The Effect Mechanism of Population Urbanization and Carbon Emissions

in China: Based on the Co-integration Test of STIRPAT model

Abstract： Climate change and population urbanization have become dual challenges for human in the 21 century, especially for most of developing countries. As a result of urbanization and industrialization, carbon emissions per capita have been increased rapidly, which lead to obviously heat island effect and regional climate change. Based on the Kaya equation and STIRPAT model, this paper uses the co-integration test to examine the long-term impacts of population urbanization factors on carbon emissions in China. Results show that GDP per capita and carbon intensity, population size, urbanization level, and economic structure are important driving factors of carbon emissions from 1978 to 2008. Wherein, the most obviously influence factors are GDP per capita and carbon intensity, which changes each 1 percentage points, respectively, will drive carbon emissions with the same direction changing about 1.0181 and 1.0019 percentage points; followed by population size and urbanization level, which changes each 1 percentage points, respectively, will result in carbon emissions with same direction changing about 0.5285 and 0.3449 percentage points; industrial structure changing on carbon emissions effects are reversed in direction, i.e. the proportion of tertiary industry GDP, each increasing by 1 percentage points, will drive carbon emissions decreased by 0.0085 percentage points, although its value is smaller, but it is reflected in the process of industrialization and urbanization, the meaning of upgrading of the industrial structure to reduce carbon emissions is obviously.

Keywords: Population Urbanization, Carbon Emissions, Effect Mechanism, STIRPAT, Co-integration Test

1. Introduction

Climate change and population urbanization have become dual challenges for human in the 21 century. In spite of scientific uncertainty was often used to be a reason to collect more evidences to take actions of controlling climate change, these amazing phenomenon also illustrated the consequences may be worse than we had expected, climate change threatened all of countries in the world, has become the mankind who are facing the complex challenges in the new century (World Bank, 2010). Urban was highly concentrated areas by population, economic activity and carbon emissions, its greenhouse gas emissions occupied by 78% of the world (Stern, 2006). Urbanization drives economic development and large-scale population agglomeration, leads greenhouse gases emissions and pollutants increased exponentially, per capita energy consumption of urban population was about 3.5-4 times by rural population (He, 2009).

According to prediction by United Nations, global population would be increased from 6.8 billion to 9.1 billion in 2009-2050, while urban population would increase from 3.4 billion to 6.3 billion

between 2007 and 2050, that the urban population would be increased by 1 times in the next 40 years (UN, 2010). As the largest developing country in the world, China is experiencing rapidly process of industrialization and urbanization in recent decades. Population growth, large-scale spatial agglomeration and economic production mode changing result in climate effect are also gradually becoming apparent. From 1978 to 2008, China's urban population was increased by 434 million; urbanization level increased from 17.92% to 45.68%, economic gross broke up 3 times (UN, 2010). The prediction by McKinsey Global Institute (2008), China would have about 1 billion people living in the urban in 2025, would appear 219 big cities that exceed 1 million population, 24 mega city that exceed 5 million population, and urban GDP occupied by total GDP would be increased from 75% to 90% in 2007-2020. The urban population promoted the economic growth at the same time also changed people's production mode, lifestyle, transportation tools and consumption model. In China, electricity was dominant fuel in all cities, but non-commercial energy sources such as stalks and firewood still dominated rural residential energy consumption patterns (Hubacek et al., 2007). Urban residents heavily dependent on modern architecture and comfortable modern traffic, not only drive fossil fuels consumption increased, greenhouse gas emissions increased, also exacerbated by climate change and global warming.

As the largest developing country in the world, China faces increasing international pressure in carbon emissions reduction. How to coordinate energy consumption, carbon emissions and economic growth becomes a key issue of low-carbon economy. In the process of population floating from rural to urban, also means the process of low carbon consumption group changing high carbon consumption group, urbanization brings many changes, especially lifestyle and production model changing. Demographic factors not only impact greenhouse gas emissions and have important implications for climate change, but also bring serious consequences of great significance. At the same time, the relationship between climate change and population was very lack of research (Jiang, 2010). Based on the Kaya equation and STIRPAT model, through analyze effect mechanism of population dynamic and carbon emissions in the process of urbanization, this paper indicates that carbon emissions caused by change of population size, urbanization level, economic growth, industrial structure and carbon intensity, to measure urbanization factors how to impact on the climate change. The remainder is arranged as follows: the second part is the related research briefly induction, the third part to construct a theoretical framework to describe effect mechanism of population urbanization and carbon emissions, the fourth part is the data and model, the fifth part is the empirical analysis result, the conclusion is last one.

2. Literature Review

Many researchers have studied on the issues about urbanization and climate change. Karl (1990) conducted a comprehensive comparison of urban and rural areas in the United States, found that obviously non-linear relationship between urban warming and population. Parikh and Shukla (1995) used panel data of developing cities to analyze energy issues and urbanization. Chung U. (2004)

argued that urbanization and industrialization were main factors of the average temperature rising nearly 50 years in Korea. Through 5 regional panel data of Canadian, Lantz (2006) found that population size and carbon dioxide emissions were inverted U type relationship in 1970-2000. At the same time, there were also some opposite views, such as Tim Dyson (2005) presented that population growth, migration, and urbanization have important influence to global warming and climate change, however, maybe other factors were more critical in the process of economic development, such as in 1950-2000, the global population has increased by 140%, but the fossil energy consumption has increased by 400% over the same period, therefore, for the long-term climate change, economic development mode would be more critical than demographic transition.

In recent years, some study showed that population growth, structural change and family size miniaturization have brought main effects on the global greenhouse gas emissions. The aging of population was an important factor in developed countries, while urbanization was even more significant factor in developing countries (Dalton et al., 2008). David Satterthwaite (2009), through the study of the relationship of carbon emissions, population growth and urbanization in 1980-2005, found that population growth was not the main driving force of global greenhouse gas emissions growth, because that the fastest growing population area was also the lowest per capita greenhouse gas emissions area, therefore, the simple control population growth measures could not achieve the purpose of mitigation of climate change. Lin (2009) based on the decomposition of Kaya identities, found that economic growth; income increasing and the energy intensity were the influence factors of China's carbon emissions significantly. In addition, urbanization rate was influenced by economic development level, energy consumption structure, per capita energy consumption, the gap between urban and rural areas and so on (Wei, 2008).

Economic growth, population dynamic, energy intensity and carbon intensity of energy consumption are important impact factors of carbon emissions. By establishing factor decomposition model of carbon emissions per capita in China, Xu (2006) found that, relationship of economic growth rate and carbon emissions per capita was exponential growth, the contribution rate of energy efficiency and energy structure on restraining carbon emissions per capita was reverse U shape. At present, China is in the stage of urbanization and industrialization, its characteristics of energy consumption is fast growth and energy demand rigidity, Lin and Liu (2010) found that GDP per capita and energy consumption carbon intensity were the main impact factors of carbon emissions in 1978-2008, other factors were the energy consumption, carbon intensity and urbanization, which changes each 1 percentage points, respectively, would drive the carbon emissions changing about 0.95, 0.94, 0.71 and 0.22 percentage points with the same direction.

Li Guozhi and Li Zongzhi (2010) used 30 provinces data in 1995-2007, to analyze the population, economy and technology how to impact China`s carbon emissions, found that population has significantly two-way impact on carbon emissions. Wang (2010) used the index decomposition method of logarithmic mean Divisia, found that positive and negative driving factors impact of carbon emissions of China between 1995 and 2007, positive driving factors including GDP per

capita, transport quantity, population size, economic structure and annual family income, while negative driving factors including energy intensity of production sector, transportation average length of transportation routes and residential energy intensity. By comparing 62 countries and regions of non-linear relationship between the population factor and carbon emissions, Wang (2011) found that population growth impact different strength of carbon emissions under different levels of economic development, elasticity coefficient of population growth in developed countries were significantly higher than developing countries. At the same time, effects of the aging of the population, family size and demographic factors were uncertain, which may be related, may also have negative correlation.

3. The Impact Mechanism of Population Dynamic and Climate Change in the Process of Urbanization: A Theoretical Framework

The impact mechanism of population dynamic and climate change is divided into three parts, including the effects of population size changing, the effects of population distribution changing and the effect of population structure changing. Population growth impacting on climate change in the transmission mechanism can be simple expression for population size increasing under the condition of constant carbon emissions per capita, leads to carbon emissions growth.

The population urbanization derived to large-scale population agglomeration, with traditional lifestyle alternative to modern lifestyle, greenhouse gases emissions and pollutants rapid increasing in the urban, with increasing of energy consumption and environmental pressure, all of above factors led to the city`s air quality dropping and heat island effect increasing. Changes of production mode not only present changes of industrial layout and industrial structure, but also people's consumption ideas, and product demand structure change results in the energy intensity and energy consumption carbon intensity changes. About lifestyle changes, mainly be reflected in the residential mode, traffic tools, fertility desire and death mode. Climate effect of urbanization or by population size changing lead to carbon emissions changing, or through carbon emissions per capita increasing resulted in carbon emissions growth.

Changes of population structure are mainly embodied in the aging population and family pattern changes. Population aging has become the global trend of population development. At present, almost the entire developed countries, the age structure of the population has been transformed into aging, and many developing countries are or will soon change for aging population. The aging of population will lead to family size becomes smaller and aging labor, while family scale miniaturization means that decreased family members size and increased household size, which leads to increased carbon emissions per capita.
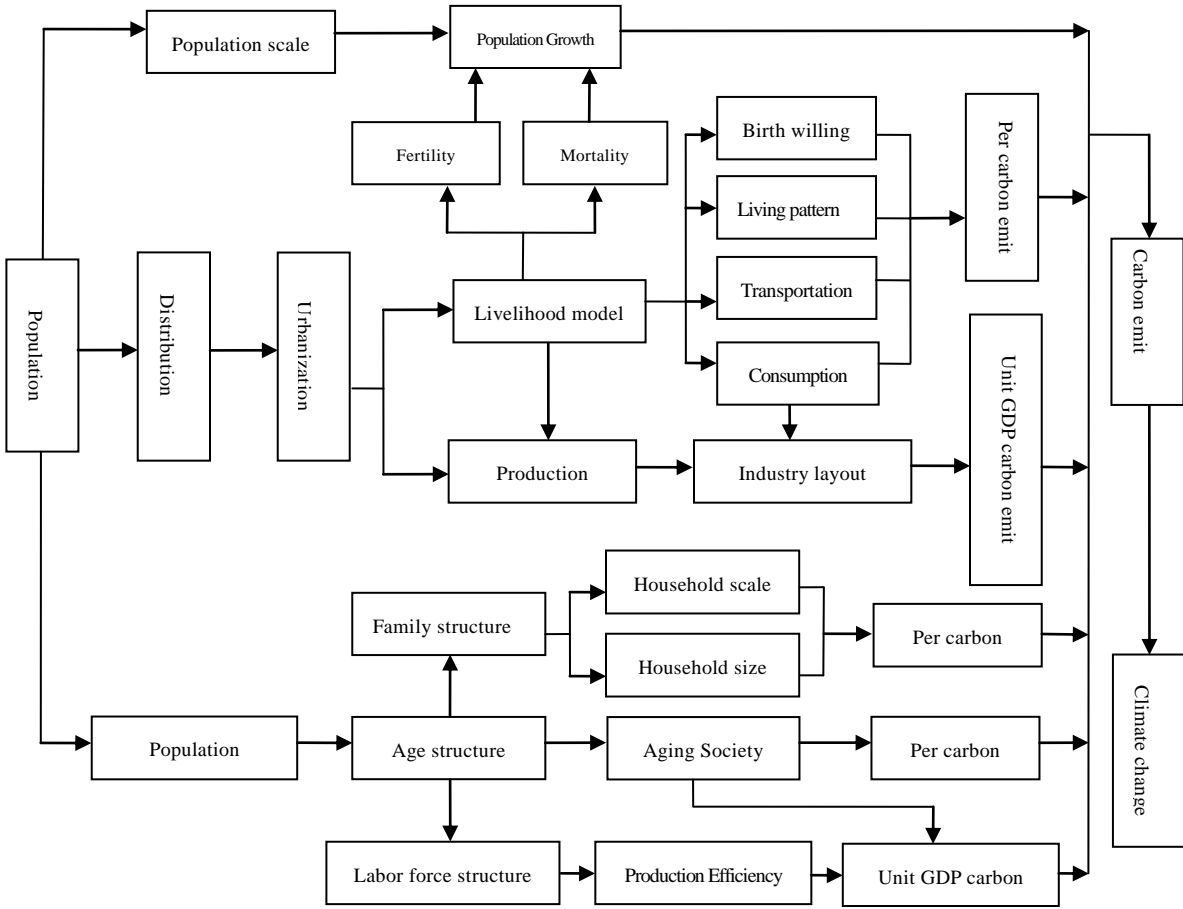
Figure 1 Impact Mechanism of Population Dynamic and Climate Change in the Process of Urbanization

The first part is the climate effect due to population size changing. Under the limited ecological capacity, continuously increasing population brings the most direct effect which produces carbon dioxide and other greenhouse gases increased in the total. In recent years, many scholars` research showed that elasticity coefficient of population size on carbon emissions is among 0.98-1.65 (Dietz and Rosa, 1997; Shi, 2003; York, Rosa and Dietz, 2003; Cole and Neumayer, 2004; Matthew, 2004; O`Neil, 2009). Knapp (1996) through the analysis of the global carbon emissions and population causality, found that population growth was the cause of global carbon dioxide emissions growth, but did not exist the long-term co-integration. Wei and Liu (2008) indicated that in 1975-2003, in the total population in low income countries, impact of population size on carbon emissions was maximum, followed by high income countries and lower middle income countries, the impact of higher the middle-income countries was minimum, therefore, slowing population growth for carbon emissions reduction meaning of relatively large in the low income countries.

The second part is the climate effect due to the change of population distribution. In the long-term, climate condition largely determined the distribution of population in the history. Geographical distribution and spatial structure were mainly affected by the natural resources, environmental

conditions and economic development levels. However, with the economic growth and social progress, the impact of climate change on population distribution becomes more and weaker, while the impact of population migration on climate change becomes more and more significant. After the industrial revolution, urbanization droved economic development and large-scale population agglomeration, leaded greenhouse gases emissions and pollutants multiplied. Along with the process of industrialization and urbanization, the energy consumption per capita and carbon dioxide emissions per capita will be increased, per unit of GDP carbon emissions intensity present higher levels. When Industrialization has been finished basically, per capita energy consumption and carbon emissions growing will be slowly, technical progress, international trade and industrial restructuring would also urge per unit of GDP carbon emissions intensity decreased gradually.

The third party is the climate effect due to population structure changing. The population structure is a result from various natural and social characteristics in a certain country or area, including the population natural structure and population social structure. Wherein, age structure and gender structure are subjected to widespread concern of population natural structure, family structure and occupation structure are the research focus of population social structure. In this paper, our analysis framework is focused on the change of population age structure and family structure changes resulting from climate effects. Wei (2008) empirical study found that 15-64 aged proportion of the total population, was negative effect in the high income and high middle income country, but was positive effect in the lower middle income country. On the one hand, Fertility decline led to the aging population and family size becomes smaller, economic benefits of energy consumption are reduced, and greenhouse gas emissions are increased. On the other hand, family size decreasing generally associated with lower fertility rate and higher economic growth rate, which leads to a significant increased of greenhouse gas emissions (United Nations Population Fund, 2009).

4. Methodology and Data

Ehrlich and Holdren (1971) was the first time using IPAT model to character the complexity of the factors affecting of human beings on the environment, considered that the impact of humans on the environment depends on the population size, resources using scale, energy efficiency and environmental safety in the process of production and consumption. York, Dieta and Rosa (2003) put forward IPAT model of random form---STIRPAT (Stochastic Impacts by Regression on Population, Affluence and Technology), in order to test the population, economic and technological factors on carbon emissions coefficient of elasticity. Kaya (1989) proposed the Kaya identities, the factorization method to establish relationship of the greenhouse gas emissions and the population size, the level of economic development and energy efficiency. If GHG represents greenhouse gas emissions, POP represents population size, GDP represents gross domestic product; TOE represents total energy consumption, Kaya identities by the following equation:

$$GHG = POP \times \frac{GDP}{POP} \times \frac{TOE}{GDP} \times \frac{GHG}{TOE}$$

In this paper, the Kaya equation and STIRPAT model based on co-integration analysis, which be used to analyze the relationships between carbon emissions and other variables, such as carbon emissions（QC_t）, population size（PP_t）, urbanization level（RU_t）, industrial structure（SI_t）, GDP per capita（PG_t）and carbon intensity of energy consumption（GC_t）, through the co-integration equation to acquire the long-term equilibrium relation of variables and carbon emissions,

$$QC_t = f(PP_t, RU_t, SI_t, PG_t, GC_t)$$

Wherein, carbon emissions (QC): as the main source of greenhouse gas emissions, fossil energy consumption is the mostly part of energy consumption, this paper uses carbon emissions data comes from the International Energy Agency (IEA) , according to the statistics of fossil energy emissions of carbon dioxide. Index of population including population size (PP) and urbanization level (RU), data derived from *"Statistical Yearbook of China"*. Indicator of economic development including GDP per capita (PG) and industry structure (SI), in which, industry structure characterization by the tertiary industry proportion of total GDP, data derived from calendar year "*China Statistical Yearbook*"; that is, in order to facilitate international comparison, and carbon emissions per unit of GDP intensity index consistency, the GDP per capita data from the International Energy Agency (IEA, 2009) published GDP per capita by PPP method, in constant US dollars in 2000. Technical index including carbon emissions per unit of GDP intensity (GC), referred to as carbon intensity, which not only reflects a national or regional industrial structure and the economic development level, but also reflects the current technology level and production processes, so it is one of the important indexes to measure the energy efficiency.

In this paper, the sample interval is between 1978 and 2008, using the analysis software of Eviews5.0. In order to make the trend of linearization, eliminate time sequence of instability and variance at the same time, does not change the function of the original co-integration relationship, the original data to be the natural logarithm, get sequence variable: LQC_t、 LPP_t、 LRU_t、 LSI_t、 LPG_t and LGC_t, subscript t representation presents certain year.

Table 1 Descriptive Statistics Index

Variable	Definition	Unit	Mean Value	Standard Deviation	Maximum	Minimum
LQC	**Carbon Emissions**	million tons of carbon	6.5687	0.4528	7.4900	5.9500
LPP	**Population Size**	10 thousands	11.6581	0.1040	11.7900	11.4700
LRU	**Urbanization level**	%	3.3716	0.2595	3.7600	2.9300
LSI	**Structure of industry**	%	3.4671	0.2239	3.7400	3.0700
LPG	**GDP per capita**	dollar in 2000	7.7626	0.7347	9.0200	6.6000
LGC	**Carbon emissions per unit of GDP**	kg carbon/dollar	-1.3452	0.4033	-0.6100	-1.8900

5. Results

If a group of non-stationary time sequences exist a smooth linear combination, namely the combination of random trend, this sequence could be co-integration and the linear combination could be called co-integration equation, which can be interpreted as the long-term stable equilibrium relationships among variables. In order to avoid the regression phenomenon of time series data, firstly, to test stationary of each variable, through testing by ADF (Augmented Dichey-Fuller) and PP (Phillps-Perron), all variables are Two order smooth at the significant level of 1%, therefore, all variables in accordance with I (2), which meet necessary conditions of construction co-integration equation, and unit root testing results in following table.

Table 2   I（2）unit root testing

	LQC	*LPP*	*LRU*	*LSI*	*LPG*	*LGC*
ADF TEST	-6.018837	-9.037095	-8.150991	-6.536307	-5.186735	-6.881950
PP TEST	-6.027654	-11.22497	-16.28697	-12.18019	-6.569033	-7.545513

This paper uses the Johansen co-integration test. The Johansen test was presented by Johansen and Juselius (1988, 1990), it based on VAR model regression coefficient method, was a kind of multivariate co-integration test methods. According to Max-Eigen statistic test results, at the 5% significance level, the variables exists at least two types co-integration relationship, considered in the co-integration relationship under the assumption that after a standardized co-integration coefficient, extracting a co-integration equation as follows (in brackets are the standard deviation):

$$QC_t = 0.5285LPP_t + 0.3449LRU_t - 0.0085LSI_t + 1.0019LPG_t + 1.0181LGC_t + 1.0032$$
$$（0.1079）\quad（0.1076）\quad（0.0068）\quad（0.0062）\quad（0.0039）$$

For China, results of Co-integration equation show that there exists a long-run equilibrium relationship of carbon emissions and population size, urbanization level, industry structure, GDP per capita and energy consumption carbon intensity in 1978-2008. In the above equation, all of variables are consistent with its economic significance, and at the 5% confidence level through T statistic test, the overall model has superior fitting degree. Wherein, the most obviously influence factors are GDP per capita and carbon intensity, which changes each 1 percentage points, respectively, will drive carbon emissions with the same direction changing about 1.0181 and 1.0019 percentage points; followed by population size and urbanization level, which changing each 1 percentage points, respectively, will result in carbon emissions with same direction changing about 0.5285 and 0.3449 percentage points; industrial structure changing on carbon emissions effects are reversed in direction, i.e. the proportion of tertiary industry GDP, each increasing by 1 percentage points, will drive carbon emissions decreased by 0.0085 percentage points, although its value is smaller, but it is reflected in the process of industrialization and urbanization, the meaning of upgrading of the industrial structure to reduce carbon emissions is obviously.

6. Conclusions

Urbanization and climate change have become a global trend, with massive migration from rural to urban continual in the developing countries, the modes of production and lifestyle of the great change on the impact of climate change has been more and more remarkable. Looking for a suitable road of low carbon urban development mode would become the global issues, especially in China such a rapid economic developing country with a large population size, industrialization and urbanization are irresistible development trend. How to realize win-win between population urbanization and climate change mitigation is imminent. This paper uses co-integration method to analyze the impact of population growth, urbanization, industrial structure, GDP per capita and carbon intensity change, found that carbon intensity and GDP per capita is the main factor influencing carbon emissions, followed by the population size, urbanization level and industrial structure. Therefore, population growth and human activities are the main factors leading to global warming, and there yet are some more crucial factors, such as changes of production mode (industrial structure changing, lifestyle (carbon emissions per capita), transportation (carbon intensity), consumption patterns (carbon emissions per capita) and family pattern (per household carbon emissions) and so on.

This paper constructs a framework which contains the impact mechanism of population size, population distribution and population structure in the process of urbanization and climate change, put forward urbanization drives mass population agglomeration, lifestyle alternative, greenhouse gas emissions and pollutants rapidly increased in the urban areas, with increasing of energy consumption and environmental pressure, which led to the regional climate effects. However, due to limited length of paper, only some of variables were empirical analysis. In the next step of process, we need to pay more attention to the climate effects by changing of urbanization lifestyle. For China, how to accomplish target of carbon intensity reduction with maintaining rapid economic growth is a severe restriction, especially in the process of speedy population urbanization and industrialization. Due to urban energy consumption is the main resource of global carbon emissions, rational route of urbanization becomes an important challenge of constructing a low-carbon economy in developing countires. Accordingly, future research would pay attention to relevant policy implications of carbon emissions reduction and the model of low carbon urbanization.

REFERENCES

1、 Chen Jiaying, Peng Xizhe, Zhu Qin, Macro-empirical Analysis of Family pattern on carbon emission effect, China`s Journal of population Science, 2009 (5): 68-78

2、 Chung U., Choi J., Yun J. I.，Urbanization effect on the observed change in mean monthly temperatures between 1951-1980 and 1971-2000 in Korea. Climate Change, 2004（66）：127-136.

3、 Cole, Matthew A. , and Eric Neumayer, 2004, Examing the Impacts of Demographic Factors on Air Pollution, Population and Environment 26: 5-21

4、 David Satterth waite, The Implications of Population Growth and Urbanization for Climate Change. Environment and Urbanization 2009, 21(2): 545-567.

5、 Dietz T，Rosa E A，Effects of population and affluence on CO_2 emissions，Proceedings of the National Academy of Sciences of the United States of America，1997，94(1):175-179

6、 Dalton, Michael, Brian C. O'Neil, Alexia Prskawetz, Leiwen Jiang et al. Population Aging and Future Carbon Emissions in The United States, Energy Economics, 2008, 30:642-675

7、 Ehrlich P.，Holdren J.，Impact of population growth，Science，1971（171）: 1212-1217

8、 He Xiaoping, Forecasting Electric Power Demand of China in the Process of Urbanization, Economic Studies, 2009 (1)

9、 Hubacek, K.; Guan, D.; Barua, A. Changing lifestyles and consumption patterns in developing countries: A scenario analysis for China and India. Futures: J. Policy, Planning, Futures 2007; 39:1084-1096.

10、 International Energy Agency, CO_2 Emissions from Fuel Combustion（2009 Edition）, http:// www.iea.org/books

11、 IPCC，Climate change 2001：Synthesis Report-Contribution of Working Group Ⅰ Ⅱ Ⅲ to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge：Cambridge University Press, United Kingdom, 2001.

12、 Jiang Leiwen, The Impacts of Demographic Dynamics on Climate Change, Population Studies, 2010 (1): 59-69

13、 Jyoti Parikh, Vibhooti Shukla, 1995, Urbanization, Energy Use and Greenhouse Effects in Economic Development: Results from a Cross-national Study of Developing Countries, Global Environmental Change, Vol. 5, Issue 2. May, pp87-103

14、 Karl T. R.，Jones P. D.，Comments on "Urban bias in area averaged surface air temperature trends" Reply to G M Cohen. Bulletin of the American Meteorological Society，1990，71，571-574

15、 Lantz V., Feng Q. Assessing Income, Population and Technology Impacts on CO2 Emissions in Canada: Where is the EKC? Ecological Economics 57, 229-238.

16、 Lawrence D. M., Slater A. G., Tomas R. A. et al. , Accelerated Arctic Land Warming and Permafrost Degradation during Rapid Sea Ice Loss, Geophysical Research Letters 35: 2008GL033985

17、 Li Guozhi, Li Zongzhi, The Impacts of Population, Economy and Technology on Carbon Dioxide Emissions: A Study based on Dynamic Panel Model, Population Studies, 2010 (3): 32-39

18、 Lin Boqiang, Forecast Environment Kuznets Curve of Carbon Dioxide and its Influence Factors in China, Management World, 2009 (4)

19、 Lin Boqiang, Liu Xiying, China's Carbon Dioxide Emissions Under the Urbanization Process: Influencing factors and Abatement Policies, Economic Studies 2010 (8): 66-78

20、 O`Neil, Brian C. 2009, Climate Change and Population Growth. In A Pivotal Moment: Population, Justice and the Environmental Challenge, New York, Island Press

21、 Peng Xizhe, Zhu Qin. Study on The Impacts of Population Situation and Consumption Patterns on Carbon Emission, Population Studies, 2010, 34 (1):48-58

22、 Population Reference Bureau, World Population Highlights: Key Findings from PRB's 2009 World Population Data Sheet，Population Bulletin Vol. 64，No. 3，September 2009

23、   Richard York, Eugene A. Rosa, Thomas Dietz, STIRPAT, IPAT and IMPACT: analytic tools for unpacking the driving forces of environmental impacts, Ecological Economics 46 (2003) 351-365

24、   Stern, The Economics of Climate Change: The Stern Review, Cambridge University Press, 2006

25、   Shi A. The impact of population pressure on global carton dioxide emissions，1975-1996: evidence from pooled cross-country data，Ecological Economics，2003，44(1):29-42

26、   The World Bank, World Development Report 2010: Development and Climate Change, http://www.worldbank.org/wdr.

27、   Tim Dyson, On Development, Demography and Climate Change: The End of the World as we know it? Population and Environment, November 2005, 27(2): 117-149

28、   UNDP，Development Report 2007/2008，Human Fighting climate change: Human solidarity in a Divided World，   http://hdr.undp.org/en/reports/global/hdr2007-2008

29、   United Nations, World Urbanization Prospects: The 2009 Revision，New York，2010

30、   United Nations Population Fund, State of World Population 2009 , Facing a changing world: women , population and climate, http://www.unfpa.or.

31、   United Nations, Urban and Rural Areas 2007，http://www.unpopulation.org

32、   UN-Habitat, China`s City Status Report (2010/2011), Foreign Languages Press, 2010 Edition

33、   World bank, World Development Report 2010: development and climate change, Tsinghua University press, 2010

34、   Wang Weiguang, Climate Change Report 2009: Towards Copenhagen, Social Science Literature Publishing House, 2009

35、   Wang Feng, Wu Lihua, Yang Chao, Driving Factors for Growth of Carbon Dioxide Emissions During Economic Development in China, Economic Studies, 2010 (2): 123-136;

36、   Wang Qinchi, Research on The Relationship of Population and Carbon Emissions Based on Nonlinear Hypothesis, Population Studies, 2011 (1): 3-12

37、   Xu Guoquan, Liu Zeyuan, Jiang Zhaohua, China's Carbon Decomposition Model and Empirical Analysis in 1995-2004, China Population, Resources and Environment, 2006 (6): 158-161

38、   Yang Xuanmei, Ge Yousong, Zeng Hongying. Based on Individual Consumption Behavior of Family Carbon Emissions in China, China Population, Resources and Environment, 2010 (5): 35-40

39、   York R，Rosa E A, Dieta T，STIPAT，IPAT and IMPACT: analytic tools for unpacking the driving forces of environment impacts，Ecological Economics，2003，46(3):351-365

40、   Yoichi Kaya, 1989, Impact of Carbon Dioxide Emission on GNP Growth: Interpretation of Proposed Scenarious,Presentation to the Energy and Industry Subgroup, Response Strategies Working Group, IPCC, Paris

41、   Zhu Qin, Peng Xizhe, Lu Zhiming, Analysis Model and Empirical Study of The impact of Population and Consumption on The Carbon Emissions, China Population, Resources and Environment, 2010 (2): 98-102