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Urbanization and Carbon Emission in China: A Review and Prospect[1]

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***A*bstract:** Urbanization is not only a worldwide phenomenon, but also the trend of historical development. This article briefly introduces the significance of the research on urbanization and carbon emission. Based on the review of carbon emission related theory, the existing literature is summarized and reviewed from the three aspects: the relationship between urbanization and carbon emissions, the influence factors of urbanization on carbon emission, and the influence degree of urbanization on carbon emission. Finally, the empirical research direction and approach of China's carbon emission are proposed. As the impact of global climate change on people and the environment grows increasingly profound, the impact of urbanization on greenhouse gas emissions, especially carbon dioxide emissions has received growing academic attention.

Keywords: Urbanization; Carbon emission; Low carbon; Energy consumption
JEL Classification: P28, Q01, Q56

The coordination between economy and environment is the most prominent problem in the current global development. With the economic development, resource depletion, environmental pollution and global warming have become increasingly prominent, which threats and challenges human development process. Urbanization, as a main aspect of the world development, is accompanied by resource development and extensive energy use, which undoubtedly adds negative impacts to global warming. Therefore, it is necessary to consider low carbon emission reduction in urbanization to realize the low carbonization and sustainability of economic and social development.

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1. Significance of Research on Carbon Emission

First, Climate change caused by carbon emissions is related to the survival and development of human society, which is the biggest challenge for human being. In the last century, due to the industrial revolution and economic development, global carbon dioxide emission and urbanization level have realized steady and synchronous development, which tend to increase in recent years (Table 1). Urbanization is not only the result, but also the driving power of economic and social development. It has a far-reaching influence on carbon emission. The urbanization process promoted by industrialization is of great significance to global climate change.

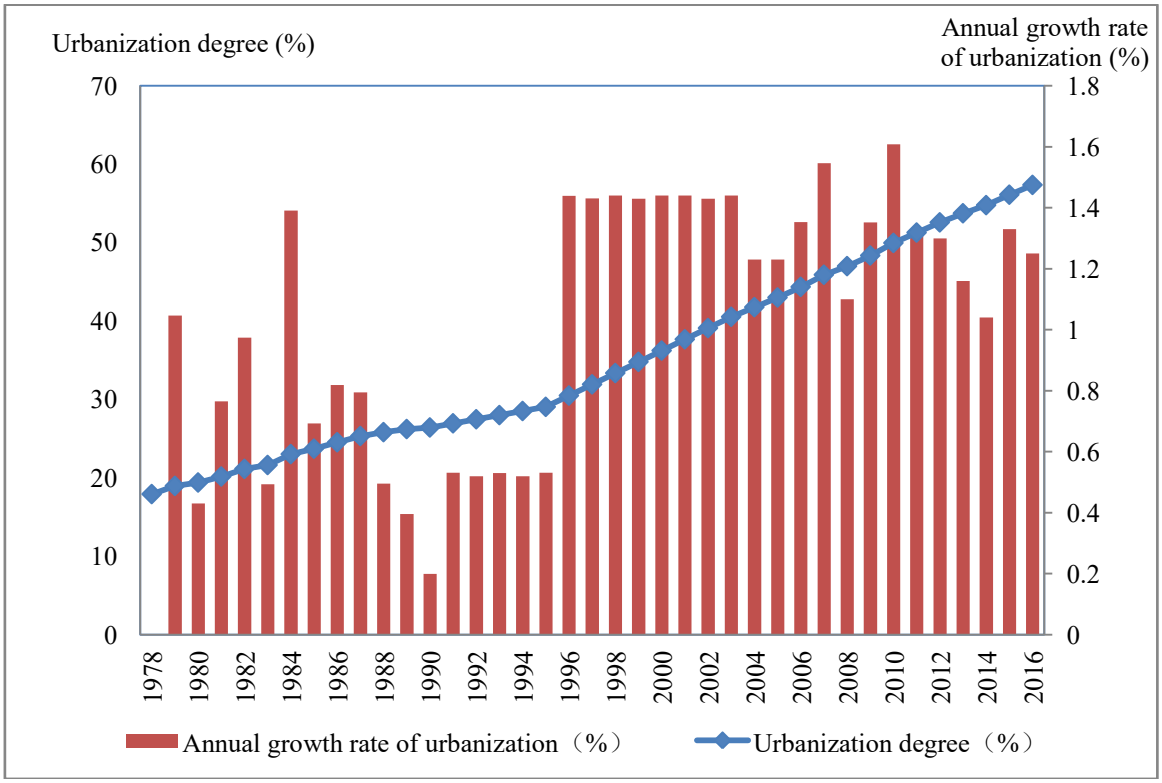
Table0. Trends of global concentrations of major greenhouse gases

Indicators / Year	CO_2 (ppm)	CH_4 (ppb)	N_2O (ppb)	Global average temperature rises (℃)	Urbanization level (%)
The extreme	450-550	-	-	-	-
2007	383.1	1789	320.9	0.74	50
2006	381.2	1783	320.1		46
1998	381.1	1786.3	320.13	0.4	45
1970	-	-	-	-	38.6
1950	-	-	-	-	28.2
1900	-	-	-	-	13.6
pre-industrial	280	700	270	0	-
1850	-	-	-	-	6.4
1800	-	-	-	-	3

Source: Gu C., *et al*. (2009). "A Study on Climate Change, Carbon Emission and Low-carbon City Planning". *Urban Planning Forum*, (3): 38-45.

Second, China faces enormous pressure of carbon emission reduction from the international community. After *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, *the Paris Agreement*, adopted at the end of 2015, is the second global agreement on emission reductions following Kyoto Protocol, which was another important step in the global response to climate change. Developed countries showed a strong mono-track trend in climate negotiations, and the pressure of carbon emission reduction on developing countries like China was increased. China faces enormous challenges in realizing its commitment to the “national contribution” promised by the government ahead of the Paris Climate Change Conference.

Third, There is a huge demand for energy in the rapid urbanization in China, which may lead to a continuously increase in carbon emissions. Since the reform and opening up, China’s urbanization has undergone a long development period. The urbanization degree increased from 17.9% in 1978 to 57.3% in 2016. The process of urbanization can be divided into two stages. In the first stage from 1978 to 1995, the urbanization degree increased from 17.9% to 29.04%, with an average annual growth rate of 2.88%. In the second stage from 1996 to 2016, the urbanization degree increased from 29.04% to 57.35%, with an average annual growth rate of 3.2%. Since 1996, China’s urbanization has entered an acceleration period (Figure 1). In the future, the sustainable and rapid urbanization development in China will be an event that affects both the world and China.



Source: Calculated by authors according to data from National Bureau of Statistics of China http://www.stats.gov.cn/.

Figure 1. Urbanization of China from 1978 to 2016

The accelerated development of China's urbanization has led to changes in production, lifestyle, land use type, industrial structure and energy structure, which significant influence carbon emission. China is dominated by coal consumption. The low-quality energy consumption structure causes unbearable burden to the environment. China's energy consumption is predicted to increase substantially in the short term. Correspondingly, carbon dioxide emission will continuously increase.

2. Review on the Basic Theories of Carbon Emission

2.1 Public goods and externality theory

The emission of greenhouse gas like carbon dioxide in urbanization belongs to the problem of "public goods". Therefore, externality theory and public goods theory can provide some guidance on the analysis of the relationship. Carbon dioxide emission has strong externality, the effects of which cannot be solved in a market, it has typical "public goods" characteristics and significant externality. "Public good theory" was first put forward by Samuelson (1954). And in "welfare economics", Pigou (2009) analyzed externalities systematically for the first time and explained environmental pollution with externalities. This externality has a long-term impact on the future survival and development of mankind. Some externalities are likely to cause environmental tragedies and environmental disasters.

2.2 Environmental Kuznets Curve

Since 1990s, the issue of carbon emission has attracted the attention of researchers. The earliest studies attempted to discover the relationship between carbon emissions and economic development in environmental problems, and found that the changes of most pollutants and per capita national income presented inverse U-shape. This inverted U-shaped curve was similar to the empirical curve between income distribution and economic development proposed by Kuznets, so it was named Environmental Kuznets Curve (EKC). EKC (Figure 2) was proposed by Grossman and Krueger (1991). It has become a classical theory describing urban growth and environmental quality.

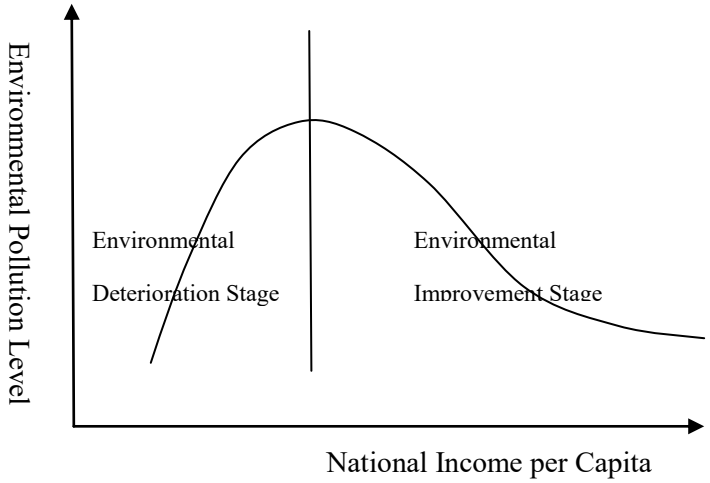


Figure 2. Environmental Kuznets Curve
Source: Grossman G.M. and Krueger, A.B.(1991)

In the middle stage of industrialization, the environmental pollution is deteriorating rapidly in China. The study of EKC started late in China. Numerous studies have shown the existence of the EKC. However, some scholars believed it is inverted U shape, N shape or even S shape. The inflection point has not appeared, which indicates that China's environmental pollution is in the increase stage.

2.3 Sustainable development and green development theory

Sustainable development refers to the development that meets the needs of the present generation without compromising the ability of future generations to meet their demands. In 1987, the United Nations world commission on environment and development (1997) formally articulated the concept of sustainable development in its report on our common future. Sustainable development is the ideal mode for human being. However, in order to realize this ideal, population, resources and environment need to coordinate and support each other to become an inseparable organic whole and achieve "win-win" through coordination.

In 2010, the Institute of Economics and Resource Management of Beijing Normal University (2010) published a series of reports on China's green development index, and put forward the idea of green development. Green development aims to establish a high efficiency green production view, reasonable and moderate green consumption view, and the coordinated development between man and nature. Green development is a breakthrough and innovation to the traditional economic theory, which marks the transformation from traditional economics to the era of knowledge economy and sustainable development in the industrial economy period.

3. Review of Carbon Emission at Home and Abroad

Economics research on urbanization and carbon emission focuses on the relationship between urbanization and energy consumption and carbon emissions. According to the existing literature, scholars used different samples to study the influence mechanism of urbanization on environmental pollution and carbon emissions so as to guide the reduction of carbon emission and pollution in urbanization.

3.1 Relationship between urbanization and carbon emission

The relevant conclusions can be divided into three categories: positive influence of urbanization on carbon emission, negative influence of urbanization on carbon emission, and uncorrelation between urbanization and carbon emission.

The results of most scholars show that urbanization has positive effects on carbon emission. Based on the data of 39 underdeveloped countries, Johansen, *et al*. (1988) carried out an empirical analysis through a fixed effect model. The results demonstrate that there is a significantly positive correlation between urbanization and carbon emission. Liu (2009) also confirmed the positive effect of urbanization on energy utilization, but the effect gradually decreased, which can be attributed to improvement in industrial and technological structures and the increase of resource efficiency. Gu, *et al*. (2011) found that urbanization has increased carbon emissions in the Yangtze River Delta, which represents the most developed and densely populated industrial area in China. Tu, *et al*. (2015) pointed out the relationship between urbanization and various driving factors mainly represented inverted U-shape, and the Environmental Kuznets Curve appeared gradually. The inflection point occurred when the urbanization level reached about 60%.

Some studies found that urbanization had a negative impact on carbon emission. By taking the OECD countries as the samples, Liddle (2004) found that urbanization and population density had a negative impact on per capita transport energy use. Fan, *et al*. (2006) found a negative relationship between urbanization and carbon emission in developed countries. These studies argued that urbanization could improve the use efficiency of public facilities and public transport, thus reducing energy consumption and carbon emission.

In addition, some studies found that there was a nonlinear relationship between urbanization and carbon emission. Grossman, *et al*. (1991) estimated the inverted U-shaped relationship between per capita income and various pollution indicators by establishing a model. Lin, *et al*. (2010) believed that China's carbon emissions should be combined with the stage characteristics of urbanization, which had no comparability with developed countries. According to the research results of Shi, *et al*. (2017), there were significant differences in the effects of urbanization degree on carbon emissions in different urbanization development regions. There was an inversely U-shaped relationship between carbon emissions and urbanization degree in first-tier and third-tier cities. Carbon emission and urbanization degree in second-tier cities presented a positive U-shaped relationship.

3.2 Influencing factors of urbanization on carbon emission

In recent years, increasing scholars began to analyze the factors affecting carbon emissions. They tended to use decomposition methods to analyze the factors affecting carbon emissions with population size, energy intensity, economic level and energy structure as explanatory variables. Kaya (1989) proposed the classical Kaya identical equation, and established the relationship between carbon dioxide emissions and population, economic development level as well as energy

use efficiency, which laid the foundation for relevant research. Pachauri, *et al*. (2008) found that the energy needs of urban residents were lower than those of rural residents. There were mainly two reasons for this phenomenon: Firstly, rural areas rely on inefficient fuels (biomass charcoal and coal). Secondly, inefficient fuels are converted into highly efficient commercial fuels (kerosene, liquefied petroleum gas and electricity) in urban areas.

3.3 Influence degree of urbanization on carbon emissions

Due to the difference in samples, the analysis results of the impact of urbanization on carbon emissions are different. Jones (1991) studied the impact of urbanization on energy consumption through the panel data of 59 developing countries, finding that every 10% increase in urban population would enhance the energy consumption by 4.5%-4.8%.Based on the panel data of 86 countries, Cole, *et al*. (2004) found a positive relationship between urbanization and carbon emission, and every 10% increase in urban population would enhance the carbon emission by 7%. By analyzing the data of nine newly industrialized countries, Hossain (2011) pointed out that the increase in energy use of 1% led to the increase of carbon dioxide emission by 1.2%, income increase increased the carbon emission by 0.2%, and urbanization decreased carbon emission by 0.6%. Guan (2013) believed that there was a long-term stable equilibrium relationship between urbanization and carbon emissions in China, and 1% increase of urbanization increased carbon emissions by 1.643%.According to the research results of Hu, *et al*. (2016), as the urbanization degree increased by 1% in China, carbon emission would increased by 1.44%.

4. Conclusion and Prospect

Generally speaking, urbanization degree can influence carbon dioxide emission at a certain stage. The experience of developed countries shows that the emission reduction of greenhouse gas is not contrary to economic growth. In contrast, emission reduction can promote energy efficiency, productivity and technological innovation. Therefore, climate change can be solved while maintaining economic growth. In this process, the win-win result of emission reduction and economic development can be realized through technology and multi-disciplinary cross-governance.

4.1 Enhance the phased assessment of *the Paris Agreement*

The Paris Agreement is the second legally binding climate agreement following *the Kyoto Protocol*. The conclusion and entry into force of *the Paris Agreement* marked an important step of the international community in combating climate change. Based on *the Paris Agreement*, policies with strong executive force shall be formulated to guarantee the objectives of *the Agreement,* enhance the effectiveness of the periodic assessment of *the Paris Agreement*, explore the dual-target control mechanism of total carbon emission and intensity of carbon emissions in China, and strengthen the capacity to combat climate change. This lays the foundation for the realization of carbon emissions targets in 2030, and pushes global environmental governance into an unprecedented new phase.

4.2 Improve governance effectiveness through interdisciplinary advantages

As a complex discipline, research on economic low-carbonization development involves many disciplines, such as environment, ecology and economics. Therefore, the interdisciplinary governance model should be explored, which helps to understand and plan comprehensive and scientific low-carbon development approach. It is necessary to improve the statistical accounting of

greenhouse gas emissions and enhance the monitoring and early warning system based on the discipline characteristics. The further strengthening of interdisciplinary research is an important breakthrough in the research and practice of low-carbon urbanization.

4.3 Perfect the construction of carbon emission database

A national greenhouse gas emission database should be established as soon as possible to explore the platform construction, historical data accounting and methodology preparation and promote the formulation and implementation of unified norms and standards. The establishment of statistics and management database of carbon emission data can improve the real-time monitoring of carbon emission and governance effect. Innovating information technology and strengthening the application of information technology in traditional industries are not only necessary conditions for promoting the industrial integration and green low-carbon development, but also important means to realize mode transformation and structure adjustment.

4.4 Promote "government-industry-university" integrated governance

In low carbonization development, it is necessary to actively promote the "government-industry-university" integrated governance mode with the market as the guide and the enterprises as the main body. The integration of "government-industry-university" governance can realize the positive interaction between government and the public and improve the effect of policy implementation. Low-carbon economy development involves strategic planning, energy-saving technology, operation mode and life-style transformation. The public should be motivated to enhance their participation enthusiasm and reflect on their daily consumption patterns and lifestyle so as to fully explore the potential of emission reduction in public life.

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