

Empirical Study on the Coordinated Development of Commercial Health Insurance and Social Medical Insurance in Guangdong

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Abstract: China's medical security system is a multi-level system that covers urban and rural residents, including basic medical insurance, commercial health insurance, and various forms of supplementary medical insurance. Commercial health insurance and social medical insurance have a close interactive relationship, and there is a trend of integration and coordinated development between the two. In order to promote a higher level of integration and coordinated development between them, this paper uses insurance data from the Pearl River Delta, East Wing, West Wing, and mountainous regions of Guangdong Province from 2015 to 2021 as samples. It employs a coupling coordination model from physics to empirically analyze the coordination relationship between commercial health insurance and social medical insurance systems in Guangdong Province from both temporal and spatial perspectives. The results indicate that in Guangdong Province, there is indeed a coupling relationship between commercial health insurance and social medical insurance, with a relatively high degree of coupling and a significant mutual impact. The coupling coordination between the two is gradually stabilizing. As far as the four major subregions of Guangdong Province are concerned, the development of commercial health insurance and social health insurance in the Pearl River Delta (PRD), the East Wing, the West Wing and the mountainous areas of Guangdong Province also shows obvious regional characteristics due to the different levels of regional economic development, geographic locations, and cultural attitudes. This requires the government to update local policies to suit the times, and enterprises as well as major medical institutions to help promote innovation in the diversified health insurance industry.

Keywords: Social medical insurance, commercial health insurance, coordinated development, coupling coordination, regional differences

1. Introduction

Guangdong Province is the birthplace of China's modern insurance industry and has a long history in this sector. The province has consistently been committed to ensuring basic coverage, providing a safety net, and promoting fairness in insurance services. Through measures such as increasing funding for social security programs, enhancing the basic public service system, and establishing a comprehensive livelihood security system covering both urban and rural areas, Guangdong has gradually improved the level of social security services and expanded the coverage of beneficiaries.

Currently, the development of basic medical insurance in Guangdong Province is in a good state, with nearly universal participation. According to data from the Guangdong Statistical Yearbook, as of the end of 2021, the number of participants in basic medical insurance in Guangdong had reached 110 million, with a coverage rate exceeding 95%. However, the commercial health insurance market in Guangdong Province is relatively small in scale, and there is a significant problem of product homogenization. By the end of 2021, the premium income from commercial health insurance in Guangdong Province was 94.469 billion RMB, accounting for only 19.9% of the total insurance market in the province, far below the premium income of property insurance and life insurance.

It is clear that Guangdong has not yet fully achieved its goal of "building and improving a multi-tiered, high-standard medical security system with basic medical insurance as the core, supplemented by various forms of supplementary medical insurance and commercial medical insurance, covering both urban and rural residents"[1]. Therefore, the purpose of this study is to investigate the interactive

relationship between commercial health insurance and social medical insurance in Guangdong Province, and to determine how to advance the development of commercial health insurance while ensuring social medical insurance. The study employs an objective approach and utilizes applicable terminology and a logical structure to achieve optimal clarity and precision. Additionally, it adheres to the established style guide and citation rules to ensure proper formatting and accuracy. This can contribute to improving the quality of medical insurance coverage and services throughout Guangdong Province. Additionally, studying the current status and issues of insurance development in Guangdong Province can provide valuable insights and inspiration for the nationwide growth of the insurance industry. It can also serve as a reference for improving insurance policies and planning in the future.

2. Literature Review

2.1 The Connotation of Coordinated Development

Dou Zhaoyang and Wang Yang (2009) analyzed the relationship between social health insurance and commercial insurance using economics' concept of elasticity. They contend that social medical insurance and commercial health insurance exhibit both substitutability and complementarity. The final effects' substitutability and complementarity rely on diverse factors, including the insurance coverage, insurance type, level of government involvement in social health insurance, residents' per capita income, and education levels. [2].

Lv Zhiyong (2013) suggested that the integration of commercial health insurance and social health insurance should prioritize social health insurance, with supplementary support from commercial health insurance, and encourage the active development of commercial health insurance policies. [3].

Yang Zhengmao (2015) proposed that the integration of commercial health insurance and social medical insurance should occur in the context of achieving universal coverage for social medical insurance. This strategy capitalizes on the specialized advantages of commercial health insurance, reduces redundancy with medical insurance, and establishes a more inclusive healthcare security system to address the diverse healthcare needs of the population. [4].

Zou Jing (2015) argued that the coordinated development of commercial health insurance and social medical insurance involves the two parties moving forward independently, based on common interests and the overall goal of healthcare system construction. At the same time, it involves implementing measures for partial joint development, achieving organic coordination between the two, and jointly improving the healthcare security system. etc. [5].

Liu Xueping (2014) explored the mechanism of the synergistic development of commercial medical insurance and social medical insurance, using the theory and methods of synergy. They pointed out that only when the synergy exceeds the dissipation, the medical insurance system can leave the initial state of non-cooperation, gradually overcome the resistance and move to a situation of coordinated development. [6].

2.2 Research Models on Coordinated Development

In the study of commercial health insurance and social medical insurance, scholars have used different models. Jiang Litong (2019) used a spatial Durbin model, and assumed the commonality of Chinese residents in having basic medical insurance, to analyze the relationship between China's basic medical insurance and commercial health insurance. It was found that basic medical insurance has a significant promoting effect on the development of commercial health insurance. [7].

Zhang Xin (2019) constructed a SVAR model using data from 1997 to 2017. The study found a positive impact of commercial health insurance on social medical insurance, and a positive impact of social medical insurance on commercial health insurance. However, this model only used indicators such as commercial health insurance revenue and the number of participants covered by basic medical insurance to measure commercial health insurance and social medical insurance, which lacks generality. [8].

Duan Mingyuan (2020) applied a GVAR model and used two indicators, namely the depth of social medical insurance and the depth of commercial medical insurance, to measure the development levels of both in the Yangtze River Delta region. The study concluded that the development of social medical insurance in Shanghai had a crowding-out effect on commercial medical insurance in the four regions of

the Yangtze River Delta. [9].

Xie Mingming (2020) conducted an investigation using a panel fixed-effects model and a panel threshold model to examine the differences in the relationship between social medical insurance and commercial medical insurance at different income levels. The study found that the development of social medical insurance generally promotes the development of commercial medical insurance, but the relationship between the two is nonlinear and complementary. [10].

Shao Quanquan and Chen Jia (2009), from the perspective of health care reform, selected 31 provinces and conducted regression analysis using DEA efficiency analysis software and EVIEWS software. They concluded that economically developed regions had a good cooperation between social medical insurance and commercial medical insurance, while in economically underdeveloped regions, the competition between the two was more significant. [11].

Based on the comprehensive development of commercial insurance and social insurance in China from 2001 to 2015, Han Ye (2019) constructed a coupling coordination model to analyze regional disparities in coupling coordination from both temporal and spatial dimensions. The study found significant regional differences in coupling coordination. [12].

This paper integrates the above research methods to construct a coupling model of commercial medical insurance and basic medical insurance. It analyzes the overall development in Guangdong Province as well as within its regions (Pearl River Delta, East Wing, West Wing, and mountainous areas). The paper innovatively explores the similarities and differences in the development of industrial coupling coordination.

2.3 Mechanisms of Coordinated Development

Commercial health insurance and social medical insurance are crucial means of safeguarding people's health. Many scholars have conducted in-depth research on how these two can coordinate their development.

Liang Hong(2013) compared the differences between commercial insurance and social insurance in terms of value orientation, institutional mechanisms, and organizational structures. They argued that clarifying the relationship between commercial health insurance and social medical insurance and promoting their complementarity and coordination are key factors in making commercial health insurance an integral part of the social security system. [13].

Cui Yuanyue (2019) suggested that the government should clearly define the boundaries between commercial health insurance and social medical insurance, allowing each to play its respective role. Legislative and policy support should be provided to promote the coordinated development of commercial health insurance and social medical insurance. [14].

He, A.J (2017) concluded, in the context of studying the relationship between public medical insurance and private health insurance in Hong Kong, that government agencies should take appropriate regulatory measures to promote the development of the voluntary insurance market. At the same time, they should ensure the accessibility and fairness of the public medical system to meet the needs of high-risk residents. The government should provide basic medical services to reduce the impact of adverse selection and offer financial assistance to those in need. Furthermore, the government should promote the development of medical technology and reduce medical costs to lower the demand for private health insurance. [15].

Petretto (1999) found that the important role of commercial health insurance lies in establishing a market competition mechanism, which can lower the costs, improve the service level, and enhance the quality of social medical insurance, thereby further promoting the sustainable development of the social medical security system. In practice, many countries have recognized the role of commercial health insurance and have introduced mechanisms of commercial health insurance to further improve the healthcare security system. [16].

Gresenz CR (2019) argued that maintaining the competitiveness of the health insurance market and regulating the market behavior of insurance companies reasonably can promote the coordinated development of social medical insurance and commercial health insurance. This, in turn, enhances the level of medical security and safeguards the health rights and interests of the people. [17].

2.4 Issues in Coordinated Development

As social medical insurance and commercial health insurance are undergoing continuous evolution, a multitude of issues have emerged. The coordination of their development has become a primary area of concern among researchers, who aim to address the challenges at hand.

John C. Goodman's (2004) study shows that nations with government-operated healthcare markets and national health insurance systems often face rising expenses and find it challenging to achieve the aim of universal access to quality services.[18]

There is a significant disparity in the coverage rates between commercial health insurance and social medical insurance. Lv Zhiyong (2013) discovered from a coupling theory's viewpoint that the development of commercial health insurance and social medical insurance in China is in the first stages of coordination, with commercial health insurance falling behind. [3].

Xian Huang (2015) argues that the expansion of social health insurance in China has worsened regional disparities in healthcare rather than alleviating them.[19]

Kang Mengmeng's (2016) findings reveal that the eastern regions in China display higher coupling levels and significantly greater coordination compared to their central and western counterparts. The coordinated development of social medical insurance and commercial health insurance also presents regional discrepancies. [20]

Peng Haoran (2017) discovered a correlation between social and commercial insurance in regions with differing levels of social insurance development. Regions with higher levels of social medical insurance saw an inverted U-shaped pattern in the relationship, rather than a straightforward promotion relationship. [21].

2.5 Significance of Coordinated Development

The integrated advancement of societal medical insurance and commercial health insurance is an indispensable criterion for the reform of the social security system and a resolution to surmount numerous malfunctions in the domain of social security. Guo Yaqin (2016) stated that the current national circumstances in China entail the concomitant advancement of social medical insurance and commercial insurance. Their collaboration is a necessary prerequisite following healthcare system reform.[22].

Zhao Xiuzhe (2007) argued that the coordinated development of commercial medical insurance and social medical insurance is not only beneficial for eliminating imbalances and shortcomings in the development of the commercial insurance industry, but also for improving the comprehensive protection capabilities of medical insurance [23].

Xu Debin (2019) believes that commercial health insurance, by participating in the construction of a multi-tier medical security system, can effectively solve its own imbalance and insufficiency in development. The vigorous development of commercial health insurance is an important reliance and support for the insurance industry to implement the principle of insurance orientation, and is also one of the important development paths for the current transformation and development of the insurance industry. [24].

Xu Chunjing et al. (2019) argued that the existing medical security system suffers from "government failure" and "market failure", and the use of government-purchased service method to promote cooperation between basic medical insurance and commercial insurance is "a choice to overcome various dysfunctions in the field of social security." [25].

Yang Zhengmao (2014) analysed the development of commercial health insurance and social medical insurance in China, and pointed out that the coordinated development of commercial health insurance and social medical insurance is essential for the establishment of an optimal medical security system. [4].

In the context of social health insurance achieving universal coverage, the direction for the coordinated development of the two is to clarify the role of commercial health insurance in the health system, exploit its unique professional advantages and avoid overlap with social insurance.

3. Construction of Coupled Coordination Model

3.1 Construction of model

The term "coupling" comes from physics and refers to the phenomenon where two or more systems interact and influence each other. The coupling model is the degree of coupling coordination model, which includes the degree of coupling and the degree of coupling coordination. It is an important model used to analyse the coordinated development level of things. The degree of coupling refers to the dynamic correlation between two or more systems that interact and influence each other to achieve coordinated development, which can reflect the degree of interdependence and mutual constraints between systems. The degree of coordination represents the degree of beneficial coupling in the coupling interactions, indicating the quality of coordination.

Since the degree of coupling can only describe the strength of interactions between elements and cannot reflect the degree of coordination in development, the concept of degree of coupling coordination is introduced to quantitatively describe the orderly changes in indicators between systems. In other words, by calculating the degree of coupling between systems and then calculating the degree of coupling coordination, we can observe the process by which internal variables within systems move from disorder to order.

In order to explore the coupling relationship between commercial medical insurance and social medical insurance, this study, inspired by the capacity coupling system models in physics, constructs a coupling coordination evaluation model that comprehensively reflects the overall effectiveness and synergy effects of commercial medical insurance and social medical insurance systems. This model is presented as:

$$D = f(C, U1, U2) \quad (1)$$

In equation (1), D represents the degree of coupling coordination between the two systems, C represents the degree of coupling between the two systems:

$$C = f(U1, U2) \quad (2)$$

The range of values for the degree of coupling C is (0, 1). If C is closer to 1, it indicates a higher degree of coupling between the two systems. Conversely, when C is closer to 0, it indicates a lower degree of coupling, suggesting that the two systems are unrelated and do not need to evolve in concert. In equation (2), U1 and U2 represent the overall assessment indices of the two systems:

$$U1 = f(w_i, x_i) \quad (3)$$

$$U2 = f(w_i, y_i) \quad (4)$$

In equations (3) and (4), α_i, β_i are the weights of the i-th indicator of the two systems U1 and U2, respectively, and X_i, Y_i denote the normalized value of the i-th indicator after de-scaling. U1 represents the commercial health insurance system, and U2 represents the social health insurance system. This study uses the entropy method to determine the weights of the subsystem indicators:

$$w_i = f(p_i) \quad (5)$$

In equation (5), P represents the overall evaluation index of the level of coordinated development between commercial health insurance and social health insurance systems. Finally, p_i represents the weight of the i-th index for the subsystem evaluation:

$$P = f(\alpha, \beta) \quad (6)$$

Where α and β represent the weights of the levels of development of the commercial and social health insurance systems, respectively. In this study, both systems emphasise balanced development, so $\alpha = \beta = 0.5$. In practical application, it is preferable to have the interval of P within (0, 1) to ensure that the interval of D also falls within (0, 1).

3.2 Selection of Evaluation Indicators

Insurance depth indicates the depth of development of the insurance industry in a region and serves as a measure of the current level of economic development and the strength of people's insurance awareness. Insurance density reflects the special and important position of the insurance industry in the

overall economic development of an area. We have selected the following indicators to make a comprehensive assessment of commercial medical insurance: insurance depth, insurance density, total premium income, total premium expenditure and health life insurance ratio. For the assessment of social health insurance, the selected indicators are insurance depth, insurance density, income and expenditure of the basic health insurance fund and the basic health insurance coverage rate. These selected indicators are used to construct the coupling model between commercial health insurance and basic medical insurance.

In order to eliminate the influence of different measurement units and scales, the relationships between the two sets of variables are transformed into relationships between dimensionless variables. In this study, we normalise the indicators using an appropriate function to simplify the calculations, as shown in the formula:

$$X_{ij}' = \frac{X_{ij} - X_{\min}}{X_{\max} - X_{\min}} \quad (7)$$

where X_{ij}' is a positive indicator, X_{ij} is the original value of the j-th indicator variable indicator for year i-th. The values obtained after polar standardisation vary between (0, 1).

The entropy method is used to calculate the weights of the indicators for both commercial health insurance and social medical insurance systems. These weights are then used in the formulas to calculate the comprehensive evaluation and coupling coordination degree for commercial medical insurance and social medical insurance in Guangdong Province from 2015 to 2020, as well as in the four subregions of Guangdong Province (Pearl River Delta, Eastern Wing, Western Wing and Mountainous Area).

3.3 Determining the degree of coupling coordination

Based on the related research literature on coupling models, the degree of coupling coordination between two systems can be divided into four intervals:

- If $D \in (0, 0.3)$, it is considered a severe unbalance.
- If $D \in (0.3, 0.5)$, it is considered a mild imbalance.
- If $D \in (0.5, 0.8)$, it is considered a primary coordination.
- If $D \in (0.8, 1.0)$, it is considered an excellent coordination.

Table 1: Levels of Coupling Coordination Degree

Degree of coordinated development	Level of coordination
$0 < D \leq 0.3$	Severe disorder
$0.3 < D \leq 0.5$	Mild dissonance
$0.5 < D \leq 0.8$	Moderate coordination
$0.8 < D \leq 1.0$	Good quality coordination

This table serves as a reference for categorizing the degree of coordination between commercial health insurance and social health insurance on the basis of the calculated D-value.

3.4 Data Processing

We selected data for commercial health insurance and social medical insurance in Guangdong Province from 2015 to 2021, including premium income data, personal insurance income data, GDP data, basic medical insurance fund income and expenditure data, the number of people covered by basic medical insurance, and year-end resident population data. We have also divided Guangdong province into four regions: Pearl River Delta, Eastern Wing, Western Wing and Mountainous Area to calculate the degree of coordination in different regions. Data sources are China Statistical Yearbook and China Banking and Insurance Regulatory Commission, Guangdong Supervision Bureau.

Due to the presence of varying systems which cannot be compared due to their differing scales, it is necessary to apply the principal component analysis technique to convert multiple system indicators into a smaller set of composite indicators. This technique involves "dimensionality reduction" through the

use of principal components, and is a multivariate statistical method. The resulting composite indicator represents the principal component. Principal component analysis involves creating linear combinations of the original variables, which are independent of each other while retaining the main information of the original variables. The aim is to find a comprehensive alternative to related variables through the correlation of the original variables. Principal component analysis has the following characteristics:

- Principal components are linear combinations of the original variables.
- The number of principal components is less than the number of original variables.
- Principal components retain most of the information of the original variables.
- Principal components are independent.

Instead, this paper applies a standardized analysis of the extreme variance of the dimensionless treatment data.

$$X_{ij}' = \frac{X_{ij} - X_{\min}}{X_{\max} - X_{\min}} \quad (8)$$

Where is the X_{ij} positive indicator, X_{ij} is the original value of the j th indicator variable indicator for year i . The values obtained after the standardisation of the polar deviation vary in the range between (0, 1). Thus studying the correlation between two groups of variables translates into studying the correlation between two variables. This normalization process makes the data comparable and suitable for further analysis.

4. Findings and Analysis

4.1 Coordination Analysis in Guangdong

The results of the coordination analysis between commercial health insurance and social medical insurance in Guangdong Province for the years 2015-2021 are presented in Tables 2 and 3 below.

Table 2: Degree of coordination in Guangdong

particular year	U1	U2	coupling degreeC	coupling coherence D	Degree of coupling coordination
2015	-0.3560	-0.3957	0.8933	0.6683	Moderate coordination
2016	0.1717	-0.4286	0.2070	0.3217	Mild dissonance
2017	-0.2072	-0.3436	0.7418	0.6090	Moderate coordination
2018	-0.0991	-0.3239	0.6523	0.5711	Moderate coordination
2019	0.0615	-0.2336	0.6690	0.5784	Moderate coordination
2020	0.2128	0.1785	0.8545	0.6537	Moderate coordination
2021	0.2164	1.5467	1	0.7071	Moderate coordination

Notes: U1 represents the comprehensive evaluation index of commercial medical insurance in Guangdong Province, while U2 represents the comprehensive evaluation index of social medical insurance in Guangdong Province.

From a development perspective (Table 2), there is an overall improvement in the comprehensive development level of both commercial health insurance and social health insurance from 2015 to 2021. This suggests that both systems are becoming more refined and advanced in their development. In terms of variance changes (Table 3), there is a significant upward trend in the comprehensive development level of social medical insurance. The variance of social medical insurance is 0.507, while the variance of commercial medical insurance is 0.051, indicating that although the development level of social

medical insurance is continuously increasing, there are still considerable annual fluctuations. In terms of their coordinated development (Table 2), the average coordination degree between commercial medical insurance and social medical insurance is about 0.7, indicating that there is indeed a coupling relationship between commercial medical insurance and social medical insurance in Guangdong. The degree of coordination between the two systems remains between 0.60 and 0.71. According to Table 1, this is in the range of moderate coordination.

Table 3 Analysis of coupled data in Guangdong Province

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Variance
Commercial health insurance	7	-0.356	0.216	0.0000	0.051
Social medical insurance	7	-0.429	1.547	0.0000	0.507

4.2 Coordination Analysis in Four Major Regions of Guangdong

The results of the coordination analysis between commercial medical insurance and social medical insurance in the four major regions of Guangdong Province for the years 2015-2021 are presented in Tables 4-9 below.

Table 4: Degree of coordination in the Pearl River Delta region

particular year	U1	U2	coupling degree C	coupling coherence D	Degree of coupling coordination
2015	-0.5582	-0.5540	1	0.7071	Moderate coordination
2016	0.1766	-0.4458	0.6319	0.5621	Moderate coordination
2017	-0.3691	-0.2363	0.9926	0.7045	Moderate coordination
2018	-0.2042	-0.0007	0.9960	0.7057	Moderate coordination
2019	0.1348	0.2155	0.9970	0.7060	Moderate coordination
2020	0.2645	0.8945	0.9889	0.7032	Moderate coordination
2021	0.5557	0.1270	0.9347	0.6836	Moderate coordination

Notes: U1 represents the comprehensive evaluation index of commercial medical insurance in the Pearl River Delta region, while U2 represents the comprehensive evaluation index of social medical insurance in the Pearl River Delta region.

Table 5: Degree of coupling and coordination in the East Wing

particular year	U1	U2	coupling degree C	coupling coherence D	Degree of coupling coordination
2015	-0.4507	-0.2447	0.6858	0.5856	Moderate coordination
2016	-0.2344	-0.2135	0.9135	0.6758	Moderate disorders
2017	-0.1537	-0.0412	0.9981	0.7064	Moderate coordination
2018	-0.0458	-0.2463	0.6724	0.5798	Moderate coordination
2019	0.0489	-0.2972	0.2749	0.3708	Mild disorder
2020	0.5307	0.6641	1	0.7071	Moderate coordination
2021	0.3049	0.3789	0.9990	0.7068	Moderate coordination

Notes: U1 represents the comprehensive evaluation index of commercial health insurance in the East Wing, and U2 represents the comprehensive evaluation index of social medical insurance in the East Wing.

Table 6: Degree of coupling and coordination in the West Wing

particular year	U1	U2	coupling degree C	coupling coherence D	Degree of coupling coordination
2015	-0.4547	0.1215	0.2651	0.3641	Mild disorder
2016	-0.2102	-0.1824	0.9989	0.7067	Moderate disorders
2017	-0.1649	-0.0019	0.9872	0.7026	Moderate disorders
2018	-0.0433	-0.5446	0.2893	0.3804	Mild disorder
2019	0.4459	-0.4883	0.4487	0.4738	Mild disorder
2020	0.2702	0.6667	0.9943	0.7051	Moderate coordination
2021	0.1569	0.4291	0.9966	0.7059	Moderate coordination

Notes: U1 represents the comprehensive evaluation index of commercial health insurance in the West Wing, and U2 represents the comprehensive evaluation index of social medical insurance in the West Wing.

Table 7: Degree of coupling and coordination in mountainous areas

particular year	U1	U2	coupling degree C	coupling coherence D	Degree of coupling coordination
2015	-0.4315	-0.0945	0.3177	0.3986	Mild disorder
2016	-0.2091	-0.0854	0.9875	0.7027	Moderate disorders
2017	-0.1122	0.0858	0.9897	0.7035	Moderate coordination
2018	0.1461	-0.4466	0.5954	0.5456	Moderate coordination
2019	0.1922	-0.5260	0.2257	0.3359	Mild disorder
2020	0.3780	0.6296	1	0.7071	Moderate coordination
2021	0.0365	0.4372	0.9840	0.7014	Moderate coordination

Notes :U1 represents the comprehensive evaluation index of commercial health insurance in mountainous areas, and U2 represents the comprehensive evaluation index of social medical insurance in mountainous areas

Table 8: Data analysis of the comprehensive evaluation index for the four major subregions of Guangdong (SPSS calculation results)

	Descriptive Statistics					
		N	Minimum	Maximum	Mean	Variance
Pearl River Delta	U1	7	-0.558	0.556	0.000	0.153
	U2	7	-0.554	0.894	0.000	0.237
East Wing	U1	7	-0.451	0.531	0.000	0.110
	U2	7	-0.297	0.664	0.000	0.140
West Wing	U1	7	-0.455	0.446	0.000	0.096
	U2	7	-0.545	0.667	0.000	0.202
Mountainous	U1	7	-0.431	0.378	0.000	0.074
	U2	7	-0.526	0.630	0.000	0.181

Notes: U1 represents the comprehensive evaluation index of commercial health insurance in mountainous areas, and U2 represents the comprehensive evaluation index of social medical insurance in mountainous areas.

Table 9: Data analysis of coupling coordination degree of the four major sub-regions in Guangdong (SPSS calculation results)

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Variance
pearl River Delta	7	0.562	0.707	0.682	0.003
East Wing	7	0.371	0.707	0.619	0.015
West Wing	7	0.364	0.707	0.577	0.027
Mountainou	7	0.336	0.707	0.585	0.026

From a developmental perspective (Tables 1-7), the overall level of development of both commercial health insurance and social health insurance in the four regions has improved. This indicates that the development of both systems is gradually becoming more sophisticated. However, during the

development process, social health insurance shows greater fluctuations than commercial health insurance, as shown by the higher variance in Table 8. Specifically, in the Pearl River Delta and East Wing regions (Tables 4 and 5), the degree of coupling between commercial health insurance and social medical insurance is relatively high, and the variance of coupling coordination (Table 9) is small. The coupling coordination remains relatively stable in the range (0.6, 0.7). Referring to Table 1, it can be observed that commercial medical insurance and social medical insurance in the Pearl River Delta and East Wing regions are in a state of moderate coordination.

In contrast, the coupling degree between commercial health insurance and social medical insurance displays greater fluctuations in the West Wing and Mountainous regions (Tables 6 and 7), with relatively high variance of coupling coordination (Table 9). The coupling coordination in the West Wing decreased to 0.3804 in 2018, and in 2019, the Mountainous region experienced a decrease to 0.3359. However, the average coupling coordination values for the Western and Hilly regions are 0.577 and 0.585, respectively. This suggests that commercial health insurance and social medical insurance in these regions are adjusting, gradually stabilising towards moderate coordination. Of the four regions, the Western region has the highest variance in coupling coordination, indicating a less stable coordinated development. In contrast, the region of Pearl River Delta exhibits the lowest variance in coupling coordination, indicating a high degree of stability in its development.

Overall, the average coupling coordination degree of each region is between 0.5 and 0.7. As shown in Table 1, the four principal sub-regions are currently in a moderately coupled stage. This suggests that the Guangdong Province's coordinated development model, which incorporates commercial health insurance as a supplement to social health insurance, has been successfully established. Figure 1: Coupling Coordination Degree in Guangdong Province and Its Regions from 2015 to 2020.

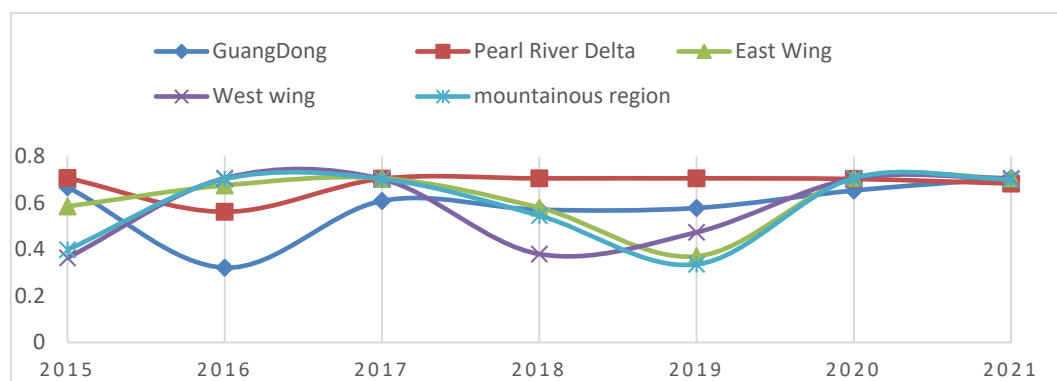


Figure 1: Degree of coupling co-ordination in Guangdong and sub-regions, 2015-2020

Based on Figure 1, the coupling coordination degree between commercial health insurance and social medical insurance in the Pearl River Delta and East Wing regions approaches the average level of Guangdong Province. This suggests a relatively high level of coordinated development. However, the West Wing and Mountainous regions display greater fluctuations in the coupling coordination degree, and it is, on the whole, lower than the average level of Guangdong Province. This indicates that the commercial health insurance and social medical insurance in the Pearl River Delta, East Wing, West Wing, and Mountainous areas of Guangdong Province possess distinct regional characteristics, shaped by factors including regional economic status, geographic location, local policies, culture, and customs.

5. Conclusion and Policy Recommendations

This study analysed the development of coordination between commercial health insurance and social medical insurance in Guangdong Province from 2015 to 2021. The research findings indicate the existence of a coupling relationship between commercial health insurance and social medical insurance in Guangdong Province.

Overall, commercial health insurance and social medical insurance coordination in Guangdong Province has moderately improved but has not reached high-quality coordination. However, both systems are developing in an orderly fashion and are expected to keep improving in the future. On a regional level, there are significant regional differences in coupling coordination among the Pearl River Delta, East Wing, Mountainous, and West Wing regions. The Mountainous and West Wing regions still show mild imbalance, largely due to the instability in the comprehensive development level of commercial health

insurance and social medical insurance.

Based on these findings, the following recommendations are proposed for the coordinated development of commercial health insurance and social medical insurance in Guangdong Province.

Given the contrasting economic foundations and development levels in the Pearl River Delta, East Wing, West Wing, and Mountainous areas that impact the insurance industry's evolution and the degree of emphasis placed on commercial health insurance and social medical insurance in each location, it is necessary to contemplate the various regional aspects, including financial status, geographical position, local policies, culture, and traditions when shaping customised support policies. Specifically, the government ought to offer modest preferential measures to the West Wing and Mountainous regions in order to stimulate the growth of the insurance sector.

6. Limitations and Future Research Directions

6.1 Limitations

Limitations of data sources and samples: This study is based on a sample of insurance data from only four regions in Guangdong Province, namely, the Pearl River Delta, the East Wing, the West Wing, and the Mountainous Region, for empirical analyses, and data from other regions have not been taken into account. Therefore, there is imprecision in the research results.

Limitations of the research method: this study adopts the coupled coordination model in physics for the analysis. Although the model can better explain the coordination relationship between commercial health insurance and social health insurance, its specific application scenarios and practical significance are yet to be further explored.

Limitations of time span: this study only examines the data from 2015-2021, which is a relatively short time span, and a longer time span may be needed to observe the development trend of commercial health insurance and social health insurance in the future.

6.2 Future Research Directions

Policy factors in coordination: Future research can explore the impact of different policies on commercial health insurance and social health insurance. Examining how policy formulation and adjustments affect coordinated development can provide valuable insights into the role of government policy in shaping the insurance landscape.

Integration of commercial health insurance and social health insurance: Coordination between commercial health insurance and social health insurance can evolve into integration. Future research can explore strategies for establishing closer and more effective cooperation mechanisms between these two types of insurance. This could include resource integration, risk-sharing mechanisms and mutual benefit arrangements to improve the overall efficiency of health care.

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