THE IMPACT OF THE NATIONAL STRATEGY FOR RESEARCH AND INNOVATION ON THE ECONOMIC DEVELOPMENT OF A COUNTRY

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Abstract: *In recent decades the economic growth based on innovation is no longer just the privilege of the industrialized countries, of countries with a high GDP. More and more developing or emerging countries have turned innovation policies in national development strategy. The economic practice has shown that innovation is one of the main drivers of economic growth. The question is: How can a developing or emerging country support financially and managerially a macroeconomic policy for innovation and especially how can it implement innovation in economy. The paper presents comparatively the situation of innovation in China and the US as an argument that a country that has shaped the innovation policy over more than 20 years may come to compete in this area with the strongest economy in the world. In 1978 China introduced the policy of innovation in the education sector, reforms that have generated an accelerated progress in higher education and research, aimed mainly at increasing the standard of successful innovation and technology. In 2010 China was the second largest economy, surpassing Japan in macroeconomic terms, and in 2014 China's GDP reached US $ 10 trillion dollars. China also leads in innovation among BRICS nations (Brazil, Russian Federation, India, China and South Africa). All these achievements were due to the political and innovation reform that China supported for several decades. In the late 1970s, China implemented a series of R&D policies to stimulate the economy and to transform the education and research system into a system close to economy. The example of this country has changed the paradigm according to which innovation and research as well as their application in the economy are only possible in industrialized countries and has also demonstrated that R&D are vital to the progress of economy.*

Keywords:innovation, education, research, reforms,

JEL classification:F510, F370,K220, F50, F02

Introduction

All countries in the world, regardless of the level of development or macroeconomic structure have perceived the need for innovation as a defining factor in their economic growth. The innovation policies at the macroeconomic level have taken different forms, depending on how countries perceive this need: supportive government policies, subsidies, stimulating fiscal policy and adaptation and modernization of the education system. At this level, almost all the methods have had positive effects. The problem facing most emerging / developing countries is the road taken from innovation and research and development to application in economy.

The literature increasingly discusses the example of China, which, in 2014 was ranked number 2globally in the GII classification in terms of knowledge and technology outputs.

This ranking is the result of a macroeconomic policy, designed and implemented by the Chinese government for a period of 30 years.
In the late 1970s China began implementing a research and development system at the macroeconomic level, a system whereby they tried and subsequently proved successful to stimulate the economy. In the *experimental phase*, carried out between 1978-1985, the initial steps focused on the spin-offs development and the privatization of public research institutions, which had to survive by capitalizing their own RD products. This first phase ended in 1984 with the implementation of the National Key Research Projects (1984), a project by which national laboratories started to focus on privately financed projects.
The *systemic reform* phase (1985-1995) resulted in the development of a national research strategy called Science and Technology System Reform Act. The main objective of this strategy was to bridge the gap between the innovations afferent to research institutions and those implemented in the relevant industries of the economy. To achieve this objective a number of initiatives to improve their marketability perspectives have been implemented - 863 Program (1986), theSpark Plan (1986), theTorch Plan (1988), andtheShenzhenStock Exchange for small and medium sized enterprises (1990) (Spark Plan can be found at Cao, 2006, and at http://in.china-embassy. org/eng/szyss/jm/zhongguonongye/ agricultureplanning/t143140.htm).
1993 is a decisive year for the RD reform, when the Chinese government implements the so-called - 211 Project, a project by which money has been allocated for applied research, to a group of large universities, such as Programme—the Hundred Talents Program of the Chinese Academy of Sciences – for the Chinese researchers who worked abroad and who wanted to return home (Hundred Talents Program, see http://english.ucas.ac.cn/JoinUs/Pages/TheHundredTalentsProgram. Aspx)
The *deepening reform* phase (1996-2006) debuted with the Act of Promoting Commercialization of S & T Discoveries and Inventions, a law attempting to rejuvenate the nation's economy with science and education. The fundamental objectives of this law aimed at moving the RD results towards the industrial sector, that is the application in economy of everything meaning innovation in RD. In another direction, the Chinese government has significantly increased the salaries of teachers and researchers to increase the attractiveness of universities as employment entities. So far, through these measures, more than 2000 researchers have been attracted from abroad, who chose to return to China.
China is an example of a country that consistently thought and implemented a macroeconomic policy and that turned this country into a world leader in the export of technology. In the year 2013, even if in terms of human capital and research, China is below the US as an indicator of education, China is far ahead of the US.

Indicator Name	China Score 0–100 or value (hard data)	United States of America Score 0–100 or value (hard data)
Human capital and research	43.1	54.0
Education	70.8	52.1
Tertiary education	11.7	39.0
Graduates in science and engineering (Tertiary graduates in engineering, manufacturing, and construction (% of total tertiary graduates)	0.0	30.1
Tertiary in bound mobility (The number of students from abroad studying in a given country, as a percentage of the total tertiary enrolment in that country.)	1.1	15.0

Source : *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

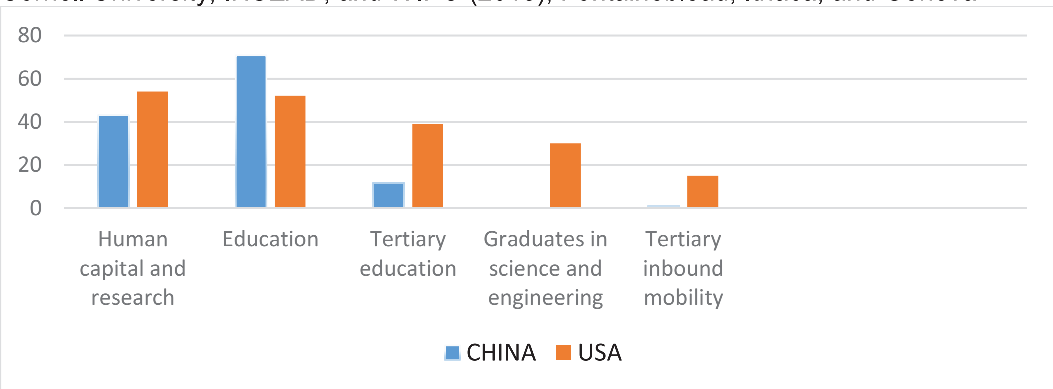


Figure 1Source : Own adaptation from *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

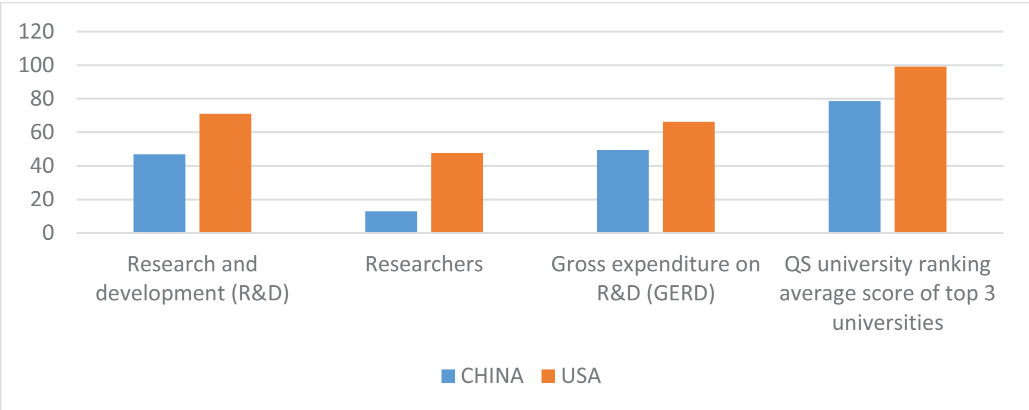
Despite all the strategies to attract Chinese researchers from abroad, China presents an important shortage of researchers (per 1 million inhabitants) compared to the USA. Also, gross expenditure on R&D as % of the GDP fail to reach the level of the American economy and the Chinese universities record a much lower score than the American universities.

Table 2: Research and development China -USA

Indicator Name	China Score 0–100	United States of America Score 0–100

	or value (hard data)	or value (hard data)
Research and development (R&D)	46.9	71.1
Researchers (Researchers, full-time equivalence (FTE) (per million population)	12.8	47.7
Gross expenditure on R&D (GERD)- (Gross expenditure on R&D (% of GDP)	49.4	66.3
QS university ranking average score of top 3 universities (Average score of the top 3 universities at the QS world university ranking)	78.5	99.2

Source : *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva



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Source : Own adaptation from *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

One area where China has supremacy is the RD expenditure financed by business enterprises, which demonstrates that the Chinese government's policy to create a link between the research centres and the economic environment has been successful. A negative situation is recorded in terms of the relationship between universities and the economic environment. The explanation is found in the fact that the policies to stimulate research in laboratories and research centers began 10 years earlier in terms of research in universities.

Table 3 : RD and business enterprises China -USA

Pillar/Sub-Pillar/Indicator Name	China Score 0–100 or value (hard data)	United States of America Score 0–100 or value (hard data)
GERD performed by business enterprise (Gross expenditure on R&D performed by business enterprise as a percentage of GDP)	45.9	56.1
GERD financed by business enterprise (Percentage of gross expenditure on R&D financed by business enterprise)	98.6	78.1
University/industry research collaboration (Average answer to the survey question: In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively])	56.7	80.8
GERD financed by abroad (Percentage of gross expenditure on R&D Financed by abroad—i.e., withforeign financing)	0.9	4.6

Source : *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

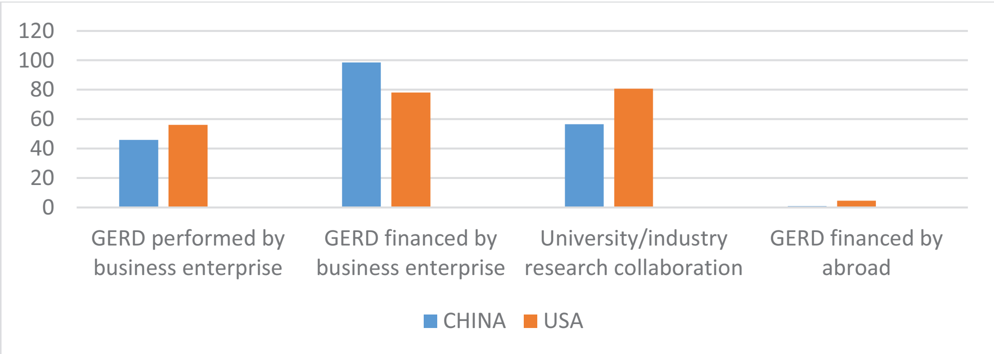

Figure 3 RD and business enterprises China -USA
Source : Own adaptation from *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

In the field of publishing and dissemination of research results, the US recorded a relatively small advance compared to China. One especially relevant indicator is High-tech exports (High-technology exports minus reexports (% of total trade) where China clearly dominates compared to the US; a possible explanation is that the export of technology is entirely based on research conducted on the Chinese territory, without resorting to imports and re-exports of technology.

Table 4: Knowledge and technology China USA

Pillar/Sub-Pillar/Indicator Name	China Score 0–100 or value (hard data)	United States of America Score 0–100 or value (hard data)
Knowledge and technology outputs	58.0	58.0
Knowledge creation	64.1	68.5
Scientific and technical publications (Number of scientific and technical journal articles (per billion PPP$ GDP)	20.9	30.9
Citable documents H index (The H index is theeconomy's number of published articles (H) that have received at least H citations in the period 1996–2013)	45.9	100.0
Knowledge impact	67.2	56.0
Growth rate of GDP per person engaged (Growth rate of GDP per person engaged (constant 1990 PPP$) | 2013)	100.0	56.6
Knowledge diffusion	42.8	49.5
High-tech exports (High-technology exports minus reexports (% of total trade)	100.0	28.7

Source : *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

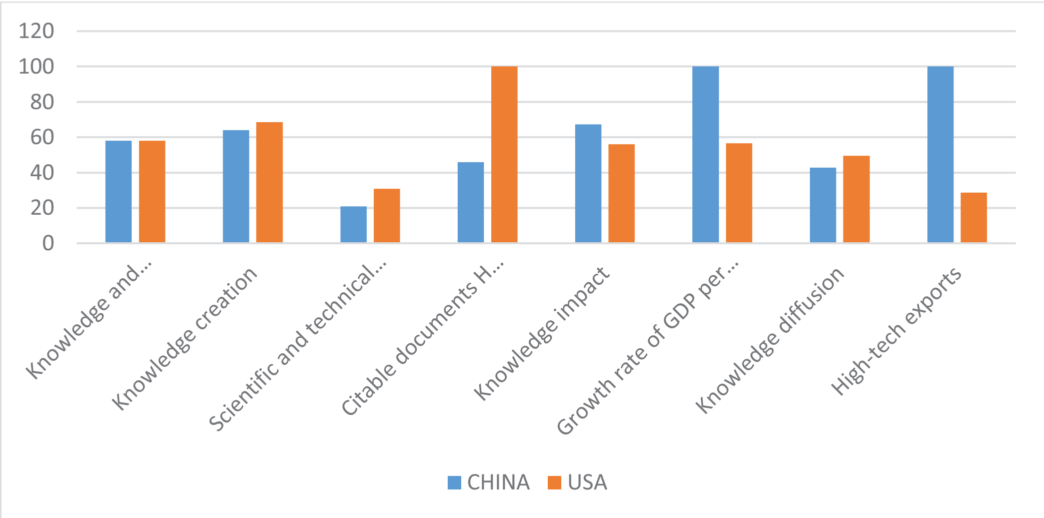

Figure 4 Knowledge and technology China USA
Source : Own adaptation from *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

Table 5 Creative goods and services China -USA

Pillar/Sub-Pillar/Indicator Name	China Score 0–100 or value (hard data)	United States of America Score 0–100 or value (hard data)
Creative outputs	35.1	47.8
Intangible assets	52.4	45.6
Creative goods and services	33.0	39.7
Creative goods exports (Creative goods exports (% of total trade)	100.0	35.3
Creation of online content	2.6	60.3
Innovation Output Sub-index	46.6	52.9

Source : *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

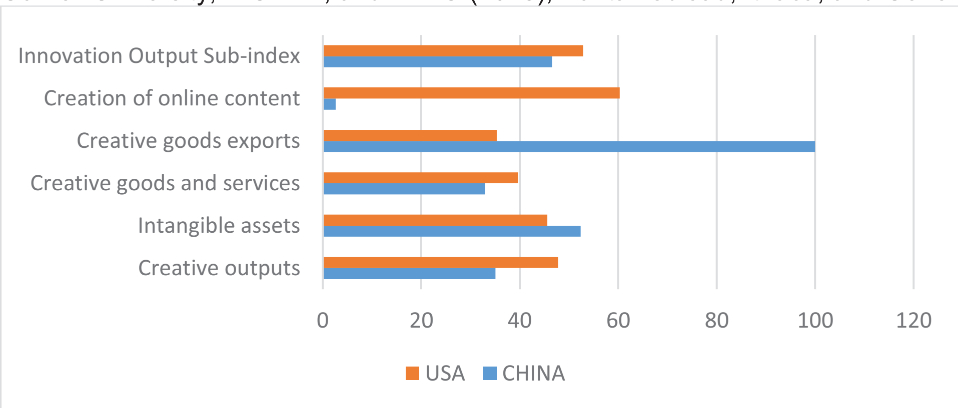

Figure 5 Creative goods and services China USA
Source : Own adaptation from *The Global Innovation Index 2015 – Effective Innovation Policies Development*, Cornell University, INSEAD, and WIPO (2015), Fontainebleau, Ithaca, and Geneva

The macroeconomic measures taken by China over several decades have reduced the gap existing between China and the major industrialized countries of the world. This is demonstrated by the fact that the total R&D investment in China increased from about 1% of GDP in 2002 to 2% of GDP in 2012 (These data are from CNKI (China National Knowledge Infrastructure), the largestChinese database, which contains abundantdata for almost every field in science andsocial science. CNKI is available at http://)

In conclusion

The data presented above demonstrate that the successful development of innovation in China cannot be separated from the development of the education system and finding ways of partnership between innovation / research and development suppliers and the economic environment that must absorb these innovations. The reform carried introduced the basic education as a pillar of macroeconomic development, with emphasis placed on human resources in universities and colleges. The number of university graduates in China increased from 1,337,300 students in 2002 to 6,081,600 in 2012, with an annual growth rate of 16.4% growth. The number of master's and doctoral graduates increased from 80,800 in 2002 to 486,500 in 2012, with an annual growth rate of 19.7% (National Bureau of Statistics of China, 2013b). It is a fact that the policies to support innovation in China had the desired effect, also demonstrated by the pace of economic growth in the period 2002 – 2012. Moreover, the positive effects generated by the development of research laboratories at national and regional level, have encouraged firms from the industrial sector to lean more towards the innovative side. The strategy to support young researchers has accelerated the development of higher education system. Although China has made remarkable progress in RD, there are still important gaps compared to the industrialized countries in terms of investment in basic research and research infrastructure.

For 2020 China has set the objective of attaining the status of innovative country leader. Achieving this objective is conditional on further reform in the field of research and education, followed by reforms leading to the modernization of the legal system and of the and regulatory systems, to the encouragement of market forces, the development of entrepreneurship and stimulation of competition among all the stakeholders.

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