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Performance impact of research policy at the Chinese Academy of Sciences☆

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ABSTRACT

We present evidence on productivity improvement experienced by the research institutes of the Chinese Academy of Sciences (CAS) after its implementation of the Knowledge Innovation Program (KIP). Using a balanced panel of data on R&D inputs and outputs of 59 research institutes in CAS, we analyze the productivity, technological and efficiency changes from 1997 to 2005. We document that the CAS research institutes have a productivity growth of 12.5% from 1998 to 2005, which can be further decomposed into 8.8% attributed to technological progress and 3.3% to efficiency improvement. Results of regional analysis show that institutes in Beijing and Shanghai, performed better than institutes in other regions during the same period.

1. Introduction

Public management reforms around the world have resulted in publicly funded research institutes facing more and more pressure for improvements in productivity and performance. Accelerating changes have led research institutes to nurture new ideas for managerial innovation that ultimately lead to increases in research capabilities and organizational productivity. However there is very little research available on productivity change in research institutes. As Crespi and Geuna (2008) write, "*After more than 50 years of scholarly work on the importance of public academic research, there is still little systematic evidence on how such investments can lead to increased levels of scientific output, improved patenting and innovative output, better economic performance and, ultimately, to increase in national wealth*."

This study is motivated by the following events: Since the 1990s, the Chinese government set the goal to make China an innovation oriented country and pledged to increase the financial funding of public research and development (R&D) activities. In this context, the Chinese government launched a pilot project of Knowledge Innovation Program (KIP) in Chinese Academy of Sciences (CAS) in 1998. The implementation of this program has increased the financial income and R&D expenditure of CAS, and at the same time Chinese government requires CAS to reform its old R&D organizational structure and its funds allocation system in order to produce more outputs to meet the national goals.

The aim of this study is to measure the productivity change of the research institutes in CAS during the years 1998–2005 by using the Malmquist productivity index approach based on a nonparametric production function. We employ a sample of 59 CAS institutes to carry out our study. We measure productivity change, technological change and relative efficiency change of CAS institutes, and employ the approach proposed by Banker et al. (2005) to test whether these changes are significant. The results of this paper address the controversial question: Is it effective for Chinese government to enhance its R&D investment in CAS and, further, is it worthwhile for the government to increase investment in R&D across the country? In addition, the results document in part the Chinese government's achievements in the establishment of a national innovation system.

The remainder of this paper is organized as follows: In Section 2, we provide a brief description of the history and role of CAS and the KIP. In Section 3, we describe various organizational changes that have occurred in CAS after the implementation of KIP. In

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Section 4, we review and discuss the input and output data used in this research. In Section 5, we employ a modified Malmquist productivity index to measure the productivity change and its different components, and describe our nonparametric estimation models. We present the empirical analysis and results in Section 5 and relevant regional analysis in Section 6. In Section 7, conclusions are summarized and the challenges faced by CAS and its institutes are discussed.

2. A brief background of CAS and the KIP

In 1949, CAS was established under the administration of the State Council of China. As a national research institution, CAS has made significant contributions in the past 60 years to the modernization of the industrial, agricultural and national defense sectors. Over the years, CAS has been the driving force of scientific research and development in China. A majority of the most outstanding scientists in China are now working for or used to work for CAS. In 2006, CAS had 84 institutes, 1 university, and other technical supporting institutions located across more than twenty provinces in China. CAS also maintains close ties with scientific researchers from universities and other organizations around the country. In the area of basic research, CAS has extensively developed many natural science disciplines, including mathematics, physics, chemistry, mechanics, astronomy, life sciences and earth and environment sciences. So far CAS' researchers have accounted for approximately half of all high quality papers from China, published in top scientific research journals such as Nature and Science.

In December 1997, CAS submitted a report titled "Strive to Build a National Innovation System to Meet the Era of Knowledge-Based Economy" to the State Council. In June 1998, CAS formally launched the pilot project of the national Knowledge Innovation Program (KIP) with a schedule to complete it in 2010. KIP is divided into three phases: the Initial Phase (1998–2000), the Phase of All-round Implementation (2001–2005), and the Phase of Optimization (2006–2010). In the Initial Phase, CAS enacted an initiative to rebuild the institutes for the purpose of improving their performance and better meeting the needs of the government and society (see Section 3.3 for more details). In the Phase of All-round Implementation, CAS deepened the organizational reforms carried out in the Initial Phase. In the Phase of Optimization, CAS built ten innovation bases to establish an innovative network among institutes to promote collaboration among the institutes (see www.cas.cn for more details).

Approximately half of the funding of CAS is the regular funds granted by the central government. The other half of the funding is external grants obtained through a competitive process. Researchers in CAS must compete against researchers across the country for research projects funded by national funding agencies, such as Ministry of Science and Technology of China (MOST), National Natural Science Foundation of China (NSFC) and other funding sources. To support the implementation of KIP, the central government also provides special funds named "innovation funds" to CAS. These innovation funds are primarily used for the adjustment of organization structure and disciplines within the institutes, the construction of science and technology (S&T) infrastructure, the retention and attraction of excellent researchers, and the settlement of laid-off researchers. The total financial income of CAS has increased rapidly since 1996. This is illustrated in Fig. 1.[1]

The implementation of KIP has promoted the R&D activities in CAS. Accordingly, the number of scientific papers is increasing rapidly. CAS has selected Max Planck Society of Germany (MPG), French National Center for Scientific Research (CNRS) and Russian Academy of Science (RAS) for benchmarking, because they are all world renowned national research institutions. Generally, they have similar mission and goals, and play an important role in basic research in their countries. As Fig. 2 shows, CAS is ahead of these institutions in achieving incremental change in publishing international scientific papers. The number of SCI papers by CAS has exceeded that by MPG and RAS.[2] For instance, in 1998 the total number of CAS's SCI papers was 6176 and that of MPG was 6822; while in 2005 CAS published 8413 more SCI papers than MPG. However, in terms of paper quality (citations per paper), CAS still has a big gap when compared with MPG and CNRS (see Fig. 3 for details).[3]

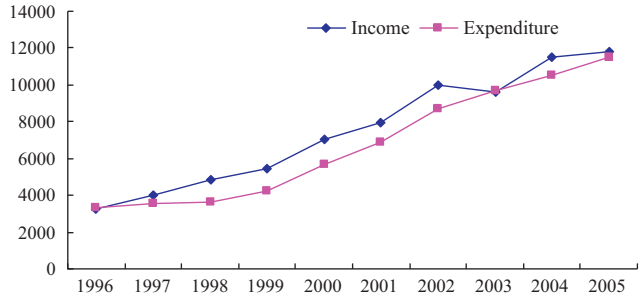

Fig. 1. Total income and expenditure of CAS institutes measured in (deflated) millions of RMB.
Data source: Statistical Yearbook of CAS in 2006.

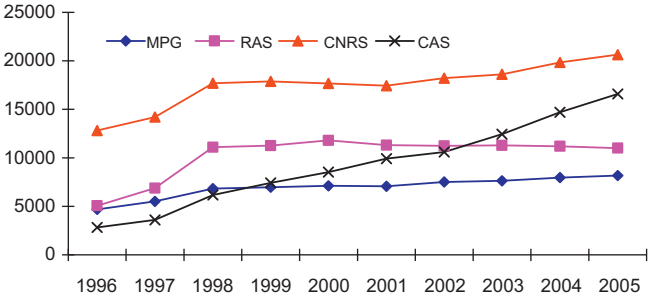

Fig. 2. Total number of SCI papers published.
Data source: ISI Web of Science—Science Citation Index Expanded.

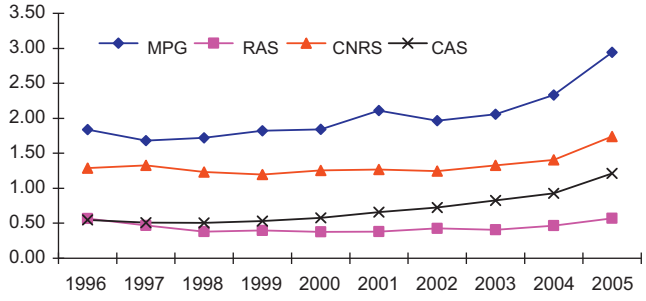

Fig. 3. Citations per paper.
Data source: ISI Web of Science—Science Citation Index Expanded.

[1] The income and expenditure have been deflated by Consumer Price Index (CPI).

[2] SCI papers refer to those research papers published in the journals catalogued by Science Citation Index (SCI).

[3] We acknowledge that citations per paper is only a partial measure of research quality.