



The cultural differences in the effects of carbon emissions — an EKC analysis

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Abstract

The postmodernism stance critiques the current discourse of modern consumption-based societies. These societies legitimize their embedded beliefs and actions based on their lifestyle reflected through their consumption patterns. Their consumption patterns relate to carbon footprints that are yet to be explored in the current body of knowledge at the macro level. The legitimacy of their lifestyle and consumption patterns rely on their conscious efforts in reducing carbon footprints. This study uses the environmental Kuznets curve model and explores the impact of household lifestyle and household consumption patterns on CO₂ emissions across different cultures and societies worldwide. 49 countries were taken to assess how different cultures define consumption patterns related to CO₂ emission. The results showed that the curvilinear relationship between consumption and CO₂ depends on the country's national cultural orientation.

Keywords Climate change · Carbon emissions · Environment stability · National culture

Introduction

Creating environment sustainability for social and cultural development has become one of the eminent agenda points in the world today. Globally, humans face challenges for socioeconomic and environmental sustainability (Ameyaw and Yao 2018; Aye and Edoja 2017; Bhattacharya 2020). In

recent times, sustainability is the main problem and concern that has interconnected the economic, social, and environmental problems (Scurati et al. 2021). Environmental sustainability can be defined as the condition of interconnectedness, resilience, and balance, which allows humans to satisfy their needs, and it also supports ecosystems by continuing the renewal of the necessary services and further reducing biological diversity (Morelli 2011). Environmentalists and scientists agree that CO₂ emissions are a great threat to climate change because they increase the temperature and fluctuate weather conditions. A global aggregate effort is needed to address the environmental complications (Ikram et al. 2020; Jebli et al. 2016; Mendonca et al. 2020).

Traditionally, economic performance is positively associated with environmental degradation, but according to the environmental Kuznets curve (EKC), a different relationship between economic growth and environmental quality, especially in the previous two decades. Environmental Kuznets curve (EKC) establishes a U-shaped hypothesis between economic growth and environmental pollution (Disli et al. 2016). At the initial development stages, greenhouse gasses increase as growth increases, and ultimately, it causes climate change and global warming. Once a country reaches a certain development level, it focuses on environmentally friendly technology, and consumers' awareness of environmental quality decreases the greenhouse gasses (Aslanidis

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2010; Dinda 2004). The same is expected for the demand or consumption practices of the households, denoting demand-led EKC.

For the case of demand-led EKC, natural culture presents itself as a major contextual aspect. It is the dominating factor that shapes individuals' and groups' collaborations and interactions. Culture comprises norms, values, and beliefs, which shapes human interactions as a strong informal institution (Hofstede 2016; Onel and Mukherjee 2014). Hofstede (1984b) defines culture as the "collective mind programming" that differentiates one group member from another group. Taking culture as a significant factor, we evaluate a country's specific cultural values, which affects its consumption patterns. Hofstede et al. (2010) provided six dimensions to distinguish the cultures of the countries, which includes (1) individualism vs collectivism, (2) high-power vs low-power distance, (3) masculinity vs femininity, (4) long-term vs short-term orientation, (5) indulgence vs restraint, and (6) high-risk vs low-risk.

Researchers and policymakers have shifted their intentions to study climate change problems associated with human activities in the global policy agenda. In 2010, carbon dioxide emissions were considered the major cause of climate change, accounting for about 76% of the global greenhouse gas emissions resulting from human activities (IPCC 2013). The presence of CO₂ emissions is a natural process due to the carbon cycle of the earth, such as the movement of carbon between animals, oceans, atmosphere, and plants, where human activities are affecting the carbon balance by adding more carbon emissions to the atmosphere that is called ecological footprint (Disli et al. 2016).

The efficiency of technology and individual personal lifestyle impacts energy use and subsequent CO₂ emissions. In the late 1980s, research has paid attention to the impacts of the behaviours of consumers related to the use of energy, and they introduced the lifestyle concept. They tried to examine the impact of personal lifestyle on economic activity, energy consumption and environmental changes. A study by Schipper et al. (1989) provided that the personal activities of the consumers, including transportation, homes, and other services, use 45–55% of the total energy. Personal activities and locations of the consumers affect the energy demands. Environmental damage is also caused by the consumption behaviour of the individuals directly by disposing of the trashes and pollution from their cars or indirectly by their production activities for satisfying them (Daly 1996; Duchin 1998; Rees 1995). A study conducted in Australia by Lenzen (1998) evaluated the effect of the activities of the consumers on the energy consumption gas emissions by using the input-output model. This study revealed that the energy consumption is moderately different across the countries, and they do not support the environmental Kuznets curve. A study of USA and Europe provides that the ratio of CO₂ emissions

caused by energy consumption is about 40–50% of the total CO₂ emissions in a year (Cohen et al. 2005; Lenzen 1998; H.-C. Park and Heo 2007; Vringer and Blok 1995).

In recent years, CO₂ emissions have risen rapidly with economic development (Shahbaz et al. 2017). Domestic energy consumption is the direct and close reason for CO₂ emissions (Feng et al. 2011), while energy is consumed in manufacturing goods and services, which is the indirect reason for CO₂ emissions. There are numerous reasons for an increase in the CO₂ emissions indirectly by the indirect use of energy, including economic activity (such as manufacturing, distributing, and using the products), home appliances, private transport, and housing which were considered to improve the living standards. A study conducted by Reinders et al. (2003) analyzed household consumption in 11 European Union countries revealed that home energy consumption differs from expenditures. Globally, governments are developing policies to minimize greenhouse gasses to reduce the impacts of climate change (Naseri et al. 2022).

A study conducted based on panel data from 69 countries by Ibrahim and Law (2014) revealed a moderating effect of social capital on EKC for CO₂ emissions. As national culture shapes the behaviours of individuals and groups in any country, it is significant in the rise of CO₂ emissions. National culture is considered an informal institution shaped through human interactions and rooted in underlying beliefs, norms, and values (Hofstede 2001; Onel and Mukherjee 2014). The evolution of culture changes the preferences of consumption patterns of individuals. This change comes from institutional development, technological shifts, and knowledge spillovers across the regions. These transitions affect people's buying behaviours, and they make adjustments in their daily life by using modern and environmentally friendly equipment. For instance, low carbon emissions of home appliances would be preferred in a community who have evolved their social responsibility to protect their environment and know its benefits to society. Power dynamics also influence consumption preferences. In low power distance countries, people perceive their green preferences towards green consumption, and on the other hand, high power distance promotes low green consumption (L. Yan et al. 2021). Generally, people have a carbon literacy orientation, and they are highly prone to green consumption behaviour once they interact in the following cultural dimensions: low uncertainty avoidance, long term orientation, low power distance, masculinity, and collectivist and indulgent societies.

Energy consumptions and CO₂ emissions are higher in developed countries due to their luxurious lifestyle. As per World Wildlife Fund, in the USA, a normal citizen needs 10-ha area to live his or her lifestyle, whereas the average European needs 5 ha (Gupta 2011). US households emitted over 6 times more CO₂ emissions per year as compared to the rest of the world. As the population, globalization, and

culture are developed, households consume more energy, resulting in increased CO₂ emissions (Gupta 2011). West values are based upon individualism followed by utilitarianism, the culture followed by the developed countries gradually transfers towards developing countries. Following the lifestyle and culture of the developed countries, the households in the developing countries are consuming more energy to live (Gupta 2011). A study in China by Wei et al. (2007) revealed that economic activities and individual lifestyles demand 26% of the total energy and 30% of the CO₂ emissions per year. In this era of globalization and advanced urban areas, rich individuals consume more energy following the advanced western culture, lifestyle, and values by getting information through mass media. Reducing energy consumption and carbon emissions requires technologies and materials with low environmental impacts (Praticò et al. 2020).

CO₂ emissions are increasing due to household energy consumption in every country, but this is increasing in China. The household sector in China consumed 406 million tons of oil in 2014, which accounts for 20% of total energy consumption (IEA 2016b), and in 2014, CO₂ emissions were 343.9 million tons (IEA 2016a). The major source of energy consumption and CO₂ emissions has become household consumption (Liang et al. 2007). The literature also shows that households with different income levels impact energy consumption differently (W. Yan and Minjun 2009). There should be attention paid to the income levels of the households when estimating the impact of their energy consumption. Another crisis is climate change, which threatens the human and natural environment as extreme weather conditions and constant changes in the climate result in an increase in CO₂ emissions.

Additionally, the global outbreak of COVID-19 has threatened human life. There is a direct association between human activities and CO₂ emissions due to the consumption of fossil fuels (Gupta 2011). As energy demands have decreased during the COVID-19 outbreak, CO₂ emissions have also declined because of reducing manufacturing activities, reduced air regional transport, and household energy demand. A complete lockdown has been imposed throughout the world to control the virus spread, decreasing by around 30% in the energy consumption related to the industry (McKibbin and Fernando 2020).

The study by Evans (2020) demonstrated that after World War II, the world had a huge fall in CO₂ emissions; this study is based on the estimates obtained from the power plants and indirect pollutants of the environment. As per the reports, a 3.8% decrease was observed in the global energy demands during the first quarter of 2020, resulting in CO₂ emissions decreasing by more than 5% compared to the first quarter of 2019. Z. Liu et al. (2020) demonstrated that the decrease in CO₂ emissions varies among countries, cultures,

and regions. Different countries, including USA, reported a decrease of 7.6%, India 12.7%, and UK 19.3% in CO₂ emissions, while there was only a smaller change in China as 1.4%. Z. Liu et al. (2020) also showed a decrease of 5.5% in the manufacturing industry, which results in a 29% decrease in the total CO₂ emissions worldwide. There was a decrease in CO₂ emissions caused by industry, in China by 39% and in India by 33%. A decline in air and ground transportation also decreased CO₂ emissions by 18.6%, and a 43% decrease was observed in the first half of 2020, respectively (Z. Liu et al. 2020).

This study aims to analyze the quadratic impact of the share of consumption in economic activity on CO₂ emissions while assessing the national culture as a contextual factor. Studies that have assessed the relationship between consumption patterns with CO₂ emissions (He et al. 2017; Saleem and Ali 2019; Shi et al. 2020; J. Zhang et al. 2017b; Y.-J. Zhang et al. 2017a) but this is the first study to analyze this relationship while considering cultural differences to underline the sustainable cultural practices. This study reveals that cultures with higher standard lifestyles and higher-income positively impact CO₂ emissions. This study provides key policy instruments to eliminate CO₂ emissions by moderating consumption practices.

Literature review

The focus is on the growing GHG through household consumption globally. Only certain industries are focused on energy consumption measures and policies, while household consumption is the major source of CO₂ emissions (Feng et al. 2011). Human activities influence about 45 to 55% of the total energy consumption (Schipper et al. 1989), consequently leading to emissions. A study conducted in Denmark by Munksgaard et al. (2000) used the decomposition method to measure the association between household consumption and CO₂ emission from 1966 to 1992. A study conducted by Reinders et al. (2003) examined the relationship between household consumption and CO₂ emissions in 11 EU countries. This study demonstrated that household consumption is varied and dependent on expenditure levels; indirect demands of energy by households and their spending were related linearly.

Greenhouse gasses are affecting the atmosphere, and these effects are increasing day by day (Houghton et al. 1990; IPCC. 1991). Global climate is threatening due to the growth of these gasses. Scientists believe that these gasses are increasing through human activities. Numerous human activities increase these gasses, also called driving forces, including economic activities, population, technology, economic and political institutions, beliefs, and attitudes (Wei

et al. 2007). These forces increase CO₂ emissions, but the global environment is also changing.

Culture, consumption patterns, and carbon dioxide emissions (CO₂)

Pachauri (2004) conducted a study in developing countries to analyze the impact of household consumption on CO₂ by using the survey data of 1993–1994, and the results revealed that household energy use is affected by demographic, socio-economic, geographic, and family factors, while income and expenditures have the highest impact. A study by Alfredsson (2004) revealed that green consumption could reduce energy use and CO₂ emissions globally. Bin and Dowlatabadi (2005) analyzed the relationship between consumer/human activities, energy consumption, and CO₂ emissions by using the consumer lifestyle approach (CLA) and showed that consumer behaviour and other economic activities are 80% of the source of energy use and CO₂ emissions. Indirect use of consumer energy affects energy consumption and CO₂ emissions twice. Lenzen et al. (2006) conducted a study from the global perspective to examine sustainable household energy use in the input-output analysis. The study results showed that the energy demands varied in different cultures and countries, and Kuznets Curve is not supported.

Rao and Reddy (2007) studied the changes in energy consumption in a developing country using micro-level data. Reddy and Srinivas (2009) examined the households' energy consumption patterns in India and identified the factors. A study conducted by Rosas-Flores and Gálvez (2010) analyzed the energy consumption trends in Mexico and revealed its influencing factors, including cooling, heating, house built, and other household equipment and appliances. In their study, Shimoda et al. (2007) and Meyers et al. (2003) examined the relationship between household energy use and its effects. Income and region also impact energy consumption and CO₂ with other factors (Reinders et al. 2003). Wei et al. (2007) examined the rural and urban households' lifestyle impacts, which directly and indirectly impact energy consumption and CO₂ emissions, using data from 1999 to 2002 in China.

Bin and Dowlatabadi (2005) examined the impacts of different lifestyles on energy use and CO₂ emissions. They claimed that consumers use energy directly, such as living and travelling in order to fulfil their needs in residential places, such as cooling, heating, lighting, cooking, and other appliances, and indirectly fulfil their needs to buy and use products such as housing and travelling clothing, and food. Production requires huge energy, so consumers, directly and indirectly, use energy, impacting CO₂ emissions.

Literature has also examined the CO₂ emissions at national and regional levels with a production perspective (Mi et al. 2016) and also focused on different sectors in

production, including the textile industry in China (Lin and Moubarak 2013); cement industry in China (Xu et al. 2012); transportation, construction, and production and electricity sectors in Taiwan (Tsai and Chang 2013); and 43 sectors in China (Yu et al. 2016). Despite all of these sectors, the major source of energy consumption and CO₂ emissions is household consumption, households generate direct and indirect demands, and all the sectors work to fulfil these demands and becomes a source of CO₂ emissions. Product transfer among the regions and countries is also the source of carbon emissions as in this way; it is difficult to identify the basic source of pollution if production-oriented methods are followed. Some organizations, such as IPCC, and scholars focus on using a consumption-oriented approach (L.-C. Liu et al. 2011). In all cultures, regions, and countries, the major source of CO₂ emissions is households' energy consumption and lifestyles.

Using the input-output model by Lyons et al. (2012), a study conducted in Ireland revealed that as household incomes increased, it indirectly increased their energy use, resulting in increased CO₂ emissions. Duarte et al. (2010) conducted a study in which a positive association was found between household income and CO₂ emissions in Spain. Chancel (2014) revealed that the top 10% of rich persons in USA and France of total population impact three times more on CO₂ emissions than the 10% of the poor persons. Households with higher income levels in rural and urban areas of China impact 6.7 times and 3.8 times more on CO₂ emissions than those with low income (L.-C. Liu et al. 2011).

In a study, Brizga et al. (2017) analyzed the growth of CO₂ emissions from household consumption from 1995 to 2011 in Baltic States. Weber and Perrels (2000) conducted a study in France, West Germany, and the Netherlands to examine how households' direct and indirect energy demands impact CO₂ emissions. Wier et al. (2001) examined the impacts of household consumption patterns on CO₂ emissions in Denmark. Dai et al. (2012) examined the impacts of households consumption patterns on the energy demands and CO₂ emissions in China. Literature has examined the numerous factors influencing the CO₂ emissions from direct and indirect energy use by households (Das and Paul 2014; Han et al. 2015), including income (Lyons et al. 2012), household size (Jones and Kammen 2014), household members age (Murray and Mills 2011), household location (Jones and Kammen 2014), and education (Büchs and Schnepf 2013).

Numerous studies have examined the relationship between urbanization, growth, energy consumption, and CO₂ emissions. Li et al. (2011); Y. Liu (2009); Y. Liu and Xie (2013); C. Zhang and Lin (2012); Wang et al. (2013a, 2013b); Wang et al. (2013a); and Parshall et al. (2010) in their studies in USA and China identified the growth and urbanization as the major influence on energy consumption.

Different research studies were conducted in different regions, in newly developed industrialized countries by Hossain (2011), in 208 counties including developed and developing by Jorgenson (2003), in Tunisia by Shahbaz and Lean (2012), and in the USA by Clement and Schultz (2011). Donglan et al. (2010) examined that CO₂ emissions were increased by income and energy consumption in urban areas of China. Poumanyvong and Kaneko (2010) conducted a study on developed and developing countries and revealed that CO₂ emissions are increased by development and urbanization. Urbanization negatively affects developing countries while it has high impacts in developed countries.

Poumanyvong et al. (2012) found that development and urbanization increase energy consumption in transport and the impact is higher in the countries with higher income levels. In his study, Al-Mulali et al. (2012) found that in the 80% of investigated countries, there is a strong relationship between development, energy consumption, and CO₂ emissions and the development level of each country impacts this relationship. O'Neill et al. (2012) revealed that the higher economic growth in China and the labour supply had affected energy consumption and CO₂ emissions. Zhu et al. (2012) studied 20 developing countries and found an inverted U-shaped relationship between development, urbanization, and CO₂ emissions.

There are also studies available in the literature that have been examined and estimated the impacts of household lifestyles on the present and future energy demands. Pachauri (2007) conducted a study to examine India's energy consumption and energy systems by using the socioeconomic approach from the perspectives of households and identified the most critical factors of non-commercial energy sources such as biofuels and diverse use of energy by households depending on the well-being and their lifestyles. Feng et al. (2011) used the grey model in China to compare the households with different lifestyles to examine the relationships between energy consumption, expenditures, and CO₂ emissions, and revealed that for urban households, the use of direct energy is diverse, while in rural areas, households use energy in a simple way. In urban areas, direct energy use and CO₂ emissions are increasing rapidly as compare to rural areas. There is greater impact of indirect energy consumption and CO₂ emissions that direct use in the urban households.

In the newly developed countries with industry growth, energy consumption has increased CO₂ emissions since the 1990s (Kasman and Duman 2015). Due to different cultural factors in different regions, the energy consumption impact on climate change might be reduced or increased as the cultural values are fixed, and changes occur gradually. The individual and group behaviours towards conflicts, self-conception, authority, and how they deal with all of them are determined by cultural values (Inkeles 1997). This is the

reason for the significance of cultural values on the impact of the environment (De Mooij and Hofstede 2010; Onel and Mukherjee 2014). Panayotou (1997) explained that EKC could be smoothed for CO₂ emissions by implementing institutional factors, including applying the laws and contracts and security of property rights throughout the countries.

Traditionally, economic performance is positively associated with environmental degradation, but according to the environmental Kuznets curve (EKC), a different relationship between economic growth and environmental quality, especially in the previous two decades. Environmental Kuznets curve (EKC) establishes a U-shaped hypothesis between economic growth and environmental pollution (Disli et al. 2016). At the initial development stages, greenhouse gasses increase as growth increases, and ultimately, it causes climate change and global warming. Once a country reaches a certain development level, it focuses on environmentally friendly technology, and consumers' awareness of environmental quality decreases the greenhouse gasses (Aslanidis 2010; Dinda 2004).

Multiple factors affect the global climate, but the energy consumption is the one that affects most. Energy consumption has been the major source of CO₂ emissions since 1990s (Kasman and Duman 2015). But the effect of energy consumption on CO₂ emissions can be increased or decreased by cultural values, which takes too long to change. Cultural values shape groups' and individuals' behaviours in relation to self-conception, authority, and other conflicts and the way they deal with those conflicts and problems (Inkeles 2017). It focuses on the importance of cultural values in the environmental consequences (De Mooij and Hofstede 2010; Onel and Mukherjee 2014).

During the initial stages of economic development, environmental problems arise, which are the major complication for developing countries (Disli et al. 2016). The early development of the economy caused pollution as the major priority is economic growth, and individuals in the societies are more concerned with jobs and income than clean water, air, and environment (Dasgupta et al. 2002). The initial level of economic growth and energy consumption puts pressure on the environment, and pollution rises as people are more concerned about fulfilling their basic needs by buying and consuming cheap products without knowing the environmental influences of the growth (Kohler 2013). As the economic crisis and income of the individuals also rises, they start valuing their environment as they have fulfilled their basic needs, and now they are more concerned with using those products which are environment friendly with the developments of institutional regulations, and in result, the demissions declined (Kohler 2013).

It is needed to identify if culture affects the EKC. This paper identifies the cultural dimensions that moderates EKC movement (at the same level of economic growth, the CO₂

emissions are higher) and which dimensions move the EKC downward (at the same level of economic growth, the CO₂ emissions are lower). Cultural values may also shift the consumption pattern of the people to the left or right of the EKC in response to the EKC maximum level, where CO₂ emissions start to decrease as the income of people increases, and they shift towards more hygienic and quality consumption. Further, this study will control the EKC model using important factors defining its context. Sultan et al. (2021) and Wang et al. (2022) pointed out that renewable energy consumption is an important factor in determining the rate at which economic activity will generate CO₂ emissions. Similarly, population density explores the intensity of economic activity and its footprint (Ali et al. 2022).

Hypothesis development

Natural culture is the dominating factor that shapes individuals' and groups' collaborations and interactions. Culture comprises norms, values, and beliefs, which shapes human interactions as a strong informal institution (Hofstede 2016; Onel and Mukherjee 2014). All cultural dimensions have been studied with their influence on the EKC separately below:

High vs low power distance

Power distance is the degree of inequality of power distribution in a country or an organization and the acceptance degree of this unequal power distribution by the individuals of a country or by the members of the organization (Hofstede 2001; Kirkman et al. 2006). Countries in which there is higher power distance have undemocratic structures of decision making, formal rules and regulations, and authority concentration. Hofstede (2001) identified similarities between high power distance and authoritarianism. In an authoritative or paternalism system, the authoritative persons benefit the people or their subordinates who are loyal to them.

In high power distance countries, decisions are made based on the balance of loyalty and favours instead of people's interests and benefits (Hofstede 2001; Husted 2005). High power distance also sacrifices their ethics for the sake of their convenience (Blodgett et al. 2001; Christie et al. 2003; Husted 1999, 2005; Swaidan and Hayes 2005; Vitell et al. 2003). Metz (1991) described the deforestation program in Nepal, stating that higher power distance can impede the program's performance because the bureaucrats, when they implement a program, focus more on the sponsors of the programs than they should focus on the technical competencies and job performance.

Based on the literature, we argue that countries with high power distance follow a hierarchical system where decisions

are made at top level of hierarchy, and lower staff who execute those decisions are not involved in the decision making. Society has a low intervention to feed policy decisions. For instance, in dictatorship and low-income countries, people are solely dependent on government policy framework, which ideally fulfil or addresses the needs of some group of people. So high power distance on the one hand does not allow them to make their contribution; on the other hand, they are alienated from the overall production processes of the countries (Hofstede 1984a). When citizens of a country are not involved in decisions, their input is not required, their needs are not identified as what quality products they require from the manufacturing organizations, then the organizations produce the products they consider of higher sales and lower cost. Organizations in a country focus on their profitability more than the production quality or the environmental performance, and they overlook the consumption patterns of the individuals as they do not seek their inputs. In such countries, CO₂ emissions are higher. So, on the basis of this argument, we develop a hypothesis that:

H₁: Consumption patterns in low-income countries will increase CO₂ emissions and shift CO₂ EKC upward with the interaction of high power distance.

Individualism vs collectivism

Individualism vs collectivism presents the relationship type of the individuals and the groups to which they belong or are more fit (Hofstede 2001). West values are based upon individualism followed by utilitarianism, the culture followed by the developed countries gradually transfers towards the developing countries. The societies or cultures with individualistic approaches provide forums for self-development, creativity, and responsibility as compared to collectivist cultures or societies. They focus more on group consensus, harmony, and cohesiveness. The societies where collectivism is more appreciated and individualism are low, in such societies, critical attitudes and creativity are discouraged, which limits the initial behaviour of the individuals (Husted 2005).

Environmental protection is very low in low individualist societies as individuals are not supported for critical initiatives. Environmental initiatives are more appreciated in societies with an individualistic approach (Dobson 1990; Scholtens and Dam 2007; Vogel. 1987). In collectivist societies, the collectivists favour in-groups at the unethical cost of out-groups and flourishing corruption (Davis and Ruhe 2003; Husted 1999, 2000; H. Park 2003; Swaidan and Hayes 2005).

We argue that the citizens are more creative and quality conscious (Nayeem and Casidy 2012). Individualistic societies strictly follow the rules and regulations independent of individuals' influence, called utilitarianism.

Rule of law obeyed in countries restrict organizations to take control measures in their production processes to produce environmentally friendly products. This creates a culture that will legitimize purchasing only eco-friendly products. In low-income or high-income societies, people will be bound to purchase those products. In low-income countries, the government provides subsidies to consume quality products. When individuals are creative and have the freedom to execute their creative ideas, they will work more for environmental protection, and their consumption pattern will also be quality-oriented as they will find ways to use the energy in more innovative manners. So, on the basis of this argument, we develop a hypothesis that:

H₂: A higher individualism in a country will decrease CO₂ emissions and shift its CO₂ EKC downward.

High vs low uncertainty avoidance

Uncertainty avoidance is a society's tolerance for ambiguous and uncertain situations (Hofstede 2001). It describes the degree of tolerating and coping with ambiguous and uncertain situations by the members of society. The societies with uncertainty avoiding behaviour are more emotional; they do not accept change and are more careful about uncertain difficulties and problems. Opposite to that, societies with low uncertainty avoidance force their people to accept and tolerate uncertain things. Societies with a higher level of uncertainty avoidance develop proper structure, policies, and regulations to cope with uncertain environmental problems (Parboteeah et al. 2005).

Due to the increasing global warming, environmental changes are challenging, and higher uncertainty avoidance societies are very proactive in improving environmental performance (Disli et al. 2016). We argue that in higher uncertainty avoidance societies, the citizens are more conscious about their energy consumption as they have no intentions of risk taking by harming their environmental quality. So, the consumption pattern of the individuals is shaped in such a way that they do not compromise on quality products, and thus, the organizations in such countries or societies produce high-quality products and develop their manufacturing systems in such a way that does not harm the environment and produce emissions. So, based on this argument, we develop a hypothesis that:

H₃: A higher level of uncertainty avoidance in a country will decrease CO₂ emissions and shift its CO₂ EKC downward.

Masculinity vs femininity

The dimension of masculinity versus femininity asserts how society values masculinity or femininity. If a society has masculinity-oriented, society is supposed to be material-focused as the values of masculinity are tough, emphatic, and materialistic, while the values of femininity are affectionate, uncertain, and the focus is on life quality (Hofstede 2001). Masculinity focuses more on economic development, wealth, and materialistic growth, and their focus is not the environmental quality (Hofstede 2001; Husted 2005). Opposite to this, the focus of feminist societies is the clean environment, social well-being, and these societies are more responsible for their social role (Eisler et al. 2003).

Feminist societies are also more concerned with environmental issues (Eisler and Eisler 1994; Fraisse 1967). As opposed to the male society, females are more concerned about environmental quality, environmental protection, and have a positive attitude towards nature (Disli et al. 2016). In masculine societies, as to achieve more economic growth, these societies and organizations in such societies focus on producing and manufacturing the goods without their concern with environmental quality. As masculine societies are male-driven and are more concerned with economic growth (Hofstede et al. 1998), then, the consumption behaviour of these societies is also concerned with consuming more energy to avail more economic growth and development without concern with environmental protection. So, on the basis of this argument, we develop a hypothesis that:

H₄: A higher level of masculinity in a country will increase CO₂ emissions and shift its CO₂ EKC upward.

Long-term vs short-term orientation

Long-term orientation is the degree to which the members of a society have thought for the long-term future. Societies with long-term orientation are more concerned with economic growth and environmental quality, while those with short-term orientation value more to their social traditions (Hofstede 2001). As opposite to short-term oriented societies, goals, plans, and strategies are developed for the long-term benefits of the societies. Short-term oriented cultures pay little emphasis on the long-term effects of their current plans and decisions, while long-term oriented cultures sacrifice their current benefits for the sake of their long-term future objectives (Laibson 1997).

The consumption pattern of societies is also affected by the long-term and short-term orientations of the culture. As in short-term oriented societies, people consume more energy to fulfil their current needs and demands at the cost of their environmental quality. At the same time, societies with long-term orientation consume energy and other

facilities by keeping in mind their future needs and environmental quality. So, based on this argument, we develop a hypothesis that:

H₅: A higher level of long-term orientation in a country will decrease CO₂ emissions and shift its CO₂ EKC downward.

Indulgence vs restraint

Indulgence refers to societies that allow free gratification of natural life for humans, whereas restraint societies control such gratification, so the individuals are restricted to enjoy their lives (Hofstede et al. 2010). Indulgent societies prefer humans to enjoy their lives and spend their money, while restraint societies regulate humans to live their lives. As in indulgence societies, humans are free to spend and live their lives; then, it is expected that they will harm the environment and spend more money on luxurious and wasteful lifestyles, which in return negatively affects the environment and fosters pollution, while in the restraint societies, the norms, values, regulations, and controlled behaviour will reduce pollution (Disli et al. 2016).

Societies with controlled behaviours tend to be more regulated in their consumption, and thus, energy can be consumed responsibly. While in indulgence societies, people are free to consume resources to fulfil their desires to enjoy their lives. So, on the basis of this argument, we develop a hypothesis that:

H₆: A higher level of indulgence in a country will increase CO₂ emissions and shift its CO₂ EKC upward.

Previous studies have explored the EKC model with different parameters. This study adopts the EKC for consumption sustainability and explores demand-led EKC dynamics changes in different cultural contexts. This study will be instrumental in identifying cultural characteristics which promote consumption sustainability at the macroeconomic level.

Methods

Variables

Following Table 1 reports the variables which are selected for this study. The data will be collected for 49 countries ranging from 2008 to 2018. Here, variables like LCO2P, LGNI, LREN, and LPD are selected from world development indicators to form the EKC model of demand and control variables, while 6 time-invariant indicators of culture are used as a moderator of the EKC model.

Theoretical model

Empirically, many studies have confirmed the environmental Kuznets curve (EKC) relationship using different environmental quality and economic activity proxies like GDP per capita, industrial value added, and fossil energy utilization. The main idea behind the EKC of demand is that buyers focus on fulfilling their necessities at low levels of demand and income, with lower priorities on the posterity and sustainability of the production processes from which the product is delivered. Thus, market forces do not compel sellers

Table 1 Variables and data sources

Symbol	Definition and Transformation	Source
LCO2P	Log of CO ₂ emissions per capita	WDI (2021)
LGNI	Log of gross national income per capita	WDI (2021)
PDI	Power distance index. A higher index indicates that hierarchy is established and executed in society, without doubt or reason. A lower degree of the index signifies that people question authority and attempt to distribute power	Insights (2022)
IDV	Individualism vs collectivism. A higher number shows a degree of collectivism in which society is integrated.	Insights (2022)
MAS	Masculinity vs femininity. A higher degree means society prefers achievement, heroism, assertiveness, and material rewards for success.	Insights (2022)
UAI	Uncertainty avoidance. A lower degree means that society is tolerant of ambiguous outcomes.	Insights (2022)
LTOWVS	Long-term vs short-term orientation. A lower index indicates that traditions are honoured and kept, while steadfastness is valued. Societies with a high degree in this index (long-term) view adaptation and circumstantial, pragmatic problem-solving as a necessity.	Insights (2022)
IVR	Indulgence v restraint. This dimension is essentially a measure of happiness, whether or not simple joys are fulfilled. Indulgence is defined as “a society that allows relatively free gratification of basic and natural human desires related to enjoying life and having fun.” Its counterpart is defined as “a society that controls gratification of needs and regulates it using strict social norms.” Indulgent societies believe themselves to control their own life and emotions; restrained societies believe other factors dictate their lives and emotions.	Insights (2022)
LREN	Log of renewable energy consumption as a percent of total energy consumption	WDI (2021)
LPD	Log of population density	WDI (2021)

to opt for production methods that are sustainable (α_2 in equation below). While at higher demand levels, buyers go to a higher order of Maslow’s hierarchy of needs to avail themselves of luxuries that are sensitive to the environment (Arshed et al. 2021; Hassan et al. 2020; Wang et al. 2021). This country needs a certain level of income/consumption beyond which demand forces will compel sellers to adopt clean production methods (α_3 in equation below). This point is the turning point in the EKC curve. There is a dearth of studies in literature that has focused on the determinants of this turning point; thus, the means to intervene cleaner environment via EKC is underexplored.

This study proposes that the country’s national culture can moderate the turning point in the inverted U-shaped EKC relationship. As pointed out in the hypothesis development, each characteristic of the national culture plays its distinct role in the way consumers/buyers behave when their incomes increase. Cultures like masculinity, risk taking, and long-term orientation define the buyers’ purchase patterns differently from what is discussed in standard EKC-based studies.

The assessment of this model is done using the following equation which alternative instruments are added for national culture to form new equations. Here, the indicators of culture are multiplied by LGNI and LGNI², where the first cross-product explains the way culture changes the CO₂ increasing consumption patterns (α_5), and the second cross-product explains the way culture changes the CO₂ decreasing consumption patterns (α_6).

$$LCO2P_{it} = \alpha_1 + \alpha_2 LGNI_{it} + \alpha_3 LGNI_{it}^2 + \alpha_4 CUL_{it} + \alpha_5 CUL \times LGNI_{it} + \alpha_6 CUL \times LGNI_{it}^2 + \alpha_7 PD_{it} + \alpha_8 LREN_{it} + \epsilon_{it} \tag{1}$$

Haans et al. (2016) provided the framework to estimate the moderation of quadratic relationships and the (Dawson

2014) algorithm to visualize the moderating effect of culture on the EKC quadratic curve.

Estimation model

Since the data varies across cross-sections and periods, and there is a mixture of time-variant and time-invariant variables, this study has opted to use the panel feasible generalized least square (FGLS) model, which will allow the standard errors of the estimates to vary across cross-sections. These heterogeneous standard errors can then be used to make the model robust to any present heteroskedasticity and autocorrelation. Hameed et al. (2021) used this FGLS model to account for similar characteristics in the data. Further, since the years per country are less than 20, this study has not used the dynamic panel data models and assumed that variables are stationary across time (Arshed et al. 2018).

Results and discussions

Descriptive statistics

Table 2 firstly reports the descriptive. Other than the CO₂ emissions, all the variables have a mean value higher than the standard deviation, confirming that these variables are underdispersed across the sample. Further, since the dependent variable is overdispersed, this calls for the use of a panel data model, which controls for the cross-sectional and time-series differences of the data.

The Pearson correlations show that LGNI, IDV, LTWVS, and IVR are positively correlated with the LCO2P, while PDI, MAS, and UAI are negatively correlated. Since the correlations of other pairs are less than 0.9, the models do not contain any hint of multicollinearity.

Table 2 Descriptives and associations

Variables	Descriptives			Correlations									
	Obs	Mean	Std. dev.	LCO2P	LGNI	PDI	IDV	MAS	UAI	LTOWVS	IVR	LPD	LREN
LCO2P	583	0.827	1.53	1.00									
LGNI	583	25.00	2.01	0.559	1.00								
PDI	583	56.75	21.52	-0.455	-0.032	1.00							
IDV	583	44.36	23.14	0.518	0.269	-0.636	1.00						
MAS	583	46.77	19.78	0.013	0.295	0.095	0.008	1.00					
UAI	583	69.55	23.41	-0.128	-0.082	0.252	-0.224	0.057	1.00				
LTOWVS	583	44.65	21.49	0.344	0.102	-0.114	0.315	-0.015	-0.023	1.00			
IVR	583	46.60	21.72	0.193	0.253	-0.255	0.101	0.060	-0.128	-0.480	1.00		
LPD	583	4.287	1.436	-0.002	0.121	0.192	-0.189	0.252	-0.116	0.247	-0.053	1.00	
LREN	583	2.794	1.639	-0.645	-0.353	0.020	-0.080	-0.305	0.145	-0.042	-0.127	-0.157	1.00

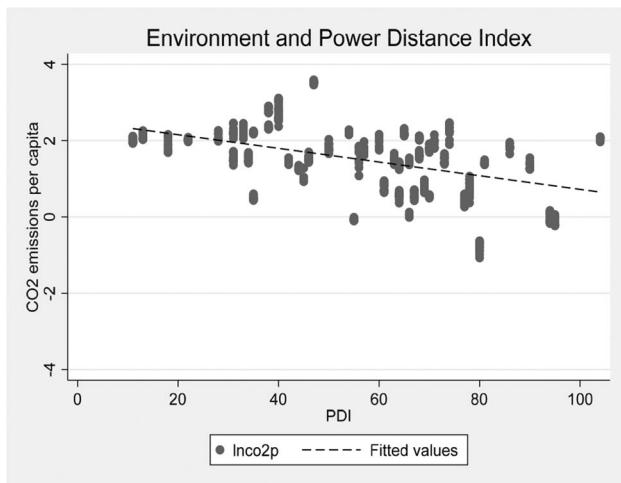


Fig. 1 CO₂ and power distance association

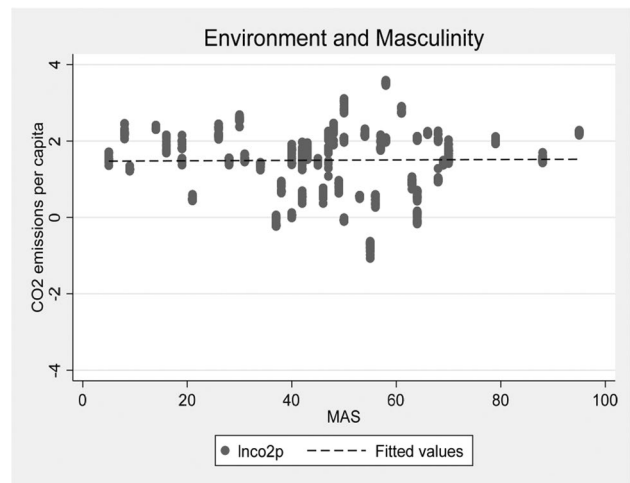


Fig. 3 CO₂ and masculinity association

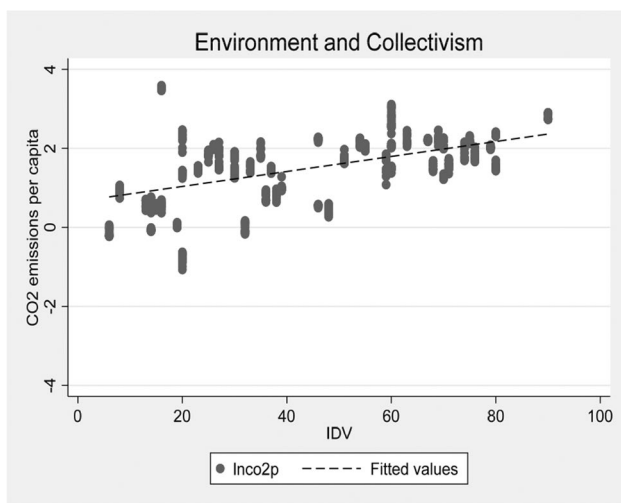


Fig. 2 CO₂ and collectivism association

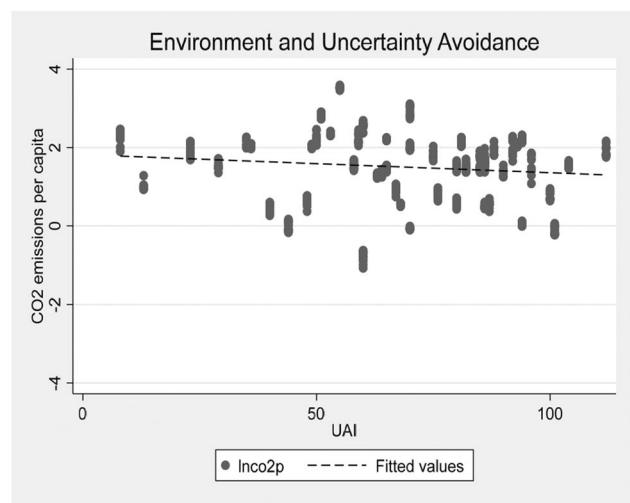


Fig. 4 CO₂ and uncertainty avoidance association

Graphical associations

Figure 1, 2, 3, 4, 5, 6 provides the graphical association between CO₂ emissions and indicators of national culture. Here, we can see that the increase in PDI and uncertainty avoidance negatively correlates with CO₂ emissions, while collectivism, term orientation, and indulgence have a positive association. At the same time, masculinity has no apparent association with CO₂.

Regression estimates

Table 3 reports the regression estimates using the panel FGLS model. For all models, the data of 49 countries are assessed, and the total sample size is 408 observations. The Wald test value is significant, which shows that the overall

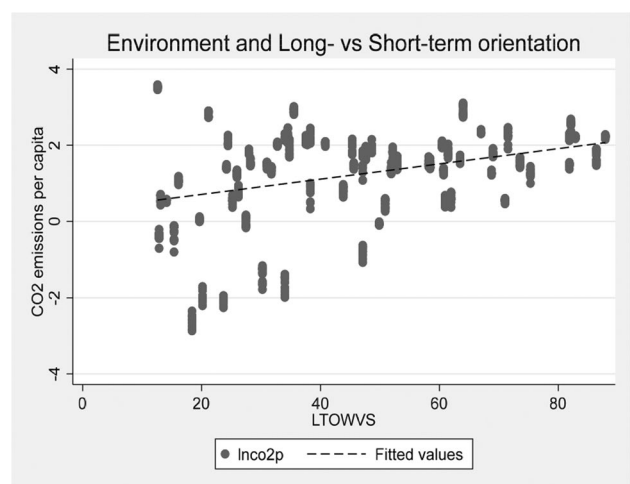


Fig. 5 CO₂ and time orientation association

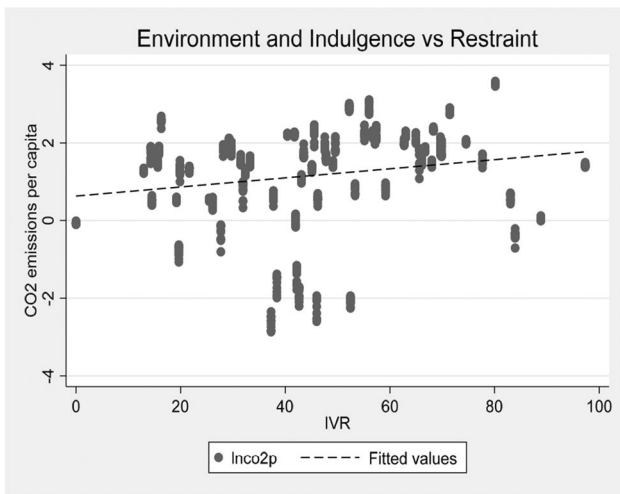


Fig. 6 CO₂ and indulgence association

model is fit in determining the changes in the CO₂ emissions (LCO2P).

There are 6 models estimated for demand EKC with quadratic moderation of culture index. The correlation values confirmed the absence of multicollinearity, and the model is robust to the presence of heteroskedasticity and autocorrelation. For all models, the effect of controlling factors LREN and LPD are negative and significant, showing that an increase in renewable energy consumption and population density tends to reduce the CO₂ emissions by the nation.

For the case of national cultural indicators of PDI, IDV, and IVR, the level coefficient of LGNI is negative, and the

coefficient of LGNI² is positive, showing the presence of U-shaped EKC. In this case, controlling these specific cultural types requires that the nation’s income be less than a particular level (threshold provided in Table 3) so that the consumption patterns do not lead to CO₂ emissions.

For the above discussed models, the individual coefficients of PDI, IDV, and IVR had a significant negative effect on the CO₂ emissions. Here, the coefficient of the product of culture indicator and LGNI is positive, while the coefficient of the product of culture indicator and LGNI squared is negative, which shows the flipping of the EKC curve, whereby initially, it was U-shaped but with the interaction of culture index; it is moving towards inverted U-shaped relation. This means economies with high PDI, IDV, and IVR will experience sustainable consumption with increased consumption size. In Figs 7, 8, and 12, the solid lines show the incidence of U-shaped demand EKC at low interaction. And the dotted lines are new EKC curves (inverted U-shaped) at high levels of culture.

While for the case of MAS, UAI, and LTWVS, the level coefficient of LGNI is positive, and the coefficient of LGNI² is negative, showing the presence of an inverted U-shaped EKC relationship. In this case, the controlling cultural types allow the nation’s income to grow beyond a certain threshold, which will benefit the environment.

The coefficients of MAS, UAI, and LTWVS significantly affect CO₂ emissions for the above discussed models. Here, the coefficient of a product of culture indicator and LGNI is negative, while the coefficient of a product of culture indicator and LGNI squared is positive, which shows the flipping of the EKC curve, whereby initially, it

Table 3 Regression estimates panel FGLS model

Dep. var = LCO2P						
Model	PDI	IDV	MAS	UAI	LTWVS	IVR
Variables	Coef (Prob)	Coef (Prob)	Coef (Prob)	Coef (Prob)	Coef (Prob)	Coef (Prob)
LGNI	-1.925 (0.00)***	-0.278 (0.65)	4.621 (0.00)***	1.666 (0.51)	9.712 (0.00)***	-4.216 (0.00)***
LGNI ²	0.040 (0.00)***	0.006 (0.63)	-0.087 (0.00)***	-0.018 (0.71)	-0.180 (0.00)***	0.086 (0.00)***
LREN	-0.616 (0.00)***	-0.577 (0.00)***	-0.724 (0.00)***	-0.221 (0.00)***	-0.309 (0.00)***	-0.355 (0.00)***
LPD	-0.252 (0.00)***	-0.230 (0.00)***	-0.324 (0.00)***	-0.876 (0.00)***	-0.178 (0.00)***	-0.083 (0.00)***
CUL	-0.581 (0.00)***	-0.364 (0.03)**	1.017 (0.00)***	0.849 (0.07)*	1.424 (0.00)***	-2.061 (0.00)***
LGNI*CUL	0.045 (0.00)***	0.029 (0.02)**	-0.079 (0.00)***	-0.059 (0.09)*	-0.104 (0.00)***	0.160 (0.00)***
LGNI ² *CUL	-0.001 (0.00)***	-0.001 (0.02)**	0.001 (0.00)***	0.001 (0.11)	0.002 (0.00)***	-0.003 (0.00)***
Const	28.204 (0.00)***	6.376 (0.49)	-55.71 (0.00)***	-29.38 (0.38)	-128.1 (0.00)***	53.73 (0.00)***
Statistics						
Cutoff Value at CUL = 0	24.06	23.17	26.56	46.28	26.97	24.51
Wald (prob)	8045.5 (0.00)***	5651.6 (0.00)***	4276.4 (0.00)***	3875 (0.00)***	2710 (0.00)***	3240 (0.00)***
Sample	408	408	408	408	408	408
Countries	49	49	49	49	49	49

***Significant at 1%, **significant at 5%, *significant at 10%

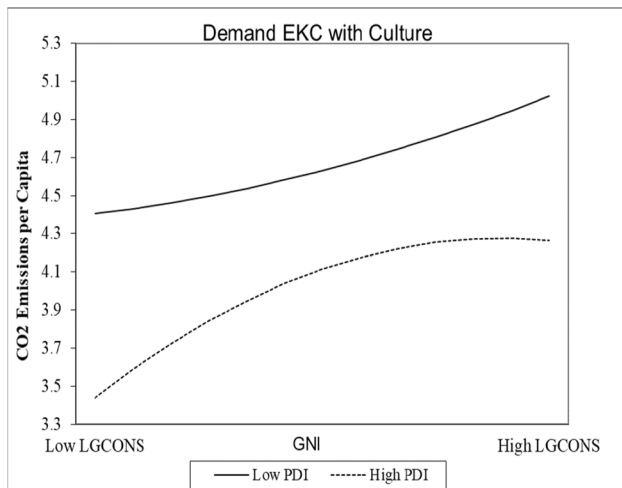


Fig. 7 EKC with power distance plot

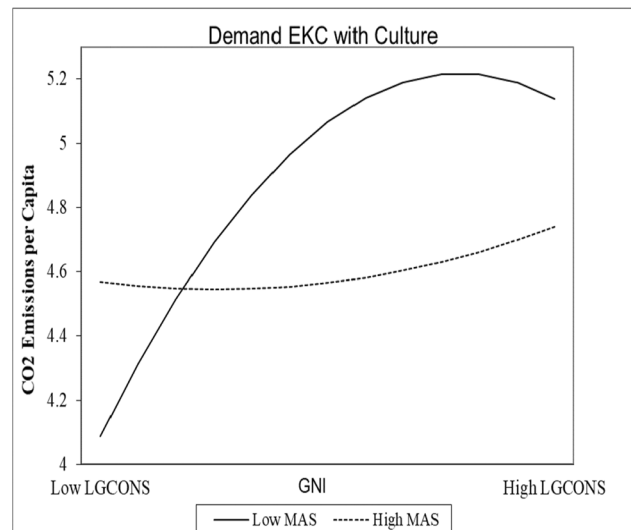


Fig. 9 EKC with masculinity plot

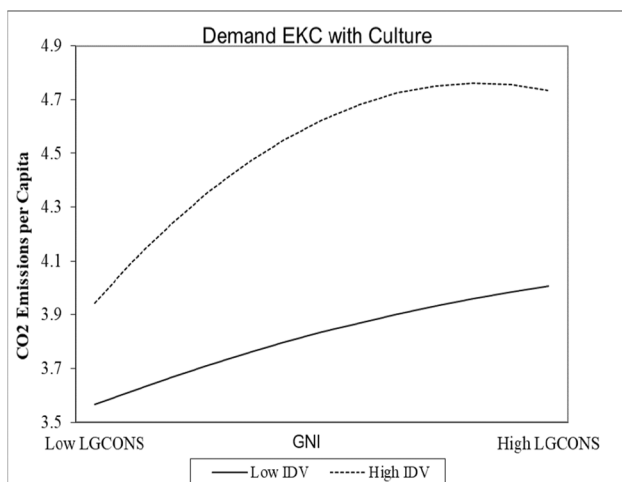


Fig. 8 EKC with collectivism plot

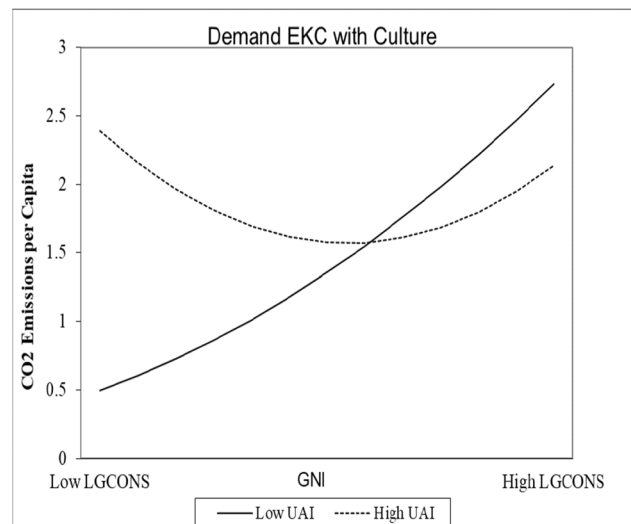


Fig. 10 EKC with uncertainty avoidance plot

was inverted U-shaped but with the interaction of culture index; it is moving towards U-shaped relation. In Figs 9, 10, and 11, the solid lines show the incidence of inverted U-shaped demand EKC at low interaction, and the dotted lines are new EKC curves at high culture levels. This shows that an increase in MAS, UAI, and LTWVS requires restraint in consumption behaviour to achieve sustainability just like IVR in (Fig. 12) so that it can help in reducing CO2 emissions associated with consumption behavior.

Conclusion and discussion

This study tested the interaction of 6 dimensions of the Hofstede National Culture Index on demand-based EKC relationships. The idea behind this is that culture defines

the way people set their consumption patterns with respect to their effect on environmental quality. Here, there are two different effects of the culture index. The first set of culture indicators could flip the U-shaped demand EKC to inverted U-shaped demand EKC. This includes indicators of PDI, IDV, and IVR. Here, the increase in PDI shows an increase in the hierarchy, an increase in IDV shows an increase in collectivism, and an increase in IVR shows an increase in the belief of having control over their own life.

These characteristics help the nation transform its consumption patterns towards environment neutral or environment friendly. People tend to believe in a collective effort toward ensuring a better future for themselves where they

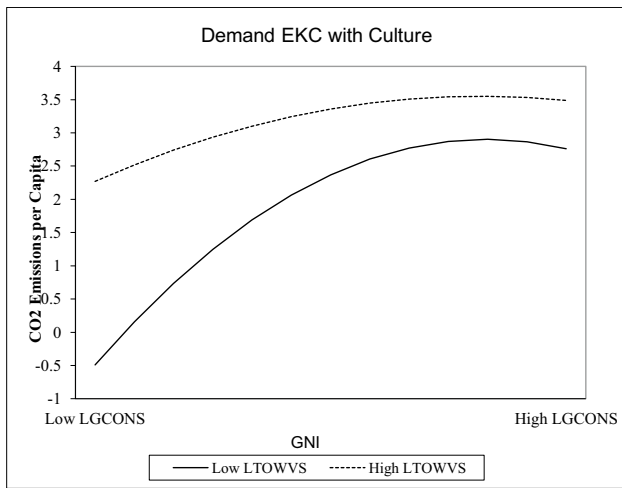


Fig. 11 EKC with time orientation plot

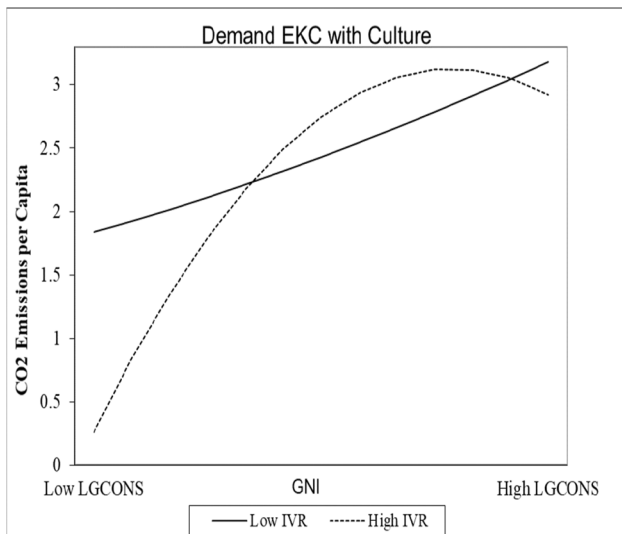


Fig. 12 EKC with indulgence plot

have better control of their lives. Hence, we experience the inverted U-shaped EKC, whereby they can greenify their consumption patterns because of the influence of the culture.

While the second set could flip the inverted U-shaped demand EKC to U-shaped demand EKC, including MAS, UAI, and LTWVS. Here, the increase in MAS shows an increase in society’s preference for achievement, heroism, assertiveness, and material rewards. An increase in UAI shows an increase in intolerance towards uncertainties and an increase in LTOWVS in long-term orientation of society that values pragmatic problem-solving.

These characteristics help the nation push its consumption patterns towards deteriorating the environment. The

materialistic goals and intolerance to the uncertainties tend to limit the environment friendly capacity of the consumption patterns. Policymakers can use the outcomes in developing an appropriate culture in the country which can help transformation towards sustainable consumption. Businesses can develop green key performance indicators to achieve national sustainability goals. Future studies can work on proposing measures that can help develop a clean environment based on the country’s national culture.

Appendix. List of countries in sample

Australia	Hungary	Pakistan
Austria	India	Peru
Bangladesh	Indonesia	Philippines
Belgium	Ireland	Poland
Bulgaria	Israel	Portugal
Chile	Italy	Romania
Colombia	Jamaica	Serbia
Costa Rica	Japan	Singapore
Croatia	Latvia	Slovenia
Denmark	Lithuania	Spain
Ecuador	Luxembourg	Sweden
El Salvador	Malaysia	Thailand
Estonia	Malta	Turkey
Finland	Mexico	
France	Morocco	
Germany	Netherlands	
Greece	New Zealand	
Guatemala	Norway	

Availability of data and material The sources of data are mentioned in Table 1.

Code availability Not applicable.

Author contribution All authors (Noman Arshed, Kamran Hameed, Asma Saher, and Naveed Yazdani) have equally contributed to developing this research manuscript.

Declarations

Ethics approval Not applicable

Consent to participate No consent is required as the study is based on secondary public data.

Consent for publication Authors provide their consent to publish the manuscript.

Conflict of interest Not applicable

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