CHINA'S TRANSITION TO A KNOWLEDGE ECONOMY INSTITUTIONAL MECHANISMS, PUBLIC POLICIES AND PRIVATE INVESTMENT

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Abstract
This study identifies and describes the underlying mechanisms, structural causes, public policies and institutional arrangements that drive China's transition towards a more innovative economy. It highlights the key characteristics of the national innovation system, in respect to funding for research, government's role and public policies, inbound and outbound foreign investment as well other factors. The study does not attempt to evaluate how innovative China is, but explains how innovation actually occurs in China.
China's technological progress relies on unique mix of liberalization, imitation, incremental innovation, strong R&D spending, burgeoning market scale, competition between local governments and strong central policies. Progress is uneven, as several technological sectors and administrative regions are global leaders, whereas others fall far behind. Elements of this landscape might be of use to other developing economies. However, due to the peculiarity of China's, including its economic and demographic scale, as well as its political system, its solutions might only fit China.

Keywords
China, innovation policy, R&D expenditure, foreign direct investment, high-tech exports

JEL Classification
H50, L24, O25, O38

Introduction

China's gross expenditure on research and development (GERD) is increasing year by year, has exceeded that of the European Union as a whole in 2014 and is predicted to exceed United States by 2020. According to *Global Innovation Index 2017* (Dutta, Lanvin, and Wunsch-Vincent), China (without Hong Kong) became the 22nd most innovative country in the world, and the only middle-income nation in Top 25. Gaps are narrowing, but China still has a long way to catch-up in order to become a leading innovative economy.

This study aims to identify and describe the mechanisms, structural causes, policies and institutions behind China's transition to a more innovative-driven growth model. The main areas to be explored are: funding for research; governmental policies; influence of foreign companies; investments abroad and others. It is not in the scope of this paper to measure the performance, quality or level of innovation. The paper will not address the question "How innovative is China?", a legitimate research topic which is due to further endeavors. Instead, this paper's main question is "How does China innovate?

Literature review

What is innovation?

The Austrian scholar Joseph Schumpeter is the forerunner of the study of innovation, concept that he placed at the core of his *Theory of Economic Development* (1934). He defined innovation as "creative destruction" – the process through which novel methods, products and ideas are transformed by firms and entrepreneurs into economic outcomes, resulting in the creation of new industries and markets and the destruction of old ones. Hage and Rogers Hollingsworth (2000) introduced the concept of "idea innovation network", distinguishing between different types of research: basic, applied, product development, production research, quality control research, and marketing.

The Organization for Economic Cooperation and Development classifies innovation on the basis of where it occurs into: product, process, marketing and organizational(OECD/Eurostat 2005). It might be incremental, which is to make gradual improvements over previous methods and products, or radical, which is to create new concepts and technologies that are highly different from the previous ones and have the potential to significantly change industries, and even create new industries whatsoever. Obtaining different types of innovation involves different degrees of difficulty, starting from the easiest - process innovation, following with incremental innovation and finally, the hardest, radical innovation(Li, 2017).

Innovation as a driver for economic growth and "catching-up"

Economic growth is the result of changes in production inputs, technological progress and productivity level, while the latter two are strongly related (Solow, 1957). Developing countries make efforts to "catch-up" with advanced economies, aiming to reduce income and technological gaps (Lee, 2013). During incipient and intermediary stages of catching-up, factor accumulation is highly important, including but not limited to machinery procurement, increase of human capital, infrastructure and constructions. At this stage, importing mature technology is the only way to narrow the technological gaps. Domestic innovation is still too costly, time-consuming and not feasible whatsoever. As the economy develops further and reaches middle-income level, the marginal effects of investments in factor accumulation gradually diminish(Liu et al., 2017). In order to maintain economic growth and momentum for transition towards high-income level, a country requires a different set of strategies. Otherwise, it risks to fall in the middle-income trap, the same way as it happened to several countries in Central and South America or the Middle East (Gill and Kharas, 2007).

How does innovation occur?

The National Innovation System (NIS) it is the most widely employed framework in innovation studies. It can be defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies"(Freeman, 1987). NIS thus puts innovation in a specific national institutional context where innovative players at different levels are in constant interaction. These interactions constitute the very fabric of the system and are shaped by factors such as culture, institutional arrangements, policies etc (Nelson, 1993). The main innovative players are firms, as they have the incentive to seek, store and accumulate innovation capabilities. However, their ability to innovate is influenced by interactions with a broad array of external organisations, state and private actors, suppliers, customers, markets etc (Li, 2017).

Methodology

Informational input is based on an extensive review of the most recent academic works covering world innovation in general and Chinese in particular, both from international and Chinese sources. Giving the highly dynamic nature of the topic under research, academic understanding has a significant temporal delay against empirical reality. For this reason, in general, it uses only academic works and data newer than 2014. However, it is well understood that the theoretical framework and fundamental concepts are based on earlier literature, beginning with Schumpeter's *Theory of Economic Development* (1934).

In order to assess governmental perspectives, a collection of official policy documents were analysed, as well as political statements from news articles and think-tank reports, in China, the United States and European Union.

Statistical data is collected from *China S&T Statistical Yearbook* (Ministry of Science and Technology), as well as international databases: *World Economic Outlook Database* (IMF, 2018), *Main Science and Technology Indicators* (OECD, 2018) and *UIS online database* (UNESCO Institute for Statistics, 2018). Very useful were also composite measurements such as *The Global Innovation Index 2017* (Dutta, Lanvin, and Wunsch-Vincent, 2017) and *The 2017 EU Industrial R&D Investment Scoreboard* (European Commission), which offer analysis on a large set of input and output factors, as comparisons among countries.

The same resourceful as secondary sources were on-site visits and interviews. I have visited industrial parks, high-tech companies, investment firms, government agencies and start-up incubators on a series of field-trips to China's major innovation clusters: Beijing, Guangzhou, Hong Kong, Shanghai, and Shenzhen. A series of structured, semi-structured and informal interviews were conducted with industry actors, policy stakeholders, consultants, journalists, researchers and members of the academia, both Chinese and foreigners.

Discussion

Funding for research

Between 2000 and 2015, China's Gross Expenditure on Research and Development (GERD) measured in current PPP $ has increased annually by approximately 18% (Ministry of Science and Technology various years). China counts for an ever-larger share of the global R&D spending and, since 2008, it has become the second biggest spender nation in the world. In 2014 it has surpassed the EU as a whole and following current trends, China could overtake the US around 2019. China's GERD expenditure relative to GDP, also known as R&D intensity, increased from 0.83 per cent in 2000 to 2.12 per cent in 2016. Although still behind US, Japan, Korea and OECD average, the nation is advancing quickly and has exceeded the EU. The 13th 5-Year Plan (2016-2020) sets an R&D intensity target of 2.5 percent by 2020, indicating that Chinese R&D expenditures will continue to rise.

Looking into the sources of funding, surprising is the fact that governmental direct funding for R&D accounts for just 21.26% of GERD. Actually, the government's contribution is lower than in Korea (23.66%), US (25.50%), EU (31.74%) and Russia (69.52%). Therefore, Business Expenditure for R&D (BERD) in China accounts for 74.73%, second only to that of Japan (77.97%). Data is confirmed by *China S&T Statistics Yearbook*, *OECD Main Science and Technology Indicators* and *UNESCO UIS* online databases.

If we compare R&D spending of Chinese companies to the rest of the world, the *2017 EU Industrial R&D Investment Scoreboard* (European Commission 2017) reveals that out of 2500 top world spenders with over € 24 million each, 376 companies are from China (combined amount $61.8 bn., 8% of total expenditure), whereas 822 companies are from US($290 bn.,39% total expenditure), 567 from EU($192,5 bn. 26%), 365 from Japan ($ 103.8 bn., 14%), and 370 from ROW ($96.4 bn., 13% total expenditure). The study records a fast growth of cumulated expenditure by Chinese firms included in the top, with 18.8% just in

2016. The growth is the fastest of all countries and is distributed across all industrial sectors considered, as well as across a large population of firms. However, the total nominal sum is still relatively small, given China's economic size.

2017 Global Innovation 1000 Study realised by PwC (2017) shows that amongst 1000 top global R&D spenders, 125 firms are from China, whereas 368 companies are from US, 235 from Europe and 171 from Japan.[1] If we narrow the ranking even further, in between 143 global companies that invest in R&D more than €1 bn., 14 firms are from China, whereas 51 from US, 39 from EU, and 22 from Japan.(PwC, 2017) Ultimately, in top 50 R&D spenders, there is only one Chinese company, Huawei, which occupies position 6. (European Commission, 2017)

Therefore, we can notice that Chinese BERD accounts for an important share of top global R&D spending which is growing rapidly. The global BERD of US and China are comparable, China being expected to exceed the US in the next few years. However, if we analyze firms distribution, we find that the more we narrow the rankings towards top spenders, the more the ratio of Chinese companies decreases. In top 2500 largest R&D spenders, 15% are Chinese companies. In top 1000 the ratio decreases to 12,5%, in top 143 to 10% and in top 50 to as low as 2%. The opposite is valid for United States, which hosts approximately 65% of top 20 R&D spenders.

Therefore R&D funding in China is particularly atomized and evenly distributed over a larger population of companies, especially outside Top 2500. The number of companies involved in R&D activities is relatively large, whereas funding per unit is relatively small. Furthermore, research efforts of Chinese companies in top 2500 are less focused on particular industries and are more evenly distributed across sectors. ICT production is the only dominant industry, accounting for 34% of all research spending. If we exclude Huawei, which accounts alone for 16.8% of all input, then ICT will decrease to 17.2% of all research spending, followed by automobiles and transport with 12.5% and ICT services with 10.1%. All the other industries account for less than 10% of research spending.

Such an atomized structure both across companies and industrial sectors brings more competition and dynamism throughout under-high tech sectors and sustains incremental innovation through improvements in production process, supply chain, business and marketing models. However, Chinese companies are relatively limited in their capacity to engage in expensive basic research with high risks and long-term gains, which is exactly the type that would eventually lead to radical breakthroughs. In other words, there are still no genuine Chinese competitors to innovation giants such as Alphabet and Amazon.

Policies and government

In terms of policies, the trigger for China's take off was the establishment of Special Economic Zones (SEZ) since 1980, areas of experimentation with market-principles and liberalised foreign investment. Some of them, such as Shenzhen, transformed into powerhouses of innovation and economic development, inspiring reforms across the whole nation.

As the market became larger and more attractive, foreign companies sought to receive access to their products. The Chinese government leveraged the opportunity and deployed the policy of "trading market for technology" (TMFT) (Xia and Zhao, 2012). TMFT has been restricting market access on conditions imposed by the government, related to the transfer of technology and production capacity to China. This usually translates into a compulsory joint venture between the foreign company and a domestic counterpart. The most known case is that of the automobile industry.

The government leads investments in those targeted areas and planned technologies that do not make financial sense for market forces, being too risky, expensive and lengthy. Such are

[1] This study does not include Huawei, China's largest spender.

the cases of wind turbines, high-speed rail, aircraft engines, and space-related industry. However, as discussed in the *Funding for Research* chapter, government direct funding for R&D accounts for less than 22% of GERD, while the large majority of funds is provided by the business sector. Nevertheless, private R&D is rather negligibly supported in terms of subsidies or favourable tax policies.

On the other hand, the government aims to remove ideological and institutional obstacles, stimulate cooperation between academia and industry, as well as to ensure a fair platform for competition and an efficient institutional environment (State Council of the People's Republic of China 2015a). Unlike previously, modern S&T strategies strongly emphasize the role of business-led innovation and the aim to commercialize technology. The state aims to stir "mass innovation and entrepreneurship" across a wide population of companies, calling for SMEs to increase their role in R&D (State Council 2015b, 2016).

Inbound and outbound FDI

Favourable policies attracted MNCs to move production in China, open branches and subcontract local companies. Initially, domestic innovation has relied on imitation and the direct import of technology. The pace was very fast, driven by the need to meet MNCs' requirements on cost, performance and quality for the goods manufactured in China (Steiber, 2018).

Domestic companies gradually began to adjust their products and services to the domestic market (Yip and McKern, 2016). Authors label this phase as "frugal innovation", which is to reduce premium features meant for developed markets, cut costs and adapt products for the local consumers (Li, 2017). China was incrementally adding to its technical know-how on the basis of a trial and error learning process, gradually employing best or near best-practice technologies (Yu, Yu, and Pan, 2017).

As the internal market grew and became more attractive, MNCs started not only to produce in China in order to sell abroad, but also to target the Chinese market itself. Domestic companies had to progress and reach higher standards in order to compete with foreign products on their own market. While foreign companies had superior technology, managing skills and a global network of resources, local companies benefited from inside-knowledge of the local markets. Chinese companies managed to move up the value chains through developing designs and technology, marketing capabilities and even attracting talents from MNCs. They made a natural use of the supply chain networks developed in China by MNCs in their global productions system, including high-quality component suppliers and subcontracted manufactures. Therefore, MNCs created both the resourceful industrial ecosystem and the competition pressure needed to drive the take-off of many Chinese successful companies. Such an evolution is maybe most visible in the ICT industry (Steiber, 2018, Li, 2017).

A more recent phenomenon is that of Chinese outbound investments. Investments abroad were first promoted in 2005 with the announcement of the "Go Global" policy. After the launch of the Belt and Road Initiative, the volumes of OFDI sky-rocketed, especially in developed markets. Direct exposure to foreign markets is enhancing Chinese companies' innovation capacity due to increased competition and knowledge transfer. Investing abroad is also a new means to acquire technology, talents and know-how.

According to the public figures released by China's Ministry of Commerce, FDI decreased in 2017 by 29.4% and reached $120 billion. This is because the government has installed capital controls, being weary about money-laundering and decreasing currency reserves. It has also set specific industry priorities for OFDI, encouraging technology-seeking investments in the detriment of other ventures. Despite recent setbacks, on the medium-term, it is expected that Chinese FDI will resume a tempered growth.

Conclusions

The experience of China shows that there is more than one way to progress. At the same time, one has to bear in mind that due to peculiarities such as political system and demographic conditions, the solutions found by China might only function for China.

Overall, economic reforms, imitation, incremental innovation, heavy R&D spending, large market scale, intense competition and a market-driven economy combined with pragmatic and sometimes strong central policies contributed in different ways to China's innovation landscape. China is still behind in many sectors, such as automotive, aerospace or high-tech industry. However, the tectonic plates are shifting. China's shares of global export markets is constantly increasing, not because manufacture would grow extensively, but because the economy is moving up the value-chain.

The nation is soon to become the largest R&D spender in the world. One of the main arguments of this study is the fact that, counter-intuitively, R&D funding in China is business-led, to an extend even larger than in the EU, US and Korea. On the other hand, government spending is also increasing, but on limited number of priority areas. Research spending is highly atomized and distributed across industrial sectors and population of companies. This reflects strong incremental innovation capacity and balanced technological development, or "mass-entrepreneurship and innovation" as policy-makers describe it. It also reflects the lack of real champions that can venture into costly, basic research, which eventually leads to radical scientific breakthroughs.

Chinese Government is not and does not aim to be the main actor or sponsor of innovation activities or the industry at large. It rather sees itself and acts as a platform and facilitator for a market-driven economy. However, there are times and specific sectors where the government considers necessary to intervene strongly in markets, which not rarely draws criticism from foreign policy and business circles. Its main policies in the field of innovation include: prioritizing certain strategic areas for resource allocation and favorable policies, stimulating the acquisition and import of foreign technology, intervening on markets when needed and sometimes in protectionist ways, reducing the nation's technological dependencies and vulnerabilities, attracting international talents, promoting outbound investments and others.

Learning from foreign companies was a fundamental driver for innovation in China. After the opening-up, foreign companies brought capital, technology and knowledge, re-shaped institutional frameworks and created a new type of industrial ecosystem. Some Chinese companies have accomplished to climb a reverse product cycle by imitation, variety creation and selection, achieving incremental improvements and eventually becoming competitive innovators themselves. Foreign companies also acted as a mobilizing factor of competition for domestic firms. They were both discriminated against and favored by the state in different stages and industries.

Finally, the study analyses recent trends in technology-oriented investments abroad carried by Chinese companies, usually in the form of mergers and acquisitions in developed markets. The main motivations for Chinese companies are entering those markets that are not easily accessible for Chinese brands, as well as acquiring fresh technology and talent. Chinese FDI outflows have increased vigorously in the last decade, but due to stricter regulations both in China and abroad, the last two years saw a relative decline in value and number of deals. The study argues such decline is situational, and the long-term trend of increasing investments will resume, probably at a more tempered pace.

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References

Dutta, S., Lanvin, B. and Wunsch-Vincent, S., 2017. *The Global Innovation Index 2017*. [pdf] Available at: < https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2017.pdf> [Accessed at 18 February 2020].

European Commission. 2017. *The 2017 EU R&D Industrial Investment Scoreboard*. Luxembourg, [online] Available at: <http://iri.jrc.ec.europa.eu/> [Accessed at 17 February 2020].

Freeman, C., 1987. *Technology and Economic Performance: Lessons from Japan.* London: Pinter Publishers.

Gill, I. and Kharas, H., 2007. *An East Asian Renaissance: Ideas for Economic Growth*. Washington, DC: World Bank. © World Bank, [online] Available at: <https://openknowledge.worldbank.org/handle/10986/6798> [Accessed at 24 March 2020].

Hage, J. and Hollingsworth, J.R., 2000. A Strategy for the Analysis of Idea Innovation Networks and Institutions. *Organization Studies*, 21(5), pp.971–1004.

International Monetary Fund. World Economic Outlook Database. Last updated 24th April 2018. Available at: <http://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx> [Accessed at 18 March 2020].

Lee, K., 2013. *Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-Creation, and the Middle-Income Trap,* [online] Cambridge: Cambridge University Press. Available at: <http://ebooks.cambridge.org/ref/id/CBO9781107337244> [Accessed 24 Apr. 2020].

Li, Y., 2017. *Innovation Pathways in the Chinese Economy*. Georgia Institute of Technology, [online] Available at: <http://hdl.handle.net/1853/59127> [Accessed at 28 February 2020].

Liu, X., Schwaag Serger, S., Tagscherer, U. and Chang, A.Y., 2017. Beyond catch-up—can a new innovation policy help China overcome the middle income trap? *Science and Public Policy*, 44(5), pp.656–669.

Liu, X. and White, S., 2001. Comparing innovation systems: a framework and application to China's transitional context. *Research Policy*, 30(7), pp.1091–1114.

Ministry of Science and Technology. *China Statistical Yearbook on Science and Technology 2018*. Beijing, [online] Available at: <https://www.chinayearbooks.com/tags/china-statistical-yearbook-on-science-and-technology> [Accessed at 30 March 2020].

Nelson, R.R. ed., 1993. *National innovation systems: a comparative analysis*. New York: Oxford University Press.

OECD, 2002. *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*. The Measurement of Scientific and Technological Activities, [online] OECD. Available at: <https://www.oecd-ilibrary.org/science-and-technology/frascati-manual-2002_9789264199040-en> [Accessed 24 Apr. 2020].

PwC, 2017. *2017 Global Innovation 1000 Will Stronger Borders Weaken Innovation?* [pdf] Available at: <https://www.pwc.fr/fr/assets/files/pdf/2017/10/2017-global-innovation-1000.pdf> [Accessed at 27 February 2020].

Schumpeter, J.A., 1980. *The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle.* London, Angleterre: Oxford University Press.

Solow, R.M., 1957. Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39(3), pp.312–320.

State Council of the People's Republic of China, 2006. *The National Medium- and Long-Term Program for Science and Technology Development (2006-2020) – An Outline*. [pdf] Available at: <https://www.itu.int/en/ITU-D/Cybersecurity/Documents/National_Strategies_Repository/China_2006.pdf> [Accessed at 16 February 2020].

State Council of the People's Republic of China, 2015. *CPC Central Committee and the State Council- Opinions on Deepening the Institutional Mechanism Reform and Accelerating the Implementation of the Innovation-Driven Development Strategy,* [online] Available at: <http://www.gov.cn/xinwen/2015-03/23/content_2837629.htm> [Accessed at 24 March 2020].

Steiber, A., 2017. *Management in the digital age: will China surpass the Silicon Valley?* Springer Briefs in Business. Cham, Switzerland: Springer.

UNESCO Institute for Statistics, 2018. *UIS Online Database: UIS.Stat*, [online] Available at: <http://data.uis.unesco.org/> [Accessed at 8 March 2020].

Xia, L. and Zhao, L.Y., 2012. Historical Evolution of the 'Trade Market for Technology' Strategy. *Contemporary China History Studies,* 19(2), pp.27–36.

Yip, G.S. and McKern, B., 2016. *China's next strategic advantage: from imitation to innovation*. Cambridge, Massachusetts: The MIT Press.

Yu, Y., Yu, J., Pan, X. and Stough, R., 2017. Governance and the China innovation economy. *Asia-Pacific Journal of Regional Studies,* 1(1), pp.63-84.