The impact of market demand, government intervention and environment changes on the output of healthcare research in China

Jinsong Wang*, Xiting Gong and Qiwen Wang

Guanghua School of Management, Peking University, Beijing, 100871 The People’s Republic of China
E-mail: wangjs@gsm.pku.edu.cn
E-mail: gongxiting@gsm.pku.edu.cn
E-mail: wqw@gsm.pku.edu.cn
*Corresponding author

Qingjiu Tao

College of Business, James Madison University, 800 S. Main Street, Harrisonburg, Virginia 22807, USA
E-mail: taoqx@jmu.edu

Abstract: In this paper, we attempt to investigate the impact of market demand, government intervention and environment changes on Chinese healthcare research and productivity. We investigate a large dataset covering healthcare research and publication report over 28 medical sub-disciplines from January 1995 to October 2008 (covering a total of 5,808,894 publications). The results indicate that market, government policy and environment changes are of significant impact on Chinese healthcare research. The impact can both be short-term or long-term in nature. There is clear indication of market failure in supply of healthcare research as a public product. While both within the realm of traditional Chinese healthcare studies, traditional Chinese medicine suffered much more significant impact from globalisation than traditional Chinese pharmacology. To eliminate the negative impact of market failure and deteriorating environment, Chinese Government needs to find a sustainable mechanism of intervention and guidance. More research on the impact of Western/modern culture on authentic Eastern culture is needed in the future.

Keywords: healthcare research output; China; market demand; government intervention; environment changes; market failure; change management.


Biographical notes: Jinsong Wang is a PhD candidate in the Department of Management Science and Engineering, Guanghua School of Management, Peking University. His main research interests lie in operational research and behavioural finance.

Xitong Gong is a PhD candidate in the Department of Management Science and Engineering, Guanghua School of Management, Peking University. His main research interests involve operations and supply chain management.

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1 Introduction

According to the pioneer of bibliometrics, (Derek John de Solla Price), to study the development of science and technology, one needs to start from the pattern of volume increase in scientific literature. He found the ‘exponential curve of science’ through extensive statistical analysis of scientific literatures covering many disciplines, which pointed out that the volume of literature in a specific discipline, is an exponential function of time. In this paper, we developed hypotheses based on the law of exponential growth and used Chinese healthcare literature as our research context. The results indicate that all 28 sub-disciplines of the Chinese healthcare literature support the law of exponential growth. However, there are significant differences in terms of growth speed among these sub-disciplines, ranging from the lowest annual growth rate of 4.98% to the highest annual growth rate of 14.36%. In addition, the extent to which each sub-discipline fits with the law of exponential growth varies significantly. Some are the addition of short-term fluctuation to the basic exponential growth pattern; some can be divided into two or more growth periods with distinctive speeds. It is our original research motivation to analyze and explain the reasons led to these differences.

In the following section of the paper, we will first provide literature review and briefly introduce the relevant literature of bibliometrics and economics of science. Section 3 is for hypotheses development and research design. Section 4 is for data source explanation. Section 5 is for empirical results and we use Section 6 for conclusions and discussion.

2 Literature review

While the economics of science can be traced back to the discussion on innovation by Smith (1972) in his ‘The Wealth of Nations’ and the analysis of potential destructive aspects of science and technology by Marx (1975); as well as Schumpeter’s (1990) statement about innovation initiated by entrepreneurs is the basic characteristic of capitalism; it did not become a significant research topic of economists until the end of World War II. It is the enormous impact of science and technology on the war that commanded unprecedented attention.

1950s to mid 1980s was an important developmental stage for economics of science. The discipline established its neoclassical theoretical framework based on the ‘economic man’ assumption of neoclassical economics and the theory on role of government and market in resource allocation.
Nelson (1959) and Arrow (1962) studied technological innovation based on the principle of maximising firm profit. Arrow (1962) treated knowledge as a public product, just like any other products. The low cost of knowledge transfer indicates that it will easily flow out of firms, thus, a firm cannot possess the entire benefit from its R&D investment. The lower private return of investment than the societal return of investment in R&D led to under investment in basic science by private firms. Nelson (1959) suggested that, national government should increase the investment in basic science and turn basic science research projects to universities and government research institutes. Private firms should mainly work on research and development of applied science.

Nelson and Arrow’s model requires the prerequisite of economic growth and increase of market demand; given the two decade of economic development in China, it is appropriate for researching current Chinese healthcare field.

Bibliometrics studies the development of science and technology from the perspective of experience statistical pattern of volume of scientific literatures. The earliest and the most important discovery is the law of exponential growth pattern of science literature. A librarian in Wesleyan University, Ryder, found out in 1944 that the volume of literatures at major US universities doubles every 16 years; this was actually one way of demonstrating the law of exponential growth in literature volume. In 1960s, Price (1985, 1987) used logistic curve to describe the growth of scientific literatures, the result not only covers the exponential growth curve, but also overcame the shortcoming of exponential curve, i.e., unlimited growth. Both exponential model and logistic model are approximations under certain conditions, it is especially convenient to use for describing the pattern of literature growth within a short period of time. For this paper, exponential growth model is more appropriate.

Bibliometrics study on Chinese healthcare research is still at its beginning stage. First of all, the existing literature is usually limited to certain region [e.g., Deng (2007)], certain institution [e.g., Huang (2009)], a specific journal, a specific illness or related to a specific medicine [e.g., Luo et al. (2007), Wang and Pang (2008)]. Furthermore, the research methods and tools are relatively rudimentary. Many studies provided only the most basic statistical description. Finally, sample sizes used were usually very small; many had less than 100. Bibliometrics studies on traditional Chinese healthcare research are even less, especially those can analyse the growth trend of traditional Chinese medicine and traditional Chinese pharmacology from time dimension. To a large extent, our research has filled in the current gap in the literature.

3 Hypotheses development and research design

We have developed four main hypotheses: the exponential growth pattern of Chinese healthcare literatures, the impact of market demand change on healthcare research, the impact of environmental change on healthcare research and the impact of government intervention on healthcare research.

3.1 The exponential growth pattern of Chinese healthcare literatures

Since the start of economic reform, the Chinese economy has experienced an unprecedented 30 years of high-speed growth. With the significant elevation of Chinese people’s living standards, the need for healthcare services has increased dramatically both
in terms of quantity and quality. The market need for all areas of healthcare research has increased at high speed at the same time. In 1978, China had 170,000 healthcare institutions, with 9,293 modern hospitals and 447 traditional Chinese hospitals; in 2007, China had 300,000 healthcare institutions, with 19,852 modern hospitals and 447 traditional Chinese hospitals. From 1980 to 2007, healthcare professionals have increased from 3.53 million to 5.90 million. Total healthcare expenditure in 2006 was 984.3 billion RMB; it was 89.5 times of spending in 1978, with an annual growth rate of 17.4\% (China Health Statistical Yearbook, 2009). Total R&D expenditure in 2007 was 371 billion RMB; it was 26.1 times of spending in 1991, with an annual growth rate of 22.6\% (China Health Statistical Yearbook, 2008).

Thus, based on the law of exponential growth of bibliometrics and the growth of market demand in China, we developed the following hypothesis:

Hypothesis 1 All sub-disciplines of healthcare research in China will follow the law of exponential growth curve.

We test the hypothesis by studying the research output $N_{ctm}^i$ of sub-discipline $i$ to see if it follows the law of exponential growth. For the following model, to all $i (1 \leq i \leq 28)$, test $\beta_i^1 > 0$

$$\ln N_{ctm}^i = \beta_0^i + \beta_1^i t$$

(1.1)

$H_0^i : \beta_1^i \leq 0$, $H_1^i : \beta_1^i > 0$.

The following four hypotheses focus on the determinants of growth speed of Chinese healthcare research output through the method of compare and contrast. That is, we will explore the different trend of change in growth speed between the focal research subject and the control subject, when some influencing factor has significant impact of the growth speed of the focal research subject and little or no impact on the growth speed of control subject.

We have chosen the population of healthcare research as our control subject for each sub-discipline. This can be done through two approaches. One is to compare the different between the growth speed of each sub-discipline and the average growth speed of all the healthcare research. The other approach is to study directly the change of share of each sub-discipline to all the healthcare research. In essence, these two approaches are the same; it is just simpler to use the ratio/share approach. When a sub-discipline’s growth speed is higher than the average growth speed of all the healthcare research, the share of the sub-discipline in all the healthcare research will increase continuously. When the growth speed of sub-discipline one is higher than the growth speed of sub-discipline two, the difference of respective share of all the healthcare research between sub-discipline one and sub-discipline two will increase continuously.

3.2 The impact of market demand change on healthcare research

The essence of China’s economic reform was marketisation. Market gradually became the dominating force in resource allocation. The impact of market on healthcare research was through research and development of new product. The increase or decrease of market demand will lead to the growth or decline of R&D on related healthcare products
and services; eventually lead to the increase or decrease of related medical and healthcare research.

Due to the difficulties in estimating the actual market demand in each sub-discipline in healthcare field, we used an indirect approach to study the impact of market demand on healthcare research, i.e., to study the impact of abrupt change of market demand on healthcare research.

Hypothesis 2 Sudden increase in market demand will lead to increase of growth speed of research output.

There were two classic examples of sudden market demand in China’s healthcare research field. The first one is the SARS crisis in 2003 and the second example is the series of healthcare reforms dictated by the government.

For SARS, we used two models to test its short-term and long-term impact. First, we need to test if the share of infectious disease research in all healthcare research increased significantly in the eruption period of SARS after controlling the normal time trend. Considering the factor of time lag, we defined the SARS period between July 2003 and June 2004. ($D_{03-04} = 1$ other time = 0). For the following model, test $β_2 > 0$

$$R_{t}^{\text{epidemic}} = β_0 + β_1t + β_2D_{03-04}$$

$$H_0 : β_2 ≤ 0, H_1 : β_2 > 0.$$  \hspace{1cm} (2.1)

The assumption for this model is that SARS has only short-term impact on infectious disease research and no long-term impact; i.e., there is only impact on the intercept item $β_0$ in the model, and no impact on the slope item $β_1$ in the model.

Second, we tested if there is significant difference in time trend for $R_{t}^{\text{epidemic}}$, after controlling for the head-raising and tail-raising factors. To control for the head-raising and tail-raising factors, this test does not include the samples within 2003 and 2004, i.e., we extended the SARS period six months earlier to January 2003 and also 6 months later to December 2004. We introduced a dummy variable $D_{Nc}$, $D_{Nc} = 0$ if before 2003 and $D_{Nc} = 1$ if after 2004. For the following model, test $β_3 > 0$

$$R_{t}^{\text{epidemic}} = β_0 + β_1t + β_2D_{Nc} + β_3D_{Nc}t$$

$$H_0 : β_3 ≤ 0, H_1 : β_3 > 0.$$  \hspace{1cm} (2.2)

This model tested the change of model structure before and after SARS, it can not test the change of model parameters during the SARS period. Therefore, we need to conduct our analysis based on both models at the same time. Similar analysis will be done in the following part of the paper and we will omit the explanation of model designation there.

To cover the healthcare reform case, we need to review the process of healthcare reforms in China first. We can divide the healthcare reform in China into three periods. The state council announced “the decision on health reform and development” in 1997. In 1998, the state council released “the decision on establishing basic health insurance policy for urban employees”. In 2000, the state council issued “the guidance on urban healthcare and health system reform”. This document initiated the reforms in basic health insurance policy for urban employees, urban healthcare and health system and drug production and distribution system. Later on, the correspondent policies on healthcare institution management, drug purchase/distribution management in hospitals,
management of drug prices, management of healthcare service prices and subsidies policies for healthcare industry. In September 2006, a new round of healthcare reform was initiated. The new healthcare reform plan drafted by the health ministry was revealed in January 2007, and the plan led to fierce debate in the society. Subsequently, multiple independent research institutions were entrusted by healthcare reform coordination team from the state council to develop new plans. At the end of May 2007, eight independent healthcare reform plans were under review by the healthcare reform coordination team and by foreign and domestic experts. In September 2007, the national development and reform committee announced that the new plan has been formed and submitted to the state council.

Based on the previous description, we can expect upsurge in research on China’s healthcare policy at three periods, from June 1997 to June 1998, from January 2001 to December 2004, and the year of 2007. We established three dummy variables, i.e., \( D_{97-98} \), \( D_{01-04} \) and \( D_{07} \), to test the hypothesis. For the following model,

\[
R_t = \beta_0 + \beta_1 t + \beta_2 D_{97-98} + \beta_3 D_{01-04} + \beta_4 D_{07}
\]

(2.3)

\( H_0 : \beta_i \leq 0, H_1 : \beta_i > 0, \quad i = 2, 3, 4. \)

Due to the sample limitation after eliminating these three periods and head-raising as well as tail-raising periods, we did not conduct the test on whether the long-term trend has change.

Markets often fail when it comes to delivering public products, it is reasonable to expect the existence of such phenomenon in the field of healthcare research.

Hypothesis 3 There exists the phenomenon of market failure in Chinese healthcare research field when it comes to public product delivery.

We tested hypothesis 3 by examining if the share of basic healthcare research on all healthcare research decrease over time. For the following model, test, \( \beta_{1}^{\text{basic}} < 0 \)

\[
R_t^{\text{basic}} = \beta_0^{\text{basic}} + \beta_1^{\text{basic}} t
\]

(3.1)

\( H_0^{\text{basic}} : \beta_1^{\text{basic}} \geq 0, H_1^{\text{basic}} : \beta_1^{\text{basic}} < 0. \)

3.3 The impact of government intervention on healthcare research

The ‘invisible hand’ of market is not panacea for solving all economic challenges; the ‘visible hand’ of government intervention is still needed when it comes to providing public products and maintains a fair market environment. The market economy in China was born out of planned economy; the Chinese Government is still a government with strong control. Comparing to Western Governments, Chinese Government is more readily to intervene and is more confident that its intervention will be effective. It influences the healthcare research through targeted funding and policies.

Hypothesis 4 Government intervention has significant impact on Chinese healthcare research.
We picked the event of traditional Chinese medicine/drug’s application for world cultural heritage as an example of impact of government guidance to healthcare research. In January 10th, 2006, the People’s Daily announced the start of traditional Chinese medicine/drug’s application for world cultural heritage. The news generated a new round of upsurge in traditional Chinese medicine/drug research.

We first tested if the share of research on traditional Chinese medicine and traditional Chinese pharmacology on all healthcare research increased significantly during the application period after controlling the normal time trend. The application period is defined as between March 2006 and February 2007 ($D_{06} = 1$ other time = 0). For the following model, test $\beta_2 > 0$

$$R_{tcm} = \beta_{0,tcm} + \beta_{1,tcm} t + \beta_{2,tcm} D_{06}$$

$$R_{tthd} = \beta_{0,thd} + \beta_{1,thd} t + \beta_{2,thd} D_{06}$$

$$H_0 : \beta_{2,thd} \leq 0, H_1 : \beta_{2,thd} > 0.$$ 

Next, we tested if there is significant difference in $R_{tcm}$ and $R_{tthd}$'s time trend before and after the application when the head-raising and tail-raising factors were controlled. This test differs from the previous test in that it does not contain the sample between September 2005 and August 2007. Dummy variable $D_{cm} = 0$ before September 2005, $D_{cm} = 1$ after August 2007. For the following model, test $\beta_3 > 0$

$$R_{tcm} = \beta_{0,tcm} + \beta_{1,tcm} t + \beta_{2,tcm} D_{cm} + \beta_{3,tcm} D_{cm} t$$

$$H_0 : \beta_{3,tcm} \leq 0, H_1 : \beta_{3,tcm} > 0$$

$$R_{thd} = \beta_{0,thd} + \beta_{1,thd} t + \beta_{2,thd} D_{06} + \beta_{3,thd} D_{cm} t$$

$$H_0 : \beta_{3,thd} \leq 0, H_1 : \beta_{3,thd} > 0.$$ 

### 3.4 The impact of environmental change on healthcare research

As China opens its door to the external world and with the increased degree of globalisation, the traditional Chinese medicine research is facing more and more challenge. While on the surface, the number of traditional Chinese hospitals increased significantly from 447 in 1978 to 2270 in 2007, many of these hospitals are actually modern hospitals; traditional Chinese medicine is dispensable. There were even debates about whether traditional Chinese medicine is ‘pseudoscience’.

Traditional Chinese pharmacology and traditional Chinese medicine are fundamentally different from the standpoint of Western science system. While the traditional Chinese pharmacology can be accepted into the Western science system, the traditional Chinese medicine is hardly compatible with it. Therefore, we can expect the extent of challenge brought by globalisation to these two distinctive research fields will be quite different.
Hypothesis 5 The deteriorating research environment will bring challenge to traditional Chinese healthcare research; the extent of challenge will be more significant on traditional Chinese medicine than traditional Chinese pharmacology.

We test the hypothesis by observing if the share of traditional Chinese medicine $R_{tcm}^i$ and traditional Chinese pharmacology $R_{thd}^i$ on all healthcare research decline over time and if the declining speed of $R_{tcm}^i$ is faster than the declining speed of $R_{thd}^i$.

Considering the impact of traditional Chinese medicine/drug’s application for world cultural heritage, we can only use the data before the application to study the pure impact of globalisation. Therefore, for the following model, we used the sample before September 2005 (which is six months before the application date on March 2006 to get rid of the impact of application) to test $\beta_{tcm} < 0$, $\beta_{thd} < 0$ and $\beta_{tcm} < \beta_{thd}$.

\begin{align*}
R_{tcm}^i &= \beta_{tcm}^0 + \beta_{tcm}^1 t \\
R_{thd}^i &= \beta_{thd}^0 + \beta_{thd}^1 t
\end{align*}

(5.1) \quad (5.2)

$H_0 : \beta_{tcm}^1 \leq 0, H_1 : \beta_{tcm}^1 > 0$

$H_0 : \beta_{thd}^1 \leq 0, H_1 : \beta_{thd}^1 > 0$.

We used dummy variables to test $\beta_{tcm}^1 = \beta_{thd}^1$.

A new array $R_t$ was generated, its first half was $R_{tcm}^t$, and its second half was $R_{thd}^t$, the sample size was 234. Dummy variable $D = 0$ for the first half sample and $D = 1$ for the second half sample. For the following model, test $\beta_3 > 0$

\begin{align*}
R_t &= \beta_0 + \beta_2 D + \beta_3 D t + \beta_3 D t
t \\
H_0 : \beta_3 \leq 0, H_1 : \beta_3 > 0.
\end{align*}

(5.3)

4 Data source

Our data set came from online Chinese Academic Literature Publication database, which is the biggest full content literature database for academic journals. It covers 99% of published periodicals and 99% of scientific literatures in China. The particular dataset used in this paper came from the statistical data organised by months and sub-disciplines of 'health/healthcare science and technology’ field, covering data from January 1995 to October 2008. Three variables were used, time, name of the sub-discipline and number of literatures/publications in the sub-discipline within this time. There are 28 sub-disciplines and covering a total of 5,808,894 publications. Considering the time lag of online publication, we did not use data after October 2008. To eliminate the seasonal factor of literature publication (i.e., bimonthly, quarterly, and biannually), we processed the data with annual moving average method. Our final sample ends up with 28 sub-disciplines, each covering 155 monthly data.

The distribution of each sub-discipline within all the literature is shown below:
5 Results

All the empirical results are shown in Table 1 and Table 2. Figure 2 and Figure 3 can help understand the results easier visually.

Hypothesis 1 was well supported. All 28 sub-disciplines generally followed the law of exponential growth; the lowest correlation coefficient between the logarithm of literature volume and time was 0.87, the correlation coefficient reached beyond 0.95 for 16 sub-disciplines.

Hypothesis 2 was also supported; it indirectly confirms that market has become the dominant force in determining resource allocation now in Chinese healthcare research field.

The SARS case showed that the infectious disease research increased significantly during the SARS eruption period, furthermore, after controlling for the head-raising and tail-raising effects, we found out that the impact of SARS is long-term. This was indicated by the statistically significant change in time trend of the share of infectious disease research on all healthcare research.

Hypothesis 3 was supported and it indicated that there exists the phenomenon of market failure in Chinese healthcare research field, especially when it comes to the delivery of public products. Therefore, basic healthcare research, as a public product, must be supported by the `visible hands`.
The impact of market demand

Figure 2  Time trend of logarithm of research output for some sub-disciplines (see online version for colours)

Figure 3  The time trend of share of some sub-disciplines on total healthcare research output (see online version for colours)
Table 1  Result of statistical analysis on exponential growth

<table>
<thead>
<tr>
<th>Field</th>
<th>$\beta_0$</th>
<th>$\beta_1$</th>
<th>Std. error</th>
<th>$t$-statistics</th>
<th>Prob.</th>
<th>Adj-$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endocrinology and metabolism</td>
<td>0.00232</td>
<td>57.83</td>
<td>0.000</td>
<td>0.956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese medicine</td>
<td>0.00136</td>
<td>63.69</td>
<td>0.000</td>
<td>0.9636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical medicine</td>
<td>0.001938</td>
<td>66.25</td>
<td>0.000</td>
<td>0.9661</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious diseases</td>
<td>0.003072</td>
<td>38.05</td>
<td>0.000</td>
<td>0.9038</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychiatry</td>
<td>0.004221</td>
<td>26.79</td>
<td>0.000</td>
<td>0.8231</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oncology</td>
<td>0.00132</td>
<td>83.74</td>
<td>0.000</td>
<td>0.9785</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventive medicine and hygiene</td>
<td>0.001656</td>
<td>63.86</td>
<td>0.000</td>
<td>0.9636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digestion disease</td>
<td>0.003122</td>
<td>33.04</td>
<td>0.000</td>
<td>0.8763</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pediatrics</td>
<td>0.001536</td>
<td>61.74</td>
<td>0.000</td>
<td>0.9612</td>
<td></td>
<td></td>
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<tr>
<td>Surgery</td>
<td>0.000955</td>
<td>96.98</td>
<td>0.000</td>
<td>0.9839</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicine and hygiene policy and law</td>
<td>0.001398</td>
<td>63.88</td>
<td>0.000</td>
<td>0.9636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstetrics and gynecology</td>
<td>0.001715</td>
<td>50.64</td>
<td>0.000</td>
<td>0.9433</td>
<td></td>
<td></td>
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<tr>
<td>Pharmacy</td>
<td>0.00136</td>
<td>63.69</td>
<td>0.000</td>
<td>0.9634</td>
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<tr>
<td>Clinical neurology</td>
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<td>38.73</td>
<td>0.000</td>
<td>0.9068</td>
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<tr>
<td>Chinese integrative medicine</td>
<td>0.003472</td>
<td>24.28</td>
<td>0.000</td>
<td>0.7926</td>
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<tr>
<td>Chinese pharmacology</td>
<td>0.001295</td>
<td>62.58</td>
<td>0.000</td>
<td>0.9622</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ophthalmology and otorhinolaryngology</td>
<td>0.001854</td>
<td>31.72</td>
<td>0.000</td>
<td>0.8672</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart disease</td>
<td>0.00116</td>
<td>30.88</td>
<td>0.000</td>
<td>0.9636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urology and nephrology</td>
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<td>32.55</td>
<td>0.000</td>
<td>0.873</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical care medicine</td>
<td>0.002298</td>
<td>31.2</td>
<td>0.000</td>
<td>0.8633</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical education</td>
<td>0.002035</td>
<td>33.37</td>
<td>0.000</td>
<td>0.8784</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military medicine and hygiene</td>
<td>0.003032</td>
<td>21.96</td>
<td>0.000</td>
<td>0.7575</td>
<td></td>
<td></td>
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<tr>
<td>Basic medicine</td>
<td>0.001126</td>
<td>57.12</td>
<td>0.000</td>
<td>0.9549</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dermatology and venereology</td>
<td>0.002246</td>
<td>27.98</td>
<td>0.000</td>
<td>0.8354</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special medicine</td>
<td>0.001854</td>
<td>31.72</td>
<td>0.000</td>
<td>0.8672</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stomatology</td>
<td>0.001627</td>
<td>31.63</td>
<td>0.000</td>
<td>0.8665</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedical engineering</td>
<td>0.001454</td>
<td>33.74</td>
<td>0.000</td>
<td>0.8808</td>
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<tr>
<td>Respiration</td>
<td>0.001725</td>
<td>28.16</td>
<td>0.000</td>
<td>0.8372</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The result of hypothesis 4 calls for more deliberate analysis. First, the result shows that the application for world cultural heritage had short-term impact and no long-term impact for traditional Chinese medicine research. The research resumed its original track completely after the application activities are over. (The time trend lines before and after the application are very similar in intercept and slope). Therefore, if the original intention of the government was to elevate the research status of traditional Chinese medicine, it was a failure in the long run. It calls for further research on how the government can guide academic research and the effectiveness of government interventions.
Table 2  Results of analysis hypothesis 2 to 5

<table>
<thead>
<tr>
<th>Equation</th>
<th>$\hat{H}_0$ (t-statistic)</th>
<th>$\hat{H}_3$ (t-statistic)</th>
<th>$\hat{H}_4$ (t-statistic)</th>
<th>$\hat{H}_5$ (t-statistic)</th>
<th>Adj R²</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2.1)</td>
<td>-1.03E-3*** (-22.5)</td>
<td>4.79E-3*** (7.27)</td>
<td>-4.09E-4 (-0.21)</td>
<td>6.64E-4*** (28.8)</td>
<td>0.77</td>
<td>155</td>
</tr>
<tr>
<td>(2.2)</td>
<td>1.88E-3*** (30.1)</td>
<td>-3.76E-3*** (-1.6)</td>
<td>1.86E-2*** (1.7)</td>
<td>1.07E-2** (1.3)</td>
<td>0.84</td>
<td>155</td>
</tr>
<tr>
<td>(2.3)</td>
<td>-1.31E-3*** (-28.2)</td>
<td>7.95E-4 (-0.4)</td>
<td>-1.81E-2*** (-28.0)</td>
<td>1.81E-2*** (1.7)</td>
<td>0.84</td>
<td>155</td>
</tr>
<tr>
<td>(2.4)</td>
<td>-1.99E-3*** (-25.4)</td>
<td>6.38E-4 (0.3)</td>
<td>-8.90E-4 (-0.3)</td>
<td>3.33E-3*** (2.9)</td>
<td>0.82</td>
<td>155</td>
</tr>
<tr>
<td>(2.5)</td>
<td>-2.41E-3*** (-26.1)</td>
<td>1.88E-2 (-0.6)</td>
<td>-2.28E-2 (-1.5)</td>
<td>-8.90E-4 (-0.3)</td>
<td>0.85</td>
<td>155</td>
</tr>
<tr>
<td>(2.6)</td>
<td>-5.85E-5 (-1.3)</td>
<td>2.01E-4 (-0.3)</td>
<td>-5.85E-5 (-1.3)</td>
<td>2.01E-4 (-0.3)</td>
<td>0.807</td>
<td>155</td>
</tr>
<tr>
<td>(2.7)</td>
<td>-6.75E-5 (-1.3)</td>
<td>2.01E-4 (-0.3)</td>
<td>-6.75E-5 (-1.3)</td>
<td>2.01E-4 (-0.3)</td>
<td>0.800</td>
<td>155</td>
</tr>
</tbody>
</table>
| Note: *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.
Further analysis indicated that the impact of application activity on traditional Chinese pharmacology is totally different from the impact on traditional Chinese medicine. On the surface, the result does not support the hypothesis of short-term impact of application on traditional Chinese pharmacology, while supports the hypothesis of long-term impact. However, more detailed analysis indicates that, even the short-term impact exists; it was confounded by the long-term impacts in the linear model, which led to the inaccurate conclusion. This short-term impact can be observed visually on Figure 2. As a matter of fact, after the application, the trend of traditional Chinese pharmacology research changed fundamentally. It changed from growing with average speed to a high speed consistent over the average.

It is clear to us that while both traditional Chinese pharmacology and traditional Chinese medicine research are all within the domain of Chinese traditional healthcare field, they are fundamentally different from each other. To some extent, the result of hypothesis 4 also indirectly supported hypothesis 5.

The result of hypothesis 5 shows China’s globalisation process has generated significant challenge to traditional Chinese medicine research, while has insignificant impact on traditional Chinese pharmacology. The result also confirms the hypothesis that the extent of challenge will be more significant on traditional Chinese medicine than traditional Chinese pharmacology.

6 Conclusions and discussion

In this research, we studied the development trend of Chinese literature volume in 28 sub-disciplines of the Chinese healthcare field between January 1995 and October 2008. It demonstrated that market demand; government intervention and research environmental changes are important factors influencing the Chinese healthcare research. Furthermore, it indicated the existence of the market failure in Chinese healthcare research field and showed the challenges brought to traditional Chinese healthcare research, especially to traditional Chinese medicine.

The impact of market demand, government intervention and environment changes to Chinese healthcare research can be short-term or long-term in nature. The government has to find out how to design the guidance mechanism with long-term effectiveness when it tries to provide guidance to the healthcare research field. The government also needs to be aware of the potential market failure and use ‘visible hands’ to eliminate the adverse effects of market failure.

Since the reform and opening up, the biggest environment change in Chinese healthcare research is globalisation. Globalisation, in a sense, is actually Westernisation. From this point of view, it is not hard to explain why challenges brought by globalisation on traditional Chinese medicine and traditional Chinese pharmacology were markedly different. Traditional Chinese pharmacology can be essentially included among the Western/modern scientific systems. It can find its theoretical basis from chemistry, botany, zoology, system science and other Western classical scientific theories. On the other hand, traditional Chinese medicine, with its own oriental theoretical system, cannot be integrated into the Western scientific system. The challenges facing traditional Chinese medicine are actually more serious than it appears, because some of the impact was diverted by traditional Chinese pharmacology. This is evident from debates in recent
 years about whether traditional Chinese medicine is a pseudo-science. The survival and
development of Chinese medicine has in fact faced with severe challenges.

The serious challenge to traditional Chinese medicine brought by globalisation is just
an epitome of impact of Western culture on traditional oriental culture. In these kinds of
impacts, the purer the oriental culture is, the stronger the challenge is.

We focused our study on healthcare research in China for the following reasons. First,
along with the significant growth in economy for the past two decades, Chinese
healthcare research has experience unprecedented growth both in term of quantity and
quality. Furthermore, the impact of economic reform on traditional Chinese medicine and
traditional Chinese pharmacology is of great interest to the Chinese healthcare industry.
That said, we expect the research method used in this paper is applicable to similar
studies in other countries and the conclusion can be relevant to other emerging market
countries.

Finally, studying the impact of market demand, government intervention and
environment changes to Chinese healthcare research through the lens of Bibliometrics is
a new attempt. We acknowledge of the limitation of the method and interpretation of the
results. There are a lot of room for more in-depth follow-up research and analysis in the
future.

References

Arrow, K. (1962) Economic Welfare and the Allocation of Resources for Invention. The Rate and
Direction of Inventive Activity, Princeton University Press, Princeton.


Huang, B. (2009) ‘Statistical analysis of articles published by the Children’s Hospital of Hunan


Price, D.J.S. (1987) Little Science, Big Science... and Beyond. Isis, December, Vol. 78, No. 4,
pp.589–591.

