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Building global-class universities: Assessing the impact of the 985 Project

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ABSTRACT

In 2006 China had become the fifth leading nation in terms of its share of the world's scientific publications. Today it is second only to the United States. This achievement has been accomplished in part by a conscientious effort by the government to improve the research performance of China's universities through a series of programs, the most important of which is the 985 Project. This paper considers the effects of the 985 Project on increasing the rate of publication in international journals by researchers at 24 universities. Using the approach of linear mixed modeling, it was found that the rate of growth in publications by lower tier universities exceeded that of China's two most highly regarded universities after controlling for university R&D funding, university personnel size, and provincial per capita income. It was also found that the rate of growth of publications for universities as a whole increased more quickly after the implementation of the 985 Project.

1. Introduction

China's emergence on the global economic map has been nothing short of remarkable. While the economic success has been undeniable, there has been ample criticism of a putative lack of innovative capability and backwardness in terms of global scientific contribution. Undoubtedly, historically Chinese universities have been under-funded and overly concentrated on undergraduate training, while making minimal contribution to the global scientific community (Hayhoe, 1987). By the late 1980s, Chinese policymakers had become seriously concerned about a perceived relative technological backwardness and launched programs meant to strengthen the nation's technological and scientific capabilities (Feigenbaum, 2003; Hu and Mathews, 2008; Jakobson, 2007; Segal, 2003). As the economy grew, largely on the basis of providing low value-added manufacturing, political leaders came to believe that better university research and graduate training were necessary, as part of an integrated economy-wide strategy for overcoming the nation's technological backwardness (Hayhoe, 1996) and building a technically trained workforce (see, for example, Simon and Cao, 2009). There seems to have been near unanimous agreement that this catch-up was critical to realizing the goals of the Chinese leadership (see, for example, Feigenbaum, 2003).

This consensus motivated the adoption of policy measures to overcome what had been identified as seriously inadequate research productivity in Chinese universities. In 1998, the shift in emphasis was announced by then Chinese President Jiang Zemin at the Centenary Celebration of Beijing University. The centerpiece of this shift was a massive new program commonly known as the 985 Project, whose specific goal was to improve the global standing of a select group of Chinese universities. Given the ambitious goals, enormous size, and global implications of this effort, this paper examines the program's results.

The outcome of the Chinese effort is significant because universities throughout the developing world are being called upon to play a more active role in upgrading their national innovation system. It is also of interest because, in contrast to the other East Asian developing nations, China is investing in university research quite early in the economic development process. For example, in both the case of Taiwan and Korea, only recently has research performance become an important goal. Prior to this, the university's main role was to provide trained personnel (Hu and Mathews, 2008). To improve their universities' performance the Chinese government is undertaking a massive program of selective investment, not so much with the goal of increasing their size, but more narrowly focused on improving the research quality of its universities.

In percentage terms, the 985 Project initiated by the Chinese government is a critical component of one of the largest sustained increases of investment in university research in human history. To illustrate, from 1999 through 2008, the compound annual growth rate (CAGR) of Chinese university R&D expenditures was 22% – a sum that exceeding the 15% CAGR of GDP (Ministry of Science and Technology, 1999–2009).[1] This rate of growth in university R&D

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[1] University R&D has ranged between 8.5% and 10.5% of China's total R&D between 1999 and 2008, and the annual growth rate of both has been close to identical, with university R&D growing at 22.4% and total R&D growing at 23.7% annually.

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expenditures is greater than was that of the U.S. in the immediate post-Sputnik era[2] – an era that propelled U.S. research to global preeminence (see, e.g., Geiger, 1993; Graham and Diamond, 1997). This is the result of the Chinese government's decision that the growth rate of education finance funding from governments at all levels should exceed the growth rate of their regular revenue (Education Law of the People's Republic of China, 1995). In a pioneering work, Zhou and Leydesdorff (2006) examined the efficiency of overall national growth in investment in terms of the number of international Science Citation Index (SCI) publications. They found that the increase in funding through 2007 was efficient in that funding growth was converted into publication growth. While their results apply to the Chinese R&D system as a whole, this paper, using a previously unexploited database of Chinese government statistics, considers the effects of the 985 Project on increasing the rate of publication in international journals by researchers at 24 individual 985 universities under the purview of the Ministry of Education.[3]

Due to the enormous size of this policy experiment, and the importance to China of building a trained workforce of individuals capable of participating in the global technological and scientific community, understanding the results of the 985 Project should be of great interest to many, not least in developing nations intent on improving R&D capabilities.

2. Placing Chinese science in a global perspective

The Chinese economy has experienced rapid growth and built an export-oriented national production system linked by global value chains to the world's leading economies (Hu and Mathews, 2008; Breznitz and Murphree, 2011). Chinese government policy has aimed to transform the economy from one based on producing lower value-added products and being dependent upon intellectual property owned by foreigners (Dobson and Safarian, 2008), to one in which China also performs higher value-added functions in the value chain (Breznitz and Murphree, 2011). The Chinese government, whose leadership today is dominated by leaders with engineering or science backgrounds, has accepted the premise that its national innovation system must begin producing global-class science and technology as the foundation for long-term economic development. As a result, strategies for enhancing national research and innovation capabilities occupy an increasingly important position in China's development policy (Wu, 2006).

The current Chinese approach to upgrading its national innovation system differs from most advanced nations, and in particular the earlier East Asian Tigers (Hu and Mathews, 2008; Sohn and Kenney, 2007) within which research institutes and industry were the major source of innovation. Given the limited innovation capacity of Chinese firms, the government has turned to research institutes and universities as a source of capabilities for addressing industry's practical problems (Hong, 2006, 2008). Also, in contrast to these other economies, Chinese policy makers are motivated by a sense that China should assume a position among the global scientific powers to accompany and reinforce its increasing economic and political power.

The extensive role of public-supported research institutions in performing industrial R&D in China has a long history. Prior to the reforms of the 1980s, research institutes had the primary responsibility for conducting national R&D (Liu and White, 2001). Traditionally, industry relied heavily upon research institutes and, to a lesser degree, universities for technology improvement (Hong, 2008) and only recently has this changed as some firms, such as Huawei, have begun to invest heavily in their own R&D.[4] With economic reforms, increasing involvement in the global economy, study of the R&D systems of other nations particularly the U.S., and an awareness of the need to rapidly improve China's technological expertise, it was decided that Chinese universities should play a greater role in performing research (Wu, 2006; Fischer and Zedtwitz, 2004; Orcutt and Shen, 2010).

Another unique feature of Chinese national innovation system (NIS) is that universities and research institutions (URIs) own enterprises (see, e.g., Chen and Kenney, 2007; Eun et al., 2006; Kroll and Liefner, 2008; Liu and Jiang, 2001). There have been some successful enterprises, such as the University of Beijing's Founder Group, Tsinghua University's Tong Fang, and Legend/Lenovo, established by computer technology personnel from Chinese Academy of Science, that can be directly traced to URIs and which have contributed substantially to the upgrading of the economy's technological capabilities. However, recently many URIs have been reducing their involvement and investment in business activities and have moved away from financing and controlling spin-off enterprises (Kroll and Liefner, 2008).

As one might expect in a dynamic and evolving NIS, the role of Chinese universities has been changing. Initially, their paramount role was providing trained personnel for industry. Later, they were expected to provide technical problem-solving for the private sector. Most recently, although the earlier goals remain, expectations are that they will conduct research that is recognized internationally.

The Chinese strategy for building its national innovation capacity differs from that of the East Asian Tigers (Korea, Singapore, Taiwan and Hong Kong). The Tigers depended to a far greater degree on key private firms and government research institutes, as universities were until very recently devoted to teaching (Hu and Mathews, 2005). In contrast, while encouraging both domestic and foreign firms to increase domestic research and continuing to support the research institutes, China has dramatically increased its investment in university research in the pursuit of developing a knowledge-based economy (Leydesdorff and Zeng, 2001).

The expansion of Chinese publications in international journals has been extraordinary (Leydesdorff and Wagner, 2009). For example, Fig. 1 shows article publications in Science Citation Index (SCI) journals of major countries from 1989 to 2009. The growth trajectory of China is striking, as it overtook the UK in 2008 and only trails the US. In 1989 the number of SCI papers by Chinese authors was only 3% of the number by U.S. authors. By 2008 this proportion had risen to 30% of the number by U.S. authors. As a point of comparison, publication by Italian and French researchers experienced only slow growth resulting in a drop in their global share. The United Kingdom, Germany, and Japan managed to retain their overall share. The nation experiencing the greatest growth in publication share was China. A recent report by the Royal Society (2011: 43) indicated it was possible that China could overtake the U.S. in terms of the sheer number of scientific publications as early as 2013 or, more probably, in 2020. In some specific areas, such as nanotechnology, China has become the world's second leading producer of nanotechnology research articles in number, and in one account, may be on the way to becoming the leader by 2012 (Lenoir, 2011). In overall terms of article citations published by their scientists, though, the U.S., in particular, and to a far lesser degree the United Kingdom, maintain enormous leads.

[2] For example, from 1958 through 1968 U.S. university R&D had a 16% CAGR.

[3] The limitation of the study to universities managed by the Ministry of Education is necessary because data for the other universities is not reported in a comparable fashion.

[4] One measure of this is that from 2006 to 2010 of the top fifteen U.S. Patent and Trademark Office (PTO) filing employers in China filing for patents at the U.S. Patent and Trademark Office, only three were Chinese firms, though the general category "individuals" was the second largest filer (USPTO, 2011).