curve in the midst of financial development, openness, and foreign direct investment in New Zealand: insights from ARDL bound test

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Abstract

The present research paper tries to explore the existence of the environmental Kuznets curve in New Zealand by taking annual time series data from 1970 to 2017. The study also considers other variables like trade openness, financial development, and foreign direct investment. Depending on the nature of the selected variables, the study has utilized the autoregressive distributed lag(ARDL) model to explore the cointegration among the variables. The result verifies the existence of the long-run cointegration among the variables. Further, it confirms the presence of the environmental Kuznets curve. The estimated result also shows that trade openness, financial development, and foreign direct investment improves the environmental quality. Moreover, to verify the environmental Kuznets curve visually, we have plotted the CO_2 emissions and economic growth, and the scatter plot exhibits an inverted U–shaped relationship between CO_2 emissions and economic growth. The turnaround point of the plot with a single break is in 1987. These findings give a wide range of policies for economic growth and environmental quality in New Zealand.

Keywords EKC · Environmental degradation · Growth · ARDL · FDI · Trade openness

Introduction

There is a general agreement among the international organizations and countries regarding the pivotal role of environmental quality for the better economic health of every country. From this understanding, the different international organizations come with the idea of green growth and sustainable development. According to the OECD (2011), green growth is "Fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies." The World Bank (2012) defined the need of green growth "as growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters. And this growth needs to be inclusive." Therefore, the role of environmental and economic growth is highly necessary for the bright future of any nation. In that sense, there has been a debate on this ground among the policymakers and environmentalists for the last couple of decades. However, the debates are not ended until today and it is still ongoing.

The studies looking to the nexus between nature and economy can be found in the seminal works done by Ricardo (1891), and Malthus (1872). Ricardo argues that the supply of poor-quality land is considered the cause for the diminishing returns in the farm production. Malthus believed that the population of the country grows in an exponential fashion, whereas the food supply is in the arithmetic progression style. Simon Kuznets (1955) found a decreasing tendency for inequality as economic growth. The study related to the environmental Kuznets curve (EKC) started in the 1990s onwards with the path-breaking work of Grossman and Krueger

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(1991); Grossman, G. M., and Krueger, A. B. (1993); Shafik and Bandyopadhyay (1992); and Panayotou (1993a, b). From there onwards, there has been a continuous increase in the studies related to the environment and economic growth. All these studies are trying to examine the existence of the threshold level for environmental degradation after attaining the specific level of income. Despite all the studies, there is no consensus in the ever-growing literature about the relationship between environmental quality and economic growth.

In the existing global-level debate on sustainable development, environmental degradation, induced by the accumulation of CO_2 emissions, has become the key concern. Many factors influence CO_2 emissions such as financial development, foreign direct investment, energy use, and trade openness. The well-established literature of EKC employs trade openness and energy use as a control variable. It is important to note that research utilizing financial development as such a major environmental quality determining factor is indeed very limited (Shahbaz et al. 2013a, b, c). There exist various theoretical reasoning behind the well-established nexus between financial development and environmental quality. Firstly, in the words of Frankel and Romer (1999) and Baloch et al. (2019), foreign direct investment (FDI) is attracted by a well-developed financial market, which in effect will boost economic development and thus impact the environmental quality. Secondly, Tamazian et al. (2009) argue that financial sector progress assists in the procurement of funds for environmentally related initiatives at decreased financing costs. Lastly, financial development promotes technological innovation, which in turn improves the efficiency and thereby reduction in emissions (King and Levine 1993; Kumbaroğlu et al. 2008; Tadesse 2005a, b). From this line, there is a considerable recent study, which analyzes the close link between financial growth and environmental quality (Beck 2002; Charfeddine and Ben Khediri 2016; Maji et al. 2017; Shahbaz et al. 2013a, b, c; Shoaib et al. 2020). However, the results are varying across the countries. For instance, some empirical findings evidenced that financial development cuts CO_2 emissions and therefore protects the environment (Shahbaz et al. 2013a, b, c; Jalil and Feridun 2011; King and Levine 1993; Shahbaz et al. 2016; Tadesse 2005a, b; Tamazian and Bhaskara Rao 2010. Conversely, certain research has shown that financial development raises the degradation of the ecosystem (Brännlund et al. 2004; Çoban and Topcu 2013; Islam et al. 2013; Sadorsky 2010, Sadorsky 2011; Tang and Tan 2014).

There are various studies related to the nexus between trade openness and environmental quality (Antweiler et al. 2001; Cole and Elliott 2003; Frankel and Rose 2005; Harbaugh et al. 2002). In reality, there exist two alternative views in environmental literature related to the nexus between trade openness and environmental quality (Rahman 2020). According to Rahman (2017), overall effects of international trade on CO_2 emissions may be either favorable or unfavorable from a theoretical point of view. Firstly, there is a positive notion regarding trade openness and environmental quality. The rationale behind the positive view is that higher levels of exports lead to increased industrial output, eventually CO_2 emissions which harm the quality of the environment (Schmalensee et al. 1998). There are some studies which support the positive notion related to international trade and environmental quality among different countries and regions (Adams and Acheampong 2019; Balsalobre-Lorente et al. 2018; Ben Jebli et al. 2019; Gasimli et al. 2019). Secondly, the idea of the negative effect of trade openness on environmental quality (Shahbaz et al. 2013a, b, c) states that nations have better exposure to larger world markets, growing the productivity and output of countries that promote the importation of cleaner carbon-reduction technologies. This line of argument is supported by Antweiler et al. (2001), ul Haq et al. (2016), and Shahbaz et al. (2012).

There is increasing literature incorporating the nexus between FDI and environmental quality. This research is focused on the hypotheses of “pollution haven hypothesis (PHH)” and “pollution halo hypothesis (P-HH).” To begin with “pollution haven hypothesis (PHH),” it argues that perhaps the supposed association between FDI and environmental pollution will contribute to multinationals to expand their export of dirty goods from a developed country to emerging economies due to various reasons like low awareness among customers; loosened or unenforced laws to satisfy development needs weaken concern for the environment; relatively weak and much less strict regulations on environmental, natural resource abundance; and cheaper workforce (Mert et al. 2019; Seker et al. 2015; Walter and Ugelow 1979; Winch 1976; Zhou et al. 2018; Zhu et al. 2016; Asghari 2013). On the contrary to PHH, “pollution halo hypothesis (P-HH)” states that FDI improves the economy of the host country and reduces environmental degradation. Voluminous studies recently explored P-HH in both county level and cross country level (Abdouli et al. 2018; Al-Mulali and Foon Tang 2013; Jiang et al. 2018; Sung et al. 2018; Zhang and Zhou 2016; Zhu et al. 2016).

This research article tries to examine whether the environmental Kuznets curve (EKC) exists in New Zealand. The country-specific study is vital due to the heterogeneous nature of different countries. Each country is different from one another in terms of institutions, economic growth pollution, and so on. Although New Zealand is a developed country, it is also not free from the menace of environmental pollution. Environment Aotearoa 2019 (EA2019) published by the Ministry for the Environment and StatsNZ[1] delineates the impact of human activity on the environmental degradation in New Zealand. The report added the main sources of pollution of air quality could be divided into two: domestic heating of coal and wood, and vehicles. Among the OECD countries, New Zealand has the highest car ownership, and it can be understood in the context where more than

[1] For more details of the environmental degradation in New Zealand, you can read from this link https://www.stats.govt.nz/.

86% of the population live in the cities and town. Hence, the emission from the vehicles will affect the people adversely more. The amount of greenhouse gases has increased by 42% during 1990–2013.[2] Environment Aotearoa 2019 expresses the concern over the extinction of 86 species and the loss of vegetation from New Zealand in the last 15 years.

Our study is different from earlier studies in the following ways: The absence of agreement about the effect of the above-discussed factors like economic growth, financial development, trade openness, and foreign direct investment on CO_2 emissions is the primary impetus for carrying out this work to provide more evidence. There is plenty of country-specific study for the validation environmental Kuznets curve (Al-Mulali et al. 2015a, b, c, d; Al-Mulali et al. 2016; Miah and Koike 2010; Dogan and Turkekul 2016; Gokmenoglu and Taspinar 2018; Lantz and Feng 2006; Ozatac et al. 2017; Ozturk and Al-Mulali 2015; Pata 2018; Roca et al. 2001; Sarkodie 2018), but best to our knowledge, the exploration of environmental Kuznets curve in the context of New Zealand is the first one in the presence of financial development, trade openness, foreign direct investment, and the structural break with an application of most popular ARDL bound test. The ARDL model is superior to other cointegration econometric techniques due to a variety of reasons, and it is widely used for validation of the environmental Kuznets curve along with other cointegration studies. In that perspective, our study is definitely an improvement over the previous New Zealand–based study of Galeotti et al. (2008). Moreover, this study takes into consideration more time period than the previous research (Galeotti et al. 2008) for the empirical analysis. Further, the study is one more contribution to the existing discussions on the linkage between the environment and economic growth. In addition to this, this study uses the recently updated GDP series (2010 US $) for the analysis as proposed by Alam and Adil (2019).

The remaining part of the study is arranged like "literature survey" in section 2. Section 3 deals with "conceptual framework, methodology, and data"; section 4 allotted for the "results and discussions," and the final section with "concluding remarks" of this research paper.

Literature survey

Nexus between environmental quality and economic growth

A few studies exist on the linkage between economic growth and carbon emissions. It is widely appreciated that since the industrial revolution, the world has undergone unparalleled economic development. Yet this rapid industrial development is focused on resource and energy production, generating a significant volume of carbon dioxide as by-products (Schandl et al. 2016; Shuai et al. 2017; Wu et al. 2019; Zhang et al. 2019). According to Wang (2013), output growth has impeded the environmental quality for both the US and China. Meanwhile, Beckerman (1992) found that higher levels of income decrease the degradation of the environment. Bhagwati (1993) has suggested that economic growth could be important for environmental quality. A Malaysia-based study of Begum et al. (2015) finds the favorable impact of economic growth on environmental quality through the reduction of carbon emissions. The study of Akin (2014) observed vitalizing impact of per-capita incomes on carbon emissions in a sample from 85 countries. As recorded from Dornbusch (1992) and Panayotou (1993a, b), economic growth in developing countries is essential for environmental quality improvement. Narayan and Narayan (2010) point out that the long-term elasticity of income in relation to carbon dioxide is lower than the short-run elasticity only in the countries of the Middle East and Asia included in their panel analysis. At the same time, studies to validate EKC also started in the same period. The first study, which examines the nexus between economic growth and environmental quality, has been explored by Grossman and Krueger (1991). The main objective of the study was to examine the impact of NAFTA across the Mexican cities. The study found that environmental quality has degraded in the earlier stages of economic growth, and after a certain point, environmental quality has improved. Moreover, in the context of developing countries, Grossman and Krueger (1991) found that despite earlier degradation of the environmental quality with economic growth, the air and water quality has improved after a point. The credit of popularizing the EKC hypothesis goes to the World Bank (1992) World Development Report; it states that "greater economic activity inevitably hurts the environment is based on static assumptions about technology, tastes and environmental investments" and it further added that "as incomes rise, the demand for improvements in environmental quality will increase, as will the resources available for investment." The first economic growth–related framework developed by Kuznets (1955) and the seminal analysis by Krueger and Grossman (1995) influenced several researchers and economists in the field of economic growth and environment (Charfeddine and Ben Khediri 2016), while the credit of coining the phrase "environmental Kuznets curve" goes to Panayotou (1993a, b). There is plenty of study regarding the EKC hypothesis; it is quite difficult and undesirable to highlight all the empirical researches related to EKC. Hence, Table 1 is giving an outline of different studies, which uses the square term of income in both time series and cross-country framework.

[2] Kindly have a look at the given link for detailed reading about the stated facts about greenhouses gases in New Zealand https://www.forbes.com/sites/lauriewinkless/2019/04/18/new-zealands-environment-is-in-serious-trouble.

Table 1 Summary of studies using quadratic term for income

Author(s)	Country	Period	Method	Conclusion
(Holtz-Eakin and Selden 1995)	130 countries	1951–1986	Panel regression	Yes
(Cole et al. 1997)	7 countries	1960–1991	Panel regression	Yes
(Agras and Chapman 1999)		1971–1989	Panel regression	Yes
(Galeotti and Lanza 1999)	110 countries	1960–1996	Panel regression	Yes
(Lindmark 2002)	Sweden	1870–1997	Kalman filtering	No
(Bednar-Friedl and Getzner 2003)	Austria	1960–1999	Ordinary least squares	No
(York et al. 2003)	111 countries	1960–2000	Ordinary least squares	Yes
(Lantz and Feng 2006)	Canada	1970–2000	Generalized least square	No
(Ang 2007)	France	1960–2000	Auto regressive distributed lag	Yes
(Faiz-Ur-Rehman et al. 2007)	Pakistan, India, Sri Lanka, and Bangladesh	1983–2006	Pooled regression	Yes
(Yaguchi et al. 2007)	Japan and China	1975–1999	Panel regression	Yes
(Dutt 2009)	124 countries	1984–2002	Robust OLS Panel regression	Yes
(Halicioglu 2009)	Turkey	1960–2005	Auto regressive distributed lag	Yes
(Jalil and Mahmud 2009)	China	1975–2005	Auto regressive distributed lag	Yes
(Apergis and Payne 2010)	11 Commonwealth countries	1992–2004	FMOLS	Yes
Bello and Abimbola (2010)	Nigeria	1980–2008	FMOLS	No
(Iwata et al. 2010)	France	1960–2003	Auto regressive distributed lag	Yes
(Lean and Smyth 2010)	5 ASEAN countries	1980–2006	DOLS	Yes for Philippines
(Boopen and Vinesh 2011)	Mauritius	1975–2009	OLS	No
(Guangyue and Deyong 2011)	27 Chinese provinces	1990–2007	Panel cointegration	Yes for full sample
(Iwata et al. 2011)	28 countries	1960–2003	PMG MG	Yes No EKC
(Ben Jebli et al. 2016)	25 OECD Countries	1980–2010	FMOLS DOLS	Yes
(Bilgili et al. 2016)	17 OECD Countries	1977–2010	FMOLS DOLS	Yes
(Li et al. 2016)	28 Chinese provinces	1966–2012	GMM ARDL	Yes
(Zoundi 2017)	25 African countries	1980–2012	Panel cointegration	No
(Katircioğlu and Taşpinar 2017)	Turkey	1960–2010	DOLS	Yes
(Destek and Sarkodie 2019)	11 newly industrialized countries	1977–2013	AMG	Yes
(Alam and Adil 2019)	India	1971–2016	Auto Regressive Distributed Lag	No
(Rahman et al. 2020)	Bangladesh–China–India–Myanmar economic corridor	1972–2014	Panel cointegration and ARDL for time series	Yes, for full sample Yes, for India and China individually
(Rasool et al. 2020)	India	1971–2014	ARDL	Yes

Source: Authors' compilation

Yes and no stand for the existence of inverted U shaped and no evidence for the EKC with squared income respectively

If we look into the literature of EKC, then we can see the inconclusive evidence regarding the nexus between environmental quality and economic growth. The reason behind the mixed evidence is due to the factors like selection of countries, time, inappropriate econometric tools, and due to the dynamic nature of EKC so that it varies with policy, globalization, and institutions (Stern 2004; Riti et al. 2017; Al-Mulali et al. 2015a, b, c, d; Adebola Solarin et al. 2017; Shahzad et al. 2017; Farzanegan and Markwardt 2018).

Nexus between environmental quality and financial development

Although it is claimed that financial growth has a major impact on the environment, its influence on the evolution of carbon emissions remains disputed. One school of thought believes that there may be an improvement in environmental quality through a reduction in carbon emissions due to financial development. For example, Tamazian et al. (2009) argue that financial development may attract foreign direct investment and a greater level of research and development, thereby boosting economic development and thus improving environmental quality. Shahbaz et al. (2013a, b, c) in a study related to South Africa by using ARDL bound testing approach to cointegration over the period ranging from 1965 to 2008 found that financial development helps to reduce the emissions from energy consumption. Another school of thought has a view related to financial development that degradation of the environment increases the carbon emissions due to financial development. There are studies in this line of argument in the literature that financial development makes it possible for customers and enterprises to gain access to low-cost financing to patronize big-ticket goods and grow their current enterprise or build new ventures that raise energy use and therefore boost carbon emissions (Sadorsky 2010; Sadorsky 2011). According to Shahbaz et al. (2016), the deterioration of the quality of the environment is a result of bank-based financial development for Pakistan for the quarterly data set ranging from 1985 to 2014. Al-Mulali et al. (2015a, b, c, d) empirically investigate the nexus between European countries' financial development and carbon dioxide emissions; note that financial development is devastating environmental quality by increasing carbon dioxide emissions. In the words of Sadorsky (2010) and Zhang (2011), developing stock markets allows public companies lower financing expenses, expand funding networks, distribute operating risks, and find a compromise between assets and liabilities to purchase new facilities and commit money to execute innovative ventures that eventually raise energy use and carbon dioxide emissions. Further, Zhang (2011) validates that financial intermediation makes purchases of household items such as washing machine, car, and so on possible, which in turn consumes the energy and promotes the carbon emissions.

Nexus between environmental quality and trade openness

Numerous studies on environmental degradation saw trade openness as being one of the major factors influencing environmental quality (Abdouli and Hammami 2017; Dinda 2004; Frankel 2009; Grossman and Krueger 1991; Nekooei et al. 2015; Ali et al. 2020). Policies related to the trade are critical for the economic growth and prosperity, industrialization, and effective distribution of resources in any country (Chenery 1961; Krueger 1997; Repetto 1994). The work of Shafik and Bandyopadhyay (1992) observed that alongside trade and other macroeconomic policy indicators, trade openness seems that there is little effect on the environment. Employing a static, two-country general equilibrium model (differentiated by income), the link between national income, pollution, and trade was analyzed by Copeland and Taylor (1994). They found that trade gains would impact emissions in a different way than economic growth gains. Like growth, free trade increases real incomes, and it also changes the composition of national output and thus changes the incidence and level of pollution. When the trend of trade-induced specialization is only driven by differences in pollution policies, after which aggregate global pollution may increase with trade, according to Copeland and Taylor (1995), when the amount of income varies between nations, a change from autarky to free trade would raise the emissions of the world. Grossman and Krueger's Pioneer Research (Grossman and Krueger 1991) examined the effect of trade openness on environmental quality. The research noticed a scale effect with the constant influence of composition and technique effect. At the same time, Frankel and Rose (2005) used instrumental variables and the gravity model to examine the effect of trade openness on the environment. The estimated coefficients of trade openness show the negative sign indicating the improvement in environmental quality. In an empirical analysis, Managi et al. (2009) analyzed the effects of trade openness on environmental quality and concluded that trade openness for OECD countries has a positive effect on the environment. The effect of trade openness on the environment was found by Al-Mulali et al. (2015a, b, c, d) using the ecological footprint as a proxy for environmental quality for 93 selected countries. Upon implementing GMM difference and system approach, a positive and significant effect was observed between trade openness and ecological footprint hinting towards the notion of degradation of environmental quality with trade openness.

Nexus between environmental quality and FDI

Due to contradictory empirical results, the role of FDI on environmental quality remains debatable in worldwide. From this neo-technology viewpoint, the FDI–environment relationship can be viewed via the Porter hypothesis. The hypothesis was proposed by Porter (1991). Later on, the improvements on this were done by Esty and Porter (1998) and Porter and van der Linde (1995). The "Porter hypothesis" states that strict environmental policies are encouraging producers to innovate and create new environmentally friendly technologies, and become net exporters of these new technologies. Another popular hypothesis is "pollution heaven hypothesis." This notes that pollution-intensive sectors with open markets and the flow of resources were to favor countries with relaxed environmental laws over those with stringent legislation. Several empirical studies in this respect demonstrate that foreign investors chose to invest in regions with easygoing environmental standards that in effect worsens the environmental condition (Copeland and Taylor 1994; Smarzynska and Wei 2001; Wei and Beata 1999). A study of a panel of 66 less developed countries by Grimes and Kentor (2003) found that heavy reliance on FDI results in increased CO_2 emissions in less developed economies. Hoffmann et al. (2005) tested the causality direction between FDI and environmental pollution in low-, middle-, and high-income countries. The result shows that in low-income countries, bidirectional Granger casualties between FDI and CO_2 emissions can be seen. Further, unidirectional causality in middle-income countries goes from FDI to carbon emissions; in the case of high-income countries, FDI and CO_2 show the neutral effect. In a study (Aminu and Aminu 2005), the FDI–environment relationship was reexamined using panel data regression in the OECD (Organization for Economic Cooperation and Development) and non-OECD case. This research showed the positive effect of foreign outflows on environmental policy in non-OECD countries. Foreign inflows in non-OECD countries do not impact environmental degradation. Leiter et al. (2011) used evidence from the European market to analyze the connection between environmental regulation and investment. Their study found that environmental policies in European countries promote further investment. A China-based study of Lan et al. (2012) suggests that the impact of FDI inflows on CO_2 emissions depends particularly on the level of workers. It indicates that FDI inflows raise CO_2 emissions in areas of a nation with the largest workforce, whereas FDI inflows reduce CO_2 emissions in areas of a nation with the least workforce. A recent study by Hao et al. (2020) based on the Chinese province-level data found that FDI will help to reduce carbon emissions. This finding is a clear-cut support for the "pollution halo hypothesis."

Conceptual framework, methodology, and data

The study tries to understand the link between economic growth and environmental quality in the environmental Kuznets curve (EKC). Let us understand the concept in historical time. EKC tries to understand the various parameters of the environmental quality degradation in response to the rise and growth of per-capita income. It is accepted that the beginning stages of economic growth, issues related to pollution, and degradation of natural resources are likely to occur in the region. This process will continue to reach the per-capita income to a particular level, and then the process goes to reverse way; i.e., more income leads to improvement in the environmental quality. If we plot the process in a two-dimensional space with *x*-axis for economic growth

Source: Frame work adapted from (Shahbaz & Sinha, 2019)

Fig. 1 EKC analytical framework. Source: framework adapted from (Shahbaz and Sinha 2019)

and *y*-axis for the parameter of the environmental degradation, then the figure looks like an inverted U–shaped curve (see Fig. 1). The name EKC came due to the seminal contribution of Kuznets (1955), who explored the relationship between income inequality and economic growth. The study of Kuznets (1955) found that inequality reduces as the economy grows. The idea of EKC emerged with the Grossman and Krueger (1991) work. Along with Grossman and Krueger (1991) work related to the environmental consequences of North American Free Trade Agreement (NAFTA), Shafik and Bandyopadhyay (1992) have done a background study on this issue for the World Development Report 1992 (IBRD 1992). Once the World Development Report 1992 (IBRD 1992) came out, the concept of EKC got popularity. World Development Report 1992 (IBRD 1992) states that "The view that greater economic activity inevitably hurts the environment is based on static assumptions about technology, tastes and environmental investments" (p. 38). Further, the report added the fact that "as incomes rise, the demand for improvements in environmental quality will increase, as will the resources available for investment" (p. 39).

For the existence of an inverted U–shaped curve in the empirical analysis, the coefficient of the income should be positive and significant, whereas the quadratic term of the income should be negative and significant. One then can we validate the existence of EKC.

From the above-stated literature and theoretical framework, now we are going to apply in our model. To begin the process of econometric estimation, we understood that there are several channels such as economic growth, financial development, trade openness, and foreign direct investment that can matter for the CO_2 emissions. Even this study also acknowledges the role of energy consumption on environmental quality. However, the reliability of the available data set of energy consumption has been questioned (Alam and Adil 2019; Ghosh 2009). They argue that substantial levels of electricity (energy) theft and pilfering demand figures and their effect on carbon emissions are underestimated. Further, the electricity authority of New Zealand also agrees with the various kinds of electricity (energy) losses that are not taking into account the total primary energy consumption.[3] Hence, we are not considering the effect of energy consumption on CO_2 emissions in this piece of work. If we take energy consumption in the model, then it probably gives us a wrong result.

The literature suggests the following Eq. (1) to estimate the long-run association among the variables in the context of the EKC analytical framework.

[3] This website of electricity authority of New Zealand (https://www.ea.govt.nz/operations/distribution/losses/) very clearly discuss the problems of energy transmission and the losses associated with the same. It divides the losses in to four: Technical losses, non-technical losses, Reconciliation losses and Unaccounted for electricity (UFE). This four types are not actually reported in the total energy consumption of New Zealand.

$$CO_{2t}=f\left(GDP_t, GDP_t^{\ 2}, FIN_t, OPEN_t, FDI_t\right) \quad (1)$$

Here, CO_2 is the carbon dioxide emissions, GDP stands for the real GDP, and GDP^2 is the square term of real GDP, the term created using orthogonal transformation to avoid the perfect multicollinearity with real GDP since the square term is derived from real GDP. FIN indicates the financial development in terms of domestic credit to the private sector. OPEN means trade as a percentage of GDP. FDI means the foreign direct investment inflows as a percentage of GDP.

For the empirical analysis point of view, Eq. (1) is converted to the following form consisting of parameters in Eq. (2).

$$CO_{2t} = \alpha_0 + \alpha_1 GDP_t + \alpha_2 GDP_t^{\ 2} + \alpha_3 FIN_t + \alpha_4 OPEN_t + \alpha_5 FDI_t + \varepsilon_t \quad (2)$$

where α stands for the parameters, ε is the error term with usual assumptions, and t means the time period of the study, i.e., year. Conceptually, the sign of α_1 should be positive meaning that the more economic growth leads to the more usage of energy resources and it leads to the CO_2 emissions. As far as the quadratic term is concerned or to exist EKC hypothesis, the sign of α_2 should be negative and statistically significant, which highlights the economic growth eventually improves environmental quality. The sign of α_4 is expected to be positive due to the fact that more accessibility to finance leads to large-scale production activities. In the case of α_4, the sign for the developed countries is expected to be negative since they need pollution-free products whereas, for developing countries, it is positive since they use more polluting products than the pollution-free product (Halicioglu 2009). The sign of α_5 is different in between developing and developed countries. In the case of developing countries, it is supposed to be negative due to the strict environmental regulation, whereas in developing countries it is not so.

The abovementioned model is estimated using annual time series data from 1970 to 2017. The selection of time period solely depends on the availability of data, which were collected from sources like Carbon Dioxide Information Analysis Center (CDIAC) for CO_2 emissions data; the link to extract the same data is here inside the parenthesis (https://cdiac.ess-dive.lbl.gov/CO2_Emission/timeseries/national), and the World Bank data for the rest of the variables (https://databank.worldbank.org/source/world-development-indicators). All the variables are in the natural logarithm except FDI to avoid the heterogeneity. Since FDI has the negative values, we were unable to take natural log for the same.

For the estimation specified model, we employ the autoregressive distributed lag (ARDL) approach to cointegration. One of the advantages of this method is that it can be used irrespective of whether the explanatory variables are I (1) or I (0), and thus it avoids the pre-testing problem of the unit root (Pesaran and Pesaran 1997). Further, it has the ability to deal with the endogeneity problems associated with other cointegration tests (Pesaran and Pesaran 1997; Pesaran et al. 2001). In addition to this, instead of using instrumental variables, we introduce the lags to overcome the endogeneity problem associated with the regression analysis (Narayan 2005).

To estimate the model in the study, we employ Eq. (3)

$$\begin{aligned}\Delta LNCO_{2t} = {} & \lambda_0 + \beta DU_{(2004)} + \sum_{i=1}^{p} \lambda_{1i}\Delta LNCO_{2t-i} + \\ & \sum_{i=1}^{p} \lambda_{2i}\Delta LNGDP_{t-i} + \sum_{i=1}^{p} \lambda_{3i} LNGDP^2_{t-i} + \sum_{i=1}^{p} \lambda_{4i}\Delta LNFIN_{t-i} + \\ & \sum_{i=1}^{p} \lambda_{5i}\Delta LNOPEN_{t-i} + \sum_{i=1}^{p} \lambda_{6i}\Delta LNFDI_{t-i} + \Delta\varphi_1 \Delta LNCO_{2t-1} + \\ & \varphi_2 \Delta LNGDP_{t-1} + \varphi_3 \Delta LNGDP^2_{t-1} + \varphi_4 \Delta LNFIN_{t-1} + \varphi_5 \Delta LNOPEN_{t-1} \\ & + \varphi_6 \Delta LNFDI_{t-1} + \mu_{1t}\end{aligned} \quad (3)$$

where Δ is the difference operator and the $DU_{(2004)}$ is the dummy variable associated with our dependent variable. λ_0 is the vector of constant and β, λ_i, and φ_i are the matrices of parameters, respectively. Summation of "i" ranges from "1" to "p" which indicates the lag length.

There are two steps in the ARDL approach to cointegration. In the first step, the hypothesis of no cointegration is tested. The null hypothesis is that the coefficients on the lagged regressors in the error correction form of the underlying ARDL model are jointly zero. That is, there exists no long-run relationship between them. The null hypothesis is represented as $\varphi 1 = \varphi 2 = \varphi 3 = \varphi 4 = \varphi 5 = \varphi 6$ and tested against the alternative hypothesis is$\varphi 1 \neq \varphi 2 \neq \varphi 3 \neq \varphi 4 \neq \varphi 5 \neq \varphi 6$. The approach uses the F-test although the asymptotic distribution of the F-statistic in this context is non-standard, irrespective of whether the variables are I (0) or I (1). The null hypothesis of no cointegration can be rejected if the calculated F-statistic value is higher than the upper bound critical value I (1), which validate the existence of the long-run relationship among the variables. If the value is below lower bound critical value I (0), then we have to accept the null hypothesis. In F value falling between upper bound critical value I (1) and lower bound critical value I (0), we have no conclusion about the cointegration. In the second step, we have estimated the short-run dynamics using Eq. (4). The error correction model (ECM) is derived from the ARDL model through a simple linear transformation that integrates short-run adjustments with long-run equilibrium without losing long-run information. We select lag length based on the Akaike information criterion and Bayesian criterion since ECM estimation requires the selection of proper lag length to avoid the endogeneity problem.

$$\Delta LNCO_{2t} = \lambda_0 + \beta DU_{(2004)} + \sum_{i=1}^{p} \lambda_{1i}\Delta LNCO_{2t-i} + \sum_{i=1}^{p} \lambda_{2i}\Delta LNGDP_{t-i} + \sum_{i=1}^{p} \lambda_{3i} LNGDP^2_{t-i} + \sum_{i=1}^{p} \lambda_{4i}\Delta LNFIN_{t-i} + \sum_{i=1}^{p} \lambda_{5i}\Delta LNOPEN_{t-i} + \sum_{i=1}^{p} \lambda_{6i}\Delta LNFDI_{t-i} + \varphi ECT_{t-1} + \mu_{1t} \quad (4)$$

Even though ARDL avoids the problem of pre-testing, in case any of the variable's order of integration is I (2), then we cannot use the model due to the unavailability of critical values of Pesaran et al. (2001). Hence, it is necessary to check the assumption for the series to employ the model. To do so, we have used the Dickey–Fuller approach and Phillip–Perron (PP). Even though the conventional unit root tests indicate a series' stationary property, such unit root tests are unable to capture structural breaks associated with the series. To capture the break, we have employed the Zivot and Andrews (2002) test on the data set.

Results and discussions

Summary statistics

Table 2 provides descriptive statistics of the used variables. It is necessary to check the statistical properties of the series before going to further analysis. Figure 2 exhibits the trend of the used variables for the analysis. It is evident that all the variables have a trend except FDI and OPEN. Series of GDP increase during the study period. The CO_2 plot indicates an upward trend, then it shows the up and down situation, and in recent years again, it is going to hike. The increasing trend in the CO2 is a matter of concern for the human existence unless it brings down in the subsequent years.

Table 2 Summary statistics

	CO^2	GDP	GDPSQ	FD	OPEN	FDI
Mean	1.973	10.214	104.362	4.051	4.027	2.071
Median	2.036	10.154	103.111	4.406	4.043	1.875
Maximum	2.209	10.537	111.025	5.071	4.227	5.829
Minimum	1.616	9.907	98.151	2.538	3.788	−3.812
Std. dev.	0.175	0.188	3.850	0.894	0.092	1.910
Skewness	−0.585	0.229	0.246	−0.418	−0.353	−0.498
Kurtosis	2.054	1.702	1.704	1.473	3.437	4.094
Observations	48	48	48	48	48	48

Source: Estimated by authors

Std. dev. means the standard deviation

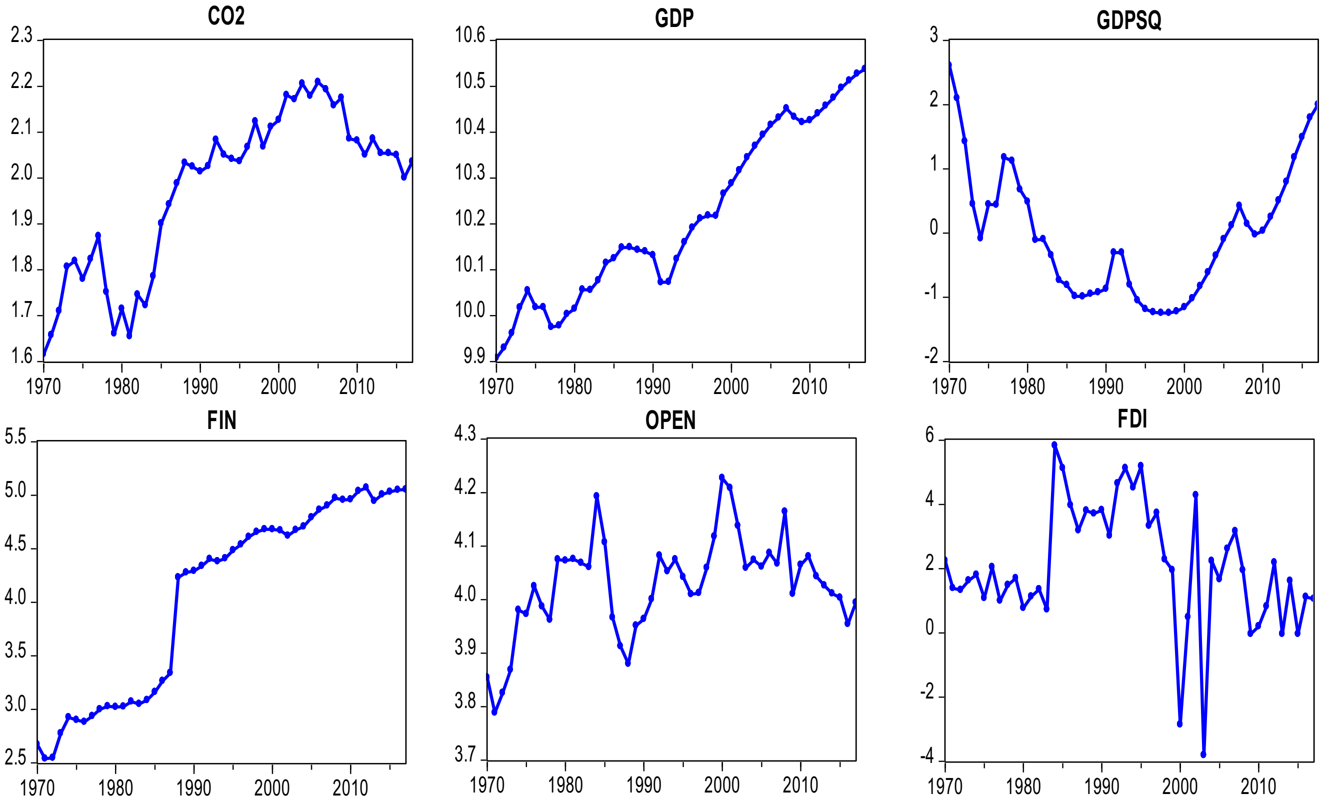
Stationarity tests and structural break test

The results of unit roots tests based on the augmented Dickey–Fuller approach (Dickey and Fuller 1979) and Phillip–Perron (PP) (Phillips and Perron 1988) test are reported in Table 3, and this test is employed to detect the order of integration of the selected variables. The tests confirm that there is no series with an order of integration with two or I (2) series. The results delineate the mixture of I (0) and I (1). Hence, we are in a position to estimate the autoregressive distributed lag (ARDL) model. Moving ahead, we also have done Zivot and Andrews (2002) structural break unit root test to detect a possible structural break in the data set due to failure of conventional unit root test to incorporate the breakpoint in the series. The result of Zivot and Andrews (2002) structural break unit root is reported in Table 4.

Cointegration results

Table 5 delineates the result of the ARDL bound test for cointegration. The selection of the ARDL bound test for the estimation is based on the results of unit root test results. The unit root measurements validate the I(0) and I(1) combination. Hence, we then go to the cointegration protocol to test if the variables have a long-term association in deciding emissions of carbon dioxide. The result that emerged from the ARDL model favors the existence of long-run association between CO_2 emissions and other explanatory variables in the estimated model since calculated *F* statistics, i.e., 5.57, falls above the upper bound critical value of Narayan (2005) in the model and it is also significant at 1% level. The above finding firmly opposes the null hypothesis of no cointegration in support of the alternate hypothesis that cointegration occurs between variables.

Tables 6 and 7 describe the result of the estimated model with the long-run and short-run coefficients and *t* values of the ARDL model. The coefficient for economic growth (GDP) in our model found to be positive and statistically significant. More specifically, a 1% increase in economic growth leads to 1.709% increase in carbon dioxide emissions. It shows that economic growth hampers the environmental quality, whereas the coefficient for the incorporated square term of economic growth (GDP^2) was found to be negative and statistically significant. Precisely, a 1% increase in square term of income leads to a decrease in carbon dioxide emission by 0.414% indicating lowering the emissions. In the short run, both economic growth and its square term show the same pattern. Why this kind of a relationship? To answer this, we need to understand the concept of inverted U–shaped association growth–CO_2 emissions. It means that the coefficient of GDP is positive (> 0), and the coefficient of the square term of GDP is negative (< 0). This situation is understood in a three-stage process as suggested by the Grossman and Krueger (1995):



Source: Authors plot

Fig. 2 Plot of the variables in the study. Source: authors plot

scale effect, composition effect, technique effect. In the case of New Zealand also, we can say that it is maybe going through all three stages as suggested by Grossman (1995). In the first stage, the *scale effect* excises a negative impact on environmental quality during the first phase of economic growth. The production process is necessary to encourage economic growth; it gives way to increase demand for natural resources. When the production process starts, a considerable amount of waste is created, and finally, it becomes a hazard to environmental quality. When the economy mainly depends upon the traditional and secondary sector, which means agricultural and industrial sectors, the policymakers focus on production process and economic growth without considering the environmental quality. Environmental degradation starts to rise with a rise in economic growth. The second stage is a transformation stage and is known as a *compensation effect* which undertakes economic growth on environmental quality to become positive. This is due to the industry shift to the cleaner technologies and secondary sector developed with considering the environment. Traditional life pattern changes to urbanization patterns by promoting the efficient use of energy and suitable technology. The final stage, with the help of progress in the technological innovations, starts with the third

Table 3 Conventional unit root test results

Variables	ADF		PP	
	I	I&T	I	I&T
CO_2	− 1.941	− 1.213	− 2.083	− 1.368
GDP	− 0.179	− 2.801	− 0.371	− 2.268
GDPSQ	− 0.368	− 0.166	− 2.132	− 1.679
FD	− 1.537	− 1.377	− 1.085	− 1.498
OPEN	− 3.475**	− 3.171*	− 2.854*	− 2.657
FDI	− 4.531***	− 4.629***	− 4.536***	− 4.629***
ΔCO_2	− 4.235***	− 4.392***	− 6.764***	− 7.007***
ΔGDP	− 4.009***	− 4.152***	− 4.707***	− 4.651***
ΔGDPSQ	− 4.875***	− 6.477***	− 3.931***	− 4.633***
ΔFD	− 4.712***	− 4.861***	− 6.535***	− 6.343***
ΔOPEN	− 4.475***	− 4.911***	− 6.976***	− 7.137***
ΔFDI	− 11.36***	− 11.24***	− 11.36***	− 11.24***

Source: Estimated by authors

I and I&T stands for the intercept and intercept and trend respectively. *, **, and *** indicate the 10%, 5%, and 1% statistical significance. Δ is the first difference

Table 4 Zivot and Andrews (1992) structural break unit root test results

Variables	*T*-value	Break	Decision
CO_2	− 3.112	2004	Unit root
GDP	− 4.293	1998	Unit root
GDPSQ	− 2.902	1980	Unit root
FD	2.49	1987	Unit root
OPEN	− 3.521	1975	Unit root
FDI	− 6.938***	1983	Stationary
ΔCO_2	− 9.003***	1979	Stationary
ΔGDP	− 5.478***	1991	Stationary
ΔGDPSQ	− 6.817***	1977	Stationary
ΔFD	− 15.51***	1988	Stationary
ΔOPEN	− 8.016***	1986	Stationary
ΔFDI	− 11.21***	2003	Stationary

Source: Estimated by authors

***indicates the 1% statistical significance. Δ is the first difference

Table 6 Long-run results from the ARDL model

Variables	Coefficients	*t*-value
Constant	− 0.818	(− 0.394)
GDP	1.709	(4.239)***
GDP^2	− 0.414	(− 5.173)***
FIN	− 0.169	(− 1.932)*
OPEN	− 3.433	(− 4.299)***
FDI	− 0.043	(− 3.114)***
$DU_{t(2004)}$	0.143	(2.048)**

Source: Estimated by authors

***, **, and * indicate the 1%, 5%, and 10% level of significance respectively

phase known as the *technique effect*; it exerts a positive relationship between economic growth and environmental quality. During the stage, the tertiary sector improves than other sectors; the economy became knowledge incentive rather than capital intensive, and started investing more in human capital, research, and development. Policymakers took consideration of environmental degradation and also polluting the secondary sector substituted by well-developed technologies. The graphical representation of the entire phenomenon shows the relationship between economic growth and environmental degradation with a bell-shaped or inverted U–shaped curve as we can see in Figs. 1 and 4. Based on the above-stated reasoning, we can say with the help of empirical evidence that with the existence of an inverted U–shaped curve in New Zealand, our coefficients of GDP and squared GDP are in line with earlier studies (Holtz-Eakin and Selden 1995; Cole et al. 1997; Agras and Chapman 1999; Galeotti and Lanza 1999; Faiz-Ur-Rehman et al. 2007; Yaguchi et al. 2007; Dutt 2009; Halicioglu 2009; Jalil and Mahmud 2009; Apergis and Payne 2010).

The impact of financial development on the CO_2 emissions is negative and significant at 1% level. A 1% increase in financial development reduces CO_2 emissions by 0.169% in New Zealand. This finding supports the finding of the earlier studies (Frankel and Rose 2002; Jalil and Feridun 2011; Shahbaz et al. 2013a, b, c; Tamazian et al. 2009). It may be due to research and development progress in the energy sector. As a result of this, energy efficiency has improved and subsequently resulted in the reduction of CO_2 emissions. Our finding deviates from the finding (Sharma et al. 2019) related to the sign of the coefficient of financial development in the Nepal-based case study. They observed a positive and significant relationship between CO_2 emissions and financial development. In the short run also, it mimics the same sign with a significance level of 1%.

Similarly, the negative and significant coefficient of trade openness indicates that the 1% increase in the trade openness reduces the CO2 emissions 3.43% in New Zealand. This finding has to be read with the help of the theoretical framework proposed by Tayebi and Younespour (2012). According to them, the impact of international trade on environmental quality varies across the countries based on the comparative

Table 5 Result of cointegration

Model	Lag length	Structural break	*F*-value	
$CO_{2t} = f(GDP_t, GDP_t^2, FIN_t, OPEN_t, FDI_t)$	(4,1,4,4,4,4)	2004	5.57***	
			Critical values	
$n = 48$, $k = 5$	Significance		I(0)	I(1)
	10%		2.08	3
	5%		2.39	3.38
	2.5%		2.7	3.73
	1%		3.06	4.15

Source: Estimated by authors

The lower and upper bound values of Narayan (2005) are used while comparing the estimated *F*-statistic values of ARDL models. ***indicates statistical significance at 1% level

Table 7 Short-run results from the ARDL model

Variables	Coefficients	*t*-value
D(GDP)	0.342	(2.720)**
D(GDP^2)	− 0.113	(− 3.647)***
D($FIN_{(t-1)}$)	− 0.102	(− 2.450)**
D(OPEN)	− 1.319	(− 6.607)***
D($FDI_{(t-1)}$)	0.030	(6.371)***
$DU_{t(2004)}$	0.094	(2.617)**
$ECT_{(t-1)}$	− 0.654	(− 7.323)***
R^2	0.79	
F-value	24.6***	
D-W statistics	2.20	
X^2 normality	0.894[0.639]	
X^2 SERIAL	1.728[0.213]	
X^2 ARCH	0.327[0.571]	

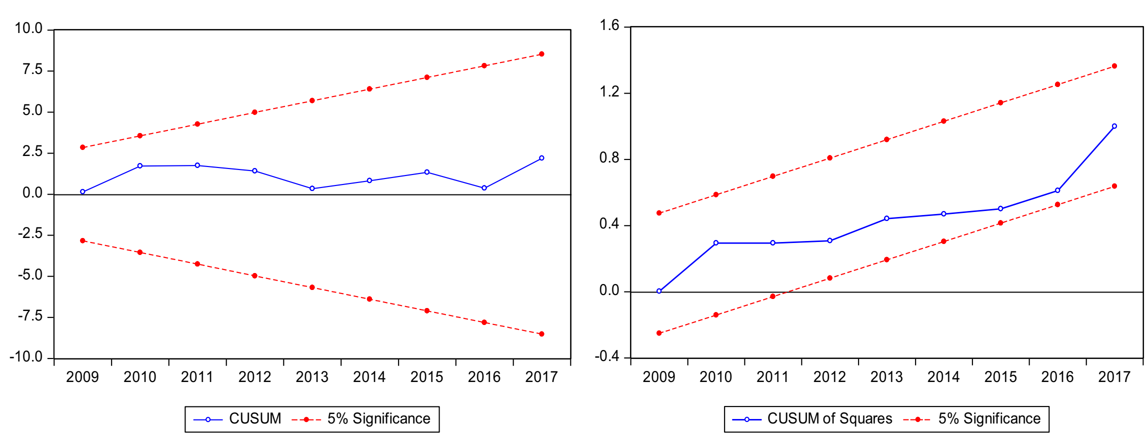
Source: Estimated by authors

*** and ** indicate the 1% and 5% level of significance respectively. Values inside the square brackets are probability values

advantage goods. It means that the country with capital abundance exports the capital abundant goods (polluting goods), whereas the labor-abundant country exports the labor-intensive goods (clean goods). Being a developed country based on the World Bank classification, New Zealand may be exporting the polluting goods and importing clean goods for the consumption purpose. This finding is line with the argument by Le et al. (2016) that indirect effect of trade openness via an increase in GDP per capita reduces the CO_2 emissions against the direct impact of CO_2 emissions and trade openness. Further, our study supports the findings by Sarkodie et al. (2019) in the trade openness link with CO_2 emissions. The finding of our study is contrary to the studies by Nguyen et al. (2019) and Sharif Hossain (2011). Our short-run result is also similar to the long-run result since short-run trade openness reduces the CO_2 emissions.

Our results show that FDI inflows work in favor of reducing the CO_2 emissions in New Zealand. A 1% increase in FDI inflows reduces the CO_2emissions at the rate of 0.043% during this period under consideration. This can be interpreted in different grounds. Firstly, FDI inflows have the good potential of increase in income, thereby economic development subsequently leads to a reduction in environmental degradation. Secondly, this finding is against the pollution haven hypothesis (PHH), which states that firms seek to set up in the regions with less stringent environmental regulations. Thirdly, FDI coming to the energy sector might help New Zealand to reduce the CO_2 emissions via an increase in energy efficiency and productivity. Our findings contradict with the findings of the studies (Haug and Ucal 2019; Pazienza 2019; Yu and Xu 2019). In contrast, the result of the FDI in our study is in line with the study by Gui et al. (2017). Short-run result indicates the positive and significant impact on the environmental quality. However, the impact is smaller, since the strength of the coefficient is low. Correspondingly, structural dummy (D) was inserted into the simulations to take account of the structural break in our dependent variable. It highlights that the structural changes spur the carbon dioxide emissions in both the short run and long run. Similarly, error correction term shows the speed of adjustment to the long-run equilibrium at an annual rate of 65%.

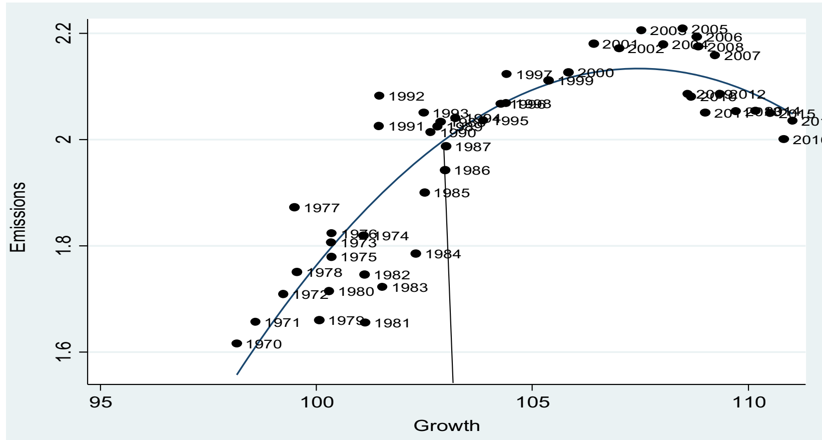
We have applied different post estimation diagnostic test for our model. Firstly, skewness and kurtosis test through the normality test. Secondly, ARCH tests for serial correlation. All the tests reject the null hypothesis in our model. Finally, the stability test for goodness of fit of estimated parameters has been employed. For this purpose, we perform the cumulative sum (CUSUM) and the cumulative sum of the square



Source: Authors plot

Fig. 3 CUSUM and CUSUMSQ. Source: Authors plot

Fig. 4 Scatter plot of growth and emissions. Note: $n = 48$, RMSE = 0.11. In 1987, a break was significant at 1% level. Source: authors plot



Note: n= 48, RMSE= 0.11. In 1987 a break was significant at 1 % level.
Source: Authors plot

(CUSMQ) test proposed by Brown et al. (1975). The results depicted in Figs. 3 and 4 indicate the estimated model is stable at 5% level of significance.

Further, we have verified the existence of EKC by using the scatter plot of growth and emissions in a bivariate case with CO_2 and economic growth. Figure 4 depicts the fascinating fact that economic growth accentuates the environmental degradation in a faster mode until 1987. After that, more economic growth leads to a stable impact on environmental quality. It means that the threshold of CO_2 emissions is 1987 based on the single breakpoint test. Until 1987, there was a faster growth of emissions; after that, there is a small increase in emissions, and eventually, it becomes harmful.

Concluding remarks

This present study investigates the long-run connection between economic growth and carbon dioxide emissions in New Zealand over the period ranging from 1970 to 2017. Our stationarity tests confirm the mixed order of integration of all the variables either I (0) or I (1). It is a precondition for employing the ARDL bound test. Depending on *F*-statistics, the bound test method shows evidence of a long-term relationship across variables. Also, it provides evidence for the existence of the EKC hypothesis in India, since the coefficient of the square term of GDP indicates the negative sign with statistical significance. The study is also taking in to consider the variables like trade openness, financial development, and FDI, the long-run coefficient sign indicates that these variables improve the environmental quality in New Zealand. Hence, the nation should push towards higher economic growth to ensure a decrease in the existing economic vulnerabilities like housing issues and government policy issues (Roy Morgan NZ survey 2017) by increasing the trade openness, financial development, and FDI inflow.

The coefficient of economic growth has a positive and significant impact on the environmental quality, indicating that the more economic activities push the CO_2 emissions through energy consumption, which is the primary source of carbon dioxide emissions. However, the coefficient of the square term of the GDP indicates that as the economy grows, the per-capita income of the people moves upward. After reaching a particular level of income, people demand good environmental quality. These phenomena are evident from the sign of the coefficient of the squared term of GDP in the short run and the long run. EKC's significant existence shows New Zealand's attempt to compress CO_2 emissions. This shows the reasonable achievement of the New Zealand government's plan of action to control environmental degradation to reduce greenhouse gas emissions by 30% below 2005 levels by 2030.[4] Consequently, in the long and short term, the environmental Kuznets curve hypothesis holds for New Zealand. Therefore, the EKC's presumption that economic development brings in the prospect of adopting advanced and less polluting innovations (Rasool et al. 2020) that can drive down emissions per unit of GDP is valid for New Zealand. The above conclusions are similar to those offered by theoretical arguments (Grossman and Krueger 1991; Barbier 1997; Beckerman 1992; McConnell 1997; Stern et al. 1996). The present research finding gives a wide array of policy for economic growth in that angle. The economic growth-oriented policy is not harmful to the environment since they are demanding the environmental quality as well so that the formulation of policy related to the agriculture and industry has to be made on the backdrop of our finding.

[4] Detailed action plan of New Zealand is in the given link: https://www.mfat.govt.nz/en/environment/climate-change/meeting-our-targets/.

Financial development coefficient also indicating a rise in domestic credit to the private sector improves the environmental quality. This kind of relationship may be due to the fact that people demand the quality environment for every activity since they have access to credit. Hence, our finding supports the arguments put by King and Levine (1993), Kumbaroğlu et al. (2008), and Tadesse (2005a, b). The available credit is used for the eco-friendly projects, so the banks have to increase the limit of the credit to the overall economy related to the environmental projects, thus the amount of environmental as well as the income of the people. As a result of this increased income, people also demand good-quality environment. Therefore, financial development affects directly and indirectly on the environment. If the bank is giving credit to any specific eco-friendly project, then it is the direct impact on the environment. On the contrary, if any other production units other than the eco-friendly project get the credit, then they will employ the people on the units. As a result, the employees get the wage, and their total income will rise, and after a threshold, they demand the quality environment.

As far as trade openness is concerned, it has a negative effect on CO_2 emissions, indicating that the rise in trade volume as a share of national income does not, in the long run, worsen the quality of the atmosphere rather than boost it. Hence, the study advises to move with the stringent environmental criteria to produce the goods. This finding has theoretical underpinning by Schmalensee et al. (1998). The finding is supportive for the notion of trade openness reduces the emissions. Hence, the degree of trade liberalization (removing the tariff and non-tariff policies) has to be expanded because trade is a process inevitable for social and economic development and social modernization (Lv and Xu 2019). By liberalizing the trade, New Zealand may have an opportunity to get the earlier expensive goods at a cheaper rate or less factor abundant good at a cheap rate. Therefore, trade openness is beneficial for the country in all the dimensions of the economy and environment.

Foreign direct investment (FDI) coefficient also indicating the similar kind of trend by reducing the CO_2 emissions in the long run. However, in the short run, it hampers the environmental quality. This may be because, after the short-run shock, the government has stringent laws for the FDI inflows. Hence, the quality of the environment has improved significantly. Our long-run result is moving with "pollution halo hypothesis" (P-HH) and related empirical works (Abdouli et al. 2018; Al-Mulali and Foon Tang 2013; Jiang et al. 2018; Sung et al. 2018; Zhang and Zhou 2016; Zhu et al. 2016). Through the FDI channel, New Zealand also has the opportunity to get the clean energy manufacturing multinationals to get rid of emissions and enhancing the economic growth as suggested by Ashin Nishan and Muhammed Ashiq (2020). To attain that objective, New Zealand has to relax the FDI norms in the various sectors.

In a nutshell, the study found evidence for the existence of the environmental Kuznets curve (EKC) in both the short run and long run. The turnaround point is in 1987, until that the growth of emissions along with economic growth is higher since the slope of the curve began to reduce from there onwards. Moreover, it is necessary to know the variability of the findings related to the EKC depends on the factors like econometric methodology employed, a used proxy for the environmental quality, and other control variables in the estimated model. Further, model specification in the reduced form may not reveal the real causal relationship among the variables (Köhler and de Wit 2019). According to Dinda (2004), due to the above-stated limitations of EKC, formulation of the policy framework is a tedious job. In future, researchers can also take in to consider varieties of variables to explore its link with CO_2 emissions and also different proxies for environmental degradation. They can also check with multiple structural breaks associated with the data set. Furthermore, the results emanate from the more sophisticated econometric technique also helps to understand the shape of EKC more reliably. Hence, the researchers have to focus on this methodological line such as quantile ARD, to understand the form of EKC with different quantiles of income and decomposition analysis, to evaluate the special relationship between environment and economic growth. Future research also possibly taking either regional level or sectoral level or longer periods depends on the availability of the data.

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