Analysis on the coupling coordination degree between regional economy and old-age service—A case study of Sichuan province

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Abstract. In the past decade, China's aging problem has become increasingly prominent. Properly solving the social problems caused by an aging population bears on the overall interests of development. In this paper the regional economic level and pension service level in 2018 of all cities and prefectures in Sichuan province were calculated by using the coupling coordination degree model to calculate the coupling coordination degree of regional economy and pension service in Sichuan province in 2018. It is found that it is difficult to match the level of regional economy and old-age service in every city and state in Sichuan province. In terms of the level of regional economy, the level of old-age service and the coupling between them, there is no ideal situation in each city or state. Chengdu, which has the highest per capita economic level, has only the ranks middle degree in the whole province in terms of per capita endowment service resources.

1. Introduction
According to the United Nations definition of aging society, China has entered the aging society around 2000. It has entered the stage of rapid development of population aging. The impact of population aging on the society is comprehensive, structural, and long-term. Such impacts include social welfare, health care systems, family structures and living arrangements, etc. Sichuan province has a large elderly population. The level of aging is higher than the national level. By the end of 2018, permanent residents aged 60 or above accounted for 21.13 percent of the total permanent population in Sichuan. Permanent residents aged 65 and above accounted for 14.17% of the total permanent population. Sichuan province has entered a deeply aging society. In addition, the population of senior citizens aged 80 years or above in Sichuan province keeps above 2 million all the year round. They make up about 12% of the elderly population. On the whole, Sichuan province has a large elderly population base and a deep degree of aging, so it faces great challenges in dealing with the social problems brought by aging.

2. Study theory and method
2.1. Coupling theory
In the study of economic and social phenomena, the interaction of two or more subsystems is called coupling. Coupling degree refers to the degree of subsystem interaction, regardless of advantages and disadvantages. The degree of coupling coordination not only requires that each element in the subsystem
can cooperate with each other, but also requires that the interaction among elements is beneficial. Coupling coordination degree is to study the matching effectiveness of each element.

There is an obvious correlation and coordination between the regional economic system and the old-age service system. The regional economic system is the carrier of the development of old-age services. Developed regional economy provides infrastructure support, financial conditions support, stimulate the needs of the elderly care industry, promote the sustainable development of the elderly care industry, etc. The effects of the pension service system on the regional economic system are mainly reflected in the following aspects: creating new growth poles for the regional economy, promoting the optimization and upgrading of regional industrial structure, driving regional employment, and driving the improvement of industrial association.

2.2. The coupling mechanism

In the two sub-systems of regional economy and pension service, the sub-system of regional economy includes three dimensions of economic aggregate, economic structure, and economic quality. The endowment service subsystem includes the endowment infrastructure level, the endowment technology level, and the endowment service level. They interact with each other to form a coupling relationship. The factors are mutually beneficial to form the effectiveness of the coupling coordination between the two systems. (As shown in figure 1)

2.3. Coupling model and improvement

Based on the capacity coupling concept and capacity coupling coefficient model in physics, the interaction coupling degree model C of multi-system is generalized:

$$C = \frac{(U_1 \cdot U_2 \cdot U_3 \cdot \ldots \cdot U_n)^\frac{1}{n}}{\prod(U_i + U_j)}$$

When $n = 2$, the coupling model of regional economy and pension service is obtained. $U_1$ represents the regional economic level index. $U_2$ is an index of the level of services for the aged. $C$ represents the coupling degree of the two. The coupling degree $C \in [0,1]$, the larger the value of $C$ is, the higher the coupling degree of regional economy and old-age service is, and conversely, the lower the coupling degree of the two is. The coupling degree $C$ shows the matching condition between the two, but it has some defects. That is, a high $C$ does not mean that both $U_1$ and $U_2$ are high. There may be cases where both are low. In order to reflect the coupling and coordination level between regional economy and old-age service more objectively and truly, the coupling and coordination degree model $D$ is introduced based on the coupling degree model $C$:

$$D = \sqrt{C \cdot T} \quad \text{Among them} \ T = \alpha U_1 + \beta U_2$$
In the model, D is the degree of coupling coordination, C is the degree of coupling coordination, T is the comprehensive coordination index of regional economy and pension service, $\alpha$ and $\beta$ are undetermined coefficients, Respectively represents the contribution degree of the two systems' cooperative operation. Both were assigned a value of 0.5 in this study. The values of $U_1$, $U_2$, and D are all between 0 and 1. Therefore, data should be standardized when calculating $U_1$ and $U_2$. Range method is used in standardized treatment.

3. Analysis on the coupling coordination degree between regional economy and the development of old-age service

3.1. Regional economic level analysis

There is a great correlation between the elderly care services and the macroeconomic statistical indicators related to the overall degree of economic development, finance, residents' life and other aspects. Taking Sichuan Province as an example, this paper selects a number of indicators from The Sichuan Statistical Yearbook and carries out mean processing. Finally, the following seven indicators are retained, and the analysis were made based on the data 2018.

| Table 1. Correlation matrix. |
|-----------------------------|
| GDP per capita              | Per capita budgetary revenue | Per capita disposable income | Per capita consumption expenditure | Per capita retail sales of consumer goods | Per capita deposit | Per capita household savings |
| GDP per capita              | 1.0000                        | 0.8270                        | 0.8390                          | 0.7650                          | 0.9170                          | 0.7570                          | 0.8290                        |
| Per capita budgetary revenue| 0.8270                        | 1.0000                        | 0.7950                          | 0.6790                          | 0.8380                          | 0.9240                          | 0.7890                        |
| Per capita disposable income| 0.8390                        | 0.7950                        | 1.0000                          | 0.9320                          | 0.9000                          | 0.8020                          | 0.8370                        |
| Per capita consumption expenditure| 0.7650                        | 0.6790                        | 0.9320                          | 1.0000                          | 0.8130                          | 0.7270                          | 0.8450                        |
| Per capita retail sales of consumer goods| 0.9170                        | 0.8230                        | 0.9000                          | 0.8130                          | 1.0000                          | 0.8200                          | 0.8570                        |
| Per capita deposit           | 0.7570                        | 0.9240                        | 0.9020                          | 0.7270                          | 0.8200                          | 1.0000                          | 0.9410                        |
| Per capita household savings| 0.8390                        | 0.7890                        | 0.8870                          | 0.8450                          | 0.8970                          | 0.8410                          | 1.0000                        |

Through the correlation analysis of the 7 groups of index data in 21 cities and states, it can be found that the correlation coefficient between the 7 indexes is generally above 0.8. It can be seen that there is a strong correlation between the pings of the 7 indicators. In order to avoid multicollinearity, principal component analysis is used to reduce dimension in this paper and calculate the regional economic level $U_1$ of each city or state in 2018. The data were imported into SPSS for principal component analysis, and the results were standardized to obtain the regional economic level $U_1$ of all cities and prefectures in Sichuan province in 2018, as shown in Table 2.
Table 2. The 2018 regional economic level indicator U1 of all cities and prefectures in Sichuan.

| Ranking | City/ state | Principal component analysis scores | Standardized treatment result U1 | Ranking | City/ state | Principal component analysis scores | Standardized treatment result U1 |
|---------|-------------|-------------------------------------|----------------------------------|---------|-------------|-------------------------------------|----------------------------------|
| 1       | Chengdu     | 3.49415                             | 1.00                             | 12      | Yaan        | -0.19211                           | 0.21                             |
| 2       | Panzhihua   | 1.27292                             | 0.83                             | 13      | Suining     | -0.20773                           | 0.21                             |
| 3       | Dechang     | 0.86532                             | 0.40                             | 14      | Meijiang    | -0.3954                            | 0.17                             |
| 4       | Mianyang    | 0.41745                             | 0.34                             | 15      | Nanchong    | -0.52022                           | 0.14                             |
| 5       | Meishan     | 0.38211                             | 0.34                             | 16      | Bazhou      | -0.58598                           | 0.15                             |
| 6       | Leshan      | 0.32946                             | 0.32                             | 17      | Ama         | -0.60837                           | 0.15                             |
| 7       | Zigong      | 0.1868                              | 0.28                             | 18      | Guangyuan   | -0.73482                           | 0.10                             |
| 8       | Yibin       | 0.07224                             | 0.27                             | 19      | Liangshan   | -0.3818                            | 0.07                             |
| 9       | Luzhou      | -0.06367                            | 0.24                             | 20      | Bazhong     | -1.13187                           | 0.01                             |
| 10      | Ziyang      | -0.08525                            | 0.24                             | 21      | Gazi        | -1.19441                           | 0.00                             |
| 11      | Guang'an    | -0.56153                            | 0.22                             |          |             |                                     |                                  |

Based on the above analysis results, it can be found that in 2018, the economic level (per capita) of various cities and prefectures in Sichuan varies greatly. There are two main performances: one is the disparity between high and low. Chengdu is far above the level of other cities and states. The second-place city Panzhihua scored only half as high as Chengdu. Most other cities and states are at low levels. Liangshan State, Bazhong, Ganzi lag behind obviously. Second, there is an obvious echelon distribution in the five large intervals. In addition to the Panxi economic zone, the other four regions ranked as the general Chengdu plain > Sichuan south > Sichuan northeast > Northwest. Panzhihua and Liangshan in the same Panxi economic zone rank high and low, with great differences.

3.2. Analysis of endowment service level

Due to the lack of old-age care data in Sichuan Statistical Yearbook, this paper adopts the old-age care data of Sichuan Provincial Civil Affairs Department in 2018. Average treatment to obtain the following six indicators: Number of pension service institutions per 10,000 people aged 65 and over, Number of employees in pension service institutions per 10,000 people aged 65 and over, Number of community pension care institutions and facilities per 10,000 people aged 65 and over, Number of staff in community pension care institutions and facilities per 10,000 people aged 65 and over, Number of community mutual aid endowment facilities per 10,000 people aged 65 and over, Number of staff in community mutual aid pension facilities per 10,000 people aged 65 and over. (The number of the elderly population aged over 65 in each city or state in 2018 was calculated from the number of permanent residents in each city or state in Sichuan Statistical Yearbook at the end of 2018 and the proportion of the elderly population aged over 65 in each city or state in the sample survey data of 1% of the national population in 2015. The results may be skewed against the actual 2018 data.)
Table 3. Indicators of old-age service levels in Sichuan cities and prefectures in 2018 U1.

| Ranking | City/state | Principal component analysis scores | Standardized treatment result U1 | Ranking | City/state | Principal component analysis scores | Standardized treatment result U1 |
|---------|------------|-------------------------------------|----------------------------------|---------|------------|-------------------------------------|----------------------------------|
| 1       | Meishan    | 1.02906                            | 1.00                             | 12      | Guangyuan  | -0.32906                           | 0.23                             |
| 2       | Leshan     | 0.9476                             | 0.90                             | 13      | Yibin      | -0.33180                           | 0.20                             |
| 3       | Panzhihua  | 0.79583                            | 0.67                             | 14      | Yaan       | -0.43409                           | 0.17                             |
| 4       | Deyang     | 0.73720                            | 0.83                             | 15      | Nanchong   | -0.43345                           | 0.16                             |
| 5       | Ziyang     | 0.59283                            | 0.75                             | 16      | Mianyang   | -0.43403                           | 0.14                             |
| 6       | Luzhou     | 0.34049                            | 0.61                             | 17      | Aba        | -0.43508                           | 0.13                             |
| 7       | Bazhong    | 0.19942                            | 0.53                             | 18      | Liangshan  | -0.49798                           | 0.13                             |
| 8       | Chengdu    | 0.19880                            | 0.53                             | 19      | Zigong     | -0.59182                           | 0.08                             |
| 9       | Guangan    | 0.18858                            | 0.52                             | 20      | Suijing    | -0.01588                           | 0.00                             |
| 10      | Daizhou    | 0.04295                            | 0.44                             | 21      | Neijiang   | -0.72770                           | 0.00                             |
| 11      | Ganziz     | -0.01462                           | 0.41                             |          |            |                                     |                                  |

After principal component analysis and standardized processing by SPSS software, U2 was obtained as the 2018 old-age care service level index of all cities and prefectures in Sichuan Province. In terms of per capita endowment service resources, Chengdu is only at the middle level of Sichuan Province. Meishan, Leshan, Panzhihua and Deyang scored higher. Neijiang, Suining, Zigong scored the lowest. On the whole, compared with the regularity of U1 scores in cities and states, there is no obvious regularity in U2 scores.

3.3. Analysis of coupling coordination degree between regional economy and old-age service

The U1 and U2 evaluation results of each city and state were substituted into the calculation formulas of coupling degree C and coupling coordination degree D. It was calculated that the coupling degree and the coupling coordination degree of the regional economy and the old-age care service in each city and prefecture of Sichuan province in 2018. The calculation results are shown below:

Figure 2. Coupling degree and coupling coordination degree of the economy and old-age care services of all cities and prefectures in Sichuan province in 2018.

From the above calculation results, it can be seen that the coupling degree C can reflect the matching degree between the regional economic level of a city and a prefecture and the level of elderly care service, but there are some drawbacks. For example, although the coupling degree of Yibin, Nanchong and Aba
is very high, they are all 1. But all three belong to the “low low high” situation. The regional economic level is not high, and the level of old-age service is not high, but the matching degree of the two is very high. Such a degree of match does not really mean much. However, the value of coupling coordination degree D is related to the regional economic level $U_1$ and the level of pension service $U_2$ itself. In the case of “high”, a higher D value can be obtained, so the coupling coordination degree has more practical significance.

Given that the value range of coupling coordination degree D is $D \in [0,1]$. In order to more accurately judge, based on the existing studies, the coupling coordination degree model is divided into 5 categories and 15 basic types according to the value of D. At the same time, according to the score results of coupling coordination degree of each city and state, the cities and states are classified into these 15 different categories.

| $D$       | Type                                | $U_1$ & $U_2$ | Characteristics                                                                 | City/State                      |
|-----------|-------------------------------------|---------------|---------------------------------------------------------------------------------|---------------------------------|
| $0.8 < D \leq 1$ | Good, coordinated development of the class | $U_1 > U_2$   | Good, coordinated development of the level of old-age care services lag          | Chengdu                         |
|           |                                     | $U_1 = U_2$   | Good, coordinated development of regional economy and the coordinated development of old-age services |                                |
|           |                                     | $U_1 < U_2$   | Good, coordinated development of regional economic level lagging type           | Panzhihua                       |
|           |                                     | $U_1 > U_2$   | The level of moderately coordinated development of old-age services lags       |                                |
| $0.6 < D \leq 0.8$ | Moderate coordinated development | $U_1 = U_2$   | Moderate coordinated development of regional economy and coordinated development of elderly care services |                                |
|           |                                     | $U_1 < U_2$   | Moderate coordinated development type of regional economic level lag            | Meishan                         |
|           |                                     |               | Reluctantly coordinated development of the level of old-age services lag        | Deyang                          |
|           |                                     |               |                                                                                  | Ziyang                          |
|           |                                     |               |                                                                                  | Leshan                          |
|           |                                     |               |                                                                                  | Yaan                            |
| $0.4 < D \leq 0.6$ | Low coordinated development class | $U_1 = U_2$   | Reluctant to coordinate the development of regional economy and pension service collaborative development |                                |
|           |                                     | $U_1 < U_2$   | Reluctantly coordinated development of regional economic level lag type        | Guangan                         |
|           |                                     |               | Moderate maladjustment and decline of old-age service level impaired type      | Dazhou                          |
|           |                                     |               | Moderate maladjustment recession type of regional economy and pension service co-loss type | Nanchong                        |
|           |                                     |               |                                                                                  | Aba                             |
| $0.2 < D \leq 0.4$ | Moderate disorder and decline | $U_1 = U_2$   | Moderate imbalance recession type of regional economic level impaired type     | Guangyuan                       |
|           |                                     | $U_1 < U_2$   |                                                                                  | Liangshan                       |
|           |                                     |               |                                                                                  | Bazhong                         |
|           |                                     |               |                                                                                  | Neijiang                        |
| $0 < D \leq 0.2$ | Severe disorder recession class    | $U_1 = U_2$   | Severe imbalance and decline in the level of old-age services impaired type     | Ganzi                           |
|           |                                     | $U_1 > U_2$   | Severe imbalance recession regional economy and pension services co-loss type |                                |
|           |                                     |               | Severe disorder recession type regional economic level damage type            |                                |

Chengdu and Panzhihua, two cities in the province, have a coupling coordination degree of more than 0.8 and belong to the category of well-coordinated development. But the level of elderly care in
Chengdu lags behind the level of economic development. The level of old-age service in Panzhihua is much higher than the level of economic development. This may also be related to the relatively developed health care industry in Panzhihua. Mianyang, Deyang, Yibin, Luzhou and other cities around the Chengdu economic Zone and the southern Sichuan economic zone are mostly in the moderate coordination category and barely coordination category. Among them, the economic level of Meishan, Deyang and other regions lags the level of old-age service. And Yibin, Mianyang and so on are the opposite. The score of Neijiang and Ganzi was 0 because the range method was adopted to standardize the calculation of $U_1$ and $U_2$ values. It also reflects that Neijiang and Ganzi are lagging behind seriously in terms of old-age service and regional economy respectively.

4. Conclusions

There are gaps in pension services in different cities, so it is difficult to match economic development with old-age development. Through the calculation of coupling degree and coupling coordination degree of the regional economy and the old-age service in Sichuan province, it can be found it is difficult to match the level of pension service with regional economy in each city and state and difficult to realize coupling coordination between them. In terms of regional economic level, pension service level and coupling degree of the two, there is no “high-high-high” ideal in any city or state. Yibin and Nanchong, with the highest coupling degree, belong to the “low-low-high” situation. Chengdu, which has the highest per capita economic level, has only the middle level in terms of per capita endowment service resources in the whole province. Meishan, which has the highest per capita endowment service resources, has average per capita economic performance.

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References

[1] Lester Parrott. Social Work and Social Care [M]. London: Routledge, 2003: 90-92
[2] Thalmann A. Anxiety and depression in the elderly results of a regional examination [J]. Gesundheitswesen, 2012, 74(1): 11-17.
[3] Patrick B. World force characteristics, perceptions, stress, and satisfaction among staff in greenhouse and other nursing house [J]. Health Services Research, 2006, 51:21-38
[4] Sun Jianping et al. Current status of institutional pension models at home and abroad. Chinese Journal of Gerontology, 201104:1264-1266
[5] Yang Lixiong, Yu Zhou. Old-age service Industry: Concept Definition and Theoretical Construction [J]. Huxiang Forum, 2019(01):24-38.
[6] Gu Shengzu et al. Strategic Thinking and Suggestions on Building a Scientific and Reasonable Pension Service System [J]. Population Research,2017(1):3-14
[7] Zhao Wanli, Li Youqun. Research on China's Multiple Endowment Service Models-Based on the Comparative Analysis of Chinese and Foreign endowment Service Models [J]. Journal of Tianjin Normal University (Social Sciences), 2019(2):61-67.