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Article

Analysis of the Impact of Energy Consumption on Economic Growth in Azerbaijan

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Abstract

The rise in energy use and industrial activities emitting CO₂ has become a major environmental concern globally. This study examines Azerbaijan's current efforts in reducing carbon emissions and promoting sustainable development, offering strategic recommendations for managing the country's carbon footprint. The goal is to help shape more effective policies by analyzing the link between economic activity and environmental impact. Using an econometric model covering the period from 1990 to 2023, the research finds that economic growth in Azerbaijan is associated with an increase in per capita CO₂ emissions, driven by heightened industrial output, energy demand, and other economic factors. Additionally, a long-term positive relationship between population growth and emissions per capita highlights growing energy needs, consumer demand, and transportation usage. Given the strong connection between economic expansion and emissions, the findings suggest that it may be too early to confirm the applicability of the Environmental Kuznets Curve in the context of Azerbaijan's developing economy.

Keywords: CO₂ emissions; energy consumption; Kuznets curve

2. Introduction

Carbon footprints play a crucial role in driving climate change, as greenhouse gas emissions contribute directly to global warming. The World Meteorological Organization (WMO) reports that the decade from 2011 to 2020 was the warmest ever recorded, with CO₂ emissions rising by 31% between 1990 and 2005. By 2008, these emissions had increased Earth's radiative forcing by 35% compared to 1990 levels (WMO, 2023). The Paris Agreement, adopted by 196 nations at COP21 and effective from November 4, 2016, aims to limit global temperature increases to well below 2°C above pre-industrial levels, preferably not exceeding 1.5°C (UNCC, 2016). The energy sector, as the biggest source of emissions, is pivotal in combating climate change. Despite numerous international efforts since the 1992 UN Framework Convention on Climate Change, CO₂ emissions from energy and industrial sources have climbed by 60%. Managing carbon footprints is vital to slowing climate change. One major environmental challenge is the CO₂ emissions resulting from growing energy consumption and industrial activity, especially in developing countries where economic growth often intensifies environmental harm. Azerbaijan, with its expanding industry and economy, has seen noticeable shifts in CO₂ emissions, remaining heavily reliant on fossil fuels. This study seeks to analyze how different economic and environmental factors influence per capita CO₂ emissions in Azerbaijan through econometric modeling. Understanding the key drivers of emissions across sectors will aid in shaping policies to reduce the country's carbon footprint and strengthen environmental governance.

3. Carbon Footprint: International Outlook

Carbon dioxide is the primary greenhouse gas contributing to climate change and global temperature rises. As of 2022, the United States holds the record as the largest cumulative emitter since the industrial revolution, releasing 427 billion metric tons of CO₂ (GtCO₂), followed by China with over 260 GtCO₂ (Tiseo, 2023). China's emissions have increased fivefold since 1990 and accounted for about 34% of global emissions by 2023. In contrast, the UK's emissions have almost halved since 1990. While developed countries like the UK, US, Japan, and Germany have reduced emissions overall, developing nations have seen rapid increases. For example, India's emissions have nearly quintupled due to fast economic growth, and Vietnam's have surged twentyfold (Tiseo, 2024a). Global CO₂ emissions from fossil fuels and industry have grown by more than 60% since 1990, reaching 37.15 GtCO₂ in 2022 and 53 GtCO₂ in 2023. China now leads in global greenhouse gas emissions, followed by the US, with its dramatic rise driven by industrialization and rapid economic expansion.

4. Carbon Footprint: Literature Review

In a seminal 1972 study, Meadows et al. examined the relationship between population growth, industrialization, and resource use, warning that ongoing trends could result in economic and environmental collapse by the end of the century. They stressed that economic growth is inherently limited by the planet's ecological boundaries, such as finite resources and pollution absorption capacity, and called for regulations to prevent overconsumption and environmental damage. The Kyoto Protocol, launched in 2005, represented a key step in climate policy by setting binding emission targets for developed countries. Meeting these goals requires structural economic shifts, including shrinking high-emission industries and promoting low-carbon sectors, which may come with economic costs. For instance, Chang (2015) showed that reducing China's emissions would demand industrial changes potentially lowering GDP by 82.59 billion Yuan (about USD 11.6 billion). Dinda and Coondoo (2006) studied CO₂ emissions and income in 88 countries (1960–1990), finding a long-term link between the two, with regional differences: in Central America, income drove emissions; in Europe, emissions influenced income; and in Africa, the relationship was bidirectional. Their earlier work (2002) questioned the Environmental Kuznets Curve (EKC) hypothesis, noting that in developed countries emissions often led to income changes, while developing countries showed the opposite or a two-way dynamic.

5. Econometric Assessment of Carbon Footprints in Azerbaijan: Methodology

Data and Descriptive Statistics

Figure 1 displays trends in Azerbaijan's sectoral carbon footprints from 1990 to 2023, showing an overall decline in emissions since 1990. Scholars often attribute this drop to the economic and industrial slowdown following the Soviet Union's collapse. However, the data—expressed per capita—may mask complexities, as population growth and economic development do not always correlate straightforwardly with emissions. The figure shows that although emissions dropped in most sectors during the 1990s, gasoline consumption—and thus emissions from transport—has risen steadily since the early 2000s before stabilizing at a higher level. On average, per capita CO₂ emissions decreased from about 7–8 tons in the early 1990s to 3–4 tons by 2010, maintaining that level through 2023. During this time, the population grew from 7 million in 1990 to 10 million in 2023, though population growth has slowed recently. GDP per capita saw fluctuations: a decline until 1995, gradual growth from 1995 to 2005, a sharp rise between 2005 and 2010, then stabilization through 2023, with particularly rapid growth in 1993–1997 and 2004–2006.

6. Conclusions and Suggestions

The analysis reveals that per capita fossil fuel use significantly influences Azerbaijan's CO₂ emissions. Regression results indicate that each additional kilowatt-hour of fossil fuel consumption per person increases total CO₂ emissions by 0.55 units. Furthermore, about 75% of shocks to emissions—whether natural or policy-related—tend to be corrected in the next period, showing emissions revert strongly to a long-term trend. Azerbaijan has lacked comprehensive time series studies on the income-emissions relationship. This study fills that gap using a cubic functional form aligned with the EKC framework and five econometric methods to ensure robustness and reduce small-sample biases. Results confirm a long-run link between income and emissions, with a U-shaped curve where the turning point lies beyond the study period (1992–2013). This suggests that CO₂ emissions in Azerbaijan continue to rise with income, meaning the EKC hypothesis does not yet apply. As a fossil fuel-dependent developing country, Azerbaijan requires substantial income growth before emissions might decline. The nearly proportional long-run relationship between income and emissions implies that without targeted environmental policies, economic growth will keep increasing CO₂ output. Growth focused on heavy industries like oil, coal, and metals could worsen environmental damage, whereas expanding low-carbon sectors such as services and IT would support sustainable development.

In summary, the study highlights the need to integrate environmental concerns into economic policy. To effectively reduce emissions, Azerbaijan should:

- Decrease reliance on fossil fuels,
- Boost renewable energy's share,
- Enforce robust environmental regulations like carbon taxes, emissions trading, and carbon capture initiatives.

These steps are essential for aligning economic growth with environmental sustainability and steering Azerbaijan toward a more climate-resilient future.

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