

The Historical Nexus between Air Quality and Economic Development: Evidence from China

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Abstract. This paper examines the relationship between economic development and air quality in China. After introducing the economic development process and air quality situation in China, a comprehensive literature review is carried out, in which several works that document research on the link between economic growth and pollution are examined critically. The findings of this study lend credence to the Environmental Kuznets Curve, which shows a correlation between rising levels of air pollution and expanding economies. After conducting research and analysis of China's economic growth after reforms, it was discovered that economic growth was a major contributor to environmental pollution. In addition, it contributed to the rise of the middle class, which increased the use of polluting fossil fuels. The study suggests that non-renewable energies, electric cars, and industrial technologies be implemented to reduce air pollution. Additionally, the study indicates that research be conducted regarding how responsible development can be achieved without necessarily having a negative impact on ecological environment.

1 Introduction

The period before China adopted economic reforms and trade liberalization was marked by an inefficient, poor, centrally controlled, and dormant economy. The economy then did not integrate much with the rest of the world. At the time, the government directed and controlled the economic output. The government took the need to support industrialization by investing in human and physical resources in the 1960s and 1970s [1]. Since the decision in 1978 by foreign trade and Investment to implement the free trade reforms, the economic growth recorded for the country was high and among the top in the world at the time. The reforms implemented mainly decentralized economic policy-making in the various sectors of trade. The firms could operate on free marketing principles, providing the best atmosphere for business to thrive. For the past few decades, China has been averaging growth of 10% on average, and has raised hundreds of millions of its citizens from poverty [2]. It is known that China has the world's second largest economic scale, and its purchasing power, manufacturing industry and merchandise trade and on the rise steadily. China has achieved these heights through an aggressive approach to industrialization, credited for the country's drastic change of path.

The aggressive approach by China's growth propelled by industries has had its fair share of negative effects on the environment. The energy-intensive industries have for years now been the largest pollutant. The level of pollution has gradually worsened during this economic development journey. The high level of pollution poses a health hazard to the population. Some

cases are reported when the government has gone to lengths of disregarding its laws guarding the environment to maintain growth in the economy. A 2018 report revealed that China alone was responsible for around 60% of the global CO₂ emission growth from 2000 to 2016 [3]. The US embassy in Beijing has, over this period, been monitoring the air quality in China, particularly the quality index of particulate matter considered to threaten people's health. They reported a period in 2013 when the air ranged from unhealthy to hazardous. The Chinese government has recently committed to slowing down energy consumption boosting the environment through reduced coal usage, and relocating high-polluting companies far from urban center.

2 Literature review

Many scholars are trying to study the connection which exists between the pollution of air and the development of the economy. Jiang et al. investigate pollution and how it relates to economic growth by making a comparison of South Korea and China. The research analyzed the interaction that exists in the growth of the economy and the pollution of air in the two countries and examined the industrial sulfur dioxide emission in the two regions, and compared this to gross domestic product per capita. Simultaneous models were used covering 286 cities for the period 2006 to 2016. The findings indicated that air pollution and the growth of the economy correlated [4].

Some other researchers sought to decouple this connection between the growth of the economy and the

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pollution of the air. These studies considered the key regions in China with continuous economic development and used the Tapio decoupling theory as a key tool, especially in analyzing the pollution of the air and the growth of the economy in the main regions. The focus regions for studies were Beijing, Hebei, and Tianjin. To test this relationship, Li et al. compared the GDP of these regions with SO₂, PM10, and NO₂ pollution between 2000 and 2019. This research revealed a strong correlation between the pollution of the air and the growth of the economy. The study indicated that interventions from relevant authorities to help improve the situation by lowering pollution and maintaining economic growth were essential [5].

Further research tried to evaluate this relationship in other areas. Armeanu et al.'s research aimed to explore the connection between the growth of the economy and pollution of air. The study took into consideration the primary energy consumption in European countries for the period 1990 to 2014, and the main goal was to examine the Environmental Kuznets Curve. Specifically, the research estimated pooled ordinary least squares (OLS) regression with the Driscoll-Kraay standard errors, allowing them to account for cross-section dependence. The results confirmed the Environmental Kuznets Curve hypothesis in the emission of non-methane and sulfur oxides. In addition, there was a correlation between the growth of the economy and the emission of greenhouse gases [6].

Based on existing literature research, this paper mainly explores the relationship between air quality and economic development. The study mainly focuses on China and analyses the correlation between China's economic development practices and the ecological environment, especially air quality. These studies may facilitate China continuously address the air quality issues and achieve green and sustainable development during the rapid economic development process.

3 Analytical framework and discussion

3.1 Industrial development and pollution

For the last 45 years, China has achieved remarkable industrial development since adopting the reforms in 1978. From 1978 to 2018, the industrial-added value rose from 162 billion yuan to 30,516 billion yuan in just 40 years. In the past two decades, China's industrial added value has increased 7.25 times, reaching 40164.43 billion yuan in 2022 [7].

As shown in Figure 1, the period of 1990-2015 generally marked by capital-intensive industries. The industries that have seen tremendous growth in this period include cement, cell phones, steel, computers, and automobiles, raising the country's status to a world giant.

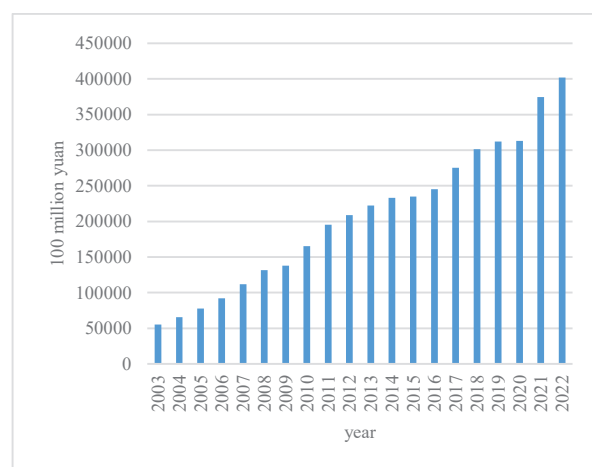


Fig. 1. China's industrial-added value 2003-2022 (Photo credit: Original).

Industrial development during this period brought with it increased pollutants discharge. In a record gracing incident reported in 2015, solid waste from the top four industries in the country reached a record 3.11 billion tons accounting for 91% of all the solid waste. According to Figure 2, the data on gas emissions shows a rapid increase from 1986 to 2015. The rise in pollution is not linear; rather, it is in a positive exponential.

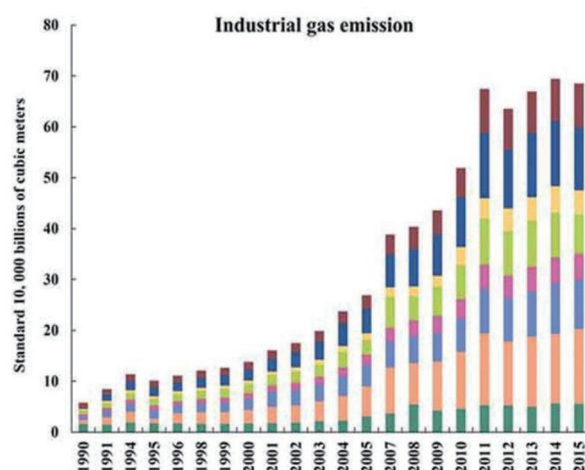


Fig. 2. Industrial gas and solid waste pollution (1990-2015). Source: China Environmental Statistics Yearbook. <https://www.tandfonline.com/doi/full/10.1080/20964129.2020.1779010>

The trend is visible in the two illustrations given above. The trend taken in the development of the industries and the rate at which China have witnessed the growth is similar to that of pollution. Solid waste and gas emissions pollution has risen over this quite alarming period. Their effects are felt in various aspects as they have also impacted the soil and the aquatic systems. The groundwater is no longer safe for people to drink as, in most cases, it has already been classified as poor. The chemicals discharged by the companies have affected the aquatic environment destroying the aquatic species and the whole ecosystem. This has also been felt for the soil and air as more of residents' habitat each day have been destroyed.

This trend of industrial pollution can be dealt with by adopting various measures. One, the country needs to

invest more in renewable energy that can reduce the use of coal, which is responsible for a significant share of greenhouse gases. Industries can take the initiative to lower air pollution by adopting pollution abatement measures like installing equipment that desulfurizes or denitrify. Companies can also be funded to support innovations in designing efficient production models with minimal pollution.

3.2 Transportation pollution

The rapid development of the Chinese economy saw an increased traffic network, and the number of vehicles in the country increased at a very high rate (see Figure 3).

The figure shows the growth rate over the same period, which is seen to peak around 2002 and 2009. From 1994 to 2016, the number of cars in the country increased from 13.64 million to 28 million [8]. Increased income has fuelled car ownership in the country, especially among the middle-class groups in the population. China's automotive production has been growing, which greatly cementing its top position in the global automotive industry.

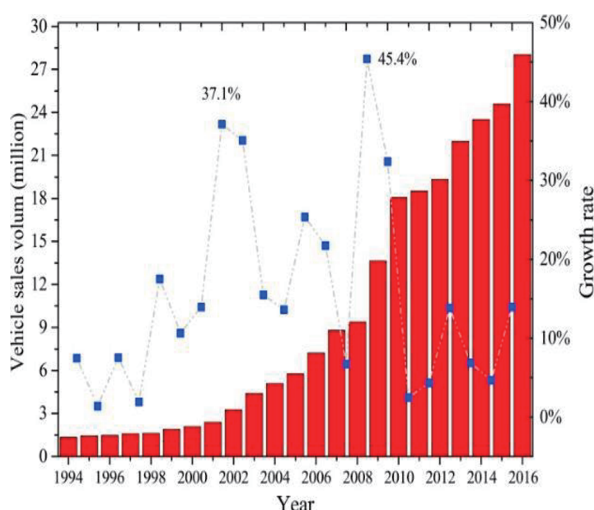


Fig. 3. Sales volume of vehicles in China (1994-2016).
 Source: China Association of Automobile Manufacturers.
<https://doi.org/10.7717%2Fpeerj.6932>

The number of vehicle sales in the country is not decreasing anytime soon. It is projected to continue rising, which by itself is a threat. Vehicles, especially those running on fuel, are major air pollutants whose increased usage threatens the environment. Vehicles produce harmful gases that pollute the air, especially in urban settings where many vehicles are used. In China, the majority of cities fail to meet emission standards and these cities are experiencing the problem of exhaust pollution.

A solution to this worrying trend needs to be found if the government decide to reduce the air pollution many people are experiencing due to transportation pollution. The first thing that comes to mind to solve this is the adaption of the electric vehicle. Electric vehicles provide an option to the conventional car that uses fossil fuels and has been a leading source of greenhouse gas emissions. Electric vehicles do not emit pollution into the air as their energy source is electricity. Electricity

can be generated using green methods like wind, solar, hydroelectric, and geothermal.

This means that the emissions by this method can be cut to close to zero emissions. There also exists hybrid cars which partially use electricity which can be used to lower emissions at a lower cost. However, this solution needs to be revised regarding the infrastructure required to support such a switch. There need to be numerous charging stations, and technology must be developed further to create cars with high travel distances per charge. Progress is being made, but there must be an assurance that the transition is fully green in that electric power is available from free sources.

The other factor that can be looked at is redesigning the roads to meet the vehicle industry boom, which could be an advantage in reducing congestion. In addition, the Chinese government should make efforts to improve the fuel quality, and in the meanwhile greatly promote the vehicle emission standards. These moves will lower the pollutant emissions of air within a short period. They should be given priority while a permanent solution like a full transition to electric cars is being worked on.

3.3 Progress of air pollution in China

As China works to build an eco-friendly society, the government has prioritized reducing pollution.

Figure 4 represents the trends in pollution and GDP as well as emissions of SO₂, NO_x, primary PM_{2.5}, non-methane volatile organic compounds (NMVOCs), and CO₂ between 1990 and 2017. From 1990 to 2017, China's GDP grew by 43 times, or at a rate of almost 10% per year. Even though China's economy has been growing quickly in recent decades, coal has been a major source of air pollution and carbon dioxide (CO₂) emissions. In 2007, China passed the United States regarding carbon dioxide emissions, and in 2009, it passed the United States regarding energy use. China was responsible for 27.6% of the world's CO₂ emissions and 23.2 % of the world's energy use in 2017 [9].

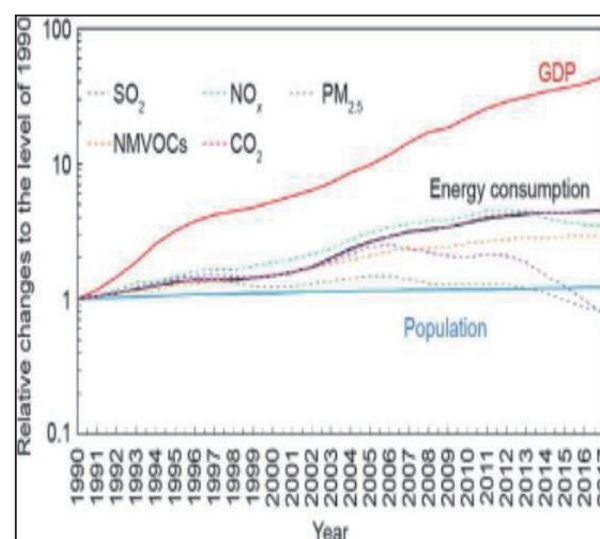


Fig. 4. China's Air pollution progress.
 Source: China Environmental Statistics Yearbook.
<https://doi.org/10.1016/j.eng.2020.03.014>

The pressure in China comes from two aspects: to fight global warming and improve the country's air quality. China has worked hard for 30 years to build a society based on sustainable development and ecological civilization. They have separated economic growth from air pollution and carbon intensity. In the 1970s and 1980s, China's first rules about air pollution were made at the provincial and municipal levels to cut down on dust emissions. Later, acid rain became a big problem in China, especially in the south and southwest. It affected about 30 % of the country [10].

Since the 1990s, regulations on coal-burning industries have become stricter to reduce SO₂ emissions. Due to these steps, China's total SO₂ and primary emissions peaked well before 2010. The strategic shift from emission control to air quality management is evident in China's three decades of air pollution progress. The worsening acid rain problem in China was fixed in 2007 by regulating sulfur dioxide (SO₂) emissions [11]. Since 2013, control activities on numerous precursors and sectors have aimed to lower PM_{2.5} concentrations, signalling a shift in focus from emissions to air quality. As ozone (O₃) pollution rises, so does the need for O₃-integrated control solutions emphasizing the intricate photochemical interactions contributing to this problem. China's energy system must be deeply de-carbonized. More synergistic routes must be developed to tackle air pollution and global climate change concurrently. If China makes significant strides toward improving its air quality, a vital indicator of ecological civilization will be achieved.

4 Conclusion

In this paper, research on the relationship between economic growth and air pollution has been conducted. There is a relationship between economic growth and air quality. This has been illustrated in depth by considering the case of China, whose economic journey that most people have evaluated. Before the reforms, the country was in a low-profile state, having the government control the economy. After the reform was put in place, the evolution of today's economic giant began. The industries developed at a very fast rate. The country experienced an economic boom, quickly transforming the urban setting into what it is today. However, throughout the journey, pollution increased with equal measure as the economy grew. Ecological and environmental issues, especially the continuous decline in air quality are not conducive to sustainable economic and social development. This resulted in harsh environmental conditions that needed to be dealt with. Another factor adding to China's ecological trouble is the transportation sector, especially the fuelled cars. As the country experienced the economic boom, the people also earned a better living, thus affording a car. This trend is alarming and threatens to cause more environmental problems.

To address the issue of air pollution in China, green energy needs to be developed as a viable alternative to traditional, non-renewable power sources like coal. Green energy sources like solar, wind, geothermal, and

hydroelectric should be explored to their full capacities. These efforts help promote the transition to a non-renewable energy structure, which will greatly reduce pollution emissions and improve air quality. In addition, China's industrial sectors should try to design innovative ways of production which can be operated at lower pollution. This involved redesigning the production systems into ones that can react with harmful gases lowering the effect on the quality of air. Regarding transportation, the government must consider how to successfully popularize electric cars. this provide a solution which will see the pollution of air caused by cars reduced to nearly zero. However, this is a procedure that will take some time. In the meantime, China should rehabilitate the roadways to lessen traffic congestion and concentrate on developing technologies that make the operation of motor vehicles more efficient.

References

1. K.P. Gallagher, I. Amos. Exporting national champions: China's outward foreign direct investment finance in comparative perspective. *China & World Economy*, **22**, 1-21 (2014)
2. W.M. Morrison. China's economic rise: History, trends, challenges, and implications for the United States. *Current Politics and Economics of Northern and Western Asia*, **28**, 189-242 (2019)
3. H.K. Wang, X. Lu, Y. Deng. China's CO₂ peak before 2030 implied from characteristics and growth of cities. *Nature Sustainability*, **2**, 748-754 (2019)
4. M. Jiang, K. Euijune, W Youngjin. The relationship between economic growth and air pollution—a regional comparison between China and South Korea. *International Journal of Environmental Research and Public Health*, **17**, 2761 (2020)
5. J. Li, L. Hou, L. Wang, L. Tang. Decoupling analysis between economic growth and air pollution in key regions of air pollution control in China. *Sustainability*, **13**, 1-22 (2021)
6. D. Armeanu, V. Georgeta, J.V. Andrei, et al. Exploring the link between environmental pollution and economic growth in EU-28 countries: Is there an environmental Kuznets curve? *PloS One*, **13**, 1-28 (2018)
7. J. Yuan, Y. Lu, C. Wang, et al. Ecology of industrial pollution in China. *Ecosystem Health and Sustainability*, **6**, 1779010 (2020)
8. J. Wang, Q. Wu, J. Liu, et al. Vehicle emission and atmospheric pollution in China: problems, progress, and prospects. *PeerJ*, **7**, e6932 (2019)
9. X. Lu, S. Zhang, J. Xing, et al. Progress of air pollution control in China and its challenges and opportunities in the ecological civilization era. *Engineering*, **6**, 1423-1431 (2020)
10. M. Liu, X. Huang, Y. Song, et al. Ammonia emission control in China would mitigate haze pollution and nitrogen deposition, but worsen acid

rain. Proceedings of the National Academy of Sciences, **116**, 7760-7765 (2019)

11. H. Mohajan. Acid rain is a local environment pollution but global concern. Open Science Journal of Analytical Chemistry, **10**, 47-55 (2018)