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The High-Quality Development of Commercial Health Insurance: Measurement and Discussion Based on 2011-2020 China's Provincial Panel Data

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Abstract

Objective: The objective of this study is to assess the high-quality development of commercial health insurance in mainland China, and discuss its effectiveness and efficiency in the sense of coordination with economic development. More specifically, the objective is threefold: (1) to construct an all-round assessment matrix with a compound index to measure the high-quality development of commercial health insurance; (2) to track the dynamic evolution of regional commercial health insurance development, as well as the regional disparities; (3) to measure the coupling coordinated development level between regional commercial health insurance and regional economics.

Methods: The study was supported by the 2011-2020 provincial panel data from *China Statistical Yearbook*、*China City Statistical Yearbook*、*Yearbook of China's Insurance*、*Almanac of China's Finance and Banking*、*China Population and Employment Statistics Yearbook*、*China's environmental Yearbook.* The analytic hierarchy process - entropy weight method was applied to analyze high-quality development of commercial health insurance and high-quality economic development. For study on regional disparities, the Theil index was used for the analysis. The coupling coordination degree model was constructed to measure the coupling coordinated development level.

Results: (i) There were around one third regions that had achieved superior commercial health insurance development and coupling coordination between commercial health insurance and economics than national average, and most of them were in the east/coastal area. (ii) The overall improvement of coordination relationship was significantly inferior to that of commercial health insurance development, which reflects the difficulty of achieving coupling coordinated development between commercial health insurance and economics. (iii) The nationwide population-weighted Theil index decreased by around 50% over the past decade, which indicates that regional disparity has been reduced remarkably. The decomposition results indicate that the total Theil was dominated by the intra-regional difference and thus it can explain a significant portion of the overall inequality. (iv) The nationwide coupling coordination degree was quite stable before 2016, and got improved rapidly since 2017. Most regions had a low coupling coordinated development level in 2011 and 15 of them finally reached medium- or high- level in 2019. (v) The COVID-19 pandemic had obvious adverse impact on commercial health insurance development and coordination relationship between commercial health insurance and economics.

Conclusion: The existing assessment is limited in that it emphasizes partially the regional disparities in an absolute sense. In contrast, the all-round assessment matrix and the coordination analysis in our study can provide decision makers with reliable measurement. It is necessary to continuously monitoring the high-quality commercial health insurance development index and the coupling coordination degree. As such, the appropriate health insurance industry policy could be developed accordingly. As the most important supplements to social security system, commercial health insurance and commercial pension scheme should serve local economic society development, effectively and efficiently.

Key words: High-quality development; commercial health insurance; AHP-entropy weight method; Theil Index; Coupling coordination degree model

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1. INTRODUCTION

In an effort to fulfill China's commitment to the United Nations 2030 Agenda for Sustainable Development, the Political Bureau of the Communist Party of China adopted the "Healthy China 2030" plan as part of a comprehensive strategy to improve the general health of Chinese people (Wu, Luo, Qiu and Bao, 2017). Under this strategy, commercial health insurance (CHI) in mainland China has experienced rapid development. According to the statistics of the China Banking and Insurance Regulatory Commission, CHI premium income increased from 67.7 billion yuan in year 2010 to 844.7 billion yuan in year 2021, with a compound annual growth rate of 26%, as shown in Figure 1.

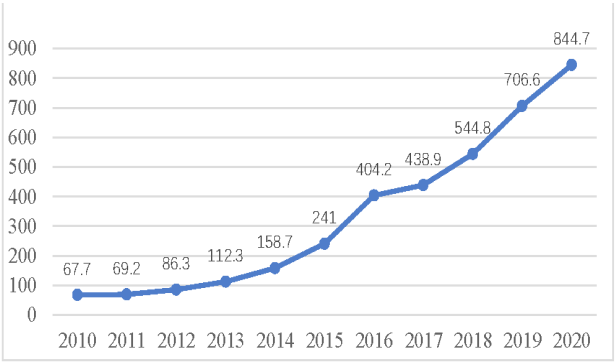

Figure 1
CHI annual premium income (billion yuan)

In contrast to fast growth in premium income, the profitability of CHI has been quite disappointing. For example, the CHI business lines of some insurance companies actually operate at a loss according to statistics in《Yearbook of China's Insurance》. We summarized the annual net profit (loss) of some key professional CHI companies in Table 1. Possible reasons for this may include product homogeneity, imperfect regulation system, and poor risk management.

Table 1
Annual net profit (loss) of professional CHI company (million yuan)

	Hexie Health	PICC Health	Ping an Health	Kunlun Health	Pacific Health	Fusun United Health	Ruihua Health
	set up in Jan. 2006	set up in Mar. 2005	set up in Jun. 2005	set up in Jan. 2006	set up in Dec. 2014	set up in Jan. 2017	set up in May 2018
2010	-40.43	-53.93	-30.61	-48.82	/	/	/
2011	-10.86	-482.45	-53.01	-113.63	/	/	/
2012	-327.69	-743.34	-65.99	-125.48	/	/	/
2013	90.22	-795.11	-79.02	-280.6	/	/	/
2014	3377.47	-386.59	-122.99	-63.15	-19.25	/	/
2015	773.56	-135.26	-115.97	151.59	-55.91	/	/
2016	2668.06	2.75	-63.82	8.91	-145.06	/	/
2017	not available	6.82	155.58	-825.63	-185.97	-44.77	/
2018	2270.04	21.15	143.79	-769.8	-137.48	-87.38	-123.83
2019	-682.74	34.29	405.52	134.28	7.26	-38.76	-101.94
2020	129.13	37.73	595.24	292.74	115.65	-74.37	-65.64
2021	not available	25.62	883.3	-1244.07	124.84	20.31	-108.76

To analyze the problems related to CHI, researchers from both industry and academia have devoted themselves to research in this field. Many articles on CHI have been contributed to the literature. Typical research outcomes can be classified into six categories, including issues related to demand and supply (Dunn, 2016; Doiron and Kettlewell, 2020; Gerfin, 2019; Stavrunova and Yerokhin, 2014; Zhao and Sun, 2021), the development level of CHI (Choi, et al, 2018; Liu, Wang, and Bian, 2010; Li, et al, 2021; Yan, et al., 2022; Suo, Wanyan and Chen, 2015), optimal CHI design (Besley, 1988; Blomqvist, 1997; Ellis, Jinag, & Manning, 2015; Rosenbaum, 2003; Zhang & Wu, 2020; Zhang, Wu, & Yao, 2021; Zhang, Wu, & Yao, 2022), health insurance coverage and healthcare expenditures (Jin, Hou, Zhang, 2016; Fang, Shia, & Ma, 2012; Li, et al, 2020; Zhang, Vanneste, Xu, & Liu, 2019; You & Kobayashi, 2011; Assaf, Campostrini, Novi, Xu, et al, 2016), social health insurance (SHI) and its impact on CHI (Dong, 2009; Yip, et al, 2019; Meng, et al, 2015; Yan, 2018; Hou & Zhang, 2017; Liu, et al, 2020), and other issues (Chen, Ding, Li, & Mou, 2021; Boone, 2015; Wang, et al, 2010).

Most existing literatures used insurance penetration and density, premium income and market concentration to calculate the development index of CHI, then measured the regional disparities, and analyzed the influencing factors by empirical approach. The results in most of the aforementioned papers appear unreliable in that the index system is overly simplistic and emphasizes partially the regional disparities in an absolute sense, without

considering the interaction of CHI and economics. The regional development of CHI should adapt to local economic society conditions and demand (Zhang & Tu, 2014; Song, Li, & Li 2019). China's economy is changing from high-speed growth to high-quality development. Evaluating the high-quality economic development level has drawn attention from the research community in China (Liu & Zhong, 2021; Liu & Lin, 2020; Zhang, 2020; Ling & Yang, 2021; Ma, et al, 2019; Zeng, Jiang, & Cui, 2022). Hence in this paper, we evaluated the CHI development in 30 provinces, municipalities, and autonomous regions in China over the past decade, and studied its relationship with economic development.

The contribution of our paper includes three aspects. First, we constructed an all-round assessment matrix with a compound index to measure the high-quality development of CHI. Second, we utilized the assessment results to track the dynamic evolution of regional commercial health insurance development as well as regional disparities. Third, we measured the level of coupling coordinated development between regional CHI and regional economics. The new insights into the vulnerability of CHI development would be useful in shaping health policy or regulations.

The rest of the paper is organized as follows. In Section 2, we first established two different sets of indexes respectively for high-quality development of CHI and economic development, then constructed a general method for evaluating the development of such systems with multiple indexes based on an improved entropy weight technique. Theil index method and coupling coordination degree model were established for further analysis. In Section 3, we analyzed the dynamic evolution of CHI development in mainland China based on the method developed in Section 2 and China's 2011-2020 provincial panel data. The regional disparities of CHI development in China were analyzed. In addition, we investigated the coupling coordination of CHI development with economic development. The discussion on CHI development level, dynamic evolution, regional disparities, and coupling coordination relationship are presented in Section 4. A conclusion is then given in Section 5.

2. METHODS

Development of CHI and economy may be reflected / measured from different aspects. Thus, in order to evaluate the CHI development and its relationship with economic development, we first identified the key indexes to measure the development for each of these two systems. Then, with each of these systems involving multiple indexes, a weighted method was developed to evaluate the development level of the system taking into account all indexes for the considered system. Finally, Theil models and coupling coordination degree models were applied to do further analysis. The indexes of the two systems and the integrated methodologies for comprehensive analysis are given below.

2.1 Indexes of CHI high-quality development

According to the policy paper 《Guidance on promoting high-quality development of commercial health insurance》 issued by the Banking and Insurance Regulatory Commission of China, the indexes of CHI development should consist of market structure and efficiency, specialization and operating level. The details are given in the table below.

Table 2
Indexes of CHI high-quality development

Performance areas	Indexes	Description
market structure and efficiency	Number of CHI companies	Number of insurance companies that provide CHI products. In addition to professional CHI companies, some life insurers and non-life insurers also provide CHI products.
	Participation rate of insurance company	Number of CHI companies / number of all insurance companies
	Market concentration	Herfindahl-Hirschman Index (HHI)
Specialization	Number of professional CHI companies	Number of professional CHI companies
	Premium income of CHI earned by professional CHI companies	Annual premium income of CHI earned by professional CHI companies
Operating level	Premium income of CHI	Annual premium income of CHI
	Market share of CHI	Premium income of CHI / total insurance premium income
	Insurance density of CHI	Premium income of CHI / population
	Claim ratio	Annual claim payout / annual premium income
	Insurance penetration of CHI	Premium income of CHI / GDP

2.2 Indexes of high-quality economic development

Achieving high-quality economic development has been one of the main goals over the thirteenth five-year plan period and the fourteenth five-year plan period. Domestic scholars have not reached a consensus on definition of high-quality economic development. With reference to the viewpoints in existing literature, we proposed the following index system, as detailed in the Table 3.

Table 3
Indexes of high-quality economic development

Performance areas	Indexes	Description
Economic growth	Real GDP	Calculation based on 2011 GDP
Innovation	Patent output rate	Number of granted patents / R&D personnel
	Turnover ratio of technology market	Turnover of technology market / R&D expenditure
	Commercialization rate of research outcome	Expenditure on new products development / sales revenue of new products
Balanced development	GDP per area	GDP / area
	Upgrade in industry structure	Output value of tertiary industry / GDP
Green development	Energy consumption per GDP	Total energy consumption / GDP
	Pollutant emission per GDP	Total waste water and gas discharged / GDP
	Volume of waste disposed per GDP	Total volume of wastes disposed / GDP
Opening-up	Proportion of FDI	Value of foreign investment actually utilized / GDP
	Proportion of import-export volume	Total value of imports and exports / GDP
Shared development	Educational fund per capita	Educational funds / population
	Number of licensed doctors per 10000 persons	Number of licensed doctors per 10000 persons

2.3 An improved entropy weight method

Entropy is a physical concept of thermodynamics, which was introduced into information theory by Shannon in 1948 (Shannon, 1948). The higher the value of information entropy, the more balanced the structure of the system is; and vice versa. The entropy weight method avoids the overlap of information between multiple indexes, and provides unbiased indexes weights. Due to the great advantage, the entropy weight method has been widely used in multiple indexes evaluation (Suo & Chen, 2015; Liu, Lin, 2020; Zhang, 2020; Ling & Yang, 2021; Ma, Luo, Wang, & Wang, 2019). However, the obvious limitation of entropy weight method is that it cannot reflect the practical experience of experts (Ma, et al, 2012; Xu, et al, 2018). To overcome this problem, we developed an improved entropy weight method that incorporating analytic hierarchy process (AHP) in our methodology. As such, both objective data information and subjective data attributes can be comprehensively utilized in this study.

The method for evaluating the development level of the considered systems are as follows.

Step 1: Construct the decision matrix. Suppose there are *m* evaluation objects and *n* indexes. Then the decision matrix is $X = (x_{ij})_{m\times n}$.

Step 2: Normalize the decision matrix. In order to eliminate the impact of index dimension and its variation range, it is necessary to normalize the original matrix. Then the normalized decision matrix is $Y = (y_{ij})_{m\times n}$.

Step 3: Calculate information entropy.

$$h_j = -\frac{1}{ln\, m}\sum_{i=1}^{m}\frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}}\left(ln\,\frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}}\right) \qquad (1)$$

Step 4: Calculate the index AHP weight and determine the final weight.

$$w_j = \frac{(1-h_j)w_j^{AHP}}{\sum_{j=1}^{n}(1-h_j)w_j^{AHP}} \qquad (2)$$

Step 5: Calculate the weighted normalized decision matrix.

$$R = (r_{ij})_{m\times n} = (y_{ij} \times w_j)_{m\times n} \qquad (3)$$

Step 6: Determine the development level.

$$L_i = \sum_{j=1}^{n} r_{ij} \qquad (4)$$

2.4 Theil index method

To study the regional disparities, we divided the 30 provinces, municipalities, and autonomous regions into 3 geographical regions, as detailed in Table 4.

Table 4
Geographical regions

Region	Provinces
Eastern	Beijing, Tianjin, Hebei, Shanghai, Zhejiang, Liaoning, Jiangsu, Fujian, Shandong, Guangdong, Hainan
Central	Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan
Western	Inner Mongolia, Chongqing, Guizhou, Guangxi, Sichuan, Yunnan, Gansu, Ningxia, Shaanxi, Qinghai, Xinjiang

The Theil index method was then used to compare the difference between the 3 subgroups. The higher the value, the more severe the inequality. In general, suppose there are *k* regions. Let be the development level of the i[th] region, *L* be the comprehensive development level of all regions, be the population of the i[th] region, and *P* be the total population of all regions. The Theil index can be decomposed into two components, which measure inter-group difference and intra-group difference, respectively. The formulas are as follows:

$$T = \sum_{i=1}^{k} \frac{L_i}{L} \log \frac{L_i/L}{P_i/P} \quad (5)$$

$$T = T_w + T_b = \sum_{j=1}^{u} \{\frac{L_j}{L} \sum_i \frac{L_{ji}}{L_j} \log \frac{L_{ji}/L_j}{P_{ji}/P_j}\} + \sum_{j=1}^{u} \frac{L_j}{L} \log \frac{L_j/L}{P_j/P}. \quad (6)$$

2.5 Coupling coordination degree method

Coupling coordination degree model has been widely used to measure the relationship among different systems (Zhang & Tu, 2014; Song, Li, & Li, 2019). It can be easily extended from two systems to multiple systems. This method produces a coupling coordination degree that ranges from 0 to 1. The higher the value, the better the coupling coordination. The method for calculating the coupling coordination degree is as follows:

Step 1: Calculate the coupling degree. Suppose L_t^A and L_t^B are the development level of system A and B, at time *t*, respectively. Then the coupling degree is

$$C_t = \frac{2\sqrt{L_t^A \times L_t^B}}{L_t^A + L_t^B} \quad (7)$$

Step 2: Calculate the comprehensive evaluation index at time *t*.

$$T_t = \alpha L_t^A + \beta L_t^B \quad (8)$$

where and represent the contribution of system A and system B, respectively. It is considered that the two systems, i.e., CHI and economics, are equally important, and so $\alpha = \beta = \frac{1}{2}$.

Step 3: Calculate the coupling coordination degree.

$$D_t = \sqrt{C_t \times T_t} \quad (9)$$

3. RESULTS

To study the CHI high-quality development in China, we used 2011-2020 provincial panel data from *China Statistical Yearbook*, *China City Statistical Yearbook*, *Yearbook of China's Insurance*, *Almanac of China's Finance and Banking*, *China Population and Employment Statistics Yearbook*, *China's environmental Yearbook*, *Annual Statistics of China National Intellectual Property Administration*, *National Economic and Social Development Yearbook*, and statistics of the Banking and Insurance Regulatory Commission of China.

3.1 CHI high-quality development in mainland China

Based on the data and the indexes listed in Section 2, we applied the improved entropy weight method to calculate the comprehensive index and measure the high-quality development of CHI over the past decade. The calculation results are summarized in Tables 5 and 6. Because data from Tibet is lack, we give the results of 30 provinces, municipalities, and autonomous regions in mainland China. Table 5 shows the regional assessment results of CHI high-quality development over the last decade, 2011 to 2020. The AHP-entropy method gives the horizontal comparison among the regions in each year. For a better understanding of the comprehensive assessment results, we ranked the regions in Table 6 in descending order.

Table 5
Comprehensive index values of high-quality development of CHI, 2011 to 2020

Province/ Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beijing	0.842	0.810	0.794	0.884	0.924	0.725	0.803	0.769	0.730	0.667
Tianjin	0.360	0.353	0.365	0.446	0.320	0.272	0.341	0.360	0.367	0.353
Hebei	0.314	0.339	0.326	0.496	0.367	0.310	0.339	0.397	0.430	0.421
Shanghai	0.595	0.680	0.616	0.561	0.529	0.553	0.786	0.596	0.522	0.462
Zhejiang	0.386	0.411	0.407	0.507	0.427	0.449	0.636	0.424	0.404	0.454
Liaoning	0.458	0.451	0.466	0.579	0.529	0.394	0.526	0.426	0.368	0.344
Jiangsu	0.433	0.464	0.459	0.672	0.537	0.597	0.730	0.486	0.481	0.437
Fujian	0.391	0.419	0.343	0.450	0.361	0.402	0.526	0.516	0.414	0.330
Shandong	0.453	0.450	0.415	0.672	0.475	0.432	0.510	0.564	0.539	0.503
Guangdong	0.515	0.559	0.526	0.677	0.656	0.855	0.730	0.698	0.735	0.722
Hainan	0.205	0.190	0.190	0.179	0.223	0.203	0.213	0.239	0.275	0.266
Inner Mongolia	0.260	0.309	0.296	0.368	0.292	0.258	0.308	0.371	0.348	0.302
Chongqing	0.263	0.277	0.275	0.244	0.294	0.273	0.341	0.350	0.353	0.346
Guizhou	0.186	0.172	0.184	0.166	0.181	0.182	0.175	0.219	0.189	0.206
Guangxi	0.219	0.241	0.232	0.264	0.221	0.211	0.249	0.292	0.279	0.291
Sichuan	0.378	0.387	0.375	0.437	0.436	0.466	0.600	0.426	0.464	0.455

Province/ Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Yunnan	0.479	0.491	0.452	0.512	0.306	0.271	0.297	0.332	0.295	0.302
Gansu	0.244	0.247	0.287	0.242	0.267	0.211	0.261	0.312	0.301	0.331
Ningxia	0.407	0.395	0.371	0.307	0.269	0.234	0.317	0.389	0.334	0.314
Shaanxi	0.242	0.274	0.252	0.305	0.294	0.274	0.314	0.278	0.358	0.328
Qinghai	0.240	0.284	0.349	0.465	0.224	0.212	0.267	0.301	0.225	0.196
Xinjiang	0.352	0.368	0.379	0.343	0.301	0.283	0.354	0.361	0.319	0.304
Shanxi	0.253	0.277	0.288	0.300	0.270	0.263	0.282	0.358	0.368	0.326
Jilin	0.297	0.302	0.329	0.349	0.279	0.219	0.279	0.410	0.402	0.393
Heilongjiang	0.277	0.284	0.268	0.324	0.268	0.380	0.350	0.445	0.462	0.504
Anhui	0.228	0.247	0.258	0.335	0.288	0.335	0.333	0.333	0.324	0.319
Jiangxi	0.296	0.309	0.327	0.504	0.285	0.276	0.322	0.374	0.334	0.328
Henan	0.277	0.316	0.325	0.458	0.347	0.299	0.374	0.558	0.500	0.483
Hubei	0.318	0.321	0.350	0.488	0.336	0.339	0.395	0.576	0.451	0.427
Hunan	0.297	0.318	0.319	0.371	0.342	0.295	0.373	0.367	0.344	0.365
National average	0.349	0.365	0.361	0.430	0.362	0.349	0.411	0.417	0.397	0.383

Table 6
Rank of regional CHI development level in each year (descending order), 2011 to 2020

Province/ Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beijing	1	1	1	1	1	2	1	1	2	2
Tianjin	12	13	12	15	14	20	16	20	16	14
Hebei	15	14	18	10	9	13	17	14	10	11
Shanghai	2	2	2	6	5	4	2	3	4	6
Zhejiang	10	9	8	8	8	6	5	12	12	8
Liaoning	5	6	4	5	4	9	8	11	14	16
Jiangsu	7	5	5	3	3	3	4	8	6	9
Fujian	9	8	15	14	10	8	7	7	11	18
Shandong	6	7	7	4	6	7	9	5	3	4
Guangdong	3	3	3	2	2	1	3	2	1	1
Hainan	29	29	29	29	28	29	29	29	28	28
Inner Mongolia	22	18	21	18	19	23	22	17	19	25
Chongqing	21	23	24	27	17	19	15	22	18	15
Guizhou	30	30	30	30	30	30	30	30	30	29
Guangxi	28	28	28	26	29	28	28	27	27	27
Sichuan	11	11	10	16	7	5	6	10	7	7
Yunnan	4	4	6	7	15	21	23	24	26	26
Gansu	24	26	23	28	26	27	27	25	25	17
Ningxia	8	10	11	23	24	24	20	15	22	23
Shaanxi	25	25	27	24	18	18	21	28	17	20
Qinghai	26	21	14	12	27	26	26	26	29	30
Xinjiang	13	12	9	20	16	16	13	19	24	24
Shanxi	23	24	22	25	23	22	24	21	15	21
Jilin	17	20	16	19	22	25	25	13	13	12
Heilongjiang	20	22	25	22	25	10	14	9	8	3
Anhui	27	27	26	21	20	12	18	23	23	22
Jiangxi	18	19	17	9	21	17	19	16	21	19
Henan	19	17	19	13	11	14	11	6	5	5
Hubei	14	15	13	11	13	11	10	4	9	10
Hunan	16	16	20	17	12	15	12	18	20	13

Since the weights of indexes vary over time, the results in Table 5 can only be used for horizontal comparison among regions in the same calendar year. To understand the dynamic evolution of CHI development of a particular region over time, the AHP-entropy method should be applied again to evaluate CHI development of this region in different years. The results are showed in Table 7.

Table 7
Dynamic evolution over the past decade of CHI development level in each province / municipality / autonomous region

Province/Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beijing	0.168	0.200	0.285	0.302	0.547	0.638	0.544	0.685	0.810	0.753
Tianjin	0.173	0.238	0.312	0.419	0.466	0.458	0.610	0.698	0.828	0.897
Hebei	0.149	0.211	0.222	0.309	0.388	0.460	0.395	0.487	0.817	0.867
Shanghai	0.208	0.315	0.327	0.258	0.478	0.745	0.751	0.741	0.778	0.781
Zhejiang	0.156	0.234	0.241	0.326	0.391	0.675	0.663	0.581	0.648	0.808
Liaoning	0.151	0.239	0.253	0.346	0.683	0.746	0.745	0.630	0.776	0.810
Jiangsu	0.136	0.199	0.210	0.262	0.348	0.643	0.494	0.465	0.779	0.788
Fujian	0.174	0.249	0.226	0.327	0.425	0.740	0.778	0.751	0.783	0.613
Shandong	0.235	0.251	0.220	0.353	0.408	0.573	0.468	0.640	0.752	0.709
Guangdong	0.136	0.197	0.205	0.273	0.388	0.794	0.536	0.678	0.777	0.818
Hainan	0.273	0.227	0.295	0.296	0.415	0.418	0.551	0.700	0.851	0.895
Inner Mongolia	0.191	0.292	0.296	0.425	0.463	0.472	0.485	0.755	0.711	0.708
Chongqing	0.206	0.241	0.245	0.200	0.287	0.303	0.433	0.525	0.734	0.898
Guizhou	0.376	0.350	0.316	0.235	0.314	0.440	0.461	0.612	0.790	0.886
Guangxi	0.229	0.309	0.348	0.425	0.390	0.411	0.542	0.649	0.775	0.806
Sichuan	0.147	0.179	0.229	0.270	0.354	0.609	0.677	0.617	0.764	0.807
Yunnan	0.187	0.253	0.378	0.355	0.472	0.594	0.620	0.651	0.812	0.861
Gansu	0.260	0.272	0.347	0.321	0.368	0.350	0.500	0.654	0.707	0.882
Ningxia	0.280	0.308	0.360	0.326	0.349	0.401	0.576	0.724	0.807	0.857
Shaanxi	0.194	0.272	0.234	0.348	0.428	0.510	0.614	0.703	0.823	0.842
Qinghai	0.369	0.341	0.385	0.435	0.385	0.509	0.670	0.802	0.849	0.769
Xinjiang	0.190	0.276	0.354	0.386	0.534	0.595	0.664	0.779	0.787	0.832
Shanxi	0.193	0.289	0.307	0.352	0.469	0.555	0.612	0.677	0.810	0.810
Jilin	0.253	0.251	0.258	0.362	0.485	0.478	0.485	0.557	0.698	0.767
Heilongjiang	0.152	0.172	0.182	0.206	0.340	0.696	0.491	0.551	0.621	0.744
Anhui	0.197	0.256	0.301	0.416	0.433	0.673	0.583	0.676	0.713	0.741
Jiangxi	0.259	0.291	0.292	0.400	0.406	0.515	0.531	0.666	0.807	0.818
Henan	0.166	0.240	0.284	0.374	0.381	0.428	0.469	0.798	0.853	0.843
Hubei	0.172	0.214	0.263	0.281	0.448	0.643	0.624	0.609	0.694	0.686
Hunan	0.210	0.316	0.318	0.435	0.442	0.574	0.515	0.639	0.611	

3.2 Theil index values and the decomposition

Table 8 presents the Theil index values for the period from 2011 to 2020. It can be noted that the inequality reflected by the Theil values decreased significantly from 0.3246 in 2011 to 0.1795 in 2020, showing that the overall disparity narrowed obviously with a sharp decrease from 2014 to 2016, due to the implementation of the national strategy. By decomposing the Theil index into inter-regional differences and intra-regional differences, we find that the intra-region Theil explains a significant portion of the overall inequality, with a proportion of 91.32% in 2011 to 98.66% in 2020, which is in line with the actual situation in mainland China. From a national perspective, the trends in Theil index are portrayed in Figure 2. The intra-regional differences followed the same trend as the national Theil index within the study period. However, the inter-regional difference was relatively low and stable. The results indicate that the government should fully consider the difference within each region when adopting policies.

Table 8
Theil index of CHI and decomposition

Year	Total Theil	Intra-Region Theil	Intra-Regional contribution rate	Inter-Region Theil	Inter-Regional contribution rate
2011	0.324607	0.296419	91.32%	0.028188	8.68%
2012	0.296366	0.268941	90.75%	0.027425	9.25%
2013	0.318785	0.291768	91.53%	0.027016	8.47%
2014	0.212655	0.195732	92.04%	0.016923	7.96%
2015	0.198537	0.177522	89.42%	0.021015	10.58%
2016	0.180357	0.162148	89.90%	0.018209	10.10%
2017	0.206916	0.188995	91.34%	0.017922	8.66%
2018	0.20216	0.19493	96.42%	0.007231	3.58%
2019	0.18373	0.179146	97.51%	0.004584	2.49%
2020	0.179541	0.177134	98.66%	0.002408	1.34%

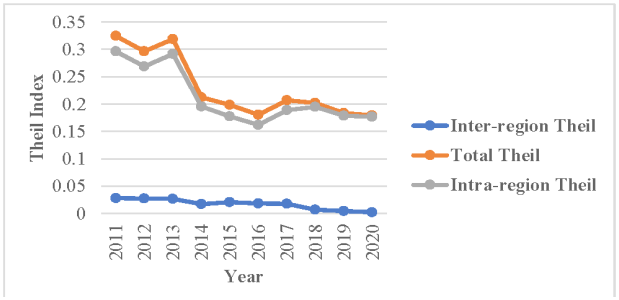

Figure 2
Trends in Theil index of CHI and decompositions

From the perspective of the three major regions in China, we calculated the Theil index of eastern, western and central, respectively. The results are shown in Table 9 and Figure 3. Both eastern and western regions had downward pattern, decreasing from 0.383 to 0.234, and from 0.328 to 0.171, respectively. It is noted that the evolution in the western region was more volatile than in the eastern region, with inflection points in 2016 and 2018. The central region had been relatively stable from 2011 to 2018 and showed upward trend since 2019. The 10-year average Theil index in eastern and western regions were similar, respectively, 0.274 and 0.246. Furthermore, both were much higher than the Theil in the central region, with an average level of 0.057. The results indicate that both level and evolution pattern vary among different regions. According to the above analysis results, the government should actively adopt policies to reduce inequality in the eastern and western regions, and monitor the central region.

Table 9
Theil index of CHI in the three regions

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
Eastern Theil	0.383	0.337	0.370	0.249	0.241	0.212	0.248	0.240	0.231	0.234	0.274
Western Theil	0.328	0.316	0.353	0.249	0.188	0.158	0.219	0.272	0.204	0.171	0.246
Central Theil	0.067	0.055	0.054	0.027	0.032	0.065	0.036	0.049	0.078	0.106	0.057

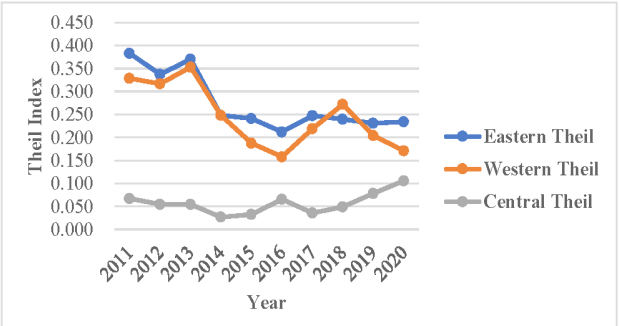

Figure 3
Trends in Theil index of CHI in the three regions

3.3 Coupling coordination of CHI development with economic development

The coupling coordination level can be classified into 3 categories according to the calculation results of the coupling coordination degree, namely uncoordinated declination, transitional development, and coordinated development, which can be further divided into several subcategories, as detailed in Table 10.

Table 10
Coupling coordination degree evaluation criteria

D	Class	D	Coordination Degree
0.00~0.39	Uncoordinated declination	0.00~0.19	Seriously uncoordinated
		0.20~0.39	Low incoordination
0.40~0.59	Transitional development	0.40~0.49	Near incoordination
		0.50~0.59	Low coordination
0.60~1.00	Coordinated development	0.60~0.79	Favorably coordinated
		0.80~1.00	Complete coordination

Table 11 displays the coupling coordination degree between CHI and economics. Table 12 summarizes the number of provinces / municipalities / autonomous regions in each of the coupling coordination degree categories according to the evaluation criteria in Table 10.

Table 11
Coupling coordination degree between CHI and economics from 2011 to 2020

Province/Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Beijing	0.873	0.849	0.842	0.851	0.884	0.841	0.870	0.863	0.857	0.768
Tianjin	0.592	0.582	0.586	0.611	0.562	0.550	0.586	0.602	0.591	0.529
Hebei	0.450	0.457	0.450	0.478	0.456	0.444	0.448	0.473	0.484	0.447
Shanghai	0.787	0.800	0.767	0.739	0.749	0.772	0.842	0.793	0.763	0.673
Zhejiang	0.564	0.567	0.554	0.571	0.559	0.571	0.625	0.569	0.561	0.538
Liaoning	0.545	0.536	0.516	0.530	0.532	0.511	0.563	0.541	0.508	0.442
Jiangsu	0.614	0.619	0.607	0.644	0.624	0.649	0.679	0.611	0.605	0.534
Fujian	0.526	0.533	0.505	0.522	0.511	0.532	0.561	0.556	0.519	0.455
Shandong	0.543	0.538	0.530	0.581	0.544	0.542	0.559	0.572	0.577	0.527
Guangdong	0.631	0.640	0.627	0.649	0.666	0.721	0.709	0.704	0.700	0.623
Hainan	0.441	0.421	0.414	0.395	0.427	0.459	0.460	0.501	0.530	0.604
Inner Mongolia	0.430	0.443	0.434	0.446	0.424	0.424	0.422	0.444	0.446	0.401
Chongqing	0.451	0.458	0.454	0.432	0.455	0.456	0.465	0.475	0.471	0.431
Guizhou	0.377	0.374	0.385	0.374	0.398	0.400	0.403	0.419	0.403	0.394
Guangxi	0.376	0.392	0.385	0.393	0.395	0.397	0.417	0.441	0.434	0.414
Sichuan	0.496	0.498	0.487	0.487	0.500	0.517	0.545	0.521	0.534	0.486
Yunnan	0.505	0.518	0.511	0.510	0.460	0.466	0.467	0.467	0.450	0.429
Gansu	0.415	0.416	0.440	0.403	0.429	0.434	0.452	0.490	0.470	0.447
Ningxia	0.427	0.396	0.383	0.382	0.360	0.386	0.436	0.434	0.419	0.378
Shaanxi	0.447	0.463	0.472	0.476	0.489	0.497	0.499	0.478	0.505	0.465
Qinghai	0.481	0.522	0.555	0.633	0.519	0.490	0.508	0.531	0.410	0.387
Xinjiang	0.476	0.481	0.488	0.468	0.452	0.448	0.486	0.494	0.479	0.455
Shanxi	0.415	0.426	0.430	0.415	0.415	0.417	0.418	0.452	0.453	0.416
Jilin	0.440	0.435	0.461	0.426	0.404	0.397	0.436	0.527	0.520	0.465
Heilongjiang	0.425	0.440	0.425	0.434	0.419	0.472	0.448	0.505	0.499	0.491
Anhui	0.420	0.422	0.424	0.430	0.435	0.452	0.443	0.449	0.446	0.414
Jiangxi	0.439	0.443	0.448	0.493	0.440	0.446	0.454	0.466	0.442	0.404
Henan	0.424	0.441	0.441	0.461	0.446	0.439	0.460	0.516	0.505	0.482
Hubei	0.442	0.443	0.459	0.488	0.467	0.475	0.490	0.533	0.501	0.464
Hunan	0.419	0.428	0.432	0.436	0.440	0.435	0.474	0.474	0.466	0.449
Average	0.496	0.499	0.497	0.505	0.495	0.501	0.521	0.530	0.519	0.480

Table 12
Number of provinces / municipalities / autonomous regions in each coupling coordination degree category, 2011 to 2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Low incoordination	2	3	3	4	3	3	0	0	0	3
Near incoordination	18	16	16	15	17	17	19	14	15	19
Low coordination	6	7	7	5	6	6	6	11	11	4
Favorably coordinated	3	2	3	5	3	3	3	4	3	4
Complete coordination	1	2	1	1	1	1	2	1	1	0

4. DISCUSSION

This paper investigated the high-quality development of CHI in mainland China by utilizing integrated methodologies and provincial panel data. In previous research, most scholars used CHI premium (in total or per person) as an indicator of development level (Suo & Chen, 2015; Yang & Jiang, 2018; Zhang, et al., 2018). To understand the uneven development of CHI, market structure was taking into account in Wang (2011), Suo et al. (2015), Yang and Jiang. (2018) (Suo & Chen, 2015; Yang & Jiang, 2018; Zhang, Lan, et al, 2018; Wang, 2011). Scholars also noted that professionalization, specialized operation, and profitability are also essential

for CHI high-quality development (Wang, 2011). Therefore, we propose the comprehensive index system and measure the CHI development over past decade. Both vertical comparison and horizontal comparison results are presented in Section 3. Empirical results also suggest that CHI development was closely related to local economics, and we did further analysis accordingly. Based on results in Section 3, the discussion will focus on three areas: (i) regional disparities in CHI development level (horizontal comparison); (ii) regional disparities in CHI dynamic evolution (vertical comparison); (iii) relationship between CHI development and economics. Followed by policy implementation strategies.

4.1 Regional disparities in CHI development level (horizontal comparison)

Based on empirical results in Section 3.1 and 3.2, we find that: (i) In each calendar year, there were around 10 out of 30 provinces, municipalities, and autonomous regions that achieved values above the national average, most of which were in the economically developed east/coastal area and the others were lower than the national average. Beijing, Shanghai and Guangdong were cities / province with most developed CHI system. (ii) During the past decade, there were 5 regions with a rapid decline in CHI development ranking, namely Liaoning, Fujian, Yunnan, Ningxia and Xinjiang; there were 8 regions with rapid rise in ranking, namely Guangdong, Chongqing, Sichuan, Gansu, Heilongjiang, Hubei, Henan and Jilin. The other 17 regions were roughly stable in ranking. (iii) 7 regions performed better than national average in CHI development in all the 10 years, namely Beijing, Shanghai, Guangdong, Jiangsu, Zhejiang, Shandong and Sichuan. (iv) Based on Theil index values and the decomposition, the overall inequality was dominated by intra-regional differences. (v) Within each geographical region, Theil index values indicate that inequality in eastern and western areas were far more severe than the central area.

4.2 Regional disparities in CHI dynamic evolution (vertical comparison)

Based on empirical results in Section 3.1 and 3.2, we find that all regions showed obvious increase trend in CHI development with fluctuations from 2011 to 2020. We illustrate the different dynamic evolution pathways in Figures 4 to 8.

(i) As depicted in Figure 4, some regions grew faster from 2015 to 2016, and then slowed down and fluctuated slightly. The driving force includes premium income of professional CHI companies, number of professional CHI companies, and claim ratio. The typical regions include but not limited to Beijing, Shanghai, Liaoning and Hubei.

(ii) As depicted in Figure 5, some regions grew rapidly in 2016, followed by immediate drop in 2017. This was incurred by dramatic volatility in premium income of professional CHI companies. The typical regions include but not limited to Zhejiang, Jiangsu, Shandong and Guangdong.

(iii) As depicted in Figure 6, some regions grew faster since 2016 notably, and kept strong growth thereafter. This was due to increase in CHI premium income and improvement in claim ratio. The typical regions include but not limited to Ningxia, Hainan, Gansu and Chongqing.

(iv) As depicted in Figure 7, some regions grew faster from 2018 to 2019, and slowed down in 2020. This results from the fluctuation in number of CHI companies, premium income, claim payout and claim ration. The typical regions include but not limited to Jiangxi, Hebei, Henan and Guizhou,

(v) As depicted in Figure 8, there were some regions that keep roughly stable growth rates from 2011 to 2020. The typical regions include but not limited to Tianjin, Yunnan, Xinjiang and Shanxi.

(vi) Comparing the CHI development in the adjacent two years in 2019 and 2020, we observe that the CHI development in most regions slowed down or even turned into contraction during the very short time period. This was very likely due to the adverse influence of COVID-19 pandemic.

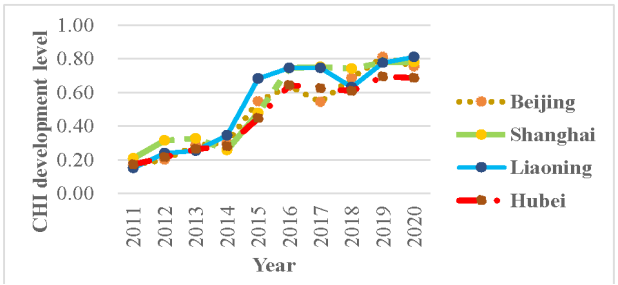

Figure 4
Trends of CHI development level in Beijing, Shanghai, Liaoning and Hubei

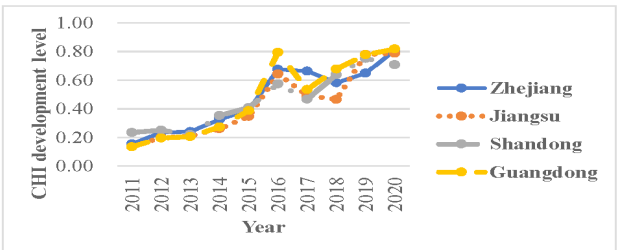

Figure 5
Trends of CHI development level in Zhejiang, Jiangsu, Shandong and Guangdong

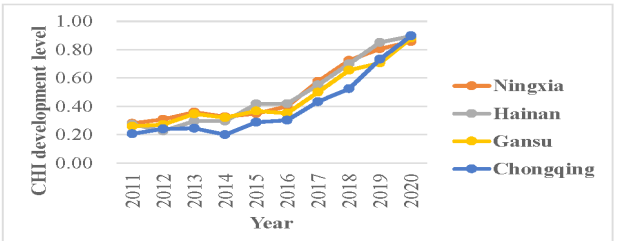

Figure 6
Trends of CHI development level in Ningxia, Hainan, Gansu and Chongqing

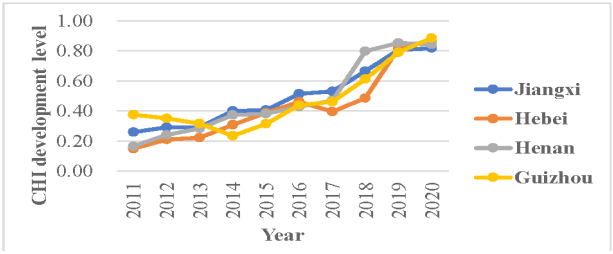

Figure 7
Trends of CHI development level in Jiangxi, Hebei, Henan and Guizhou

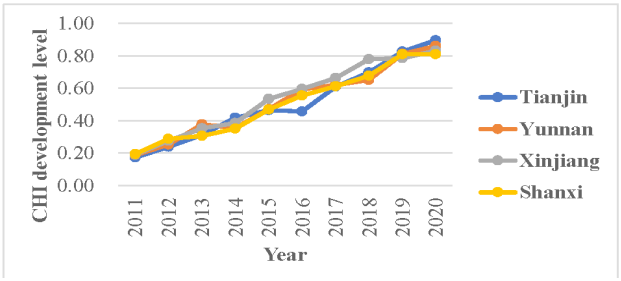

Figure 8
Trends of CHI development level in Tianjin, Yunnan, Xinjiang and Shanxi

Based on Theil index values and the decomposition, the overall disparity narrowed obviously with a sharp decrease from 2014 to 2016. The intra-region Theil had the similar pattern as the total Theil, whereas the inter-region Theil was relatively low and stable. Within each geographical region, both eastern Theil and western Theil had downward volatile pattern, whereas the central region had been relatively low and stable from 2011 to 2018 and showed upward trend since 2019.

4.3 Relationship between CHI development and economics

Based on empirical results in Section 3.3, we find that:

(i) In each calendar year, the degree of coupling coordination in 10 regions was greater than the national average level, and that in the other 20 regions was lower than national average level. Among the 10 above average level regions, most of them were located east, which is similar to the comprehensive index values of CHI high-quality development.

(ii) 7 regions performed better than national average in coupling coordination in all the 10 years, namely Beijing, Shanghai, Guangdong, Jiangsu, Zhejiang, Shandong and Tianjin. We notice that most of the 7 regions were superior in both CHI development and coupling coordination of CHI and economics, except for Sichuan and Tianjin. It is implied by indexes values that the main reason is Sichuan has been lagging behind in economic development, and Tianjin has been lagging behind in CHI development.

(iii) The regional growth rates of CHI got accelerated significantly in 2015 and continued in the following years. Meanwhile, the regional coupling coordination degrees had been relatively stable from 2011 to 2017, and became fluctuated from 2018 to 2020. The overall improvement of coordination relationship was significantly inferior to that of CHI development, which reflects the difficulty of achieving coupling coordinated development between CHI and economics.

(iv) Among the 30 provinces, municipalities and autonomous regions, only 8 regions showed obvious fluctuation over time, namely Shanghai, Jilin, Hainan, Qinghai, Yunnan, Guangxi, Sichuan and Heilongjiang. Specifically speaking, Qinghai, Yunnan and Shanghai showed a decreasing trend; whereas Jilin, Hainan, Guangxi, Sichuan and Heilongjiang showed an increasing trend. The other 26 regions displayed fairly stable pattern without upward or downward trend.

(v) Comparing the regional coupling coordination degrees in the adjacent two years, i.e., 2019 and 2020, a downturn occurred to all regions except for Hainan province, which shows a negative impact of COVID-19 pandemic. Due to the rapid increase in opening-up progress and technological innovation, Hainan experienced a fast growth in economics and enhance the coordination relationship between CHI and economics.

(vi) To make a more intuitive comparison of coupling coordination, we present the number of regions in each of the categories in Table 12. Beijing played the leading role in all the 10 years and achieved complete coordination from 2011 to 2019. Guangdong, Shanghai and Jiangsu have been favorably coordinated in the past decade. There were 3 regions in the low coordination category and remained unchanged from 2011 to 2016, and 2020. The situation got temporarily improved from 2017 to 2019. The number of regions in the transitional development class has been roughly stable with some switch between the two subclasses of low incoordination and near coordination.

To sum up, the adoption of suitable indexes and reliable methods in this study leaded to a more accurate understanding of CHI development, and resulted in different findings from those of previous research (Suo & Chen, 2015; Yang & Jiang, 2018; Zhang, et al, 2018; Wang, 2011). First, with the implementation of national strategy "Healthy China" and regulations of promoting insurance development, the overall equality of CHI development has been improved rapidly. All regions have achieved remarkable growth in CHI along diversified dynamic evolution pathways. Second, over the past decade, the rankings of nearly half of the regions have varied dramatically. To figure out the driving force, the index system and data should be examined carefully. It's worth noting that regional economics has been highly related to local CHI development, but it cannot explain the evolution completely. This phenomenon requires the government to avoid a "one size fits all" formulation of policies. Rather, the heterogeneous, evidence-based policies that reflect the characteristics of different regions should be adopted, from the perspective of coupling

coordination of CHI development and economics. Last but not least, in addition to premium income, professionalization, specialized operation, and profitability also play a pivotal role in CHI development, which should be a concern for both policy makers and enterprise operators. With population ageing and shrinking, more attention has to be placed on close monitoring, identifying and updating key indexes. Consequently, further studies are essential to address these important issues in the future.

5. CONCLUSION

In this study, we constructed an all-round assessment matrix with a compound index to measure the high-quality development of commercial health insurance. By using the 2011-2020 China provincial panel data, we applied integrated statistical methods to track the dynamic evolution of regional commercial health insurance development, as well as the regional disparities. In addition, we applied a coupling coordination degree model to measure the coupling coordinated development level between regional commercial health insurance and regional economics. The results indicate that (i) The existing assessment is limited in that it emphasizes partially the regional disparities in an absolute sense. In contrast, the all-round assessment matrix and the coordination analysis in our study can provide decision makers with more reliable information. (ii) It is necessary to continuously monitoring the high-quality commercial health insurance development index and the coupling coordination degree. As such, the appropriate health insurance industry policy could be developed accordingly. (iii) As the most important supplements to social security system, commercial health insurance and commercial pension scheme should serve local economic society development.

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