Assessing the Regional Imbalance between Environment and Economic Development within China

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Abstract. This paper systematically analyzed the imbalance between economic development and ecological environmental protection in provinces of China. A coordination degree evaluation method based on comprehensive economic index and comprehensive environmental index has been established and used to assess the coordinated development at three levels. The results showed: 1) for all China's 31 provinces, the environmental conditions have been lagging behind the regional economic development. 2) The overall level of economic development and urbanization of most provinces were relatively high, average scores of indicators on GDP per capita, population urbanization, disposable income of urban residents were 0.6388, 0.8207, 0.9664, respectively. 3) Pressures on deepening reform and expanding opening, and the gap between urban and rural development were main factors that led to the uncoordinated development of regional economy. 4) Most provinces made good performance in urban environmental management and air pollution control, but low investment in industrial pollution control and undesirable aquatic ecological environment were still major obstacles to coordinated development of economy-environment system.

Introduction

Contradiction between economic development and ecological environment has caused widespread concern throughout international and domestic communities, and formulating an effective response to such conflict has become a major concern in China which is in rapid modernization and urbanization process [1-7].

In the interests of promoting the sustainable development of China's economy and society, several scholars have conducted studies on the degree of coordination between economic development and ecological environment in both national [8-12] and provincial dimension [13-18]. Previous studies showed, in provinces and cities in eastern China with relative high level of economic and social development, degree of coordination between economic development and ecological environment have remained at a high level. Conversely, in provinces, autonomous regions and cities in central and western China, the degree of coordination has declined at a low level [19-25].

Recently, studies on degree of coordination between economy and environment have also extended to fields include energy, tourism and urbanization.

However, the methods and results of previous studies also showed a certain degree of one-sidedness and inaccuracy. Current research has focused almost exclusively on macroeconomic indicators such as GDP and industrial structure, environmental pressure indicators such as industrial emission and ecological environmental status indicators such as landscape vegetation and land use patterns. The present study proposes a comprehensive index system for evaluating the degree of coordination between economic development and ecological environment in China.

Methodology

Index System for Coordination Degree Assessment

The evaluation system is divided into three levels. The first layer, refers to as the target layer, includes economic development layer and ecological environment layer, measures the overall level of economic development and ecological environment status of coordination degree between economic development and ecological environment. The second layer, the criteria layer, includes 9 layers such as overall level of economic development, opening up, environmental pressure, etc. The third level includes 22 assessment indicators (Table 1).

Table 1 Risk assessment indicators with weight distribution and standardization

Target Layer	Criteria Layer	Indicators	Unit	Direction	Weight	Expectations
Economic development (T1)	Overall level of economic development (C11)	GDP per capita (ED1)	CNY	+	0.102	75000
		Industrial added value per capita (ED2)	CNY	+	0.078	25000
		Average annual growth rate of GDP in the past five years (ED3)	%	+	0.065	11
	Urbanization and urban-rural development (C12)	Ratio of population urbanization (ED4)	%	+	0.081	65
		Disposable income of urban residents (ED5)	CNY	+	0.056	25000
		Net income of farmers (ED6)	CNY	+	0.059	15000
	Opening up (C13)	Foreign direct investment per capita (ED7)	Dollar	+	0.111	2500
		Total import and export (ED8)	106 Dollar	+	0.085	200000
	Industrial structure (C14)	Proportion of tertiary industry (ED9)	%	+	0.129	60
		Ratio of real estate investment in total fixed assets investment (ED10)	%	-	0.071	15
		Asset-liability ratio of above-scale industrial enterprises (ED11)	%	-	0.064	45
		Output of industrial products of industries with excess capacity (ED12)	See below	-	0.039	See below
		Ratio of exports in total import and export (ED13)	%	+	0.060	60
Ecological environment (T2)	Environmental pressure (C21)	Industrial wastewater emission of 104 CNY industrial added value (EE1)	t	-	0.112	10
		Industrial exhaust emission of 104 CNY industrial added value (EE2)	kg	-	0.122	100
		CO2 emission of 104 CNY GDP (EE3)	kg	-	0.142	1300
	Sudden environmental risk (C22)	Number of sudden environmental emergencies (EE4)	Times/year	-	0.125	2
	Environmental governance (C23)	Treatment rate of life garbage (EE5)	%	+	0.110	100
		Ratio of industrial pollution control investment in GDP (EE6)	%	+	0.145	2
	Ecological conditions (C24)	Water resources per capita (EE7)	m ³	+	0.061	20000
		Urban green coverage (EE8)	%	+	0.093	60
		Area ratio of nature reserve (EE9)	%	+	0.091	18

^a CNY refers to China Yuan, which the official currency and the main currency in circulation of China.

Data Set

Taking 2014 as base year of evaluation, the values of economic development and ecological environment indicators in Table 1 are obtained in 31 provincial administrative regions (including provinces, municipalities and autonomous regions, except Hong Kong, Macao and Taiwan) from surveys, statistics, and yearbooks [26-28]. Meaning and calculation methods of part of indicators with Chinese characteristics are depicted below.

Results

Overall Results of Coordinated Development

The computational results on comprehensive economic index, comprehensive environmental index and coordinated development index of provinces, municipalities and autonomous regions are shown in Table 2. It can be seen that, economic development scored higher than ecological environment in all the 31 provinces, municipalities and autonomous regions in China during the study period (year 2014). Moreover, there were large gaps between economic development and ecological environment. Indicated that in China, which is in rapid modernization and industrialization

processes, the environmental pressure were synchronously upgrading with economic advancement and the ecological construction has been lagging behind economic development. For the degree of coordinated development, coordinated development indexes of 21 provinces, municipalities and autonomous regions including Beijing, Tianjin, Shanghai, Guangdong and Inner Mongolia exceeded 0.7000, and the average value of coordinated development indexes of which was 0.7224. Indicated that the overall coordinated development level in China was low coordinated level and most provinces in China were in the early stage of coordinated development between economic development and ecological environment.

However, only Tianjin scored 0.8508 in coordinated development index and achieved the moderately coordinated level. Furthermore, coordinated development indexes of 10 provinces and autonomous regions including Shaanxi, Ningxia, Xinjiang, Henan and Shanxi were lower than 0.7000. Among which, Shanxi and Gansu scored 0.6361 and 0.6245, respectively. Indicated that the economy-environment systems of such 10 provinces and autonomous regions were in transition phase of coordinated development, Shanxi and Gansu were close to the edge of maladjustment.

Table 2 Overall results^a

Provinces	Economy	Environment	Coordination	Provinces	Economy	Environment	Coordination
Beijing*	0.8362	0.5431	0.7930	Hubei	0.6712	0.4629	0.7276
Tianjin*	0.8643	0.6460	0.8508	Hunan	0.6370	0.5700	0.7745
Hebei	0.6017	0.4511	0.7107	Guangdong	0.8344	0.5070	0.7702
Shanxi	0.5922	0.3431	0.6353	Guangxi**	0.5943	0.4265	0.6951
Inner Mongolia**	0.6939	0.5262	0.7663	Hainan	0.6429	0.4568	0.7203
Liaoning	0.7878	0.4642	0.7383	Chongqing*	0.7293	0.4627	0.7334
Jilin	0.6567	0.5127	0.7531	Sichuan	0.6145	0.5332	0.7537
Heilongjiang	0.6202	0.4606	0.7191	Guizhou	0.5254	0.3892	0.6613
Shanghai*	0.8729	0.4744	0.7489	Yunnan	0.5376	0.4327	0.6884
Jiangsu	0.8777	0.4667	0.7433	Tibet**	0.5579	0.5205	0.7334
Zhejiang	0.8607	0.4760	0.7498	Shaanxi	0.6485	0.3834	0.6709
Anhui	0.6018	0.4081	0.6845	Gansu	0.5536	0.3329	0.6245
Fujian	0.8312	0.4919	0.7598	Qinghai	0.6012	0.4487	0.7093
Jiangxi	0.6495	0.4688	0.7283	Ningxia**	0.6161	0.3822	0.6677
Shandong	0.7973	0.4575	0.7340	Xinjiang**	0.6088	0.3766	0.6629
Henan	0.6082	0.4107	0.6869				

a Provinces refer to the provincial administrative regions in China, including provinces, municipalities and autonomous regions. Provinces with * and ** refer to municipality and autonomous regions, respectively.

Results of Main Economic Development Indicators

Overall Level of Economic Development and Industrial Structure.

The computational results on indicators about overall level of economic development and industrial structure are shown in Table 3. It can be seen that, firstly, Beijing, Tianjin, Shanghai and Jiangsu scored 1 in ED1 (GDP per capita). Inner Mongolia and Zhejiang also achieved scores closed to 1. Liaoning, Fujian, Shandong and Guangdong scored more than 0.8000 in ED1, which was closed to the ideal status. Indicated that the circle of economy around the capital and Yangtze River Delta were still the most economically developed regions of China, and the eastern coastal region was still the key areas of China's economic development. However, except for Tianjin, central and western regions including Anhui, Hunan, Chongqing, Guizhou and Yunnan showed higher levels in ED7 (average annual growth rate of GDP). Indicated that such regions had great potential for development.

In addition, it was apparent that for most provinces with high scores in ED₂, (industrial added value per capita indicator) the scores of ED₁ were also high. Indicated that provinces with high level of economic development also made good performance in industrial development. The results also showed that industries, especially manufacturing, is the backbone of China's economy. However, Shaanxi and Jilin scored 0.8470 and 0.9338 in ED₂, respectively, the ED₁ scores of these two provinces were only 0.6248 and 0.6688. Imbalance between industry and regional economy in these two provinces implied that reliance on the energy industry, extensive development, single industrial structure and other problem demanded prompt solution.

Thirdly, ED₁ score of Guangdong was only 0.8431. Such result was different from popular knowledge that Guangdong was the most economically developed province in China, and there was serious regional development imbalance in Guangdong, especially between Pearl River Delta and the rest areas.

Table 3 Results of overall level of economic development

Provinces	ED ₁	ED ₂	ED ₃	ED ₇	Provinces	ED ₁	ED ₂	ED ₃	ED ₇
Beijing	1	0.6964	1	0.7828	Hubei	0.6277	0.756	0.6909	1
Tianjin	1	1	0.8261	1	Hunan	0.5351	0.6383	0.7031	1
Hebei	0.5313	0.7221	0.6209	0.6913	Guangdong	0.8431	1	0.8166	0.7331
Shanxi	0.4664	0.5999	0.7416	0.6147	Guangxi	0.4396	0.5103	0.6311	0.9427
Inner Mongolia	0.9459	1	0.6586	0.7973	Hainan	0.5169	0.2279	0.8642	1
Liaoning	0.8693	1	0.6961	0.834	Chongqing	0.6358	0.6922	0.7797	1
Jilin	0.6688	0.9338	0.6028	0.8866	Sichuan	0.4674	0.5824	0.645	0.9704
Heilongjiang	0.5232	0.4992	0.7628	0.7019	Guizhou	0.3522	0.3581	0.7426	1
Shanghai	1	1	1	0.5949	Yunnan	0.3625	0.3308	0.7209	1
Jiangsu	1	1	0.7835	0.8598	Tibet	0.3861	0.0832	0.8911	1
Zhejiang	0.9725	1	0.7974	0.7001	Shaanxi	0.6248	0.847	0.6169	1
Anhui	0.457	0.6218	0.5899	1	Gansu	0.3518	0.3494	0.7337	0.9687
Fujian	0.8427	1	0.66	0.936	Qinghai	0.5268	0.6547	0.6173	1
Jiangxi	0.4613	0.6031	0.6133	0.9731	Ningxia	0.5543	0.5882	0.723	0.9317
Shandong	0.8094	1	0.7247	0.7904	Xinjiang	0.5381	0.5535	0.6804	1
Henan	0.4937	0.6702	0.6183	0.7849					

Urbanization and Urban-rural Development.

The computational results on indicators about urbanization are shown in Table 4. It can be seen that, in Beijing, Tianjin and Shanghai, the degree of urbanization of the population and living standards of urban and rural residents achieved the desired state. Scores of the three indicators of Jiangsu, Zhejiang, Fujian and Guangdong also approach the ideal level. Indicated that, provinces in the eastern region, especially southeast coastal areas, had a high level of urbanization, urban and rural development of these provinces was also relatively balanced. Moreover, for all provinces except Xinjiang Qinghai, and Tibet, scores of ED₅ (disposable income of urban residents) exceeded 0.9000, indicated that in most areas of China, income levels and living standards of urban residents were at or approach the ideal state. However, in central and western provinces, especially western provinces including Guizhou, Yunnan, Gansu, Qinghai and Tibet, the income level of farmers (ED₆) was at a low level. Finally, for Shanxi, Inner Mongolia, Liaoning, Chongqing, Shaanxi, Gansu, Qinghai and Ningxia, there were large score gaps (over 0.2000) between ED₄ (ratio of population urbanization) and ED₆ (net income of farmers). Indicated that, in these provinces, the fast urbanization process has resulted in development disconnection between urban and rural.

Table 4 Results of urbanization

Provinces	ED4	ED5	ED6	Provinces	ED4	ED5	ED6
Beijing	1.0000	1.0000	1.0000	Hubei	0.8565	0.9941	0.7233
Tianjin	1.0000	1.0000	1.0000	Hunan	0.7582	1.0000	0.6707
Hebei	0.7588	0.9657	0.6791	Guangdong	1.0000	1.0000	0.8164
Shanxi	0.8274	0.9628	0.5873	Guangxi	0.7077	0.9868	0.5789
Inner Mongolia	0.9157	1.0000	0.6651	Hainan	0.8280	0.9795	0.6608
Liaoning	1.0000	1.0000	0.7461	Chongqing	0.9171	1.0000	0.6327
Jilin	0.8436	0.9287	0.7187	Sichuan	0.7123	0.9694	0.6232
Heilongjiang	0.8927	0.9044	0.6969	Guizhou	0.6157	0.9019	0.4447
Shanghai	1.0000	1.0000	1.0000	Yunnan	0.6420	0.9720	0.4971
Jiangsu	1.0000	1.0000	0.9972	Tibet	0.3967	0.8806	0.4906
Zhejiang	0.9980	1.0000	1.0000	Shaanxi	0.8090	0.9746	0.5288
Anhui	0.7562	0.9935	0.6611	Gansu	0.6413	0.8722	0.4184
Fujian	0.9507	1.0000	0.8433	Qinghai	0.7653	0.8923	0.4855
Jiangxi	0.7726	0.9724	0.6744	Ningxia	0.8250	0.9314	0.5607
Shandong	0.8463	1.0000	0.7922	Xinjiang	0.7090	0.9286	0.5816
Henan	0.6954	0.9469	0.6644				

Pressure for Reforms and Opening Up.

According to related government documents and planning, supply-side reform is one of the core tasks of China's development in the thirteenth Five-Year period. To characterize the difficulty of supply-side reform, the scoring evaluation results of indicators about pressure for reforms and opening up are shown in Table 5. The results showed, firstly, coastal provinces and municipalities including Beijing, Tianjin, Shanghai, Zhejiang, Jiangsu, Fujian, Shandong, Liaoning and Guangdong scored high in ED7 (foreign direct investment per capita) and ED8 (total import and export). Coastal regions showed high degrees of opening up and strong ability to attract foreign investment. However, such provinces and municipalities scored uneven in ED13 (ratio of exports in total import and export), indicated that due to the varied industrial structure and market demand, the provinces had different emphases on import and export. From Table 7, in energy provinces including Hebei, Shanxi, Liaoning and Xinjiang, and manufacturing provinces including Jiangsu, Zhejiang and Guangdong, the ratio of exports was high. Indicated that heavy industries and manufacturing were dominated sectors of China's foreign economy and trade. In addition, it is noteworthy that for Tianjin, Shanxi, Inner Mongolia, Liaoning, Jilin, Jiangxi, Hainan and Chongqing there were large score gaps (over 0.2500) between ED7 and ED8. Showed that such provinces had great potential for opening up.

Secondly, inventory backlog of real estate is the primary problem China faced in destocking reform. From the scoring results of ED10 (ratio of real estate investment in total fixed assets investment), scores of Beijing and Shanghai were 0.2796 and 0.2815, respectively. Showed that the two cities with highest level of economic and social development in China were under the greatest pressure of real estate destocking. Meanwhile, Zhejiang, Guangdong, Hainan and Chongqing have also been facing grim situation of real estate destocking.

Thirdly, high debt is the major obstacle in the processes of industrial structure adjustment and upgrading of China's enterprises. From the scoring results of ED11 (asset-liability ratio of above-scale industrial enterprises), all of the 31 provinces, municipalities and autonomous regions made poor performance in this indicator. In energy and industrial province such as Hebei, Shanxi, Inner Mongolia, Xinjiang and provinces with relatively backward economic development such as Qinghai, Gansu, the situation of high debt enterprises was particularly serious.

Finally, overcapacity is also a major problem of industrial structure optimization and reform of economic mode in China. From the scoring results of ED12 (output of industrial products of industries with excess capacity), Hebei, Liaoning, Jiangsu, Shandong, Henan, Hubei, and Guangdong were in serious condition of overcapacity. Meanwhile, severity of overcapacity didn't

show any correlation with economic development level. Indicated that industrial and product structure, and the reliance of regional economy on leading industries were decisive factors of de-capacity reform.

Table 5 Results of pressure for reforms and opening up

Provinces	ED ₇	ED ₈	ED ₁₀	ED ₁₁	ED ₁₂	ED ₁₃
Beijing	1	1	0.2796	0.5615	1	0.2308
Tianjin	1	0.6694	0.9283	0.4696	0.4247	0.6043
Hebei	0.2805	0.2994	0.9855	0.3935	0.0841	0.9175
Shanxi	0.3574	0.0812	1	0.3561	0.3841	0.8474
Inner Mongolia	0.3519	0.0728	1	0.4047	0.7807	0.6757
Liaoning	1	0.5700	0.6998	0.4620	0.2530	0.7928
Jilin	0.4037	0.1319	1	0.4875	1	0.3369
Heilongjiang	0.2086	0.1945	1	0.4488	1	0.6856
Shanghai	1	1	0.2815	0.5965	0.8731	0.6931
Jiangsu	1	1	0.7634	0.5054	0.1638	0.9332
Zhejiang	1	1	0.5011	0.5053	0.4028	1
Anhui	0.2632	0.2459	0.7562	0.4891	0.3851	0.9850
Fujian	1	0.8870	0.5970	0.5608	0.3816	0.9838
Jiangxi	0.4919	0.2137	1	0.5017	0.5077	1
Shandong	0.6784	1	1	0.5037	0.2265	0.8039
Henan	0.2080	0.3249	1	0.5738	0.2885	0.9325
Hubei	0.4452	0.2152	0.8628	0.4872	0.2178	0.9523
Hunan	0.2291	0.1542	1	0.5323	0.4103	0.9951
Guangdong	1	1	0.5163	0.5462	0.2440	0.9233
Guangxi	0.2622	0.2027	1	0.4504	0.4650	0.9230
Hainan	1	0.0793	0.3261	0.4597	1	0.4284
Chongqing	0.7524	0.4772	0.5076	0.4393	0.7460	1
Sichuan	0.3389	0.3510	0.7986	0.4598	0.3411	0.9826
Guizhou	0.1470	0.0539	0.6189	0.4442	0.5209	1
Yunnan	0.1786	0.1480	0.6059	0.4129	0.5175	0.9762
Tibet	0.1392	0.0113	1	0.5390	1	1
Shaanxi	0.3950	0.1368	1	0.4322	0.5459	0.7831
Gansu	0.0870	0.0432	1	0.4151	1	0.9489
Qinghai	0.1770	0.0086	1	0.3191	1	1
Ningxia	0.2600	0.0272	0.7270	0.4029	1	1
Xinjiang	0.1100	0.1384	1	0.3196	0.9839	1

Results of Main Ecological Environmental Indicators

Environmental Pressure and Sudden Environmental Risk.

Scoring results of indicators about environmental pressure and sudden environmental risk are shown in Table 6. The two indicators characterize sudden and cumulative risks that regional ecological environments suffered. Firstly, for all the 31 provinces, municipalities and autonomous regions except Tianjin and Inner Mongolia, scores of EE1 (industrial wastewater emission of 104 CNY industrial added value) were low. Indicated that, high discharge intensity of industrial wastewater was a common environmental stress factor in China.

Secondly, it can be found from the scoring results of EE2 (industrial exhaust emission of 104 CNY industrial added value), discharge pressure of industrial exhaust showed significant heterogeneities on location, regional leading industries and energy structure. Energy and heavy industry provinces such as Hebei, Shanxi, Inner Mongolia, Heilongjiang and Xinjiang, generally showed strong industrial emission intensity. Indicated that the economic-environmental efficiency of such provinces was relative low. Economically developed regions including Beijing, Tianjin,

Shanghai, Jiangsu, Zhejiang and Fujian scored relative high in indicator EE2. It is noteworthy that, there was a great gap between scores of EE1 and EE2 in provinces along large rivers. For instance, emission intensity of industrial wastewater (characterized by EE1) was higher than industrial exhaust (characterized by EE2) in Shanghai, Jiangsu, Zhejiang that close to Yangtze River, Guangdong that close to Pearl River and Fujian with abundant water resources. Indicated that, due to the great demand for water consumption, industrial enterprises that may emit large quantities of industrial wastewater were mostly located in the surrounding large water bodies.

Thirdly, EE3 (CO2 emission of 104 CNY GDP) scores of provinces in central China including Hebei, Shanxi, Inner Mongolia and northwestern China including Gansu, Qinghai, Ningxia, Xinjiang were low. Indicated that, carbon emission intensity of central and western provinces was relative high and the energy efficiency of such provinces was relative low. Shanxi, Inner Mongolia and Ningxia scored 0.1657, 0.2212 and 0.1385 in EE3, respectively, indicated that the energy structure and efficiency of these three provinces needed to be improved.

Table 6 Results of environmental pressure and sudden environmental risk

Provinces	EE ₁	EE ₂	EE ₃	EE ₄	Provinces	EE ₁	EE ₂	EE ₃	EE ₄
Beijing	0.248 6	1	1	0.181 8	Hubei	0.364 4	0.659	0.666	0.4
Tianjin	0.792 2	1	0.703	1	Hunan	0.346 8	0.642 7	0.811 9	1
Hebei	0.430 3	0.296 2	0.288 4	1	Guangdong	0.322	1	0.943 2	0.087
Shanxi	0.377 2	0.144 5	0.165 7	0.333 3	Guangxi	0.276 6	0.462 3	0.640 1	0.25
Inner Mongolia	0.706 3	0.22	0.221 2	1	Hainan	0.130 7	0.341 3	0.589 4	0.666 7
Liaoning	0.481 5	0.419 5	0.390 1	0.5	Chongqing	0.354 9	0.467 1	0.826	0.125
Jilin	0.525 9	0.46	0.506	1	Sichuan	0.357 8	0.654 6	0.761 6	0.285 7
Heilongjiang	0.319 7	0.239 6	0.410 9	1	Guizhou	0.283 2	0.175	0.334 3	0.666 7
Shanghai	0.332 9	1	0.784	0.018 5	Yunnan	0.247 5	0.259 5	0.468 4	0.666 7
Jiangsu	0.448 5	0.929 4	0.699 6	0.028 6	Tibet	0.121 4	0.099 5	1	1
Zhejiang	0.401	1	0.708 2	0.074 1	Shaanxi	0.548 3	0.364	0.430 5	0.024 4
Anhui	0.347 2	0.484 1	0.563 9	0.222 2	Gansu	0.343	0.168 9	0.294 7	0.090 9
Fujian	0.400 1	0.918 2	0.779 8	0.1	Qinghai	0.414 9	0.180 5	0.271 6	0.333 3
Jiangxi	0.328 8	0.445 6	0.775 6	0.333 3	Ningxia	0.261 2	0.095 4	0.138 5	0.285 7
Shandong	0.492 6	0.577	0.509	0.333 3	Xinjiang	0.309 5	0.125 7	0.253	0.4
Henan	0.373 9	0.451 4	0.537	0.333 3					

Environmental Governance and Ecological Conditions.

Scoring results of indicators about environmental governance and ecological conditions are shown in Table 7. From the scoring results of EE5 (treatment rate of life garbage) and EE8 (urban green coverage), most of provinces made good performances in urban greening, treatment and disposal of municipal solid waste. Indicated that most provinces and cities achieved some success in the field of

urban environmental management. However, scoring results of EE6 (Ratio of industrial pollution control investment in GDP) showed the investment intensity in industrial pollution control of all the 31 provinces was low and far below the ideal level.

Moreover, scoring results of EE7 (water resources per capita) showed that, water scarcity was a major ecological environmental problem China faced. Although in areas with abundant water resources such as Jiangxi, Fujian and Guangxi, water resources per capita were below the ideal level.

From the scoring results of EE9 (area ratio of nature reserve), nature reserve area showed certain spatial heterogeneities. Nature reserve area of the middle and lower reaches of the Yellow River Basin (including Hebei, Shandong, Shanxi, Henan and Shaanxi), middle and lower reaches of Yangtze River Basin (including Shanghai, Jiangsu, Zhejiang, Anhui, Hunan and Hubei) and southeast coast (including Fujian, Guangdong and Guangxi) were relative small.

Table 7 Results of environmental governance and ecological conditions^a

Provinces	EE ₅	EE ₆	EE ₇	EE ₈	EE ₉	Provinces	EE ₅	EE ₆	EE ₇	EE ₈	EE ₉
Beijing	1.00	0.02	0.00	0.82	0.44	Hubei	0.90	0.05	0.08	0.63	0.31
Tianjin	0.97	0.07	0.00	0.58	0.44	Hunan	1.00	0.03	0.13	0.64	0.34
Hebei	0.87	0.15	0.01	0.70	0.21	Guangdong	0.86	0.03	0.08	0.69	0.40
Shanxi	0.92	0.12	0.02	0.67	0.39	Guangxi	0.95	0.06	0.21	0.66	0.33
Inner Mongolia	0.96	0.22	0.11	0.66	0.64	Hainan	1.00	0.08	0.21	0.69	0.39
Liaoning	0.92	0.07	0.02	0.67	0.74	Chongqing	0.99	0.02	0.11	0.68	0.57
Jilin	0.62	0.06	0.06	0.60	0.72	Sichuan	0.95	0.04	0.16	0.63	1.00
Heilongjiang	0.59	0.06	0.12	0.60	0.83	Guizhou	0.93	0.10	0.17	0.57	0.28
Shanghai	1.00	0.04	0.01	0.64	0.29	Yunnan	0.93	0.10	0.18	0.64	0.42
Jiangsu	0.98	0.04	0.03	0.71	0.22	Tibet	-	0.06	1.00	0.73	1.00
Zhejiang	1.00	0.08	0.10	0.68	0.09	Shaanxi	0.96	0.09	0.05	0.68	0.32
Anhui	1.00	0.04	0.06	0.69	0.21	Gansu	0.63	0.13	0.04	0.51	0.91
Fujian	0.98	0.09	0.16	0.71	0.17	Qinghai	0.86	0.16	0.68	0.53	1.00
Jiangxi	0.93	0.04	0.18	0.74	0.42	Ningxia	0.93	0.50	0.01	0.63	0.57
Shandong	1.00	0.12	0.01	0.71	0.27	Xinjiang	0.82	0.17	0.16	0.61	0.65
Henan	0.93	0.08	0.02	0.64	0.24						

Discussion and Conclusion

Comprehensive economic evaluation index and comprehensive environmental evaluation index are calculated and evaluated to characterize the level of economic development and ecological environmental conditions in 31 provinces, municipalities and autonomous regions of China. For all the 31 provincial-level administrative regions, the ecological and environmental conditions have been lagging behind the regional economic development. Moreover, except a small part of central and western provinces such as Hunan, Sichuan and Tibet, there were relative big gaps between ecological environmental construction and economic development in most provinces. Based on calculation and evaluation results of economic and environmental indexes, coordinated development index is defined to characterize the degree of coordination between economic development and ecological environment. The average value of coordinated development indexes of 31 provinces was 0.7224 and coordinated development indexes of 21 provinces were higher than 0.7000. Indicated that the overall coordinated development level in China was low coordinated level and most provinces in China were in the early stage of coordinated development. Coordination degrees of eastern regions were higher than central and western regions, implied the regional and spatial imbalance of coordinated development.

From the indicators on economic development, the overall level of economic development and urbanization of most provinces were relative high. However, in parts of central and western provinces, over-reliance on industry and imbalance between urban and rural development were major obstacles to coordinated development. Reforms, especially supply-side reform and expanding

of opening up, are major tasks in the process of economic and social development during Thirteen Five period. From the computation results of relative indicators, high debt and overcapacity were the main resistance to the reform process and coordinated development. From the indicators on ecological environment, most provinces made good performance in urban environmental management and air pollution control. However, low investment in industrial pollution control and undesirable aquatic ecological environment may affect the coordinated development of economy-environment system.

At the regional level, regional development imbalance has been a common feature of the two regions. Therefore, it's necessary to develop integrated development policy and adjust the mode of development and prevent the development disconnection between Beijing and surrounding areas, Yangtze River Delta and middle and upper reaches of Yangtze River basin.

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