Innovation in China: Evidence From the Provincial Data

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China has made remarkable gains in industrialization and development. In the last years, in order to ensure the sustainability of its economic and social development, China gave more importance to the innovativeness of business enterprises. In the domestic arena, the sustainability of the growth model that China has followed over the past decades has been criticized because of its excessive reliance on capital and resources as opposed to knowledge and innovation. In 2006, that transformation has been at the centre of the government's "scientific development strategy". Today, in fact, innovation and promotion of entrepreneurship are essential conditions for competitiveness of firms and nations, for the long-term growth and, therefore, for the economy as a whole. This paper investigates the level of potential innovation reached in China in 2008 through a disaggregated analysis, evaluating the production capacity of the Chinese provinces. "Innovation" has been widely studied by economic literature, specially with reference to the output. In this paper, we will refer to the European Innovation Scoreboard (EIS) index, to measure the progress of innovation, which represents the skill to innovate of a territory, but not the achieved innovation. First, we will propose some methodological changes of this method, that allows to obtained a ranking, in order to better understand the results reached by the Chinese provinces; Then we will test a different methodology in order to measure the level of potential innovation overcoming the limits of current practice—from a composite index obtained through a mean of disaggregated indices to multivariate analysis.

Keywords: development, innovation, multivariate analysis

The Notion of Innovation

China has become one of major attraction for R&D facilities due to its rich endowment of low-cost and well-trained scientists and engineers as well as its fast growing domestic market and burgeoning foreign investment in manufacturing. The growth in both domestic and foreign investment in R&D implies that China will improve its position in global economic and technological competition.

In fact, it is a shared opinion (Schumpeter, 1942; Aghion & Howitt, 1992) that the innovation of a given country plays a key role on its level of economic development.

Innovation and promotion of entrepreneurship are essential conditions for the competitiveness of firms and nations, for the long-term growth and, therefore, for the economy as a whole.

Innovation has been defined in many ways (Levitt, 1963; Pearson, 1988; Drucker, 1998; Hamel & Prahalad, 1994). In its basic meaning, it refers not only to new products and procedures, to a different organizational model,

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to an unusual marketing strategy—that not necessarily involve sophisticated technology or to investment in R&D, but also to other not easily identifiable variables (Reichstein & Salter, 2006; Becheikh, Landry, & Amara, 2006; Birkinshaw & Mol, 2006).

According to Frascati Manual (2002), innovation activity can be defined like "all the scientific, technological, organisational, financial and commercial steps, including investments in new knowledge which actually, or are not intended to, lead to implementation of technologically new or improved products and processes".

R&D is only one of these activities and may be carried out at different phases of the innovation processes. It may act not only as original source of inventive ideal but also as a means of problem solving which can be called upon at any point up to implementation.

The analysis of innovation processes has developed two main models of interpretation of this phenomenon: the linear and the chain model. The linear model assumes that innovation proceeds sequentially through the stages of basic research, applied research, development, and development of the manufacturing process, production and marketing. The model "chain"—the most frequently used in innovative processes—differs from the linear model for the role that the perception of the potential market has in the innovation process. Once identified the potential market, the innovation process starts, focusing on design. Innovation is thus no novelty in absolute terms, but an original recombination exists (Perani & Sirilli, 2008).

The topic "innovation" has been widely studied by economic literature, both in general terms and with reference to China (Yifei Sun, Von Zedtwitz, & Simon, 2007; Schaaper, 2009). In the last case, the analyses were always carried out with reference to the output.

Instead, in 2001, European Commission has devised the "European Innovation Scoreboard" (EIS) index[1], to measure the progress of innovation, that is to say the skill to innovate of a territory, but not the achieved innovation. The potential innovation is the capacity to develop and advance further. This potential is proportional with the country's available intellectual assets including all public goods and intellectual properties (e.g., the number of patent applications reflects well a country's intentions to improve and develop). A country's innovation potential also depends on the material and financial resources provided for these purposes, which corresponds with the size of the GDP.

The EIS analyzes the national performance in several sectors using many indicators collected into five categories. On these bases, R&D is only one requirement for an effective innovation policy. Innovators also need the expertise, funding and market opportunities to turn ideas into reality.

EIS identifies five dimensions of innovation, providing an accurate picture of the balances and imbalances of innovation system: (1) "innovation drivers" measure the structural conditions necessary to carry out the innovative potential; (2) "creation of knowledge" is the result of investments in R&D; (3) "innovation and entrepreneurship" evaluates the initiatives of individual enterprises for innovation; (4) "applications" analyzes the results in working and business activities of innovative companies; and (5) "intellectual property" measures the use of innovation by companies.

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[1] The European Innovation Scoreboard (EIS) is the instrument developed at the initiative of the European Commission, under the Lisbon Strategy, to provide a comparative assessment of the innovation performance of EU Member States. The EIS provides an annual assessment of innovation performance across the EU and other leading innovative nations.

Innovation Policy in China

The origin of the Chinese innovation system can be traced back to the 1978s when reform of the science and technology (S&T) system was included in the broader agenda of economic reforms.

Beyond this step, OECD (2007) has defined three other main phases marked by the strategic National S&T Conferences (1985, 1995 and 2006), where strategy decisions were taken.

The reform of S&T policy has taken an incremental approach, characterized by a progressively deeper understanding of policies, systemic transformation and institutional innovation.

The 1978 conference started the process of S&T reform. It defined the productive roles of science and technology and of intellectuals in economic growth by discarding the earlier doctrine that viewed science and technology and intellectuals as "non-productive" and "non-proletariat" forces. The years until 1984 were marked by bottom-up experiments aimed at freeing the energy and potential of research community. An unanticipated institutional innovation of the period was the creation of spin-offs from the public research organizations (PROs) to commercialize research results and bridge the gap between research and industry by taking advantage of the economic freedom created by the reform. University reform initially focused on the promotion of basic research and the establishment of graduate programmes. However, R&D institutions and direct institutional funding mechanisms of the pre-reform period changed little. Policy learning was predominantly based on analysis, "self-criticism" and "learning by doing" through the implementation of reform experiments.

Following the government's decision to reform the economic system, institutional reform of the S&T system was launched in 1985. The primary goal was to overcome the separation of R&D from industrial activity, the key shortcoming of the pre-reform S&T system.

This reform gradually enhanced the economic orientation of the S&T system by introducing elements of competition and market discipline. Major institutional innovations have included the establishment of a variety of government R&D programmes, the emergence of markets for technology and of non-governmental technology enterprises. The increased reliance of public research organizations on non-governmental funding, and a growing share of R&D funded and performed by the enterprise sector were also among the main achievements of the period.

Against the background of the emerging global knowledge economy, and in the face of global technology based on competition, the Chinese leadership adopted in 1995 the "revitalising the nation through science and education strategy", which initiated a new phase of S&T reform and policy. The strategy was inspired by concerns over China's future competitiveness in the global knowledge economy following the decision to join the World Trade Organization (WTO). In the following decade, S&T policies focused on engineering and implementing a systemic shift from the PRO-centred R&D system to an enterprise-centred innovation system, while fostering firms' innovation capabilities and commercialization of technology. The institutional innovations included further R&D funding programmes, on the one hand, and intensified reform of PROs, on the other hand, as in the Knowledge Innovation Programme of the Chinese Academy of Science (CAS). During this phase, China paid increasing attention to learning from advanced OECD countries, as senior policy makers and analysts became familiar with the leading innovation policy concepts. The official adoption of an enterprise-centred technology innovation system is a result of this phase of policy learning. However, experience has proved that to improve the innovation capability of Chinese firms and to make firms the centre of technology innovation is much more a

challenging task than the adoption of a new conceptual framework. The government still faces the challenge of appropriately balancing the new market-based approaches to innovation and direct government support through national R&D programmes. These remain the two most important challenges today. The 2006 National Science and Innovation Conference and the adoption of the Medium- to Long-Term Strategic Plan for the Development of Science and Technology are the most recent phase in the construction of the national innovation system. It will be supported by new and enhanced S&T policies and measures. The S&T Strategic Plan (2006-2020), which is part of the government's effort to shift China's current growth model to a more sustainable one, seeks to make innovation the driver of future economic growth, and emphasizes the building up of an indigenous innovation capability.

The 2006 S&T program (Zhang, Zhihua, Mako, & Seward, 2009) established an innovation strategy for the next 15 years consisting of four pillars: (1) "indigenous innovation" (increasing domestic innovation capacity); (2) a "leap-forward in key areas" (concentrating resources to achieve breakthrough in priority areas); (3) "sustaining development" (meeting the most urgent demands of economic and social development); and (4) "setting the stage for the future" (getting prepared for future development with a long-term vision) (Zhang et al., 2009).

Accomplishing this task will require some fundamental reorientation and increasingly sophisticated policy and governance. The main challenges involve a change from an uncoordinated, piecemeal style of S&T policy making to a co-ordinated whole-of-government policy approach, from policies targeted at promoting R&D activities to policies for creating an innovation—friendly framework, and from one-size-fits-all policy measures to fine-tuned and differentiated policy measures tailored to delivering more sophisticated support for policy needs. These changes imply that the government will embark on a steep learning curve and that in some areas drastic institutional innovations will be called for.

It is a challenging task to characterise the current state of the rapidly evolving Chinese innovation system in terms of its structure, performance, integration into global S&T networks and potential for future development, not least because it involves international comparison and benchmarking.

All that means that innovation has been highly considered by the top leadership and adopted as a national strategy.

Potential Innovation Scoreboard

The Chinese innovation system is too large and complex to be summarised by a single model, and the regional dimension should not be overlooked. Beyond some broad common features, the system includes several regional systems characterised by different development levels and dynamics. Over the past two decades, regional initiatives have played an important role in shaping the new S&T landscape.

Therefore, through disaggregated analysis, we have analyzed the level of potential innovation reached in China in 2008 (22 provinces, 5 autonomous regions, 4 municipalities and 2 special administrative regions), comparing the results after the reform with the ex ante situation.

In other words, we have studied the ability of each Chinese province to develop its production capacity and to create innovation, compared to the national average.

For this study, the EIS method has been adapted on China features. Particularly, changes on EIS calculation method have been done in consideration of China "scientific development strategy", the availability of data[2] and on the bases of some methodological observation.

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[2] The EIS index measures also the dynamics of innovation performance over time: in this paper we doesn't refer to this problem.

Our analysis, carried out on a large scale (China), as well as at a greater level of detail (provincial), shows the differences between the several Chinese provinces.

In order to verify the potentiality of a country that allows us to assess the weight of various determinants of development, treating China as a single aggregate appears ineffective, while readable results can be obtained by taking provincial areas.

Then, Chinese territory has been reviewed by considering the multiplicity of possible determinants of innovation as variables, in order to verify the role that have assumed in the increase of the gap in terms of attractiveness of the investments.

The study area covers the 28 Chinese provinces, and the three municipalities: the data used make reference of 2008[3].

We have defined a battery of 31 variables (see Table 1) [4], chosen between those considered more correlated to the represented phenomenon, taking into account the indications of EIS methodology.

The assessment is based on a wide range of indicators covering structural conditions, knowledge creation, innovation at the firm level, throughputs and outputs in terms of new products and services.

The innovation indicators are grouped over 5 different innovation dimensions and 3 major groups of dimensions:

• The group of "Enablers" includes the main drivers of innovation that are external to the firm and is divided into a "Human resources" and a "Finance and support" dimensions, capturing in total 13 indicators;

• "Firm activities" include innovation efforts that firms undertake recognising the fundamental importance of firms' activities in the innovation process. This group captures the entrepreneurial efforts and the related collaboration efforts among innovating firms and also the public sector through the "Throughputs", capturing a.o. the Intellectual Property Rights (IPR) generated as a throughput in the innovation process. This group includes 12 indicators in total;

• "Outputs" include the outputs of firm activities and are divided into 2 dimensions using 6 indicators. "Innovators" capture the success of innovation by transaction value in technical market; "Economic effects" capture the economic success of innovate on in employment, exports and sales due to innovation activities.

The EIS methodology is summarized below (European Commission, 2009):

Step 1: Transforming data: Data are transformed using a square root transformation.

Step 2: Identifying outliers: These outliers are not included in determining the Maximum and Minimum scores in the normalization process.

Step 3: Determining maximum and minimum scores: The maximum score is the highest relative score found for the whole time period within the group of core China provinces excluding positive outliers. Similarly, the minimum score is the lowest relative score found for the whole time period within the group of core China provinces excluding negative outliers and "small" countries.

Step 4: Calculating re-scaled scores: Re-scaled scores of the relative scores for all years are calculated by first subtracting the minimum score and then dividing by the difference between the maximum and minimum

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[3] We are aware the Beijing presence has effect on the overall, but we decided not to delete this municipality because, in our opinion, it represents an emblematic situation of innovation policy. Moreover, the problem it was solved by defining dimensional data.

[4] The data are taken from the "National Bureau of Statistics of China".

score. The maximum re-scaled score is thus equal to 1 and the minimum re-scaled score is equal to 0.

Table 1

Variables by Regions (2008)

	Dimension/Indicators	Unit
Enablers		
	Human resources	
1.1.1	Number of entrant students in Specialized Courses in Institutions of Higher Education	% 15-64
1.1.2	Number of enrollment students in Specialized Courses in Institutions of Higher Education	% 15-64
1.1.3	Number of graduates with diplomas or degree specialized	% 15-64
1.1.4	Number of degree conferred in Institutions of Higher Education	% 15-64
1.1.5	Number of students per 100,000 population for higher education	% 15-64
	Finance and support	
1.2.1	Governmnet appropiation for education	(% of GDP)
1.2.2	Funds from social organization and Citizens for running schools	(% of GDP)
1.2.3	Donations and Fund-raising for running schools	(% of GDP)
1.2.4	Income from teaching research and other auxiliary activity	(% of GDP)
1.2.5	Other educational funds	(% of GDP)
1.2.6	Government expenditure S&T	(% of GDP)
1.2.7	Government expenditure R&D	(% of GDP)
1.2.8	Local government S&T appropriation	(% of GDP)
Firm activities		
	Throughputs	
2.2.1	Patents application accepted	(% million popolation)
2.2.2	Accepted inventions	(% million popolation)
2.2.3	Accepted utility models	(% million popolation)
2.2.4	Accepted design	(% million popolation)
2.2.5	Patents application granted	(% million popolation)
2.2.6	Granted inventions	(% million popolation)
2.2.7	Granted utility models	(% million popolation)
2.2.8	Granted design	(% million popolation)
2.2.9	Rate of products with excellent quality	(% of total)
2.2.10	Rate of products with first grade quality	(% of total)
2.2.11	Rate of products with qualified quality	(% of total)
2.2.12	Rate of loss due to bad quality	(% of total)
Output		
	Innovators	
3.1.1	Transaction value in technical market	(% of GDP)
	Economic effects	
3.2.1	Number of staff and workers at year-end by manufacturing sector	(% of total workeforce)
3.2.2	Number of staff and workers at year-end by scientific research sector	(% of total workeforce)
3.2.3	Number of staff and workers at year-end by education sector	(% of total workeforce)
3.2.4	R&D personnel	(% of total workeforce)
3.2.5	National imports and exports of high-tech products by region	(% total export)

Step 5: Calculating composite innovation indexes: For each year and for each innovation dimension (human resources, finance and support, throughputs, innovators, economic effects) a dimension composite innovation

index (DCII) is calculated as the unweighted average of the re-scaled scores for all indicators within the respective dimension. For each year and for each block of dimensions (enablers, firm activities, outputs) a block composite innovation index (BCII) is calculated as the unweighted average of the re-scaled scores for all indicators within the respective block.

Since its introduction in 2000, the EIS has been both welcomed as a relevant tool for innovation benchmarking but has also been criticized (Frietsch, 2005; Grupp & Mogee, 2004; Peters, Sandra, & Christian, 2007; Rammer, 2005; Sajeva et al., 2005; Schibany et al., 2007; Schibany & Streicher, 2008; Schubert, 2006) for not capturing all relevant dimensions of the innovation process, for using improper indicators, for not taking into account structural differences between countries and for its methodology of summarizing countries' innovation performance by using composite indicators (Cherchye et al., 2004; Grupp, 2006).

According to these considerations, our analysis, carried out by EIS methodology, also presents results that appear unconvincing (e.g., the membership of Beijing in the second cluster).

We have found several problems in the application of the methodology.

First, in a complex system such as China, with enormous territorial, social and economic differences, the assumption of applying the Chauvenet criterion reneges. Instead, the latter alters the rankings among the provinces.

The choice to eliminate the positive and negative outliners seems questionable, since the best practices are considered like errors.

Furthermore, among the various issues, we criticize the choice to repeatedly normalize data: standardization, in fact, may alter their informative content (Rostirolla, 1997).

The following analysis will show that different methods of normalization bring to different rankings.

Table 2 presents the results of a test carried out following three different procedures: we started from the application of the method in accordance to the original formulation (column A), in the other procedures the potential innovation index is calculated with some differences to EIS method.

In case B, we have proceeded to the normalization of the elementary variables[5], by putting some of them, for example, in relation to the workforce in the interested area (obtaining the variables expressed as percentage of staff on the workforce), some others in relation to the population (obtaining for example the number of occupied as percentage of population) and others in relation to the regional GDP (e.g., incidence of the transaction high tech value on the Gross Domestic Product).

The index is planned not normalizing further the data and by maintaining all cases.

Case C presents the results of the analysis without eliminating the upper and lower values of three times the average (as required for EIS method).

In both cases, for each province, the columns show the geographical area, the value obtained, and cluster membership (obtained as division of achieved values in four group—quartiles value).

Comparing all the methods, the results show that the type of normalization changes the ranking of the provinces (different colours define different ranking). Moreover, even the alternative elimination breeds spurious results because it does not allow reading the important causes of duality among the Chinese provinces.

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[5] Because as absolute data, related to areas of various dimension, do not allow some comparisons among various considered areas.

Table 2
Composite Innovation Index Using Different Procedures

Area	Province	(1) Value EIS	Group 1	(2) Value EIS without exclusion outliners	Group 2	(3)Value new procedure	Group 3
C	Shanghai	0.705	1	0.493	1	0.601	1
C	Guangdong	0.411	1	0.294	1	0.454	1
C	Jiangsu	0.432	1	0.324	1	0.451	1
C	Zhejiang	0.442	1	0.,357	1	0.441	1
N	Tianjin	0.557	1	0.437	1	0.371	1
O	Shaanxi	0.408	1	0.308	1	0.367	2
S	Chongqing	0.369	1	0.28	2	0.353	2
S-E	Hubei	0.396	1	0.3	1	0.324	1
N	Beijing	0.345	2	0.648	1	0.439	1
C	Fujian	0.354	2	0.277	2	0.409	1
S	Sichuan	0.338	2	0.239	2	0.408	1
C	Shandong	0.338	2	0.261	2	0.356	2
S	Gansu	0.3241	2	0.222	3	0.32	2
S-E	Jiangxi	0.348	2	0.283	2	0.318	2
S-E	Anhui	0.326	2	0.25	3	0.313	2
S-E	Hunan	0.329	2	0.243	3	0.308	2
S-E	Liaoning	0.312	3	0.199	4	0.331	2
N-E	Jilin	0.322	3	0.238	3	0.304	3
N-E	Heilongjiang	0.32	3	0.229	3	0.301	3
N	Hebei	0.279	3	0.218	3	0.294	3
O	Ningxia	0.284	3	0.214	3	0.278	4
N	Shanxi	0.29	3	0.221	3	0.267	4
S-E	Hainan	0.277	3	0.209	4	0.242	3
S	Guizhou	0.272	4	0.207	2	0.325	3
S	Yunnan	0.266	4	0.186	4	0.323	2
S-E	Henan	0.271	4	0.2058	4	0.306	3
S	Tibet	0.164	4	0.191	4	0.273	4
O	Qinghai	0.26	4	0.17	4	0.271	4
S	Guangxi	0.199	4	0.142	4	0.27	4
O	Xinjiang	0.25	4	0.178	4	0.252	4
N	Inner Mongolia	0.237	4	0.175	4	0.251	4

Besides, among several problems, we agree with other authors who criticize the assumption that the use of a single composite indicator and ranking table leads to "naming and shaming" (Grupp, 2006), while missing the complexity of the process behind one simple number (e.g., Cherchye et al., 2004).

Without considering the merits of the importance of rank among the provinces that offers few interpretations, even if we refer to our procedure—we found other problems which result from the use of a univariate procedure. In fact the only result achieved through the use of this index is a ranking that has many interpretations. The division made according to quartiles values leads to a breakdown of this type.

- Shanghai, Guangdong, Jiangsu, Zhejiang, Beijing, Fujian, Sichuan, Tianjin are the innovation leaders, with the best innovation performance. Of these countries, Shanghai well above that of the China average and all other countries;

- Shaanxi Shandong, Chongqing, Liaoning, Guizhou, Hubei, Yunnan, Gansu, are the innovation followers, with innovation performance below those of the innovation leaders. Shaanxi, Shandong and Chongqing have an innovation performance above that of the China average;

- Jiangxi, Anhui, Hunan, Henan, Jilin, Heilongjiang and Hebei are the Moderate innovators, with innovation performance below the EU average;

- Ningxia, Tibet, Qinghai, Guangxi, Shanxi, Xinjiang, Inner Mongolia and Hainan are the Catching-up countries with innovation performance well below the China average.

In fact, if we compare two provinces, Beijing and Gansu, which present similar values in the aggregate index, and we decompose the results by examining the 5 different dimensions of innovation (human resources, finance and support, throughputs, innovators and economic effect), we can show strong differences.

Figure 1 shows the impact of 5 different dimensions of innovation for each province.

In particular, Beijing differs from Gansu for the "throughputs" and "human resources", with better results, but also for the value of "innovators" and "economic effects", where it reaches lower values.

Gansu's "finance and support" value is in accordance with the re-balance policies promoted by the Chinese Government since 1978. In fact, there is also a strong tendency of the government to encourage economically disadvantaged areas[6].
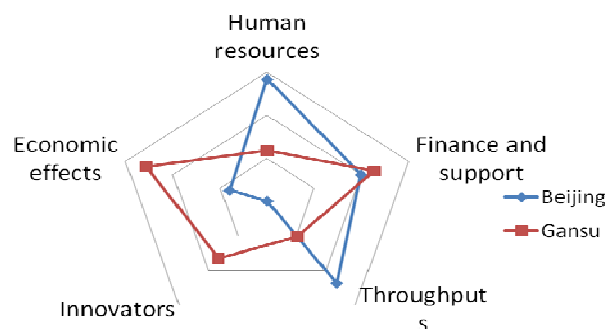

Figure 1. Comparison between the disaggregated results for the different innovation dimensions in the provinces of Beijing and Gansu.

Cluster Analysis

In order to show the potential innovation of the Chinese provinces and to give some economic policy clues, it is necessary to better interpret the available data, while considering a single index that summarizes all the collected information through a simple average, which flattens all the differences that appear ineffective.

First, it is essential to switch from an aggregate index to disaggregate indices that take into account the different aspects of the problem; Second, to overcome the limitations of univariate analysis through the use of exploratory techniques of multivariate analysis.

Methodologically, we use multidimensional statistical techniques (in particular, principal component analysis and cluster analysis), through which it was possible to make a reading of a large amount of descriptive data of all possible aspects that are relevant for the analysis.

Readable results can be obtained by taking homogeneous areas, and it must not be built on the basis of

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[6] Chongqing is part of the "go west policy".

aprioristic joints, but through a combination of several indicators, with the support of statistical techniques of multivariate analysis.

In fact, the employed technique defines the characterizing elements of the innovation structure of the Chinese provinces and reads the main peculiarities.

The objective of this analysis phase is to capture the major features about the potential innovation of the provinces taken into account, in order to read the needs and the main potential, which can be translated into any "key ideas" for development.

Factorial analysis generated two latent variables, linear combinations of original variables, able to succinctly explain the behavior of this system, in order to highlight the interdependencies between the original variables and the role assumed by the provinces through correlation with the factorial axes.

The most important structural variable, described in Figure 1, explains 35.16% of total information and is represented by axis 1 horizontal plane. In particular, it is positively correlated with the variables expressing the economic aspects in terms of both researches funding and generating economic effects; negatively to the throughputs.
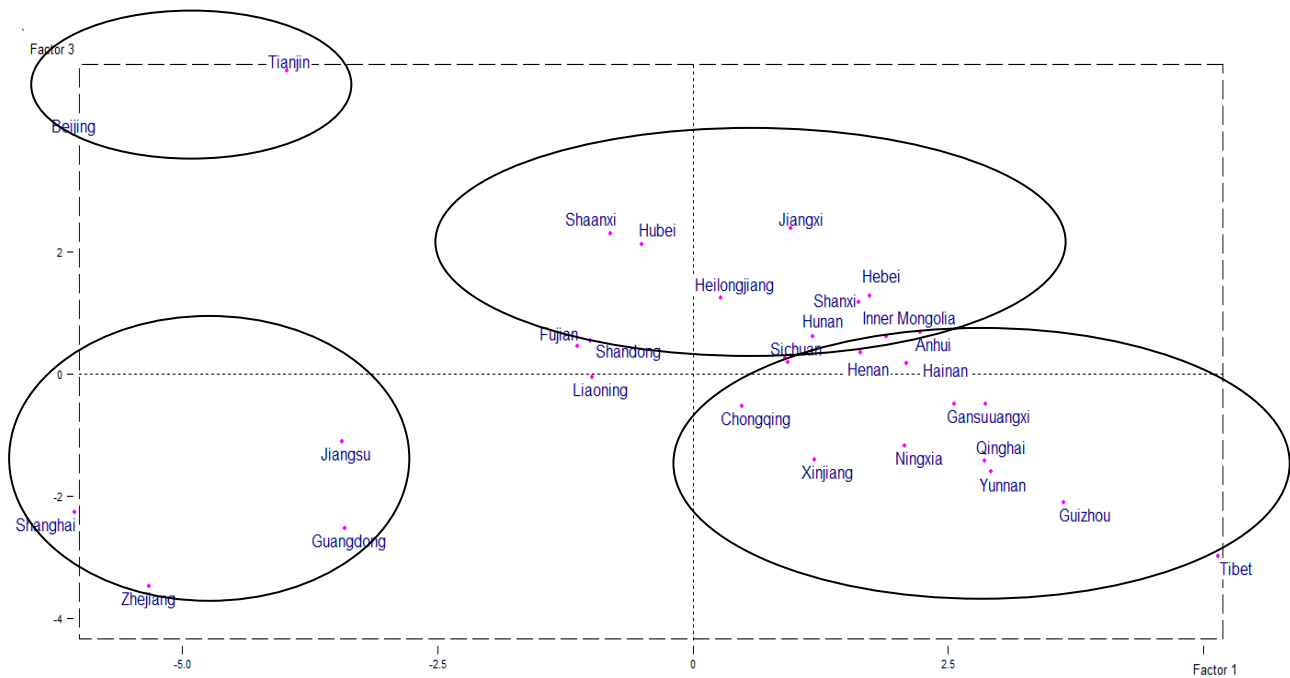

Figure 2. Representation of the main factorial axes and cluster composition.

The second latent variable is described by the vertical axis of the chart and explains 12.29% of the information. It is positively correlated with variables representing the availability of human resources and negatively correlated with the productive capacity of the provinces.

Once defined the factorial axes, it is useful to employ a technique (cluster analysis) that allows us to obtain the location of the group of provinces that are characterized by the same distinctive elements and that, therefore, have interior homogeneous characteristics that are possibly the most heterogeneous between the groups.

Therefore, a homogeneous class will be described as a combination of characters that constitute an

informative base to use like support in order to employ the existing resources at best.

The reclassification established four homogeneous classes of provinces[7]. In summation, it is possible to understand the main differences between:

- The first class, consisting of the coastal provinces (Zhejiang, Guangdong, Jiangsu, Shanghai), shows good rates of production capacity and financing;

- The second class is formed by Beijing and Tianjin. They present high levels of human resources. In fact, Beijing and Tianjin concentrate on the lion's share of basic research in public institutes but may not have an industrial base able to commercialise the results;

- The third class, consisting of the South and West Provinces (Ningxia, Gansu, Yunnan, Guizhou, Guangxi, Tibet, Xinjiang, Qinghai, Chongqing), presents a good financial performance but with low production capacity and staff;

- The fourth class (Hebei, Henan, Jilin, Heilongjiang, Anhui, Hubei, Hunan, Inner Mongolia, Shanxi, Shandong, Sichuan, Fujian, Hainan, Jiangxi, Liaoning, Shaanxi) presents either lack of financial support or throughputs.

Conclusion

This research started from the requirements to examine the level of the potential of innovation reached in China in order to review the differences between provinces.

Therefore, we agreed to use the EIS index, widely used in Europe, but then we realized that it is an inadequate instrument.

We started from the application of the method in accordance to the original formulation, and then, we made various adjustments to the original method in order to proceed with its correct application.

In particular, the criticisms advanced by us include:

- The elimination of alternatives that have outliers;

- The choice of normalizing the data several times;

- The procedure for calculating the composite innovation index as the unweighted average of the re-scaled scores for all indicators within the respective block.

As we considered questionable the relevance about the ranking of the provinces, which doesn't offer any relevant information, we interpreted the same phenomenon through the multivariate analysis. That methodology allowed for a more reliable reading of the phenomenon in question, obtaining interpretations in order to operate and utilize the potential of the investigated areas.

In this sense, China was analyzed through the principal component method and cluster analysis, which allowed us to interpret the phenomenon establishing homogeneous classes, which have been described by a linear combination of common variables.

In each province, we had this main result: Chinese provinces still have a low innovation level, except for few cases, as the coastal provinces that are not only technologically advanced but also have the strongest economy. In fact, in these provinces, there is a connection between foreign investments, transport infrastructures and potential

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[7] The used data are the same utilized for the aggregate index.

tax incentives (Arbolino, 2008). With reference to this topic, we are currently improving this phase of analysis.

Significant disparities exist among the Chinese provinces in terms of R&D intensity and innovation performance, and a clear group of top performers far surpasses the others. In general, provinces and municipalities with provincial status on the east coast are more innovative than the provinces in the central and western parts of China. Regional levels of innovativeness are highly correlated with their GDP per capita and their contribution to high-technology exports, but less with their shares in national R&D expenditures.

Moreover, countries differ in their state of economic development and in their industrial patterns of specialization. Not all countries need to invest so heavily in innovation as some of the innovation leaders do, other strategies for improving economic well-being might be more realistic for those countries, e.g., by relying on productivity improvements driven by increases in more traditional production factors. Differences in industrial structure may validate the calculation of industry-adjusted indicators and differences between countries may imply using different indicator weights for different groups of countries.

In order to obtain results, national authorities must assume a leadership to promote innovation and identify the strategic areas in which operate.

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