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The Decoupling Analysis of Carbon Emission Factors by Residents' Living Consumption during the Period of Economic Growth in Jilin Province

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***Abstract*—Global climate change has already seriously endangered the health and development of human, energy consumption and carbon emission control have become the social issues of common concern to all countries. This paper takes Jilin province as an example, using Tapio decoupling theory to research the decoupling relationship between the residents' living consumption carbon emissions influenced by economy, technology and so on. According to the research, the decoupling relationship between carbon emissions of life energy and urbanization rate, total population is always in an alternate state of strong decoupling and growth negative decoupling. Per capita household consumption has a limited role in promoting the life energy carbon emissions. The technical factors represented by carbon emissions intensity have an impact on the life energy carbon emissions to some degree. The improvement in the share of the tertiary industry can reduce carbon emissions of life energy in a certain extent. The research results can lay the foundation for taking the control countermeasures about carbon emissions from the residents' living consumption.**

Keywords-residents' living consumption; carbon emission; impact factor; decoupling analysis; Jilin Province

I. INTRODUCTION

Global climate change has already seriously endangered the health and development of human, energy consumption and carbon emission control have become the social issues of common concern to all countries. According to the data of the developed countries, family direct emissions account for 20% or so of the total carbon emissions, which is the main source of carbon emissions.

II. THE CONSTRUCTION AND DATA SOURCE OF THE DECOUPLING MODEL

A. *The Approach of Model*

We select the decoupling model raised by Tapio. The constructed model can be expressed as follows:

$$E_1 = \frac{\%\Delta CO_2}{\%\Delta U} = \frac{(CO_{2_{i+1}} - CO_{2_i})/CO_{2_i}}{(U_{i+1} - U_i)/U_i}$$

Among them, E_1 is the decoupling index of the urbanization rate and the life energy carbon emissions; $\%\Delta CO_2$ refers to the change rate of life energy carbon emissions in Jilin province; CO_{2_i}, $CO_{2_{i+1}}$ represent the life energy carbon emissions in the year of i and i+1 respectively in Jilin province; $\%\Delta U$ stands for the change rate of urbanization rate in Jilin province; U_i, U_{i+1} are the urbanization rates in the year of i and i+1 respectively in Jilin province.

Using this method, we can study the decoupling relationship among the total population, per capita residents' consumption, carbon emissions intensity and the carbon emissions of life energy respectively. The following model was constructed respectively as follows:

$$E_2 = \frac{\%\Delta CO_2}{\%\Delta P} = \frac{(CO_{2_{i+1}} - CO_{2_i})/CO_{2_i}}{(P_{i+1} - P_i)/P_i}$$

$$E_3 = \frac{\%\Delta CO_2}{\%\Delta A} = \frac{(CO_{2_{i+1}} - CO_{2_i})/CO_{2_i}}{(A_{i+1} - A_i)/A_i}$$

$$E_4 = \frac{\%\Delta CO_2}{\%\Delta T} = \frac{(CO_{2_{i+1}} - CO_{2_i})/CO_{2_i}}{(T_{i+1} - T_i)/T_i}$$

Among them, P_i, P_{i+1} are the total population in the year of i and i+1 in Jilin province respectively; A_i, A_{i+1} are per capita residents' consumption in the year of i and i+1 in Jilin province respectively; T_i, T_{i+1} are carbon emissions intensity in the year of i and i+1 in Jilin province respectively; S_i, S_{i+1} are the share of the third industry in the year of i and i+1 in Jilin province respectively.

TABLE I. DECOUPLING INDEX SYSTEM TABLE

Decoupling state		ΔCO_2	ΔU	Elasticity E
Negative decoupling	Weak negative decoupling	< 0	< 0	0 < E < 0.8
	Strong negative decoupling	> 0	< 0	< 0
	Growth Negative decoupling	> 0	> 0	> 1.2
Decoupling	Recession decoupling	< 0	< 0	> 1.2
	Strong decoupling	< 0	> 0	< 0
	Weak decoupling	> 0	> 0	0 < E < 0.8
Connection	Recession connection	< 0	< 0	0.8 < E < 1.2
	Growth connection	> 0	> 0	0.8 < E < 1.2

B. *Data Sources*

Influenced by the statistical yearbook data of Jilin province, we analyze the data from the year 1995 to 2012. In this paper, the data such as the Jilin province economy, urbanization rate, total population, per capita residents' consumption, carbon emissions intensity and the share of the third industry are from the statistical yearbook of Jilin province.

III. THE INFLUENCE FACTORS ANALYSIS OF DECOUPLING INDEX OF RESIDENTS' LIVING CONSUMPTION CARBON EMISSIONS IN JILIN PROVINCE

A. *The Decoupling Relationship between Urbanization Rate and The Life Energy Carbon Emissions*

Among years from 1996 to 2012, the decoupling relationship between life energy carbon emissions and urbanization rate in Jilin are in the alternative states of being strong decoupling and increasing negative decoupling, only in 1997 there is an increase in the status of the connection. Life energy carbon emissions have been increasing continuously since 2001, the growth rate is in a constant volatility, among the carbon emissions of the years from 2007 to 2011, there are also some decline phenomenon. For more than 10 years, city rate has been in a rising trend, but the growth has slowed in recent years. From the perspective of the decoupling index of life energy carbon emission and urbanization rate, from the year 1996 to 2000 there has been in a strong decoupling and growth of the state, which indicates that the effects of reducing emissions in recent years are obvious in Jilin Province, and the rise of urbanization rate does not cause a significant increase in the amount of energy carbon emissions of life. However, the state of negative decoupling has been maintained basically after the year of 2001. In the years of 2007 and 2011 there are also strong decoupling phenomenon, which indicates that the growth in urbanization rate increases the carbon emission in life energy. The strong decoupling states appeared in the years of 2007 and 2011 might be related to carbon emission measures introduced by the government, of which the average decoupling index is 15.81. That illustrates the growth of urbanization rate has a significant effect on the increase of life energy carbon emissions.

B. *The Decoupling Relationship Between Total Population and Life Energy Carbon Emissions*

Under the guidance of the Tapio decoupling theory, using the total population and the life energy carbon emission data of Jilin province from the year 1995 to 2012, the decoupling relationship between total population and carbon emissions can be sorted out. From the view of decoupling state, the decoupling relationship between the total population of Jilin province and the number of life energy carbon emissions are in the alternate state of strong decoupling and growth negative decoupling. The years of 1996, 1998, 1999, 2000, 2007 and 2011 are strong decoupling, which indicates that the increase in total population does not lead to an increase in carbon emissions from living energy. The rest of the years are negative decoupling of growth with rather large decoupling index value, of which the average value of the decoupling index reached 38.8, indicating that the total population in Jilin province has a great influence on the increase of living energy carbon emissions.

C. *The Decoupling Relationship between Per Capita Consumption and Life Energy Carbon Emissions*

Under the guidance of the Tapio decoupling theory, the decoupling relationship between per capita consumption and carbon emission can be sorted out by the data of per capita consumption and living energy carbon emissions from the year 1995 to 2012 in Jilin Province. From the decoupling index, decoupling index is negative in the year of 1996, 1998, 1999, 2000, 2007 and 2011, and in the state of strong decoupling, which indicates that the growth of per capita consumption in recent years has not increased the living energy carbon emission. The decoupling index is positive in the rest of the years, and is in the alternation of weak decoupling and negative decoupling of growth. This shows that per capita consumption has a certain effect on energy carbon emissions. The average decoupling index is 0.63, which indicates that per capita consumption plays a limited role in promoting living energy carbon emissions.

D. *The Decoupling Relationship between Carbon Emissions Intensity and Life Energy Carbon Emissions*

In the light of the Tapio decoupling theory, the decoupling relationship between carbon emissions intensity and carbon emissions can be sorted out by the data of carbon emissions intensity and life energy carbon emissions from

the year 1995 to 2012 in Jilin Province. Vertically observed, the growth rates of life energy carbon emissions intensity and carbon emissions have been in fluctuation from the year 1996 to 2012, which shows positive or negative occasionally. In most of the relevant years, decoupling index is positive and under the alternating state of weak negative decoupling and growth negative decoupling, which shows that the technical factors represented by carbon emissions intensity affect the life energy carbon emissions to a certain extent. The decoupling index is negative in the year of 2001, 2005, 2008, 2010, 2012, which shows that technical factors do not affect life energy emissions. The average of decoupling index is 2.61, which shows that the increase in the life energy carbon emissions intensity plays a certain part in promoting the life energy carbon emissions.

IV. CONCLUSION

Combined with the results of two models, we can conclude that total population is the most important impact factor of the life energy carbon emissions, the increase in population will inevitably lead to the increase in energy consumption, correspondingly, CO_2 emissions will greatly increase as well. Urbanization rate has a great influence on life energy carbon emissions. The urbanization rate of Jilin province increases from 42.25% in the year 1995 to 53.7% in 2012. On the one hand, the growth of urban population can increase people's demands for energy, correspondingly, CO_2 emissions increase. On the other hand, though the urbanization rate of Jilin province is higher than national average level, there is no accumulation of technical funds, and still lead to an increase in the amount of the life energy carbon emissions, which indicates that the quality of urbanization in Jilin province is not high. Carbon emissions intensity has some influence on life energy carbon emissions. The growth in carbon emission intensity will lead to the increase of life energy carbon emissions, which shows that improving the technical level and reducing the carbon emission intensity can have a certain effect on energy saving and emission reduction. The proportion of the third industry has a strong restriction on life energy carbon emissions. Jilin province is one of the old industrial bases in Northeast China, in which the second industry with high pollution and emissions plays a dominant role. Improving the proportion of the third industry and optimizing the industrial structure will produce a significant effect on reducing the carbon emission of life energy in Jilin Province.

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