

## The Influence of Regional Intellectual Capital on Regional Economic Development-Evidence from China

Liu Chao, Li Xiao and Xu Lingyu

*Business School Shandong University Weihai, China*  
*liuchao@sdu.edu.cn, 764969501@qq.com, 373840158@qq.com*

### **Abstract**

*The aim of this paper is to examine the relationship between regional intellectual capital and economic performance in China. Using the methods of factor analysis and ridge regression, this paper makes an empirical study on the function of regional intellectual capital (RIC) on regional economic development by evaluating the RIC of 17 cities in Shandong Province in 2012. It is found that RIC and the development of regional economy are positively correlated and regional intellectual capital explains 29.9 percent of the growth of GDP. But there exists some differences in the degree of their contribution to the economic development. In the four elements of intellectual capital, the regional innovation capital and structure capital have larger contribution on regional economic development than relational capital and human capital. And there also exists some differences in the level of RIC in different areas. Based on the results of such research, it will then be possible to recommend appropriate comments and suggestions of promoting balanced development of regional economy through the development of RIC.*

**Keywords:** *regional intellectual capital, regional economic development, Shandong Province*

### **1. Introduction**

In the background of globalization and knowledge economic, intellectual capital is becoming a hot topic of academic research. In China, the study of intellectual capital is still in the emerging stage. Most scholars just study the intellectual capital on firm level, and there are few people to apply the intellectual capital theory into the research of regional economy. In today's world, the development of economic depends more on the production, diffusion and use of intangible knowledge, intelligence, *etc.*, than ever before, and intellectual capital has become an important resource for the development of economic. The competitive advantage within new economies has shifted from material and financial assets to intangible and non-financial assets. In the knowledge economy, the value of countries, regions, organizations and individuals is directly related to their knowledge and intellectual capital<sup>[1]</sup>. In order to promote the sustainable and healthy development of economy and society of China, we must attach great importance to the role of intellectual capital in promoting regional economic development. Since we implement the policy of reform and opening-up, the economic achieves a steady and rapid development. At the same time, we must be clearly aware that the problem of unbalanced developing, coordination and unsustainable is still prominent, mainly is the imbalance of regional economic development. Entered a new stage of development, the task to investment and accelerate the development is arduous for some areas. Furthermore, some areas are limited in space for development and lack of development potential. Therefore, in order to achieve rapid economic development, we must promote the coordinated development of regional economy. The key to achieve the coordinated development of regional economy lies in how to solve the problem of space constraints, resources and change the traditional elements of relying on physical capital resources, environment, *etc.*

Lying the east coast of china, Shandong is one of the representative provinces with repaid growth in economy and trade. In terms of geographical distribution, like China, Shandong province can be divided into eastern, central and western regions. From the perspective of the development of economic, the general level of economic development of middle region is less than east region largely and the general level of west region is less than middle region largely. Therefore, in this paper, taking Shandong Province as an example, we analyze the basis relationship of regional intellectual capital and regional economic development from the perspective of regional intellectual capital. And based on the results of such research, we will recommend some appropriate comments and suggestions of promoting balanced development of regional economy through the development of RIC.

## 2. Literature Review

As a strategic management theory, intellectual capital is of great significance not only at the enterprise level, but also at the national and regional economic level. Amidon (2001) was the first scholar to propose that we should apply the intellectual capital theory into macroeconomic analysis. He sorts out the theory of regional intellectual capital development and opened up a new idea of regional economic research. The intellectual capital of nations is a concept that applies the principles of intellectual capital on a macroeconomic level in such a way that it helps to give direction to future economic development. Bontis (2004) defined the national intellectual capital as containing the hidden values of individuals, enterprises, institutions, communities, and regions that are the current and potential sources for wealth creation. These hidden values are the roots for nourishment and the cultivation of future [2]. Andriessen and Stam (2005) defined intellectual capital is “all intangible resources that are available to an organization that give a relative advantage, and which in combination are able to produce future benefits”. With deeper understanding of the concept of regional intellectual capital, scholars began to quantitative measure intellectual capital from the perspective of empirical [3]. Bontis (2004) paid particular attention to the Arab region’s development of national intellectual capital and he articulated a system of variables (National Intellectual Capital Index) that can help to uncover the invisible wealth of a country. He divided intellectual capital into human capital, structure capital, relationship capital and innovation capital [2]. Andriessen and Stam (2005) applied multidimensional value measurement to valuation of the intellectual capital of 15 European states. They grouped the intellectual capital into human capital, structure capital and relationship capital [3]. Suciu (2006) pointed out that Intellectual Capital of Nations is a concept that applies the principles of intellectual capital measurement and management on a macro-economic level, in such a way that it helps to give direction to future economic developments. In his paper, he pointed out that intellectual capital is the essential root of competitive advantage in the new economics and knowledge-based society and he presented some examples of how to measure, report and monitor intellectual capital.<sup>[4]</sup> Lin and Edvinsson (2008) compared the national intellectual capital of 40 developed countries on the basis of a set of 29 indicators. Findings clarified the status of national intellectual capital of the Nordic countries, thereby providing valuable information for stakeholders and policy makers to formulate effective strategies for building sustainable national competitiveness. They concluded that national intellectual capital represents the foundation of a nation’s competences and capabilities deemed essential for economic growth [5]. Schiuma (2008) provided a knowledge-based understanding of the intellectual capital, highlighting the existence of a positive correlation between intellectual capital and value creation of the Italian regions. But there exists some differences in the degree of the contribution of intellectual capital's components to the value creation [6]. Marcin (2013) presented the concept of intellectual capital (IC) from regional perspective and define intangible assets as knowledge that can be converted into value or profit. He indicated that intellectual capital is the key factor of

socioeconomic development of regions and countries [7]. Seleim and Bontis (2013) examined the relationship between national intellectual capital and economic performance in less developed countries. Their results indicated that national intellectual capital explains 70 percent of the variance in economic performance in developing nations [8].

Chinese scholars' research on regional intellectual capital started relatively late. Chen Yufen (2006) divided RIC into regional human capital, regional structural capital, regional relational capital and regional innovation capital. By constructing the index system, he made an evaluation on the level of RIC of 31 provinces in China [9]. From the theoretical framework of the regional intellectual capital, Li Ping (2006) analyzed the meaning of intellectual capital and national intellectual capital, and introduced the present situation of the theoretical research on national intellectual capital in western countries in detail. Based on the summarizing of the research contents and the basic research methods of the theory of national intellectual capital, he put forward policy suggestions to enhance the research work of national intellectual capital in China [10]. Wang Xiaobin (2009) made a quantitative study on the function of regional intellectual capital on regional economic development by evaluating the regional intellectual capital of 31 provinces in China in 2006. It is found that RIC and the growth rate of regional economy are positively correlated and the correlation coefficient is very high; 1% improvement of regional intellectual capital will bring 0.815% improvement of regional GDP. Such four components as regional human capital, regional relation capital, regional structure capital and regional innovation capital of regional intellectual capital have a notably positive correlation with economic development. But there still exists some differences in the degree of their contribution to the economic development [11]. Chen Wu and Chang Yan (2011) divided RIC into regional human capital, regional structural capital, regional relational capital and constructed a mechanism model of influencing of intellectual capital on regional innovation capability, and analyzes the influences mechanism of these three dimensions of intellectual capital on regional innovation capability separately. And it held that there exist direct and indirect effects of regional intellectual capital on regional innovation capability [12]. Yi Yingying and He Weihong (2012) made an empirical study on the function of regional intellectual capital (RIC) on regional economic development by evaluating the RIC in Jiangsu Province. She found that RIC and the development of regional economy are positively correlated and regional intellectual capital explains 50.1 percent of the growth of GDP [13]. Wang Minghai (2013) divided RIC into human capital, institutional capital and marketing capital. Through SWOT analyzing, he discussed the specific role of intellectual capital in the economic transformation in Beijing [14].

Anyhow, domestic and foreign scholars have made some research on regional intellectual capital and the influence of RIC on regional economic development from different angles, using different measuring methods and different indicators and the sample, the regional intellectual capital and its relationship with regional economic development. Most research results have proved that there is a positive relationship between the regional intellectual capital and economic development. But there exists some differences in the degree of their contribution to the economic development. In summary, the main research can be divided into two categories: (1) Models or frameworks to measure national intellectual capital. As regards the models to measure national intellectual capital, inspired by the navigator of Skandia, it is worth highlighting the proposals by the World Bank (2006), Bontis (2004), Yeh-Yun Lin and Edvinsson (2008) [15]. Composite indices were developed by Andriessen and Stam (2004), Bontis (2004), and Lin and Edvinsson (2008, 2011). These frameworks were based on the Skandia Navigator, which examined intellectual capital through a list of indicators. Several researchers including Hervas-Oliver and Dalmau-Porta (2007) [16], Martins and Viedma (2006) [17] and Schiuma, *et al.*, (2008) [8] extended the organizational perspective by introducing models for measuring regional intellectual

capital. (2) Empirical studies about the influence of regional intellectual capital. In the knowledge economy, the value of countries, regions, organizations and individuals is directly related to their knowledge and intellectual capital (Edvinsson L., Bounfour A., 2004). National intellectual capital represents the foundation of a nation's competences and capabilities deemed essential for economic growth Yeh-Yun and Edvinsson (2008). Through empirical analysis, scholars found that there exists positive association between national intellectual capital and economic performance (Yeh-Yun C, Edvinsson LL, Chen J, Beding T. [18] Phusavat K, Comepa N, Sitko-Lutek A, Boon Ooi K. 2012 [19]. Pulic A. 2005 [20]). Kin (2006) concluded that there is a strong positive association between national intellectual capital and economic growth [21].

The research of regional intellectual capital is of great importance not only on theoretical value, but also in practical significance. Just from the results of the current study, we can find that the majority of the scholars have focused on the national level and regional (provincial) level, but few scholars have conducted research on the city level [21]. In this paper, we designed the index system of evaluating RIC based on the Skandia Navigator, which examined intellectual capital through a list of indicators. On this basis, we made an empirical study on the function of regional intellectual capital (RIC) on regional economic development by evaluating the RIC of 17 cities in Shandong Province in 2012. According to the results of empirical research, I will propose some appropriate comments and suggestions on the development of regional economy in different regions of Shandong Province in the last.

### **3. The Assessment of Regional Intellectual Capital**

#### **3.1 Index System**

Considering domestic and foreign scholars' classification on intellectual capital, we divide regional intellectual capital into human capital, structural capital, relational capital and innovation capital in this paper.

According to OECD (2000), human capital consists of knowledge about facts, laws, and principles in addition to knowledge relating to teamwork, and other specialized and communication skills [22]. Education is the basic building block of human capital [23]. Argyris and Schon (2007) pointed out that the human capital plays an irreplaceable role in the realization of the strategic goals of the development of regional economic. Organizational learning theory asserts that human capital is the origin of all types of knowledge [24]. Therefore, human capital is the core component of intellectual capital because it is the main source of intellect, innovation, and invention.

The second type of national capital, the structural capital, comprises the nonhuman sources of knowledge in a nation like a country's infrastructure, these sources facilitate the creation, accessibility, and dissemination of information [25]. The structural capital reflects the organization's potential ability and function mechanism of polymerizing human resources and creating values.

The third type of national capital, the relational capital, is similar to external relational networking and social capital in a micro setting in that it represents a country's capabilities and successes in providing an attractive and competitive incentive in order to meet the needs of its international clients, while also sharing knowledge with the rest of world [2].

The fourth type of national capital, the innovation capital, is defined as a nation's future intellectual wealth and the capability for innovation that sustains a nation's competitive advantage [26]. The strength of regional innovation capital directly affects the level of regional innovation capacity, and in the modern economic development, regional innovation capability has become a key driver of the growth of regional economic.

According to the research of some scholars, such as Chen Yufen (2006), Wang Xiaobin (2009), considering the data readily available, this paper selects specific indicators system to evaluate RIC shown in Table 1.

**Table 1. Index System of Evaluating Regional Intellectual Capital**

Primary Indicators	Secondary Indicators	Tertiary Indicators
Human Capital H	Education level H <sub>1</sub>	Education budget expenditure to GDP ratio H <sub>11</sub> High school students in the school to total number ratio H <sub>12</sub>
	Medical level H <sub>2</sub>	Number of doctors per capita H <sub>21</sub> Number of beds per capita in medical institutions H <sub>22</sub>
	Social security H <sub>3</sub>	Population participating in pension insurance to total population ratio at the end of the year H <sub>31</sub> Population participating in unemployment insurance to total population ratio at the end of the year H <sub>32</sub> Population participating in basic medical insurance to total population ratio at the end of the year H <sub>33</sub>
Structural Capital S	Industrial Structure S <sub>1</sub>	Percentage of primary industry S <sub>11</sub> Percentage of tertiary industry S <sub>12</sub>
	Government efficiency level S <sub>2</sub>	Public finance budget revenues to GDP ratio S <sub>21</sub> Public finance budget expenditure to GDP ratio S <sub>22</sub>
	Social circulation mechanism and information communication mechanism S <sub>3</sub>	Per capita total passenger S <sub>31</sub>
		Per capita total freight S <sub>32</sub> Per capita total postal and telecommunication services S <sub>33</sub> Per capita number of library S <sub>34</sub>
Relational Capital R	International trade R <sub>1</sub>	Total investment from foreign to GDP ratio R <sub>11</sub> Total import and export to GDP ratio R <sub>12</sub> Total capital FDI contracts used to GDP ratio R <sub>13</sub>
	Domestic trade R <sub>2</sub>	Total retail sales of social consumer goods to GDP ratio R <sub>21</sub> Total deposits from financial institutions to GDP ratio R <sub>22</sub> Total loans from financial institutions to GDP ratio R <sub>23</sub>
	Personnel exchanges R <sub>3</sub>	The proportion of foreign tourists R <sub>31</sub> International tourism receipts to GDP ratio R <sub>32</sub>
Innovation Capital I	Innovation investment I <sub>1</sub>	The expenditure of R&D to GDP ratio I <sub>11</sub> Local Financial Allocation to Local fiscal expenditure ratio I <sub>12</sub>
	Innovation output I <sub>2</sub>	The proportion of patent applications I <sub>21</sub> The proportion of utility model applications I <sub>22</sub> The proportion of appearance design applications I <sub>23</sub>
		Innovators I <sub>3</sub>

### 3.2 Evaluation of the Results

Lying the east coast of china, Shandong is one of the representative provinces with repaid growth in economy and trade. In terms of geographical distribution, like China, Shandong province can be divided into eastern, central and western regions. From the perspective of the development of economic, the general level of economic development of middle region is less than east region largely and the general level of west region is less than middle region largely. Therefore, in this paper, taking Shandong Province as an example, we analyze the basis relationship of regional intellectual capital and regional economic development from the perspective of regional intellectual capital. This paper selects the cross section data of 17 cities in Shandong province in 2012. The data are from "Shandong Statistical Yearbook" and "Shandong Statistical Yearbook of science and technology" in 2013. In this paper, we use the Min-max method to transform the original data.

Formula is as follows:

$$\text{New data} = (\text{raw data} - \text{minimum value}) / (\text{maximum value} - \text{minimum value})$$

Using the above formula to normalize relevant raw data, we can obtain the values of each index in Table 1. And then we use SPSS19.0 to evaluate the regional human capital, regional structural capital, regional relational capital and regional innovation capital respectively.

**3.2.1. The Evaluation of Regional Human Capital:** before we do factor analysis, we need to test the sample data to ensure that they are suitable for factor analysis. The KMO value of regional human capital is 0.727(>0.6), the Bartlett value is 110.882 and the p value is 0.000, which indicates that the data is suitable for factor analysis. The three principal components are 63.809%, 16.944% and 8.516%. The accumulative variance contribution of the first three principal components was 89.270%.

On the analysis, by normalizing the indexes with Statistical Software SPSS19.0, rotating them by the method of varimax, analyzing the component matrix, three components' coefficient vectors were draw.

$$\begin{aligned} a^{(1)} &= (0.412, -0.069, 0.273, 0.456, 0.330, 0.302, -0.050) \\ a^{(2)} &= (-0.924, 0.058, -0.075, -0.371, -0.112, -0.068, 0.437) \\ a^{(3)} &= (-0.021, 0.852, 0.268, 0.008, -0.177, -0.190, 0.103) \end{aligned}$$

Put the normalized value multiply the corresponding coefficient vectors and we can get the scores of three factors. According to the standardized scores of the three main components and their respective weights, we can calculate the composite score of regional human capital.

$$\begin{aligned} F_1 &= 0.412H_{11} - 0.069H_{12} + 0.273H_{21} + 0.456H_{22} + 0.330H_{31} + 0.302H_{32} - 0.050H_{33} \\ F_2 &= -0.924H_{11} + 0.058H_{12} - 0.075H_{21} - 0.371H_{22} - 0.112H_{31} - 0.068H_{32} + 0.437H_{33} \\ F_3 &= -0.021H_{11} + 0.852H_{12} + 0.268H_{21} + 0.008H_{22} - 0.177H_{31} - 0.190H_{32} + 0.103H_{33} \end{aligned}$$

Formula to calculate weights of factors are as follows:

$$F_n = \text{factor variance contribution rate} / \text{the cumulative variance contribution rate} \quad (1)$$

According to (1), we can calculate the weights of F1, F2 and F3 respectively. Each of them accounts for 71.48%, 18.98% and 9.54% of the total variance, respectively. So we can get the scores of regional human capital:

$$F_H = 0.1173H_{11} + 0.0428H_{12} + 0.20647H_{21} + 0.2565H_{22} + 0.1977H_{31} + 0.1846H_{32} + 0.0569H_{33}$$

**3.2.2. The Evaluation of Regional Structural Capital:** The KMO value of regional structural capital is 0.503(<0.6) and the data is not suitable for factor analysis. Use the method of comparative eliminating one by one, after eliminating the index of percentage of tertiary industry, and the KMO value of regional structural capital becomes 0.591. The KMO value is close to 0.6 and the p value is 0.000, which indicates that the data is suitable for factor analysis. The three principal components are 43.134%, 22.060% and 18.554%. The accumulative variance contribution of the first three principal components was 83.747%.

On the analysis, by normalizing the indexes with Statistical Software SPSS19.0, rotating them by the method of varimax, analyzing the component matrix, three components' coefficient vectors were draw.

Put the normalized value multiply the corresponding coefficient vectors and we can get the scores of three factors. According to the standardized scores of the three main components and their respective weights, we can calculate the composite score of regional structural capital.

$$\begin{aligned} F_1 &= -0.049S_{11} + 0.036 - 0.291S_{22} + 0.123S_{31} - 0.220S_{32} + 0.367S_{33} + 0.332S_{34} \\ F_2 &= -0.424S_{11} + 0.018S_{21} + 0.057S_{22} + 0.288S_{31} + 0.558S_{32} - 0.156S_{33} + 0.019S_{34} \\ F_3 &= -0.134S_{11} + 0.708S_{21} + 0.456S_{22} - 0.026S_{31} - 0.059S_{32} + 0.125S_{33} + 0.048S_{34} \end{aligned}$$

According to (1), we can calculate the weights of F1, F2 and F3 respectively. Each of them accounts for 51.51%, 26.34% and 22.15% of the total variance, respectively. So we can get the scores of regional structural capital:

$$F_S = -0.1664S_{11} + 0.1802S_{21} - 0.0340S_{22} + 0.1334S_{31} + 0.0208S_{32} + 0.1758S_{33} + 0.1867S_{34}$$

**3.2.3. The Evaluation of Regional Relational Capital:** The KMO value of regional relational capital is 0.635(>0.6) and the p value is 0.000, which indicate that the data is suitable for factor analysis. The three principal components are 54.784%, 23.302% and 10.660%. The accumulative variance contribution of the first four principal components was 88.746%.

On the analysis, by normalizing the indexes with Statistical Software SPSS19.0, rotating them by the method of varimax, analyzing the component matrix, three components' coefficient vectors were draw.

Put the normalized value multiply the corresponding coefficient vectors and we can get the scores of three factors. According to the standardized scores of the three main components and their respective weights, we can calculate the composite score of regional relational capital.

$$\begin{aligned} F_1 &= 0.197R_{11} + 0.135R_{12} + 0.222R_{13} + 0.098R_{21} - 0.103R_{22} - 0.140R_{23} + 0.306R_{31} + 0.338R_{32} \\ F_2 &= 0.082R_{11} + 0.06R_{12} + 0.041R_{13} - 0.093R_{21} + 0.474R_{22} + 0.535R_{23} - 0.115R_{31} - 0.242R_{32} \\ F_3 &= -0.016R_{11} - 0.406R_{12} + 0.008R_{13} + 0.858R_{21} + 0.008R_{22} - 0.161R_{23} + 0.151R_{31} \\ &\quad + 0.177R_{32} \end{aligned}$$

According to (1), we can calculate the weights of F1, F2 and F3 respectively. Each of them accounts for 61.73%, 26.26% and 12.01% of the total variance, respectively. So we can get the scores of regional relational capital:

$$F_R = 0.1583R_{11} + 0.0759R_{12} + 0.1714R_{13} + 0.1276R_{21} + 0.0094R_{22} - 0.0209R_{23} + 0.2176R_{31} + 0.2207R_{32}$$

**3.2.4. The Evaluation of Regional Innovation Capital:** The KMO value of regional innovation capital is 0.692(>0.6) and the p value is 0.000, which indicate that the data is suitable for factor analysis. The accumulative variance contribution of the first four principal components was 91.500%.

On the analysis, by normalizing the indexes with Statistical Software SPSS19.0, rotating them by the method of varimax, analyzing the component matrix, three components' coefficient vectors were draw.

Put the normalized value multiply the corresponding coefficient vectors and we can get the scores of three factors. According to the standardized scores of the three main components and their respective weights, we can calculate the composite score of regional innovation capital.

$$\begin{aligned} F_1 &= 0.107I_{11} - 0.369I_{12} + 0.487I_{21} + 0.668I_{22} - 0.286I_{23} + 0.107I_{31} \\ F_2 &= 0.63I_{11} + 0.551I_{12} - 0.193I_{21} - 0.074I_{22} - 0.213I_{23} + 0.139I_{31} \\ F_3 &= -0.515I_{11} + 0.237I_{12} - 0.015I_{21} - 0.428I_{22} + 1.08I_{23} + 0.181I_{31} \end{aligned}$$

According to (1), we can calculate the weights of F1, F2 and F3 respectively. Each of them accounts for 73.72%, 17.89% and 8.39% of the total variance, respectively. So we can get the scores of regional innovation capital:

$$F_I = 0.1481I_{11} - 0.1535I_{12} + 0.3229I_{21} + 0.4434I_{22} - 0.1585I_{23} + 0.1192I_{31}$$

So we can get the formulas of regional human capital, regional structural capital, regional relational capital and regional innovation capital. The formulas are as follows:

$$\begin{aligned} F_H &= 0.1173H_{11} + 0.0428H_{12} + 0.20647H_{21} + 0.2565H_{22} + 0.1977H_{31} + 0.1846H_{32} + 0.0569H_{33} \\ F_S &= -0.1664S_{11} + 0.1802S_{21} - 0.0340S_{22} + 0.1334S_{31} + 0.0208S_{32} + 0.1758S_{33} + 0.1867S_{34} \\ F_R &= 0.1583R_{11} + 0.0759R_{12} + 0.1714R_{13} + 0.1276R_{21} + 0.0094R_{22} - 0.0209R_{23} + 0.2176R_{31} + 0.2207R_{32} \\ F_I &= 0.1481I_{11} - 0.1535I_{12} + 0.3229I_{21} + 0.4434I_{22} - 0.1585I_{23} + 0.1192I_{31} \end{aligned}$$

According to the above formulas, we can calculate the scores of the four elements of RIC in 2012. According to Chen Yufen (2006), we add the scores of regional human capital, regional structural capital, regional relational capital and regional innovation capital as the composite scores of regional intellectual capital. The scores are shown in Table 2.

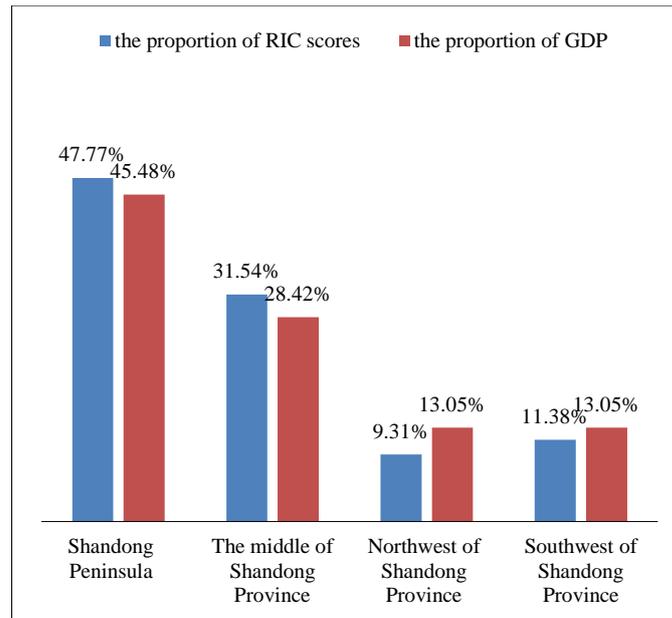
From the results of Table 2, we can find that the level of regional human capital, regional structural capital, regional relational capital and regional innovation capital are totally different in different areas in 2012. There exists great difference in the level of different compositions of intellectual capital in the 17 cities. In terms of regional human capital, Weihai, Qingdao and Jinan stay ahead, but the levels of Heze, Liaocheng and Dezhou are relatively lower than the average. In terms of regional structural capital, the levels of Qingdao, Yantai and Zibo are relatively higher, while the levels of Dezhou, Taian and Liaocheng are relatively lower than the average. In terms of regional relational capital, Weihai, Qingdao and Yantai stay ahead, but the levels of Binzhou, Zaozhuang and Dongying are relatively lower than the average. In terms of regional innovation

capital, Jinan, Qingdao and Yantai stay ahead, but the levels of Rizhao, Laiwu and Weihai are relatively lower than the average.

From the composite score, we can find that there exists great difference in the level of regional intellectual capital in the 17 cities. Scores that ranked the top five are Qingdao, Jinan, Yantai, Weihai and Weifang and the sum of their intellectual capital scores accounts for more than half of the total score in Shandong Province. The cities of Yantai, Weihai and Qingdao that are located in Jiaodong Peninsula scored more than one-third of the total score in Shandong Province. The intellectual capital score of Qingdao that is ranked the first place is 2.556497, which is 6 times more than the last place-Dezhou, whose score is 0.38156.

**Table 2. The Scores Of Regional Intellectual Capital in 2012**

	H	S	R	I	Composite Scores	Rank
Jinan	0.767936	0.267452	0.419713	0.711415	2.166516	2
Qingdao	0.787111	0.326555	0.781112	0.661719	2.556497	1
Zibo	0.69584	0.274445	0.219648	0.051048	1.240981	6
Zaozhuang	0.278418	0.198801	0.093776	0.03359	0.604585	14
Dongying	0.474186	0.213447	0.047514	0.148423	0.88357	11
Yantai	0.7646	0.303009	0.461402	0.282419	1.81143	3
Weifang	0.540659	0.191469	0.36871	0.267472	1.368309	5
Jining	0.440969	0.165757	0.320126	0.151985	1.078838	7
Taian	0.366828	0.119148	0.281796	0.225539	0.993312	8
Weihai	0.819551	0.244321	0.501387	-0.0083	1.556964	4
Rizhao	0.232988	0.119448	0.454537	-0.00289	0.804084	12
Laiwu	0.539128	0.176327	0.20958	-0.00308	0.921951	10
Linyi	0.16313	0.133843	0.249042	0.061235	0.60725	13
Dezhou	0.120973	0.099585	0.13237	0.028632	0.38156	17
Liaocheng	0.116366	0.068836	0.192619	0.05837	0.436191	16
Binzhou	0.47224	0.188545	0.093792	0.176994	0.93157	9
Heze	0.139227	0.130041	0.173772	0.01246	0.455501	15
Average	0.454126	0.189472	0.29417	0.168061	1.10583	-



**Figure 1. The Proportion of Regional Intellectual Capital Scores and GDP**

Learning from the research of Liu Fang(2013) [27], we divide Shandong province into Shandong Peninsula (Qingdao, Yantai, Weihai, Weifang, Rizhao, Dongying), the middle of Shandong Province (Jinan, Tai'an, Zibo, Laiwu, Linyi), Northwest of Shandong Province (Liaocheng, Dezhou, Binzhou) and Southwest of Shandong Province (Heze and Jining, Zaozhuang). From Figure 1, we can find that the proportions of Shandong Peninsula, the middle of Shandong Province, Northwest of Shandong Province and Southwest of Shandong Province are 47.77%, 31.54%, 9.31% and 11.38% respectively, and the proportion of Peninsula accounts for half of the total score of Shandong Province. The GDP of Shandong Peninsula, the middle of Shandong Province, Northwest of Shandong Province and Southwest of Shandong Province in 2012 are 2.328702 trillion yuan, 1.455211 trillion yuan, 668.149 billion yuan, 667.964 billion yuan, and the proportions are 45.48%, 28.42%, 13.05%, 13.05%. The proportions of GDP and intellectual capital score are roughly same. In addition, from Figure 1, we can clearly find that the proportion of intellectual capital is lower than GDP in Northwestern region, which indicates that the regional intellectual capital does not match the region's economic strength and economic development depends on traditional material resources mainly. In the peninsula, the proportion of intellectual capital is relatively high and economic growth is more dependent on intangible assets such as the diffusion and use intellectual capital.

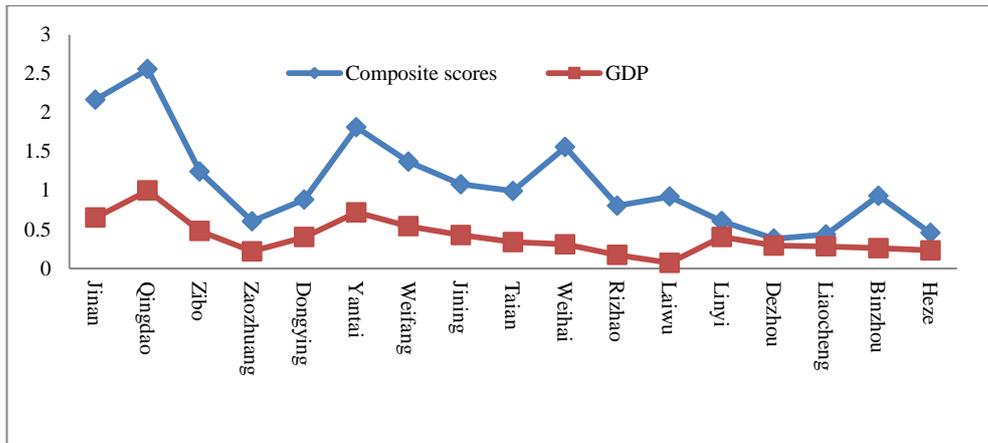
#### **4. The Impact of Regional Intellectual Capital on Regional Economic Development**

In this section, we analyze the relationship between the composite score of regional intellectual capital and the level of GDP in Shandong Province. On this basis, we put the four elements of intellectual capital into the regression model and analysis the differences in the degree of their contribution to the economic development.

##### **4.1 Correlation Analysis of Regional Intellectual Capital and Regional Economy**

Putting the composite score of intellectual capital and GDP into the same piece of scatter, we can get the line chart between regional intellectual capital scores and GDP. It

can be seen from Figure 2, the trends of composite score of intellectual capital is consistent with the trends of GDP.



**Figure 2. Regional Intellectual Capital Scores and GDP**

In order to have an accurate understanding of the relationship between the level of intellectual capital and economic growth, we do correlation analysis about these two variables. The correlation coefficient was 0.835 \*\* (\*\* indicates significant correlation at the 0.01 level), which indicates that there is a significant positive correlation between intellectual capital and GDP. To further analyze the relationship between them, we use SPSS19.0 software to do regression analysis between intellectual capital and GDP. To make  $Y = \text{GDP}$ ,  $X = \text{composite score of intellectual capital}$ , we find that  $R^2$  of the model is 0.697, F value is 34.449 and p value is 0.000, so we can believe that the model as a whole is significant.

The regression results are as follows:

$$y = 0.060 + 0.307x$$

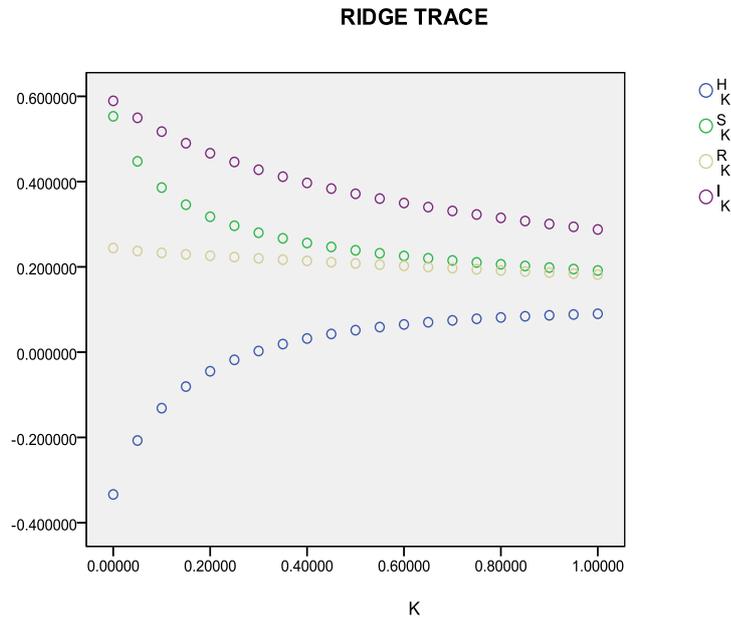
From the above equation, we can say that RIC and the development of regional economy are positively correlated and regional intellectual capital explains 30.7 percent of the growth of GDP. From the result, we can conclude that the raise of the level of regional intellectual capital can promote the development of regional economic. And our theoretical analysis can be verified from the result.

#### 4.2 Regression Analysis of Four Elements of Regional Intellectual Capital and The Regional Economic

To put the four elements of intellectual capital into the regression model, we find that  $R^2$  of the model is 0.843, F value is 16.090 and p value is less than 0.001, so we can believe that the model as a whole is significant.

Due to the presence of multicollinearity between the four elements of intellectual capital, the coefficient of regional human capital and regional relational capital at the 10% significance level are not significant, so we hold that the model is not effective. In order to ensure the application of the model in practice, we use ridge regression methods to eliminate the independent variable multicollinearity problem. Ridge regression is a widely used biased estimation technique applicable in the presence of multicollinearity [28]. The problem of multivariate regression in this paper can be resolved by ridge regression analysis, as there are multiple collinearity among the independent variables. Using SPSS19.0 software to analysis, we can get the ridge trace diagram under different K values and ridge regression coefficients (Figure 3). As shown in Figure 3, when  $k=0.8$ , the regression coefficient of each variable stabilized, and the standardized regression equation is as follows:

$$Y = 0.0814H + 0.2061S + 0.1916R + 0.3150I$$



**Figure 3. Ridge Trace**

Through the above empirical analysis, we can draw the following conclusions:

(1) By making correlation analysis of regional intellectual capital and regional economy, we find that RIC and the development of regional economy are positively correlated and regional intellectual capital explains 30.7 percent of the growth of GDP.

(2) By making regression analysis of the four elements of intellectual capital and the regional economic, we find that there exists some differences in the degree of their contribution to the economic development. In the four elements of intellectual capital, the regional innovation capital and structure capital have larger contribution on regional economic development in Shandong Province than relational capital and human capital. Combined with the current actual situation of Shandong Province, we can see that adjustment of industrial structure in Shandong Province has made substantial progress and innovative construction has made a substantial breakthrough since the "Eleventh Five-Year Plan" was proposed, but the level of opening up in Shandong Province is still not high and the task to protect and improve the livelihood is still arduous. In the future, while ensuring the smooth development of the structural capital and innovation capital, we should increase the input of human capital and relational capital.

(3) Through analyzing the regional intellectual capital scores of 17 cities in Shandong Province, we can see that there exists great difference in the level of RIC in different areas. The level of RIC in Peninsula is significantly higher than in the middle of Shandong Province, Northwest of Shandong Province and Southwest of Shandong Province. The difference is proportional to the level of economic development, so that the conclusion can be explained from the side the level of RIC is one of the main cause of the imbalance in regional economic development.

## 5. Policy Recommendations

Regional Intellectual Capital is a comprehensive index and it's the result of economic, political, educational, scientific, cultural and other factors to coordinate and couple<sup>[29]</sup>.

Therefore, in order to enhance the level of regional intellectual capital of a region, we must proceed from regional human capital, regional structural capital and regional relational capital and regional innovation capital, etc.. By measuring and analyzing the scores of the different compositions of regional intellectual capital in different areas in 2012, we can discover the strengths and weaknesses of regional intellectual capital in different areas. According to the advantages and disadvantages in different regions, we can put up with appropriate policy recommendations to promote the development of regional intellectual capital. On the basis, the areas can enhance the competitiveness in the economic development.

According to the results of the empirical analysis above, considering the advantages and disadvantages of different areas, we propose the following policy recommendations in connection with different compositions of regional intellectual capital:

(1) Improve the level of human capital, strengthen technological innovation and focus on nurturing human capital. Human capital plays an irreplaceable role in the realization of the strategic goals of the development of regional economic and is the core component of intellectual capital because it is the main source of intellect, innovation, and invention. We can say that regional human capital is one of the most crucial factors which have impact on regional development, so it's critical to improve the level of regional human capital. Through the above analysis we can find that the level of medical care has a greater impact on the level of human capital in Shandong Province. The lower level of health care is still a big problem in Shandong province. The government of Shandong provincial should increase the investment in health care, personnel training, health education and infrastructure construction to completely solve the people's problems which is difficult and expensive to see a doctor. At the same time, education and social security issues should not be ignored. The unbalance of the educational development is an ignorable factor causing the unbalance between the urban and rural economic development. Education is the foundation of a nation and social security is strategies to protect people's livelihood. In addition, we only analyze the data in 2012, so the final result indicates that the impact of regional human capital on GDP is not significant. It is worthwhile to continue to explore in the future.

(2) Improve regional structure capital, optimize the various institutional, institutional arrangements, improve infrastructure and create a favorable environment for the development of regional structure capital. From the above analysis, we can find that the regional structure capital has great influence on the development of economic. On one hand, the government should strengthen management capacity for the economic and social society and increase communication between different cities and provinces to create a harmonious and efficient society. August 2013, the government of Shandong province proposed to open intercity bus and intercity rail between Jinan and Laiwu to form cooperation areas. Both the two cities will achieve common development in the following five areas, transportation, communications, household, public services and the allocation of resources. There is no doubt that it is a strong measure to improve the structure capital of Shandong Province. On the other hand, the government should improve government efficiency. More effective government will deliver security, basic services, development and employment.

(3) Increase the investment of regional relational capital and strengthen the positive effect of relational capital on regional economic development. From the above analysis, we can find that the indicator of personnel exchange has a great effect on the level of regional structural capital. In addition, international trade and foreign direct investment are also necessary for further stage of economic growth. The government should execute more active opening-up strategy, expand new open fields and space to promote reform and opening development. In recent years, foreign investment plays a positive role in relieving employment pressure and increasing employment opportunities in Shandong Province. Foreign direct investment has been a great power that we can't neglect for the development

of Shandong economy. Since 1984, Shandong Province had a long improvement and a fast development in making use of foreign direct investment. So Shandong Province should promote foreign trade for the sake of sustainable economic growth. But at the same time, we should also see that the distribution of foreign investment is very uneven, which increases the economic gap between the eastern and western regions to some extent. In the future, the government should develop appropriate incentives to guide the flow of foreign investment to promote coordinated and healthy development of the regional economy.

(4) Attach great importance to the role of innovation capital on regional economic development and make it the inexhaustible motive force for sustained economic and social development. In recent years, scientific and technological achievements and innovative talents have increased a lot in Shandong Province, but there still exists many problems in general. As an agricultural and population large province, how to enhance its economic power through the construction of regional innovation ability has become an anxious problem to solve. Just as we can see from the above analysis, the regional innovation capital has largest contribution on regional economic development in Shandong Province in the four indicators. The government should take the scientific and technological progress and innovation as accelerating the transformation of the mode of economic development. By improving the level of education modernization, enhancing the ability of independent innovation, strengthening the innovation talented person troop, promoting the development of science and technology progress, we can quickly achieve the goal to build an innovative province. In the year of 2010, the government of Shandong Province officially launched the high-tech industry innovation action plan, which fully demonstrated the "innovation-driven" strategy of Shandong Province. The plan pointed out that from the year of 2010 to 2012, we should cultivate ten strategic high-tech industries to seize the initiative and the high ground in the next round of economic development. On the basis, we should try our best to achieve the goal of becoming an innovative province.

(5) Narrow the gap of intellectual capital in different regions gradually and promote regional coordination and common development steadily. As we can see from the results of the empirical analysis, Shandong is a province whose regional intellectual capital development is unbalanced. And there exists great difference in the development of different compositions of regional intellectual capital in different areas. There is no doubt that the unbalanced regional intellectual capital will do some damage to the sustainable development of the economic in Shandong Province. Therefore, there is an urgent need to promote the balanced development of RIC in Shandong Province. In order to promote the balanced development of RIC, the government should have an overall development plans to achieve complementary advantages in different regions. According to their actual conditions, each region should select direction and leading industries to accelerate development of competitive industries in accordance with the requirements of industrial policy. There is a bidirectional and interaction relationship between the development of Shandong economy and overall development both urban and rural. In the context of this new era, creating a peninsula blue economic zone and a yellow economic zone has become a major strategy to promote Shandong economic development. It is a great measure to realize the coordinated development of the economy of Shandong Province, balance promotion of regional economy and lessen regional differences. Sustainable development of national economy is possible only by enhancing balanced development through coordinate cooperation between government and market.

## **Acknowledgements**

This paper is supported by Shandong Education Reform Project (A study on the Management Model and Quality Evaluation of College Enterprising Education in Shandong Province, No. 2012158), Shandong Social Science Project (The influence of Regional Intellectual Capital on Regional Economic Development-Evidence from

Shandong Province, No. 10DJGJ04) and School Education Reform Project (The course design about ERP sand Table simulation training based on the cultivation of entrepreneurship ability, No. A201307).

## References

- [1] E. Leif and B. Measuring Business Excellence, vol. 1, no. 8, (2004).
- [2] B. Nick, Journal of Intellectual Capital, vol. 5, (2004).
- [3] A. Daniel and S. Christiaan, "Intellectual Capital of the European Union", Paper for the 7th McMaster World Congress on the Management of Intellectual Capital and Innovation, (2005).
- [4] S. Christina, International Conference on Business Excellence, (2006).
- [5] Y. Y. C. Lin and E. Leif, Journal of Intellectual Capital, vol. 9, (2008).
- [6] S. Giovanni, L. Antonio and C. Daniela, Journal of Intellectual Capital, vol. 9, (2008).
- [7] M. Kozak. Procedia Economics and Finance, (2013).
- [8] S. Ahmed and B. Nick, Research Article, vol. 20,(2013).
- [9] Y. F. Chen, Statistical Research, (2006).
- [10] P. Li, Chongqing Technology Business University, vol. 16, (2006).
- [11] X. B. Wang, W. Chen and X. J. Wang, The Journal of Quantitative & Technology Economics, (2009).
- [12] W. Chen and Y. Chang. technical and economic, vol. 7, no. 30, (2011).
- [13] Y. Y. Yi and W. H. He, Commercial Times, (2012).
- [14] M. H. Wang, The Journal of Central Party School, (2013).
- [15] V. R. L. Ruiz, D. N. Pena and J. L. A. Navarro, editors, "A Model to Measure Intellectual Capital Efficiency at National Level: Comparison, Results and Relationships", Proceedings of the 2<sup>nd</sup> European Conference on Intellectual Capital, (2010), Portugal.
- [16] J. L. Hervás-Oliver and J. I. Dalmau-Porta, Journal of Intellectual Capital, vol. 3, no. 8, (2007).
- [17] Martins B, Viedma JM. Journal of Knowledge Management, vol. 5, no. 10, (2006).
- [18] C. Yeh-Yun, L. L. Edvisson, J. Chen and T. Beding, New York, (2013).
- [19] K. Phusavat, N. Comepa, A. Sitko-Lutek and O. K. Boon, Industrial Management & Data Systems, vol. 6, no. 112, (2012).
- [20] A. Pulic, "Value creation efficiency at national and regional levels: case study-Croatia and the European Union", In Intellectual Capital for Communities, (2005), Elsevier, Oxford.
- [21] S. J. Kim, Y. C. Yoon, B. H. Kim, L. By and H. J. Kang, International Journal of Business and Information, vol. 1, no. 1, (2006).
- [22] "OECD", International science and technology co-operation: towards sustainable development, Proceedings of the OECD Seoul Conference, (2010), Paris.
- [23] A. Daniel and S. Christiaan, Editors, "Intellectual Capital of the European Union 2008", Proceedings of the European Conference on Intellectual Capital, (2009) April 28-29, Holland.
- [24] A. Chris and S. Donald, Bloomsbury Business Library-Management Library, (2007).
- [25] Y. Y. C. Lin and E. Leif, Electronic Journal of Knowledge Managemen, vol. 8, (2010).
- [26] F. G. Su, Modern Management Science, (2011).
- [27] F. Liu, Journal of Linyi University, vol. 6, no. 35, (2013).
- [28] R. Zhang, Communications in Statistics: Theory & Methods, vol. 7, no. 34, (2005).
- [29] H.Y. Pu and H. Chen. Industrial Technology & Economy, vol. 9, no. 29, (2010).