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COMMENTARY

China’s Economic Expansion and CO_2 Emissions: An IPAT Framework Analysis

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IPAT Framework Analysis: 2000–2022

The IPAT equation, expressed as Impact = Population × Affluence × Technology, is a useful framework for understanding how human activity drives environmental pressures. When applied to China, the model illustrates how demographic shifts, rapid economic growth, and technological advancements have impacted the country’s greenhouse gas (GHG) emissions over the past two decades. As the world’s largest emitter of carbon dioxide, China’s emissions trajectory is central to global climate action and sustainable development (Wang et al., 2021).

In 2022, China released approximately 11.5 billion metric tons of CO_2, accounting for about 30% of global emissions (Climate Watch, 2023). While China leads in total emissions, its per capita emissions remain lower than those of the United States. Between 2000 and 2020, China’s population grew from approximately 1.26 billion to 1.41 billion (World Bank, 2023). However, population growth has slowed sharply in recent years due to the long-term effects of the one-child policy, declining fertility rates, and rapid urbanisation (United Nations, 2023; World Bank, 2023). By 2022, population growth had largely stalled, with early signs of population decline beginning to emerge (National Bureau of Statistics of China, 2023). This slowing demographic growth in China has eased some of the upward pressure on emissions, while rapid urbanization continues to concentrate energy use in cities and can increase carbon intensity (Pan et al., 2021; Tang et al., 2024).

China's economic rise has been dramatic. GDP per capita jumped from around $950 in 2000 to more than $12,700 in 2022 (Ritchie et al., 2023), representing a more than thirteenfold increase. However, higher incomes have driven increased demand for energy-intensive goods and services, including automobiles, air conditioning, meat consumption, and international travel. The massive scale of manufacturing and infrastructure development has also driven up emissions (Pan et al., 2021; Tang et al., 2024). Between 2000 and 2013, China's GHG emissions more than doubled, largely due to the energy requirements of rapid growth and economic expansion (IEA, 2023).

Within the IPAT model, "technology" reflects the carbon intensity of economic activity, or the amount of CO_2 emitted per unit of GDP. Since 2005, China has steadily reduced its carbon intensity through large-scale investments in renewable energy, stricter efficiency standards, and a gradual shift away from coal (IEA, 2023).

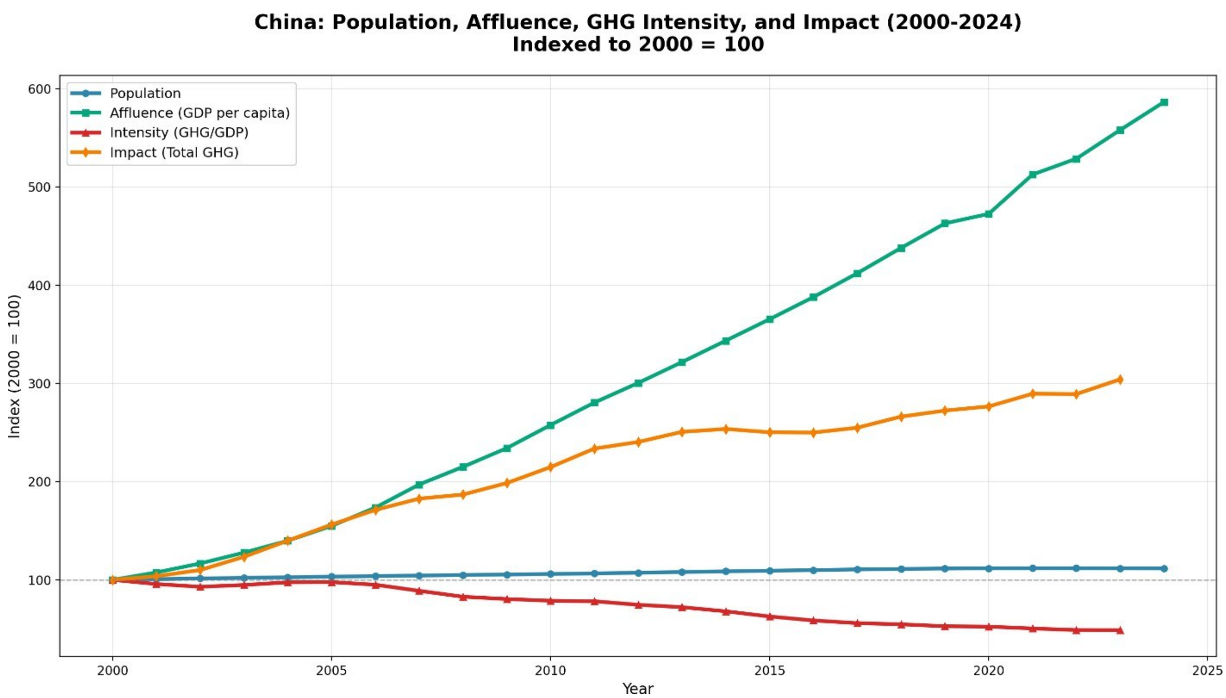

Figure 1 *Pattern of IPAT Components in China (2000–2023).*
Note. *All variables are indexed to 100 in 2000. Source: Graph generated by [ChatGPT] using Python (OpenAI, 2025).*

China now leads the world in the production and deployment of solar panels, wind turbines, and electric vehicles (Climate Watch, 2023). The country has also expanded national energy-efficiency programs and launched a nationwide emissions trading system. As a result, China's carbon intensity has declined by more than 50% since 2005, dropping from 2005 levels to about 0.42 kg of CO_2 per dollar of GDP by 2022 (World Bank, 2023; IEA, 2023). Still, coal continues to account for more than half of China's energy supply, and new coal-fired power plants are still under development (International Energy Agency [IEA], 2025). This reliance on coal slows the pace at which technology gains can counterbalance emissions growth generated by rising affluence.

The IPAT model helps explain China's emissions trajectory over the past two decades. Affluence, driven by rapid economic expansion, has exerted the strongest upward pressure on emissions, while technology has increasingly pushed emissions in the opposite direction through large-scale renewable energy deployment, industrial efficiency improvements, and declining carbon intensity (IEA, 2023; Climate Action Tracker, 2024). Population, once a major driver, has become less significant as China's demographic growth slows and begins to decline (World Bank, 2023). This combination has created a delicate balance in which emissions growth has slowed but remains high overall.

Under its climate commitments, China aims to achieve carbon neutrality before 2060 and has introduced its first absolute emissions-reduction target, seeking to cut total net greenhouse gas emissions by 7–10% from peak levels by 2035 (Climate Action Tracker, 2024). Table 1 illustrates the slowdown of GHG emissions from 5.6% to 3.2% annually following the Paris Agreement. While this trend is encouraging, it may also reflect slower growth in affluence and population, since this period includes the COVID-19 pandemic.

Table 1: *China's IPAT Components (2000–2022)*

Period	Population growth (% per year)	GDP per capita growth (% per year, PPP, constant 2017 international $)	Change in carbon intensity (% per year)	Growth in total GHG emissions (% per year, excluding LULUCF)
2000–2015	+0.7%	+9.2%	–3.8%	+5.6%
2016–2022	+0.3%	+6.7%	–5.1%	+3.2%

Note. Population growth, GDP per capita growth, carbon intensity change, and total greenhouse gas (GHG) emissions growth are reported as average annual percentage changes. GDP per capita is measured in purchasing power parity (PPP), constant 2017 international dollars. Carbon intensity refers to CO_2 emissions per unit of GDP. Total GHG emissions exclude land use, land-use change, and forestry (LULUCF).

Source: Data are drawn from the World Bank World Development Indicators (WDI, 2023).

In conclusion, China's experience highlights the challenge of balancing economic development with environmental sustainability. The IPAT and Kaya frameworks reveal that affluence and technology are the most influential drivers of emissions trends. With population growth nearly flat, future emissions reductions will depend largely on China's ability to further decouple economic growth from carbon output.

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data, or analytical results. All interpretations, conclusions, and final content were reviewed, revised, and approved by the author, who takes full responsibility for the accuracy and integrity of the work. Any errors in interpretation, calculation, or presentation are entirely my own, and readers are encouraged to critically evaluate the findings and consult additional sources where appropriate.

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Kikelomo Olanipekun's academic and professional journey began with a background in Agricultural Economics and early work experience as an agronomist. Through her work in agricultural systems, she developed firsthand insight into how land, people, and policy shape one another. Those years working closely with farmers and agricultural systems sparked a deeper curiosity about sustainability, resource management, and the economic forces that influence who thrives and who struggles within rural and agricultural contexts.

This intellectual curiosity eventually led her to Thompson Rivers University, where she is currently studying Environmental Economics and Management. Today, she brings practical agricultural experience and analytical training to explore how communities can transition toward

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