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Theoretical and empirical analysis of the influence of public library on scientific and technological innovation

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ABSTRACT

This paper adopted statistical and econometric methods to analyze the relationship between the indicators of public libraries, including the total collection of books, total number of circulation, volume of books borrow, total expenses, acquisition expenditures of books and technological innovation. The results indicate that there is a significant positive correlation between them and two indicators: newly acquired collections and the total collection of books, play an especially important role. According to the empirical analysis, this validates that public library services have facilitated the development of scientific and technological innovation

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KEYWORDS

Public library;
Scientific and technological
innovation;
Regression analysis.

INTRODUCTION

Public Library Manifesto promulgated by UNESCO clearly states that public library is the information center of a region, for it could provide a variety of knowledge and information for users. In the 12 provisions of public library, the 10th one stipulates that it should off adequate information services for local businesses, community groups; regulations of provincial public library also clearly state that there are 6 main tasks of provincial library, and the second one is to provide books and periodicals materials for the region's economic development and scientific research. Both the Public Library Manifesto issued by United Nations or China's public library regulations clearly define that public library should serve the production and scientific research.

A special duty of the public library is to provide

timely thematic information services for government decision-makers using rich collection of resources and high level of community information services for readers. In the era of knowledge economy and technological innovation, technological innovation requires information, so the library should make quick response and take the initiative to play its special role, thus providing in-depth, comprehensive, diversified information service.

There are few studies about the relationship between the development of public library and technological innovation, and only two can be searched from the journal net. Xiao Hongyuan, Chen Yunyun (2002) elaborated the role that public library played in technological innovation with the scientific and technological innovation as an object, where they pointed out that public library will provide information for be technological innovation with its knowledge-intensive advan-

tage and social education function; it may also offer impetus for technological innovation with its rich information resources, scientific development and information utilization means, as well as the innovative ways and means with its deepening services. Huang Lihua^[2] discussed the new requirements of the national science and technology innovation system for the public library and called library staff to make contributions to the construction of national science and technology innovation system. However, related researches laid much emphasis on the theory and normative research, and lacked of empirical studies. Therefore, this paper attempts to study the relationship between public library and technological innovation based on the empirical studies, trying to build an empirical model to analyze the influence of public library on the development of scientific and technological innovation.

THEORETICAL ANALYSIS OF THE INFLUENCE OF PUBLIC LIBRARY ON SCIENTIFIC AND TECHNOLOGICAL INNOVATION

To provide the knowledge for scientific and technological innovation

By the ongoing literature search, the library has reserved a lot of knowledge and technologies which could form a complete and orderly knowledge system after collation and processing, and then it could be frequently exploited by technological innovation workers. Therefore, every technological innovation project is inseparable from the literature and knowledge of library. The Library could provide knowledge dynamic for the technological innovation by the literature circulation, reference, issue tracking and other services.

To nurture talent for technological innovation

Scientific and technical personnel are the source and power of technological innovation, and the flexibility and breadth of education implemented by library implementation is a kind of supplement for the formal schooling. Due to its openness, the public library constantly cultivates and fosters talents and improves their quality as well as subtly nurtures the potential personnel by providing services of literature information such as the knowledge disseminating.

To provide information about policy and regulations

It is necessary to obtain the related information policies and regulations in the decision-making and implementation process of scientific and technological innovation projects to ensure their stability and successfully implementation. Information about policy and regulations includes national conditions and strength, development of policies and technological innovation. Thus, the library could facilitate the technological innovation by information collection, collation, dissemination, recommendation, consulting and other services.

To provide market information

It is necessary to collect relevant market information and conduct analysis when the innovation projects and products are established, which is conducive for the decision-making of innovative projects, the development, production and market launch of innovative product and the transfer of innovative technologies. By the special database construction for market information, etc, the library could carry out targeted services for users to enable scientific and technological innovation workers to grasp a large number of practical market information, thus promoting innovation work.

To present the status and some forward-looking information of innovation projects

To avoid duplication of innovation and improve the application value and market efficiency of innovative products, it is necessary to make use of information provided by libraries and other information sectors in the process of technological innovation, in order to fully understand and master the history, status and trends of innovative projects.

To facilitate the application and information transformation of innovative products

Whether the innovative products can be ultimately launched into the market or into new innovations, or become effective patented technology with high value, is a manifestation of innovation benefits. In the whole process of technological innovation, it is necessary to search literature and collect information to grasp that by which industries, departments, units the innovative products are utilized, as well as which technological

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projects are these innovative products will be used. The library is the best sector to achieve this.

Empirical analysis of public library and technological innovation

Index selection

When it comes to the output quantity and quality of technological innovations, though many potential factors (in this case, it is solved by environmental factors of technology capabilities in the system evaluation process) cannot be characterized in technological capacity building and the quantization process, its explicit knowledge is what we must consider. In 2005, Gong Weijun et al concluded from the regression analysis that implicit knowledge is highly individualized during the developing process of ability and it is difficult to regulate. The existence of enormous tacit knowledge makes it more difficult to enhance the overall scientific and technological capacity. On the contrary, the increase in and the organization of the number of explicit knowledge are beneficial to improving the overall scientific and technological capacity. The mobility of scientific and technological knowledge and the strength of explicit are directly related to activating the likelihood of technology and economic and social resources, science and technology capability-building as well as the achieving the increase of the efficiency of knowledge explicit. Among technological innovation output indicators, explicit knowledge factors are broadly divided into two categories, namely, morphological indicator for knowledge quantity and morphological indicator for magnitude of value. Morphological indicator for knowledge quantity consists of the direct result of science and technology, mainly including academic papers, scientific research inventions and patents. Levin also confirmed that raising the level of investment in research and development needs to give some kind of monopoly power to developers to stimulate or motivate them. Only those subjects who accumulate critical quality patents have better abilities to create. When the property right of a new invention is protected, the patent owners can transfer its right to use through payment to compensate their investment and to get benefits. Patents granted in a country are the best characterization indicator of the output of science and technology resources. In addition, technological innovation depends on not only the

number of scientific and technological achievements, but also their promotion in practical production and use as well as the size of benefits, that is, the morphological indicator for magnitude of value. It is the indirect technological achievement, which can be characterized by the transaction volume of contracts in technology market. In summary, scientific and technological innovations are measured by two indicators: ① transaction volume of contracts in technology market (TEC), reflecting the promotion of scientific and technological achievements in the practical production and use as well as the economic benefits to be obtained; ② Patents Granted (PAT), as the reflection of science and technology resource output of knowledge quantity morphology and as well the property protection of intellectual rights.

According to Zheng Jinghua^[1], public library development indicators select the total collection of books, the total circulation of readers, volumes of books borrowed, total expenditures, acquisition expenses of collection, and newly acquired collections. This paper uses the data of main science and technology output indicators from 1995 to 2006 to analyze economic indicators such as the transaction volume of contracts in technology market, the total expenditure, and the acquisition expenses of collections. To eliminate the impact of price changes, the consumer price index (1978 = 100) is applied to deflate all of them.

Correlation analysis

Large technological innovation output means more information and technologies can be applied to economic production and the libraries will expand fast. Thus it could make greater contribution to the scientific and technological innovation and form more technological innovation output. The technological innovation and the development of a library should be positively correlated.

As can be seen from the quantity of the scientific output, the number of patent application and grant has been increasing from the 45,064 in 1995 to 268,002 in 2006, with an average annual rise of 16.53%; from the turnover in the national technology market, its value has been increasing from 67,610,000 yuan in 1995 to 386,026,000 yuan in 2006, with an average annual rise of 19.32%; the average growth rate indicates that the

growth rate of the scientific output is higher than that of economy. The average annual growth rate of the total expenditure and the acquisition expenses of book collection is 13.21% and 10.18%, higher than that of the total book collection and newly acquired collections. This indicates that China's intensive protection of intellectual property and copyright causes the growth rate in unit cost of books higher than the expenditures of book acquisition. Meanwhile, it also may indicate that lower growth ratio of public libraries development may give rise to greater growth ratio of science and technological output. (As shown in TABLE 1).

Is there a dependence relationship between the library's business development and technological innovation? The relevant data from 1995 to 2006 is used to measure the correlation matrix of various indicators of technological innovation and library development, and the calculation results are shown in Table 2. Check the correlation coefficients and all of them have passed the significance test with the freedom degree of 10 and the significance level of 1%, showing that all variables of library development are significantly correlated with the technological innovation output.

The correlation coefficients of the number of granted

TABLE 1 : The average annual growth rate of the indicators

Project name	Average annual growth rate
The number of granted patents	17.60
Transaction volume in technological market (10 thousand yuan)	17.16
Total book collection(10 thousand volumes)	3.90
Total number of circulation(10 thousand)	2.96
Volumes of books borrow(10 thousand volumes)	5.39
Total expenditure(10 thousand yuan)	13.21
Acquisition expenses of book collection(10 thousand yuan)	10.18
Newly acquired collections (10 thousand volume)	7.45

Note: calculation based on data from *China Statistical Yearbook*

patents, the transaction volume in the national technology market and the acquisition expenses of book collection, the total book collection and the total expenditure of the public library are all greater than 0.95. This indicates that with advances in technology and public libraries, a growing number of technologies are transacted by the technology market which thus has become a bridge between the scientific and technological progress and library development. The economic growth caused by the scientific and technological innovation promotes the increase in the acquisition expenses of book collection, the total book collection and the total expenditure, which enhances the library's services for technological innovation; the growing strength of library is conducive for enterprises to develop new products and improve their R & D capabilities; while the enterprises could improve their overall technological level, shorten the development cycle of new products, enhance the market competitiveness and promote scientific and technological innovation by technologies purchased in technological market.

TABLE 2 : Correlation coefficients of library development indicators and technology output indicators

	BXG	CZF	LTRC	WJCS	ZCL	ZZC	PAT	TEC
BXG	1.000	0.951	0.885	0.865	0.926	0.965	0.930	0.959
CZF	0.951	1.000	0.928	0.930	0.987	0.983	0.958	0.965
LTRC	0.885	0.928	1.000	0.832	0.909	0.943	0.937	0.944
WJCS	0.865	0.930	0.832	1.000	0.935	0.921	0.881	0.887
ZCL	0.926	0.987	0.909	0.935	1.000	0.980	0.960	0.964
ZZC	0.965	0.983	0.943	0.921	0.980	1.000	0.985	0.994
PAT	0.930	0.958	0.937	0.881	0.960	0.985	1.000	0.992
TEC	0.959	0.965	0.944	0.887	0.964	0.944	0.992	1.000

Note: calculation based on data from *China Statistical Yearbook*

Modeling

In order to reflect the influence of the development of public libraries on the technological innovation output more accurately, we established a mathematical model based on the correlation analysis to quantitatively analyze the relationship between them.

The correlation coefficient between the two indicators is up to 0.99 at the technological innovation level,

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so any indicator could be selected as the dependent variable of the model. Here we select the transaction volume in the national technical market as the dependent variable to establish model. This is because patent is a physical quantity indicator and the number cannot reflect the quality of scientific and technological innovation. According to the principle that the variables of the established mathematical model should be as independent as possible, it is likely to select only one of the independent variables. To eliminate the autocorrelation between variables, carry out natural logarithm transform for them in the calculation and the following six regression equations are obtained:

$$\text{TEC} = -3.55 + 1.88 \times \text{BXG} \quad (1)$$

(-2.71) (10.11) $R^2 = 0.91$ s.e. = 0.19

$$\text{TEC} = 2.66 + 1.56 \times \text{GZF} \quad (2)$$

(4.99) (13.20) $R^2 = 0.95$ s.e. = 0.15

$$\text{TEC} = -26.12 + 3.62 \times \text{LTRC} \quad (3)$$

(-6.23) (8.58) $R^2 = 0.88$ s.e. = 0.22

$$\text{TEC} = -23.87 + 3.44 \times \text{WJCS} \quad (4)$$

(-4.85) (6.82) $R^2 = 0.82$ s.e. = 0.27

$$\text{TEC} = -39.44 + 4.62 \times \text{ZCL} \quad (5)$$

(-11.55) (14.38) $R^2 = 0.95$ s.e. = 0.14

$$\text{TEC} = 1.67 + 1.34 \times \text{ZZC} \quad (6)$$

(6.14) (29.12) $R^2 = 0.99$ s.e. = 0.07

Check the t-distribution table, when the degree of freedom is 10, the t-test value with the significant level of 5% and 1% was respectively 2.228 and 3.169. The absolute value of t-value of each equation is greater than 5% of the decision value 5%, which passes the test with the coefficient of 0 and probability of 5% and the estimated regression coefficient is significant. The goodness of fit of the model is greater in formula (1), (2), (5), (6), which shows that most of changes in the transaction volume in the national technology market could be explained by regression (> 90 %).

This shows that the newly acquired collections are highly correlated with the volume of transaction in the national technological market. The regression coefficient is 1.88, indicating that when the newly acquired collections increase by 1%, the growth rate of transaction volume in national technology market will be 1.88%, which shows that the newly acquired collections is conducive in promoting the acquisition expenses of books and total expenditure. Similarly, when the acquisition expenses of books, the total number of books and the total expenditure of public libraries respectively increase by 1%, the growth rate of transaction volume in na-

tional technology market will be 1.56%, 4.62% and 1.34%. The above models will provide theoretical references for the further study of the relationship between the development of public libraries and technological innovation.

CONCLUSION AND SUGGESTIONS

In recent years, the development indicators of public libraries: the acquisition expenses of books, total collection of books and the total expenditures are highly correlated with the technological innovation indicators: transaction volume and the patent licensing of national technology market. The newly acquired collections, the acquisition expenses of books, total collection of books are linearly dependent of the volume of transaction of national technology market. If the development indicators of public libraries increase by 1%, the growth rate of transaction volume in national technology market will be 1.88%, 1.56%, 4.62% and 1.34%. The total collection of books and the newly acquired collections play more important role than the acquisition expenses of books and total expenditure, which verifies the theoretical analysis of the role of public libraries in section 2. The 6 regression equations reflecting the relationship between the development of public libraries and the transaction volume in national technology market will provide theoretical references for the further study of the relationship between the development of public libraries and economic growth.

To study the influence of public libraries on the scientific and technological innovation, there are still a lot of factors which cannot be quantified such as library legislation, library resource sharing, digital library, network level, etc., so it is necessary to conduct more comprehensive researches, thus verifying the important promotion of public libraries in building a harmonious society and facilitating scientific and technological innovation.

According to this study, the newly acquired collections and the total collection of books play an important role in promoting the transaction volume in national technology market, so in the future library development, these two parts should be laid more emphasis.

Meanwhile, the modern scientific and technological innovation is instructive for the literature information

demand, so librarians should teach scientific and technological innovation workers how to effectively use the search methods as well as the online literature, electronic literature and thematic databases, and guide them on how to abstract, refine and restructure literature information, in order to make use of the literature information accurately and efficiently.

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