Economic Development Status of the Countries along the Belt and Road and Their Correlations with Population and Carbon Emissions

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Abstract: The construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road are important measures for allowing China to expand its opening up to the outside world under the background of economic globalization. Based on this consideration, and from the perspective of geo-economics, this study uses a variety of mathematical statistical methods to analyze the economic development status and differences among the 30 countries along the Belt and Road. In addition, the correlations between GDP, population and carbon emissions in these countries are also analyzed. The results show that the current economic development levels of the countries along the Belt and Road are quite variable; the gaps between the indicators of the economic development of the countries along the Belt and Road are convergent; the GDP, population, and carbon emissions of the countries along the Belt and Road each showed an overall upward trend during the study period, and the changes in these three values showed significant correlations. Across all countries, the correlation coefficients between GDP and population (0.989), between GDP and carbon emissions (0.995), and between population and carbon emissions (0.993), all indicate that the correlations between GDP, population and carbon emissions are very high. Among them, GDP has the highest correlation with carbon emissions, reaching 0.995. Regression analysis shows that the value of R^2 reached 0.995, indicating that the regression fitting effect is very good and the calculation result is highly reliable. Based on these results, this paper proposes the following two suggestions: (1) Promoting the Belt and Road initiative should handle the relationship between developing and developed countries; and (2) Promoting the Belt and Road initiative should also be linked to China's domestic regional development strategy.

Key words: the Belt and Road; geo-economics; correlation; globalization; China

1 Introduction

At the Bo'ao Forum for Asia in Hainan on March 27, 2015, the National Development and Reform Commission, the Ministry of Foreign Affairs and the Ministry of Commerce jointly issued the "Vision and Action for Promoting the Construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road" referred to below as just "Vision and Action". This event marks "The Belt and Road Initiative" officially becoming a national grand strategy of China. The "One Belt, One Road" initiative was born in the context of adjusting the world pattern and economic globalization. The construction of the Belt and Road is an inevitable requirement for implementing a new pattern of all-around opening in China and an inevitable choice for promoting the common development and prosperity of Asian and European countries (Yuan, 2014). Based on ex-

isting bilateral and multilateral systems, the Belt and Road aims to develop mutual political trust, economic cooperation and cultural exchanges among the participating countries (Hao et al., 2018).

At present, studies of the Belt and Road area have become important research directions in the disciplines of economics, geography, political science, and many others. At the research method level, most of the existing studies have concentrated on the theoretical level (Yang, 2015; He, 2019), and research which combines theory with empirical evidence is relatively rare (Liu, 2015; Hu, 2018). At the research perspective level, most studies mainly focus on infrastructure investment (Liu, 2017; Cai, 2018; Yang et al., 2018), political analysis (Lee et al., 2016; Zeng, 2017) and environmental protection (Andrzej and Zdzislaw, 2016; Muhammad et al., 2018).

The geo-economy refers to economic cooperation between countries, regions or ethnic groups based on geographical location, resource endowment, economic structure and other factors, such as cooperation, alliance (economic grouping) or competition, opposition, and even containment (Lu and Du, 2013). After the end of the Cold War, the geo-economy has become an important factor affecting international relations. Achieving a balance in the geo-economic era, in which economic conflicts have intensified economic competition and cooperation between countries, is an important issue in today's international relations (Huang et al., 2019).

At present, the academic community has carried out much work related to geo-economics. At the research object level, these efforts have mainly focused on China (Lin, 2012; Yang et al., 2016; Peng et al., 2019), China and ASEAN countries (Li et al., 2015; Wang et al., 2017a; Wang et al., 2017b), Germany (Kundnani, 2011; Maull, 2018) and the world (Coccia et al., 2012; Lee et al., 2012). In terms of research content, the focus mainly includes economic linkages (Jiang et al., 2012; Zhang et al., 2014; Xu and Wu, 2016), economic relations (Su et al., 2013; Zhao et al., 2015), and the evolution of spatial differences in time and space (Song et al., 2017; Zhao et al., 2019).

By summarizing the status of the above research, we find that the existing research on regional economic differences mainly focuses on China's domestic research, and there are few studies on regional economic differences between countries or on the correlations between GDP, population and carbon emissions in large regions. However, due to the differences in resource endowments and location conditions, there are uneven development characteristics among regional economies. Therefore, this paper takes 30 countries along the Belt and Road as the study area, and based on geo-economic and political views, it then applies several mathematical statistical methods. This paper not only analyzes the current economic development level of China and the countries along the route, but also examines the correla-

tions between the three factors of GDP, population and carbon emissions in the countries along the Belt and Road. This investigation not only enriches the research content of the Belt and Road on the theoretical level, but also has certain practical significance. In addition, according to the results of this study, we not only discover the economic development characteristics and differences among the countries along the Belt and Road, but also determine the changes and correlation degrees of the three factors of GDP, population and carbon emissions in these countries during the study period. Therefore, the findings of this study can provide certain guidance for the deepening development, prosperity, stability and sustainable development of the Belt and Road, and therefore it has a certain practical value.

2 Research area, data sources and research methods

2.1 Research area and data sources

Because the Belt and Road covers a wide geographical range and includes many countries, those with smaller economies have less impact on the overall strategy. Therefore, this paper selects a total of 30 countries and regions: including China, Japan, South Korea, Sweden, the Netherlands, Germany, France, United Kingdom, Thailand, Vietnam, Laos, India, Myanmar, Cambodia, Philippines, Italy, Russia, Singapore, Afghanistan, Malaysia as those with the highest economic scale along the Belt and Road; along with Pakistan, Bangladesh, Uzbekistan, Tajikistan, Kyrgyzstan, Turkmenistan, Kazakhstan, Saudi Arabia, Indonesia, Iran. This study covers the major countries of the Shanghai Cooperation Organization and the Association of Southeast Asian Nations. The European countries selected are the main economies at the western end of the Eurasian Continental Bridge, which completes the coverage of both ends of the Eurasian continent.

The main data source used in this paper is the World Bank statistics for 2004−2014, while Indonesia's foreign exchange reserve data are from Sina Finance. The value added of agriculture, industrial added value, and the value added for the service industry as a percentage of GDP are calculated in accordance with the International Standard Industrial Classification (Li and Fang, 2013). GDP, population and carbon emissions data for 2002−2014 are downloaded from the World Bank website (http://data.worldbank.org.cn). The GDP and populations of most of the 30 selected countries and regions are increasing. In addition, except for a few countries, the increases in carbon emissions in most of the countries and regions show falling tendencies.

2.2 Research methods

2.2.1 Coefficient of variation

The coefficient of variation, also known as the "standard deviation rate", is one of the most commonly used statistics for measuring the degree of variation in each parameter. The

coefficient of variation is a normalized measure of the degree of dispersion of the probability distribution, which is defined as the ratio of the standard deviation to the mean. It is expressed by *CV* (coefficient of variation):

$$CV = \frac{\alpha}{\mu} \tag{1}$$

In the formula, α is the standard deviation of the observed values, and μ is the expected value of the observed value. According to the relevant literature, if the coefficient is greater than 0.2, then the variation between the observations is considered to be significant (Li and Fang, 2013).

2.2.2 Principal Component Analysis

This method is a dimensionality reduction multivariate statistical analysis method. It converts a set of original variables into another set of a much smaller number of new variables without reducing the total variance of the original indicators. Therefore, the new variables can comprehensively reflect the variation of the original variables. This method is used here to calculate the comprehensive differences in the economic development levels of various economies in the China-ASEAN Free Trade Area. Among them, the indicator of economic growth scale is per capita GDP, and the indicators reflecting the economic structure are 1) the proportions of industrial added value and the added value of the tertiary industry, 2) the inflation rate reflecting the overall level of prices and the level of urbanization which reflects the urban construction situation, and 3) the indicator of the degree of economic extroversion which reflects the proportion of imports and exports (Li and Fang, 2013).

3 Characteristics and differences in economic development among the countries along the Belt and Road

3.1 The economic development trends of the countries along the Belt and Road

The per capita GDP indicator reflects the per capita economic aggregate of a country or region. The magnitude of its value reflects the productivity status and economic development level of a country. The stage of economic development is an important part of a countrys national conditions or a regional situation. Judging the stage of economic development of a country or a region is one of the important prerequisites for that country or region to formulate a sound economic development strategy and promote economic development.

In 2014, the per capita GDP of the countries in the study area varied greatly, with Sweden, Singapore, and the Netherlands exceeding US$50000, while Afghanistan was less than US$1000. According to the classification criteria of economically developed countries, the countries in the region can be divided into four levels. Eleven countries are at the first level, including Sweden and Singapore. These countries have entered the ranks of the world's developed countries. They have high economic development levels, advanced infrastructure, perfect social security systems and good living conditions for the people. The second level includes Kazakhstan and other seven countries. Their incomes are at the middle level globally, and they are mainly regions with better economic development than developing countries. Their politics are relatively stable, their food supply is self-sufficient, and the proportion of absolute poverty is small. Only Iran and Thailand are in poor states of development. The third level includes five countries, such as Indonesia. The people's lifestyle in these countries and regions is at a lower level overall, the infrastructure is poor, the people lack perfect social security, and poverty and a poor living environment are common characteristics of these countries. However, India has a large population size and a complete industrial system, and it even ranks among the world's leaders in some industries. The fourth level includes seven countries and regions such as Pakistan, which have poor geographical conditions and low levels of productivity, and they are at the bottom of the international division of labor.

According to the standard of economic development, although the differences in economic development can be seen, and it is impossible to judge the economic development stage of each economy, so this study uses the grading standard for industrialization phases from the book "Comparative Study of Industrialization and Economic Growth" by Chennai et al. (1989). According to these criteria for the division of economic growth stages of Chennai et al. (Table 1),

Table 1 Criteria for Chennai's economic development stage divisions

Phase I		Phase II			Phase III		Remarks
Primary product		Industrialization			Developed economy		
Production stage I	Production stage II	Initial	Medium term	Late	Initial	Era	
100–140	140–280	280–560	560–1120	1120–2100	2100–3360	3360–5040	US dollars in 1970
340–470	470–940	940–1890	1890–3770	3770–7070	7070–11310	11310–16970	US dollars in 1990
393–550	550–1100	1100–2200	2200–4400	4400–8250	8250–13200	13200–19800	US dollars in 1995
440–620	620–1240	1240–2490	2490–4970	4970–9320	9320–14910	14910–22380	US dollars in 2000
500–710	710–1410	1410–2820	2820–5640	5640–10570	10570–16920	16920–25380	US dollars in 2005
560–790	790–1570	1570–3150	3150–6300	6300–11810	11810–18900	18900–28350	US dollars in 2015

the division of countries and regions in this study are shown in Table 2. According to per capita GDP data in 2014, 11 countries such as the Netherlands and Sweden are in the advanced stage among developed economies. These countries include 7 European countries, such as the Netherlands, and four Asian countries, such as Japan. Among them, Western Europe is the birthplace of capitalism and the modern scientific and technological revolution, and it is a region with one of the highest levels of economic development in the world. Japan and South Korea are the two countries with the highest levels of economic development in Asia. Singapore is a typical example of an urban country. Saudi Arabia's wealth is mainly derived from its abundant oil resources. Russia, Malaysia, Turkmenistan and Kazakhstan are in the intermediate stage among developed economies. Russia is the world's industrial France, inheriting the main industrial base of the Soviet Union. Malaysia is one of the four Asian tigers and its economy is open to the public. China, Thailand, Iran and the other three countries are in

the primary stage among developed economies. Eleven countries, including Indonesia, are in the stage of gradual industrialization. Southeast Asia has a superior natural environment, rich mineral resources and an especially geographical location. It is a region with great economic development potential. Afghanistan is at the stage of primary product production. Mainly due to the lack of resources and the turbulent political situation, the economic level is very low.

3.2   The unbalanced economic growth rate along the line

The economic development potential of a country can be measured by the speed of its economic growth. The standard of living of a country depends on its ability to produce and deliver products and services, which is also achieved through long-term stable economic growth. Table 2 shows the economic growth rates of the countries of the Belt and Road.

Table 2   Classification of economic growth rates along the Belt and Road*

Economic growth rate	>7%	5%–7%	2%–5%	<2%
Countries and regions	Laos, China, Tajikistan, Afghanistan, Cambodia, Indonesia, Kyrgyzstan, Thailand	Kazakhstan, Uzbekistan, Bangladesh, Saudi Arabia, Russia, Pakistan	Italy, Malaysia, Philippines, Sweden, Vietnam, Turkmenistan	United Kingdom, France, Germany, Singapore, Netherlands, Japan, Iran

Note: * There are lacks of data for a few countries (regions) and the countries (regions) did not participate in the classification.

First, Table 2 shows the overall picture of the economies of the countries along the Belt and Road. In addition to the negative growth of Iran's economy, the other countries have different positive growth rates. Second, the economic growth rates of developing countries in Asia are generally higher than those of the developed countries in Europe. The economic growth rates of countries along the Belt and Road can be divided into four types. Eight countries, including China and Laos, are growing rapidly. These countries are mainly emerging developing countries with large population bases and low labor costs, and have achieved rapid economic growth. The second type and the third type includes 12 countries, such as Kazakhstan, most of which are CIS countries. After the economic stagnation in the 1990s, the economy in this type has achieved steady growth thanks to the transformation of abundant resources and the economic system. The fourth type includes the United Kingdom and six other countries where the economic growth rate is below 2%, while Iran has experienced negative growth. Except for Iran, these countries are all Western capitalist powers with high levels of economic development, but the economic growth shows a significant structural slowdown. This is because the efficiency of service industries in developed countries is lower than the efficiency of manufacturing. However, these developed countries have high levels of marketization and fewer barriers to other economic factors. Although the growth rate is low, the economic strength is

still very strong.

3.3   Variations in industrial competitiveness

The regional industrial structure is the framework for regional implementation and resource allocation. Under the premise of the economic system and enterprise efficiency, the efficiency and development of regional economic growth depend to a large extent on the advanced nature and changes in the regional industrial structure. The transformation of the industrial structure is a core variable for understanding the difference between economic development in developing countries and developed countries, and it is also the essential requirement for allowing late-developing countries to accelerate their economic development. The evolution of industrial structure is a process of continuously improving the labor productivity, and different industrial structures reflect the quality of economic growth in a region. According to the proportions of the added value of the three industries to GDP, the countries along the Belt and Road can be divided into three types based on their national industrial competitiveness (Table 3).

Table 3 shows that the first group is comprised of the agricultural countries in the initial stage of industrialization, which includes six countries such as Myanmar. The agricultural added value accounts for more than 20% of GDP, reflecting a low level of industrialization. The second type includes 11 mid-industrial developing countries such as Uzbekistan, where agricultural output accounts for between

Table 3　Classification of national industrial competitiveness along the Belt and Road

Stage	Industrialization starting stage	Industrial process	Late industrialization
Countries and regions	Myanmar, Cambodia, Laos, Tajikistan, Pakistan, Afghanistan	Uzbekistan, Vietnam, India, Kyrgyzstan, Bangladesh, Philippines, Turkmenistan, Kazakhstan, Indonesia, Thailand, Iran, China	Malaysia, Russia, South Korea, Italy, Saudi Arabia, Netherlands, France, Sweden, Japan, Germany, United Kingdom, Singapore

10% and 20% of GDP. The secondary industry is dominant in the national economy, indicating that the economic growth of these countries still relies on the low costs of resources, labor, raw materials, and the economic growth mode of low value-added and large scale production. The third type of countries are developed countries in the late stage of industrialization. The added value of the primary industry in these countries accounts for less than 10% of GDP, and the proportion of the tertiary industry exceeds 50%, leading to a typical three-two-one structure.

3.4　Countries along "The Belt and Road Initiative" Region are in different stages of urbanization

The city is a congregation of residents with a certain population size and a mainly non-agricultural population. The town is a major venue for economic, political and cultural activities, and provides products and services. Therefore, improving the level of urbanization is also an important factor in a country's economic development, social progress, and productivity levels, and the world has entered the stage of comprehensive urbanization. The American geographer Northam proposed the S-shaped law of urbanization in 1975. By studying the changes in the proportion of urban population in the total population of each country, he found that the urbanization process was staged and the whole process presented a slightly flattened S-curve. Therefore, in order to more clearly understand the urbanization stages of the countries along the Belt and Road, we statistically analyzed the urbanization stages of these countries. The specific statistical results are shown in Table 4.

Table 4　Stages of urbanization along the Belt and Road*

Stages of urbanization	First level (>70%)	Second level (30%–70%)	Third level (<30%)
Countries and regions	Singapore, Japan, Netherlands, Sweden, Saudi Arabia, South Korea, United Kingdom, France, Germany, Malaysia, Russia, Iran	Italy, China, Kazakhstan, Indonesia, Turkmenistan, Thailand, Philippines, Pakistan, Uzbekistan, Kyrgyzstan, Myanmar, Bangladesh, India	Tajikistan, Afghanistan, Cambodia

Note: * There are lacks of data for a few countries (regions) and the countries (regions) did not participate in the classification.

Table 4 shows that the third level is the primary stage of urbanization; that is, the urbanization rate is less than 30%, and mainly occurs in the three countries of Tajikistan, Afghanistan and Cambodia. The specific characteristic of urbanization at this stage is the slow growth of the urban population. The second level is the middle stage of urbanization, where the urbanization rate is between 30% and 70%, which is found in 13 countries including Italy, China, Kazakhstan, and Indonesia. These countries are mainly located in Southeast Asia and South Asia, and they are mainly developing countries. The main feature of urbanization at this stage is an accelerating urbanization rate, which is accompanied by the continuous increase of the urban population and the rise of emerging towns. The first level is the later stage of urbanization, where the urbanization growth rate is more than 70%, and includes 12 countries such as Singapore, the Netherlands, Japan, the United Kingdom, France, and Germany. These countries are mainly located in Europe, and most of them are developed countries. The state of urbanization at this stage is characterized by an urbanization process that is stagnant or slightly declining.

3.5　Economic development differences based on the coefficient of variation

By calculating the coefficient of variation of selected indicators from 2003–2014 in the study area, the variations of internal differences in the 30 countries along the Belt and Road can be obtained. The coefficients of variation for some economic indicators of the countries along the Belt and Road from 2003 to 2014 are shown in Table 5.

Table 5 shows that the annual coefficients of variation of the GDP per capita indicators in the study area are greater than 1, indicating that the Belt and Road is the framework for regional cooperation between economically developed countries and developing countries, and many of these contradictions need to be overcome. On the other hand, from 2003 to 2014, the coefficient of variation narrowed from 1.341 down to 1.159, indicating that the economic development levels of countries along the line are converging, reflecting the proportions of exports to GDP, the proportions of imports to GDP, and the values of agricultural added value to GDP. The coefficients of variation of the indicators are greater than 0.6, indicating that the economies of the countries along "The Belt and Road" Initiative Region have large differences in economic extroversion, while there are both developed industrialized countries and less-developed agricultural countries. The phenomenon of unequal foreign trade may form trade barriers, and the added value of the service industry accounts for the large proportion of GDP. The coefficients of variation of industrial added value to

Table 5　Coefficients of variation for some economic indicators of the countries along the Belt and Road from 2003 to 2014

Years	GDP per capita	Exports as a share of GDP	Service industry added value as a share of GDP	Industrial added value as a share of GDP	Imports as a share of GDP	Agricultural added value as a share of GDP	Total capital formation
2003	1.341	0.875	0.270	0.296	0.791	0.963	0.316
2004	1.337	0.884	0.261	0.289	0.791	0.965	0.317
2005	1.296	0.900	0.253	0.285	0.778	0.983	0.281
2006	1.267	0.902	0.253	0.287	0.772	0.990	0.287
2007	1.258	0.871	0.251	0.279	0.731	0.981	0.292
2008	1.229	0.917	0.252	0.283	0.783	0.988	0.271
2009	1.223	0.874	0.242	0.289	0.735	0.998	0.322
2010	1.181	0.881	0.248	0.290	0.739	1.006	0.305
2011	1.158	0.856	0.258	0.301	0.724	0.993	0.333
2012	1.159	0.855	0.251	0.293	0.712	0.975	0.364
2013	1.156	0.849	0.237	0.272	0.709	0.951	0.347
2014	1.159	0.855	0.231	0.265	0.706	0.938	0.322

GDP and total capital formation are greater than 0.2, indicating that the economic development efficiency, industrial production capacity and ability to attract foreign investment in the various study area countries are different.

Except for the narrowing trend of the per capita GDP index in recent years, there are no obvious convergence trends for any of the other indicators. Therefore, the promotion of the Belt and Road initiative must take into account different levels of economic development, political systems, resources and environment, social systems, cultural traditions, and religious beliefs.

4　Correlation analysis of national GDP, population and carbon emissions along the Belt and Road

4.1　Trends in GDP, population and carbon emission in countries along the Belt and Road

Considering the availability of data, this study selects the period from 2002 to 2014, and summarizes the GDP, population and carbon emissions data for the countries along the Belt and Road. In addition, the average annual growth rates of these three values in 2002–2014 are also summarized. The specific statistical results are shown in Table 6.

Table 6 shows that during the period from 2002 to 2014, the GDP, Population and Carbon emission values of most countries along the Belt and Road continued to increase. Specifically, in terms of GDP, the GDP values of the 30 countries selected in this study have maintained increasing trends. Among them, as of 2014, the top five countries by GDP total are China, Japan, Germany, United Kingdom, and France. Thus, the total GDP of countries in East Asia and the traditional industrial powers in Western Europe still occupies a clear dominant position in the region. In addition, these countries are located at the eastern and western ends of the Belt and Road, which will undoubtedly play a powerful role in promoting the overall strategy of the Belt and Road. In addition, the top five countries with the largest GDP growth rates are Turkmenistan (67.34%), Myanmar (66.59%), Kazakhstan (61.44%), Uzbekistan (53.18%), and Laos (50.36%). In addition, the economies of Tajikistan, China, Russia and Afghanistan, which are included in the core of "The Belt and Road Initiative", maintain very high growth rates. Therefore, the economic development of the countries along "The Belt and Road Initiative" Region, especially in the core areas, also indicates that the Belt and Road has a very broad development prospect and great development potential.

In terms of Population, as of 2014, the top five countries by population are China, India, Indonesia, Pakistan and Bangladesh, and the other countries in the study area also have relatively large populations. Therefore, we can find that the countries along the Belt and Road include those with some of the largest populations in the world, indicating a sufficient population base and consumption potential. In addition, except for the negative population growth in Germany, Japan and Russia, the populations of the remaining 27 countries in the study area showed positive growth. The top five countries with the largest population growth rates were Afghanistan (3.67%), Saudi Arabia (3.21%), Singapore (2.38%), Pakistan (2.35%) and Tajikistan (2.19%). These countries are mainly located in the Central Asia, West Asia and Southeast Asia regions of the Belt and Road. At the same time, the current populations of these countries are relatively small compared to others in the region, reflecting the fact that the population growth in the study area tends to be reasonable and the population distribution is continuously being optimized.

In terms of Carbon emission, as of 2014, the top five countries in terms of carbon emissions are China, India, Russia, Japan and Germany. In addition, Germany, France, United Kingdom, Italy, Japan, Netherlands, Sweden and Uzbekistan each showed negative growth in their carbon

Table 6   Changes of GDP, population and carbon emissions of countries along the Belt and Road in 2002–2014

Countries	2002			2014			Average annual growth rate (%)		
	GDP (×10⁸ USD)	Population (×10⁴ person)	Carbon emission (×10⁴ t)	GDP (×10⁸ USD)	Population (×10⁴ person)	Carbon emission (×10⁴ t)	GDP	Population	Carbon emission
Afghanistan	40.55	2260.08	107.08	204.85	3337.08	980.92	31.17	3.67	62.78
Bangladesh	547.24	13247.81	3370.71	1728.85	15452.02	7318.97	16.61	1.28	9.01
China	14705.50	128040	385026.93	104385.29	136427.00	1029192.69	46.91	0.50	12.87
Germany	20791.36	8248.85	82972.48	38987.27	8098.25	71988.34	6.73	−0.14	−1.02
France	14942.87	6180.53	37507.54	28521.66	6631.61	30327.56	6.99	0.56	−1.47
United Kingdom	17730.16	5937.05	52864.21	30347.29	6461.32	41982.02	5.47	0.68	−1.58
Indonesia	1956.61	21735.78	30673.72	8908.15	25512.90	46417.62	27.33	1.34	3.95
India	5149.38	109331.72	105425.88	20391.27	129560.42	223837.71	22.77	1.42	8.64
Iran	1286.27	6728.48	40176.02	4344.75	7746.58	64948.07	18.29	1.16	4.74
Italy	12665.11	5705.90	45261.05	21517.33	6078.91	32041.15	5.38	0.50	−2.25
Japan	41151.16	12744.50	122004.76	48504.14	12727.60	121404.84	1.37	−0.01	−0.04
Kazakhstan	246.37	1485.89	13373.55	2214.16	1728.83	24831.46	61.44	1.26	6.59
Kyrgyzstan	16.06	499.07	495.78	74.68	583.55	960.75	28.09	1.30	7.21
Cambodia	42.84	1263.77	220.75	167.03	1527.45	668.49	22.30	1.60	15.60
South Korea	6090.20	4764.47	46563.20	14113.34	5074.67	58715.64	10.13	0.50	2.01
Laos	17.58	549.32	115.14	132.68	663.98	195.45	50.36	1.61	5.37
Myanmar	67.78	4770.22	920.78	654.46	5228.08	2163.16	66.59	0.74	10.38
Malaysia	1008.45	2420.84	13374.28	3380.62	2986.66	24282.14	18.09	1.80	6.27
Netherlands	4716.14	1614.89	18166.32	8909.81	1686.50	16730.32	6.84	0.34	−0.61
Pakistan	723.07	14954.97	11408.40	2443.61	19530.68	16629.85	18.30	2.35	3.52
Philippines	813.58	8136.53	7133.78	2845.85	10051.31	10565.36	19.21	1.81	3.70
Russia	3454.70	14530.60	155708.52	20599.84	14381.97	170534.57	38.18	−0.08	0.73
Saudi Arabia	1896.06	2180.53	32640.70	7563.50	3091.70	60104.70	22.99	3.21	6.47
Singapore	925.38	417.60	4723.10	3148.51	546.97	5637.28	18.48	2.38	1.49
Sweden	2643.46	892.50	5742.52	5744.13	969.61	4342.09	9.02	0.66	−1.88
Thailand	1343.01	6406.91	20832.23	4073.39	6843.87	31621.27	15.64	0.52	3.98
Tajikistan	12.21	642.69	188.12	91.13	825.28	518.88	49.71	2.19	13.53
Turkmenistan	44.62	461.00	3996.66	435.24	546.63	6842.26	67.34	1.43	5.48
Uzbekistan	96.88	2527.19	12834.87	766.59	3075.77	10521.36	53.18	1.67	−1.39
Vietnam	350.64	8153.44	7080.61	1862.05	9171.46	16691.08	33.16	0.96	10.44
Total	138093.97	396833.12	1260909.7	387061.46	446548.65	2132995.99	13.87	0.96	5.32

emissions, reflecting the effectiveness of these countries in energy conservation and emission reduction, and they mainly are developed countries. Among the 22 countries with positive increases in carbon emissions, the top five countries in terms of carbon emissions growth were Afghanistan (62.78%), Cambodia (15.60%), Tajikistan (13.53%), China (12.87%), and Vietnam (10.44%). These are all developing countries, their economic development mode is relatively extensive, and their resource utilization efficiency is low. Therefore, these countries need to gradually transform the industrial development model, introduce advanced science and technology, and vigorously promote energy-saving emission reduction and cleaner production.

4.2   Correlation analysis of GDP, population and carbon emissions along the Belt and Road

Before conducting the regression analysis, we conducted a correlation analysis in order to explore the correlations between the three factors of GDP, population and carbon emissions in the countries along the Belt and Road. The correlation coefficient between GDP and population of the countries along the Belt and Road is 0.989, while the correlation coefficient between GDP and carbon emissions is 0.995, and the correlation coefficient between population and carbon emissions is 0.993. These values show that the correlations between the three factors of GDP, population

and carbon emissions are very high. Among them, GDP has the highest correlation with carbon emissions, reaching 0.995, because the industrial production that produces carbon emissions is one of the most important sources of GDP. In addition, the degree of correlation between population and GDP is also very high, reaching 0.989, because the population reflects the consumer group and motivation is one of the main drivers of GDP growth. In order to more clearly reveal the detailed changes in the three values of GDP, population and carbon emissions in the countries along the Belt and Road from 2002 to 2014 the graph plotted in Fig. 1 shows the growth of these three variables.
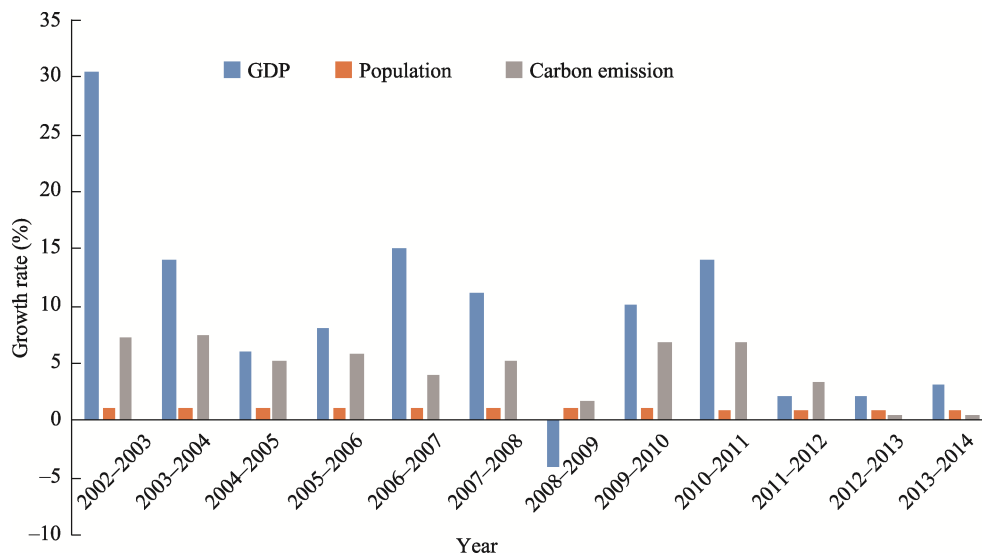

Fig. 1   Annual growth of GDP, population, and carbon emission in the countries along the Belt and Road in 2002−2014.

Figure 1 shows that the GDP, population and carbon emissions of the countries along the Belt and Road have significant correlations during the period from 2002 to 2014, especially the correlation between GDP and carbon emissions. Among the three factors, except for the change in population, the changes in GDP and carbon emissions have shown obvious fluctuations. The average growth rate of GDP in 2002−2014 was 13.87%, and the highest increase of 30.33% was in 2002−2003. The lowest increase was during the global financial crisis of 2008, when GDP experienced a negative growth value of −4%, but it soon recovered. The change in carbon emissions shows a downward trend overall, reflecting the fact that under the global environment of energy conservation and emission reduction, those efforts in the countries along the Belt and Road made certain progress. Specifically, the average increase in carbon emissions was 5.32%, while the highest increase of 7.21% was in 2002−2003, and the lowest increase of 0.5% was in 2012−2013. The regression analysis shows that the value of R^2 reached 0.995, indicating that the regression fitting effect is very good, the calculation results are highly reliable, and the significance level was $P<0.05$, indicating a significant correlation between several elements. In particular, the significance P value of GDP and carbon emissions is 0.06, indicating a significant correlation between these two elements.

5   Discussion

Due to the large differences in economic development levels among the Belt and Road countries, the list includes not only developed industrialized countries but also underdeveloped agricultural countries. At the same time, the Belt and Road countries have different national conditions, and there are still many contradictions within and between these countries. Therefore, in order to realize the full development of the One Belt, One Road initiative, each of the countries must profoundly recognize that development is the first priority and they need to achieve a common development level based on the principle of mutual benefit and win-win. Specifically, countries with more developed economies should increase investment and construction in the less-developed countries, while the countries with less developed economies should also increase the introduction of capital and advanced technologies from the developed countries. In terms of carbon emissions, countries should strive to reach more stringent agreements and develop high-efficiency, low-energy, clean production. Some disputes should also be resolved by peaceful negotiations. In addition, countries along "The Belt and Road Initiative" should also increase exchanges and interactions in the realms of culture, tourism and education.

At present, China's economic development has entered a new era, and its total economic output has jumped to the second place in the world. However, China's per capita national income is still in the middle and lower reaches of the world, the development gaps between different regions in China are large, and the quality of urbanization is not high. In the traditional manufacturing industry, due to the rising

costs of raw materials and various labor factors, the sustainable development of the economy faces a huge dilemma. At the same time, China already possesses a number of world-class technologies such as aerospace, electronic information, high-speed railway and deep-sea development. Therefore, in the construction of the Belt and Road, it is necessary to consider the development characteristics of the different countries and the complementarity between these countries and the Chinese economy. In addition, economic cooperation with developed countries should focus on high-tech scientific and technological cooperation and promote cooperation between the developing countries to transfer domestic traditions. At the same time, "The Belt and Road Initiative" strategy aims to achieve the deepening and expansion of China's opening up strategy in the new era. In the process of promoting the sustainable development of the Belt and Road strategy initiative, we must also pay attention to cooperation with domestic regional development strategies.

6　Conclusions

Through this research, we found that the per capita GDP of countries in the study region along the Belt and Road varies widely. Aside from the negative growth of Iran's economy, the economies of the other countries have increased to varying degrees. In addition, the economic growth rates of Asian developing countries are generally higher than those of developed European countries. The annual coefficients of variation of per capita GDP indicators in the study area are greater than 1, indicating that the Belt and Road is the framework for regional cooperation between developed and developing countries. These contradictions need to be overcome. In terms of the correlations between GDP and population and carbon emissions between 2002 and 2014, for most countries along "The Belt and Road Initiative" each of these measures continued to increase. The correlation coefficient between GDP and population along the Belt and Road is 0.989, the correlation coefficient between GDP and carbon emissions is 0.995, and the correlation coefficient between population and carbon emissions is 0.993. Thus, the correlations between GDP, population and carbon emissions are very high. Among them, GDP has the highest correlation with carbon emissions, reaching 0.995. The regression analysis showed that the value of R^2 reached 0.995, indicating that the regression fitting effect is very good and the calculation result is highly reliable.

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　　摘　要：丝绸之路经济带和 21 世纪海上丝绸之路的建设，是经济全球化背景下中国扩大对外开放的重要举措。基于此，本文从地缘经济学的角度出发，同时运用多种数学统计方法，对"一带一路"沿线 30 个国家的经济发展状况和差异进行了分析。此外，还进一步分析了这些国家的 GDP 与人口和碳排放之间的相关性。结果表明，"一带一路"沿线国家目前的经济发展水平存在很大差异；"一带一路"沿线国家经济发展的各项指标的差距在整体上呈现出逐步缩小的特征;中国的经济发展质量为"一带一路"沿线国家提供了广阔的发展空间。在研究期间，"一带一路"沿线国家的 GDP、人口和碳排放呈现总体上升趋势，这三个值的变化显示出显著的相关性。GDP 与人口之间的相关系数为 0.989，　GDP 与碳排放之间的相关系数为 0.995，人口与碳排放之间的相关系数为 0.993，表明 GDP，人口与碳排放之间的相关性非常高。其中，GDP 与碳排放的相关性最高，达到 0.995。通过回归分析，我们发现 *R* 值达到 0.995，表明回归拟合效果很好，计算结果高度可靠。根据研究结果，本文提出以下建议：（1）推进"一带一路"倡议应处理好发展中国家与发达国家之间的关系；（2）推进"一带一路"倡议也应该与中国的国内区域发展战略联系起来。

　　关键词："一带一路"；地缘经济；相关性；全球化；中国