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The impact of internet on Chinese national innovation system

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ABSTRACT

National Innovation System(NIS) is the key to promote innovation capability of a country, and Internet changed ways of storing, obtaining and using knowledge, thereby affecting NIS profoundly. But few literatures analyzed the effect of Internet on NIS empirically. In order to fill up this gap, employing the mothed of grey incidence analysis, this paper investigated the impact of Internet on the whole Chinese NIS as well as main institutions constituted NIS . The empirical result based data of China indicated that: 1) innovation intensity, innovation performance and knowledge transfer have been promoted with Internet development on the whole NIS level; 2)Internet has more influence on innovation performance of research institutes and universities, and more influence on knowledge transfer of firms; 3)the impact of Internet quality are more than Internet penetration. The result of this paper has important theoretical significance to understand the relationship between Internet and NIS, and beneficial enlightenment for policy maker.

Keywords: Internet Penetration; Internet Quality; NIS; Grey Incidence Analysis

INTRODUCTION

Since the end of last century, Internet developed rapidly in China. In 1997, the number of people using Internet in China was 620000, and by the end of June in 2013, this number increased to 591 million, among which the people in the countryside accounted for 27.9%, the total number of domain-name also reached 14.7million.

Internet has influenced many aspects of society, especially changed ways of storing, obtaining and using knowledge. The configuration and flow of knowledge is the key of National Innovation System(NIS). Therefore, Internet is an infrastructure for NIS. According to the experience of developed countries, the developing period of Internet is also the time for innovation. In other words, there is a positive acceleration of the development of Internet to NIS.

For China, improving the efficiency of NIS is important to pursue innovation-driven development. Besides increasing the input of resources and optimizing the structure of NIS, building the infrastructure for innovation is also important. Some lectures analyzed the impact of informatization on Chinese NIS theoretically[1][2], but few of them focused on the Internet and provided empirical evidence. In order to fill this gap, this paper investigated the impact of Internet on Chinese NIS, employing the mothed of grey incidence analysis.

This paper proceeds by a discussion of theoretical background about Internet development and NIS. Then, in section three, variables and research method is briefly presented, while section four presents the empirical result and conclusions offered in the last section.

2. Theoretical Background

"An innovation system is constituted by actors and elements which interact in the production, diffusion and the use of economically useful knowledge"[3]. The configuration and flow of knowledge is the key of NIS. Essentially, Internet changed the way of configuration and flow of knowledge, then influence on innovations intensity,

knowledge transfer and performance of NIS.

First, Internet could increase innovation intensity. In this paper, innovations intensity refers to the quantities of innovation. Innovation is "a process where knowledgeable and creative people and organizations frame problems and select, integrate, and augment information to create understandings and answers"[4]. So, more information and knowledge institutions have, more possibility institutions carry out innovation[5]. Using Internet could help institutions to obtain information and knowledge with low cost and high speed, and the quantities of innovations will increase.

Second, Internet contribute to knowledge transfer. Text or product entity are main forms for codified knowledge. And in the age of the Internet, electronic documents and pictures are more likely to be searched and transferred, speeding up the transmission of codified knowledge[6]. For tacit knowledge, face to face communication is key. All kinds of instant communication technology produced relying on the network makes the communication is no longer hindered by space distance, and the efficiency is greatly increased.

Thirdly, the development of Internet promoted the performance of innovation. On the one hand, the development of the Internet effectively reduced the cost of knowledge transfer, storage and processing, promoted the efficiency of innovation[7]. More importantly, with the development of Internet, many modes and tools of innovation management appeared, making the whole innovation system more efficient[8]. And the same time, the development of Internet stimulated many new business models and the development of technical service industry[9][10], this promotion of efficiency is not only directly reflected in the production of technical knowledge, also reflected in the economic performance of NIS.

3. Data and Method

3.1 Variables and Data

There are two features of Internet development in China(Figure 1). On one hand, the number of Internet user increased substantially; on the other hand, main ways of accessing Internet changed from dial-up to broadband, which has aster speed and higher stability. This paper used two variables to represent the development level of Internet: Internet penetration and Internet quality. Internet penetration was measured by proportions of the populations using the Internet, and Internet quality was measured by broadband subscribers of Internet.

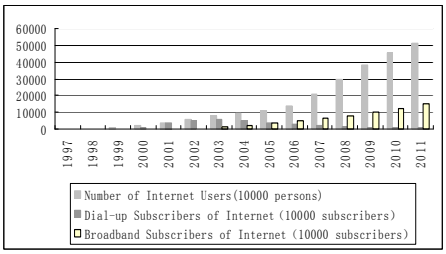

Figure 1 Internet Development in China

NIS is composed of firms, research institutes and universities[11]. In this paper, we not only pay attention to overall NIS, but also concerns these institutions. Based on the theoretical background above, this paper focus on innovations intensity, innovation performance and knowledge transfer of whole NIS as well as the three institutions. The variables were shown in table 1.

Table 1 Variables and Measurement

	Variable	Measurement
Internet Development	Internet Penetration	Proportion of the Population using the Internet (%)
	Internet Quality	Broadband Subscribers of Internet (10000 subscribers)
NIS	Innovation Intensity	Expenditure on R&D (100 million yuan)
	Knowledge Transfer	Transaction Value in Technical Market (100 million yuan)
	Innovation Performance	Value of High-tech Products Export (100 million yuan)
Firms	Innovation Intensity	Number of New Products Development Projets (item)
	Knowledge Transfer	Expenditure for Assimilations of Technology (100 million yuan)
	Innovation Performance	Sales Revenue of New Products / Expenditure on New Products Development (%)
Scientific Research Institutes	Innovation Intensity	Number of R&D Projects (item)
	Knowledge Transfer	Expenditure on R&D Source of Firms / Expenditure on R&D (%)
	Innovation Performance	Number of Inventions Applications / Full-time Equivalent of R&D Personal (%)
Universities	Innovation Intensity	Number of R&D Projects (item)
	Knowledge Transfer	Expenditure on R&D Source of Firms / Expenditure on R&D (%)
	Innovation Performance	Number of Inventions Applications / Full-time Equivalent of R&D Personal (%)

All data we used sourced from *China Statistical Yearbook*, from 1997 to 2011. The statistic caliber of firms is large and medium-sized industrial enterprises.

3.2 Methods

Grey incidence analysis be employed in this paper. Internet has a complex influence on NIS. There are a lot of difficulties to use the regression methods to obtain data and setup models. But grey incidence analysis could not restrict by sample size and regularities of distribution[12].

Concretely, the core of grey incidence analysis is to reflect the similarity of geometric shape between sequence curves by using grey incidence degree. Grey incidence degree includes absolute incidence degree, relative incidence degree and integrated incidence degree. This paper mainly use the grey relative incidence degree, which can avoid the analysis biased error probably being caused by dimensional difference, because it is only connected with the rate of change of the sequence curves[12].

Specifically, grey relative incidence degree(r_{0i}) of sequences X_0 and X_i represent the rate of change of X_0 and X_i relative to their start point. The initial image of X_i is:

$$\begin{aligned} X_i^{'} &= (x_i^{'}(1), x_i^{'}(2), \ldots, x_i^{'}(n)) \\ &= (\frac{x_i(1)}{x_i(1)}, \frac{x_i(2)}{x_i(1)}, \ldots, \frac{x_i(n)}{x_i(1)}), \quad i = 1,2,\ldots, \quad m \end{aligned} \tag{1}$$

And the image of the zero starting point is:

$$\begin{aligned} X_i^{'0} &= (x_i^{'0}(1), x_i^{'0}(2), \ldots, x_i^{'0}(n)) \\ &= (x_i^1(1) - x_i^1(1), x_i^{'}(2) - x_i^{'}(1), \ldots, x_i^{'}(n) - x_i^{'}(1)), \quad i = 1,2,\ldots,m \end{aligned} \tag{2}$$

From formula (1) and (2), we can get:

$$\left|S_i^{'}\right| = \left|\sum_{k=2}^{n-1} x_i^{'0}(k) - \frac{1}{2} x_i^{'0}(n)\right|, \quad i = 1,2,\ldots,m \tag{3}$$

$$\left|S_i^{'} - S_0^{'}\right| = \left|\sum_{k=2}^{n-1} (x_i^{'0}(k) - x_0^{'0}(k)) - \frac{1}{2}(x_i^{'0}(n) - x_0^{'0}(n))\right|, \quad i = 1,2,\ldots,m \tag{4}$$

Then, relative degree incidence can be computer by formula (5).

$$r_{0i} = \frac{1 + \left|S_0^{'}\right| + \left|S_i^{'}\right|}{1 + \left|S_0^{'}\right| + \left|S_i^{'}\right| + \left|S_i^{'} - S_0^{'}\right|}, \quad i = 1,2,\ldots,m \tag{5}$$

According to the principle of grey incidence analysis, the greater grey incidence degree is, the impact is bigger. In fact, based on this premise that Internet develops rapidly in our country, larger grey relative incidence degree not only means the rapid growth of a certain characteristic variable of the NIS, but also means that there is a high similarity between the growth rate of variables and that of the development level of the Internet. Therefore, grey relative incidence degree essentially reflects dynamic impact of Internet on NIS.

4. Research Result

For whole NIS, innovation intensity, knowledge transfer and innovation performance increased obviously. Figure 2 shows the fixed-base growth rate of these variables. We also can find similar trend about innovation intensity of three institutions(Figure 3). But for knowledge transfer and innovation performance, the trends were different.

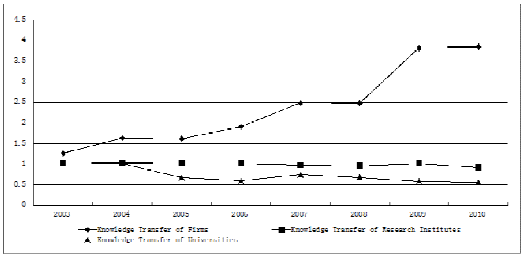

Figure 2 Fixed-base Growth Rate of NIS

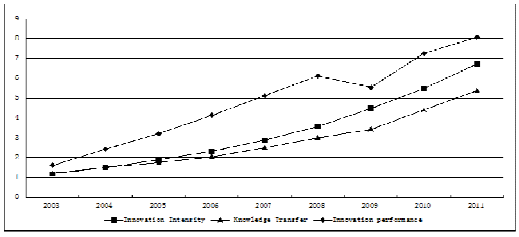

Figure 3 Fixed-base Growth Rate of Innovation Intensity

As shown in figure 4, fixed-base of knowledge transfer of firms increased, but that of research institutes and universities declined at the same time. In figure 5, innovation performance of universities rose substantially, that of research institutes increased slightly. However, innovation performance of firms stalled.

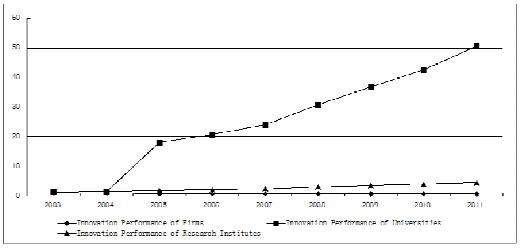

Figure 4 Fixed-base Growth Rate of Knowledge Transfer

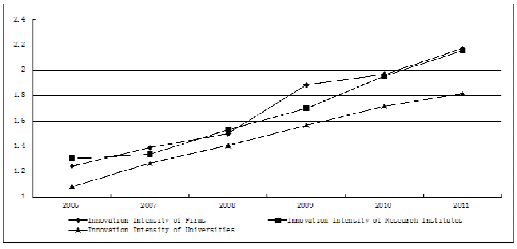

Figure 5 Fixed-base Growth Rate of Innovation Performance

Table 2 reports the result of grey incidence analysis. According to table 2, we can get the following results.

First, Internet and whole NIS developed synchronously. In Table 2, the grey incidence degrees between Internet development and variables of NIS are above 0.9, and some of them are above 0.99. This result indicated that with developing of internet, innovation intensity, innovation performance and knowledge transfer be promoted obviously. As we discussed above, Internet is the infrastructure of NIS, and could facilitate the development of NIS. Result of gery incidence analysis supported this viewpoint.

Second, Internet had greater impact on knowledge transfer on firms than that of research institutes and universities. The grey incidence degrees between Internet development and knowledge transfer of firms are above 0.9 in table 2. But these degrees of research institutes and universities are low. Especially, the degrees of universities are about 0.5.

Table 2 Result of Grey Incidence Analysis

		Internet Penetration	Internet Quality
NIS	Innovation Intensity	0.9762	0.9944
	Knowledge Transfer	0.9972	0.9550
	Innovation Performance	0.9353	0.9423
Firms	Innovation Intensity	0.9070	0.9242
	Knowledge Transfer	0.9367	0.9534
	Innovation Performance	0.6188	0.7698
Scientific Research Institutes	Innovation Intensity	0.8768	0.9161
	Knowledge Transfer	0.6155	0.7132
	Innovation Performance	0.9232	0.9568
Universities	Innovation Intensity	0.9027	0.9448
	Knowledge Transfer	0.5235	0.5407
	Innovation Performance	0.9261	0.9599

Third, for innovations performance, the contrary is the case. Internet has more influences on innovation performance of research institutes and universities than that of firms. The grey incidence degree between Internet development and innovation performance of research institutes and universities are more than 0.9, but the degree of firms is below 0.8.

In order to explain these two result, we should consider the different functions of institutions. Research institutes and universities are mainly producer on new knowledge in an NIS. Comparing with firms, the knowledge they transferred are more appropriative and tacitness. There are many obstacles which could not be completely broken by Internet in process of knowledge transfer. Firms apply new knowledge to economy in an NIS, and their innovation performance is economic performance. But for research institutes and universities, the performance are about knowledge output. Obtaining economic performance is more risky and difficult then knowledge output, and effect of Internet is limited.

At last, Internet quality has greater influence on NIS than Internet penetration. From table 2, we can find that almost all grey incidences between Internet quality and NIS are greater than that between Internet penetration and NIS.

CONCLUSION

This paper investigated the impact of Internet development on Chinese NIS. This paper measured degree of Internet development from two dimensions, named Internet penetration and Internet quality, and focus both on whole NIS and three institutions levels, which are firms, research institutes and universities. Employing grey incidence analysis, this paper find that Internet development have difference impact on these two levels. At first, on the whole NIS level, innovation intensity, performance and knowledge transfer have been promoted with Internet development. At scend, for knowledge transfer, firms benefit from Internet development more than research institutes and universities, but innovation performance of research institutions and universities have been promoted more obviously. At last, Internet quality has greater impact on both levels of NIS.

In recent two decades, Internet developed rapidly in China, and influenced all aspects of society. But a few research focus on the impact of Internet development on NIS. Our research can partly fills in this gap. As a exploratory research, there are certainly limitations. We find that Internet development has different impact on firms, research institutions and universities, but the reasons for this should be analyzed theoretically and be supported by more empirical evidences.

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