



Energy consumption, carbon dioxide emissions and economic development: Evaluating alternative and plausible environmental hypothesis for sustainable growth



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ABSTRACT

Pursuit of excellence in economic development, in the midst of damaging the natural environment, is a shameless growth. The economic impacts on environmental degradation are quite visible in industrialized economies where human health is compromised by rapid economic growth and energy induced emissions. This study examines the interrelationship between energy consumption, economic growth and carbon dioxide (CO₂) emissions under the six alternative and plausible hypothesis including Environmental Kuznets Curve (EKC), Pollution Haven Hypothesis (PHH), population based emissions (IPAT), energy led emissions, sectoral growth emissions and Emissions emancipated Human Development Index (eHDI) in the context of low and middle income countries, high income countries and in aggregated panel, over the period of 1975–2015. The results supported the EKC hypothesis, IPAT hypothesis, energy induced emissions, and sectoral growth emissions in different regions of the world, while PHH and eHDI hypothesis does not confirm across regions. This study exclusively determines the key socio-economic and environmental problems in a large pool of the world economies to understand the need of development policy agenda for sustainable growth.

1. Introduction

The global growth is projected around 3.4% in 2016 and it would be added at 0.2% in 2017 that make around 3.6%. This estimate would larger than 0.3% (2016) and 0.5% (2017) from the year 2015, which is currently estimated at 3.1% points. Although, this projection as simulated by World Economic Outlook [64] largely emphasized on the positive growth trajectory in some BRICS countries and some countries of the Middle East, however, the slow down & rebalancing the Chinese economy and distress economic growth in emerging markets, the IMF report provoked to see some positivity in the global economic growth.

According to the latest report of International Energy Outlook [30], the devastating rate of CO₂ emissions resulting due to the combustion of fossil fuels, which is further linked with the climate change debate. The report projected that global energy- induced CO₂ emissions would increase around 35.6 billion metric tons in 2020 which will further added up to 7.6% in 2040 to make a figure up to 43.2 billion metric tons, which would be far greater than the estimates of 2012 i.e., 32.3 billion metric tons. The report further argued that emissions' growth is highly sensitive in the developed nations that continue to rely heavily

on fossil fuels to gear the pace of economic growth to utilized energy demand. OECD emissions will be contribute around 13.8 billion metric tons in 2040 while non-OECD emissions contributes around 29.4 billion metric tons, which is about 8% and 51% higher than the existing emissions level of 2012.

The recent trends of economic growth and energy -induced CO₂ emissions strike the need of well-balanced economic model that fundamentally approved by sustainable agencies for better health and wealth. This study takes an initiative to propose an interactive environmental model that aligned with the key factors of green growth and renewable energy resources to support sustainable growth agenda across the globe. The importance of sustainable growth in a policy liaison is broad-based that need careful examination to evaluate energy, environment and economic growth in a heterogeneous panel of countries by including financial and trade liberalization, social expenditures, and sectoral value added. This study attempts to explore these factors in a panel of low, medium, and high income countries.

The relationship between CO₂ emissions and per capita income extensively debated in the academic arena. Kuznets [58] explored an inverted U-shaped relationship between income inequality and per capita income. The followers of Kuznets school of thought added CO₂

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emissions in relation with the per capita income and evaluate the EKC hypothesis, which is still the icon for the academic arena (See, [46,53,57,21,51]; etc). Seldon and Song [46] investigated the EKC hypothesis in the panel of cross sectional countries and found that air quality pollutants including suspended particulate matter, sulfur dioxide (SO₂), nitrogen oxides, and carbon monoxide increases along with the increase per capita income, while at the later stages of development, these air pollutants significantly decline over time, hence the EKC hypothesis was found in all of the four air pollutants. Stern et al. [53] discussed the EKC hypothesis in relation with the global air pollutants and per capita income, and found a significant rise in SO₂ emissions and deforestation till the years 2025. Torras and Boyce [57] investigated the triangular relationship between per capita income, income inequality and pollution and found that literacy, political rights and civil liberties significantly impact on environmental quality in low income countries. Dinda [21] evaluated the global literature on EKC hypothesis and argued that income per capita does not identify the income range where environmental pollutants start to decline. However, EKC hypothesis holds with the local pollutants. Stern [51] presented the history of EKC hypothesis and discussed the rise and fall of EKC in different countries/ regions. Stern and Common [52] evaluated EKC hypothesis in relation with the SO₂ emissions and per capita income and found that EKC hypothesis was not related with the income of the country/region, however, it was pronounce with the time factor. In addition, EKC hypothesis holds in high income countries with the SO₂ emissions. The diverse literature is available on EKC hypothesis which needs to be critically examine in a large pool of countries for robust inferences. The subsequent sections critically discussed the different alternative and plausible environmental hypothesis for sustainable growth.

1.1. Tradeoff between CO₂ emissions and economic growth (Environmental Kuznets Curve approach)

The relationship between air pollutants and income per capita is widely discussed in the environmental economics that linked with the theory of 'Environmental Kuznets Curve (EKC)'. The recent strikes of the literature on the EKC hypothesis is the ray of hope that provide sun shine to the other regions of the world i.e., Tutulmaz [59] investigated the possible reasons of controversial EKC results for similar model and selected a case study of Turkish economy, by using the time series data ranging from 1986 to 2007. The results discussed some major rationale by using a selection of model in a country's perspectives and in a panel of developing countries, and discussed the policy implications for sustainable growth agenda. The study of Yang et al. [66] reinvestigated the EKC hypothesis in relationship with the different air pollutants in 29 provinces of China, by using extreme bound analysis from the period of 1995–2010. The results do not confirm the inverted U – shaped relationship in relation with different pollutants and China's per capita income. Bernard et al. [15] examined the EKC hypothesis with the CO₂ emissions and SO₂ emissions and found the validity of EKC hypothesis in the context of OECD countries. Robalino-López et al. [44] followed the EKC hypothesis in Venezuela for the period 1980–2025, and were unable to find any significant sign of EKC hypothesis during the study time period. Jebbie and Youssef [31] included renewable energy sources, non-renewable energy sources, trade, and economic growth in EKC model for Tunisia during the period of 1980–2009. The results show that non-renewable energy sources and trade both have a positive and significant impact on CO₂ emissions, while renewable energy sources decreases CO₂ emissions at nationwide. In addition, EKC hypothesis does not hold in the country's context. [6,9] investigated the EKC hypothesis in the panel of 93 countries by using ecological indicator and confirmed the EKC hypothesis across countries. Mazur et al. (2015) investigated the relationship between environmental quality and growth per capita in the panel of European Union countries, by using the data from 1992 to

2010. The results do not confirm the EKC hypothesis in the 28 current EU member states. Ozturk and Al-Mulali [40] investigated the EKC hypothesis in Cambodia by using the two stage least square and generalized method of moments technique and found that macroeconomic variables including energy demand, trade liberalization, urbanization and income per capita significantly increases CO₂ emissions in a country, however, EKC hypothesis was not visible at nationwide.

The above literature confirmed the viability of EKC hypothesis in different countries and regions of the world. This study followed the pattern of EKC modeling and builds the theoretical framework in order to assess the EKC hypothesis in a panel of selected countries for open policy discussions.

1.2. Tradeoff between CO₂ emissions, trade openness and FDI inflows (pollution haven hypothesis)

The relationship between CO₂ emissions and trade (FDI inflows) are widely discussed topic in the trade and environmental literature. The link between CO₂ emissions and trade-FDI inflows come to the meaningful conclusion that we called "Pollution Haven Hypothesis (PHH)". The PHH is the most conceivable hypothesis that has been investigated in different countries across the globe. The major motivation behind all of the studies is that polluting industries damage the natural environment of the world's precious resources that should have to be preserved with the effective environmental regulation policies. Shahbaz et al. [47] investigated the relationship between FDI inflows and CO₂ emissions in the panel of low, middle and high income countries and confirmed the visibility of PHH in different regions of the world. Aktas [4] found that globalization promotes polluting industries in Turkey, while Ali et al. [6] argued that environment is on the stake, as rapid progression of air pollutants are merely due to the higher economic growth. Tang and Tan [55] investigated the PHH in the context of Vietnam, using the time series data set ranging from 1976 to 2009. The results show that energy demand, economic growth, and FDI inflows have a strong determinant to influence CO₂ emissions in a country. The policies should be taken with care while handling environmental issues with respect to FDI and economic growth together. Salahuddin et al. [45] examined the long-run relationship between energy demand, per capita income, financial development, and CO₂ emissions in the selected Gulf cooperation countries and found that energy demand and per capita income both increase CO₂ emissions while financial development significantly decreases CO₂ emissions. Ibrahim and Law [28] investigated the impact of trade openness, institutional supremacy, and their interaction term on CO₂ emissions in a panel of selected Sub-Sahara African countries and found that trade openness significantly increases environmental quality of those countries that have a strong institutional supremacy and hurt environmental quality where institutional quality reforms are poor.

The above discussion confirmed the strong nexus between CO₂ emissions, FDI inflows and trade in different countries settings. The PHH is valid in different countries' contexts, and we find the traces of significant association of FDI and trade with the CO₂ emissions from the literature. The present study attempts to explore PHH in the panel of selected countries.

1.3. Tradeoff between CO₂ emissions and population growth (IPAT hypothesis)

The impact of population growth on CO₂ emissions is widely visible topic and a normative debate in the environmental arena, however, the blame on population growth to deteriorate environment is not fairly justice. McGee et al. [36] investigated the impact of economic growth, technology and population on carbon emissions for the panel of 173 countries and concluded that stochastic impacts by regression on population, affluence and technology have considerable policy implications on future technology generation. Zhang and Liu [67] investigate

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