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China's innovation financing system: Triple Helix policy perspectives

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Abstract

The purpose of this study is to examine the innovation financing system of China from a Triple Helix policy perspective. The analysis comparing the case with the USA, the world's most innovative economy, provides interesting insights regarding the innovative performance of China. The study shows that while the Chinese government introduced many intervention policy initiatives after the country joined the World Trade Organization (WTO), a comparative study with the US model has shown the development of an innovation system through market mechanism with strong Triple Helix interactions in its industrial clusters. The study provides lessons and insights that are useful for other emerging economies to use as policy guidelines in strengthening their innovation financing systems.

Keywords: Innovation system; Triple Helix; Government policies; China; USA

Spanish: El sistema de financiación de la innovación en China: perspectivas de una política de Triple Hélice.

Resumen: El propósito de este estudio es examinar el sistema de financiación de la innovación en China desde una perspectiva de Triple Hélice. El análisis, en comparación con el caso de los Estados Unidos –la economía más innovadora del mundo–, aporta interesantes reflexiones sobre el funcionamiento de la innovación en China. El estudio muestra cómo el gobierno chino introdujo varias iniciativas de políticas de intervención tras la adhesión del país a la Organización Mundial del Comercio (OMC). Un estudio comparativo con el modelo estadounidense señala el desarrollo de un sistema de innovación mediante mecanismos de mercado con fuertes interacciones de Triple Hélice en sus clústeres industriales. El estudio ofrece lecciones y reflexiones de gran utilidad que otras economías emergentes podrían emplear como directrices en el diseño de políticas dirigidas a fortalecer sus sistemas de financiación de la innovación.

French: Le système de financement de l'innovation en Chine: les perspectives d'une politique de Triple Hélice.

Résumé: Le but de cette étude est d'examiner le système de financement de l'innovation en Chine, dans une perspective de Triple Hélice. L'analyse comparée avec les États-Unis, — l'économie la plus innovante au monde, — fournit des indications intéressantes quant à la capacité d'innovation de la Chine. L'étude montre que le gouvernement chinois a introduit plusieurs initiatives politiques d'intervention après l'adhésion du pays à l'organisation mondiale du commerce (OMC). L'étude comparée avec le modèle américain montre le développement d'un système d'innovation à travers des mécanismes de marché avec une forte interaction de Triple Hélice dans ses clusters industriels. L'étude fournit des leçons et des idées utiles à d'autres économies émergentes comme lignes directrices d'une politique visant à renforcer leurs systèmes de financement de l'innovation.

Russian: Инновационная финансовая система Китая: перспективы трехспиральной модели.

Абстракт: Целью настоящего исследования является изучение инновационной финансовой системы Китая с точки зрения перспектив теории Тройной спирали. В сравнении с опытом США, признанной самой инновационной экономикой мира, в работе представлены интересные наблюдения, касающиеся инновационной деятельности в Китае. По результатам исследования отмечено, что китайским правительством с момента вступления страны во Всемирную Торговую организацию (ВТО) реализовано множество прорывных инициатив. Сравнительный анализ китайской и американской моделей показал, что залогом успеха является развитие инновационной системы через маркетинговые механизмы с усилением взаимодействий в рамках Тройной спирали в промышленных кластерах. Выводы и рекомендации, представленные в настоящей работе, могут быть полезны для прочих развивающихся экономик в качестве базы для разработки стратегических документов, нацеленных на укрепление инновационных финансовых систем.

Chinese: 中国的创新融资体系：三螺旋政策视角

摘要: 本文目的在于从一个三螺旋政策视角审视中国的创新融资体系。通过与世界上最具创新活力的经济体——美国的案例比较研究，提供关于中国创新绩效的有趣的见解。研究表明：在加入世界贸易组织（WTO）后，中国政府提出了许多干预政策举措。通过与在其产业集群中具有强大三螺旋相互作用的美国模式的比较研究，我们揭示了通过市场机制实现的创新体系的发展。这个探索所提供的经验教训和见解，有益于其他新兴经济体的发展，可以用作加强其创新融资体系的政策指引。

Portuguese: O Sistema de Financiamento da Inovação Chinesa: Perspectivas de Políticas Públicas de Hélice Tríplice.

Resumo: O propósito deste estudo é examinar o sistema de financiamento da inovação na China, a partir de uma perspectiva de política pública da hélice tríplice. A análise fornece insights interessantes sobre o desempenho inovador da China em comparação com os EUA. O estudo mostra que o governo chinês introduziu muitas iniciativas na política de inovação após a adesão do país a Organização Mundial do Comércio (OMC). Um estudo comparativo com o modelo norte-americano mostrou o desenvolvimento de um sistema de inovação, por meio de mecanismos de mercado com fortes interações hélice tríplice, em seus clusters industriais. O estudo fornece lições e insights que são úteis para outras economias emergentes usarem como orientações de políticas públicas de intervenção no fortalecimento de seus sistemas de financiamentos da inovação.

Multilingual abstracts

Please see Additional file 1 for translation of the abstract into Arabic.

Background

China has attempted to remodel itself into an innovation-driven economy since joining the World Trade Organization (WTO) in 2001. At present, it is one of the fastest growing economies in the world (with average growth rate of 10% per annum). In 2013, China was placed in 21st position according to the International Institute for Management Development (IMD) world competitiveness ranking and 29th position by the World Economic Forum (WEF). After joining WTO, China has adopted trade liberalization policies and various government policies to drive the innovation system.

The paper is organized as follows. Section Theoretical framework reviews the theoretical framework on the national innovation system, cluster development model, and Triple Helix policies to support innovation development. Section Research methodology describes the research design and methodology. Section Analyses of findings analyzes the innovation financing system of China with regard to the Triple Helix policy perspectives. The study also uses a comparative case of the USA, the world's most innovative economy, as a model to understand the policies and innovation financing system of China. Section Conclusions concludes the paper by drawing lessons and insights that can be used as policy guidelines to strengthen the innovation financing system.

Theoretical framework

National innovation system

The concept of national innovation system (NIS) stresses the importance of networkings among the actors and institutions. In other words, NIS is the interactive system of existing institutions, private and public firms (either large or small), universities, and government agencies, aiming at the production, diffusion, and exploitation of knowledge within national borders (Lundvall, 1992, 1998,

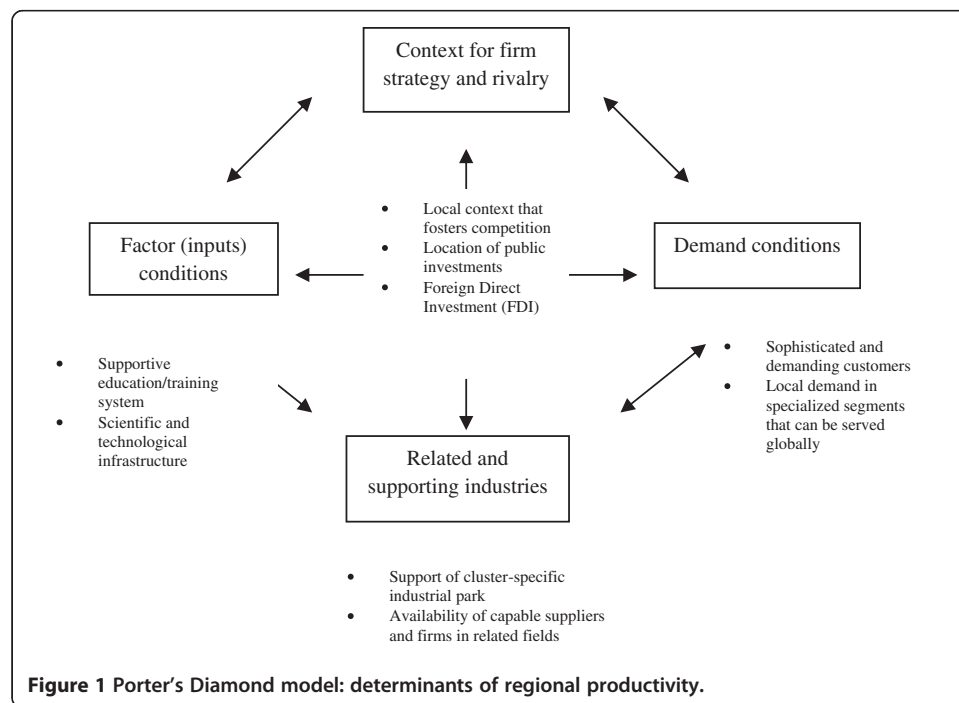
1999, 2003; Freeman 1987; Nelson 1988, 1993; Fagerberg and Srholec 2008; Guan and Chen, 2012). Interactions can be achieved by both market mechanism and non-market mechanisms such as collaboration and long-term network arrangements. The NIS concept is a dynamic tool to investigate, formulate, plan, and position the national economic and social development by using technology and innovation as the main driving force (Lundvall, 1992, 1998, 1999, 2003).

An understanding of NIS can help policy makers develop approaches to enhance the nation's innovation performance. The NIS studies explore the interrelations between technological development and the institutional embeddedness of innovative organizations (Freeman, 1987, 1988, 1992; Lundvall, 1992, 1993, 1998, 1999, 2003; Nelson, 1988, 1993, Fagerberg and Srholec 2008; Guan and Chen 2012 among others). The level of resources devoted by each nation to research and development (R&D) and innovative activities represents a basic characteristic of the NIS (Lundvall 1992; Nelson 1993; MjØset 1992). Determinants of national economic performance and technological capabilities are the size of a country, R&D intensity, and market structure (Freeman 1987; Archibugi and Michie 1997).

Schumpeter (1939, 1967) argues that finance and financial institutions are the mainstream of innovation system as well as crucial determinants of the entrepreneurial ability to develop the new economy. The entrepreneurial firms play a crucial role to the economy in terms of creating jobs contributing to economic growth. The financial innovation system provides specific institutional frameworks and interlinkages with financial markets, government agencies, financial institutions, regulatory authorities, and research organizations to support innovation activities and strengthen technological capabilities at sectoral and national levels (Pavitt 1984; Patel and Pavitt 1994; Archibugi et al. 1999; Malerba 2002). The financial innovation system thus provides necessary resources required for financing enterprises to enhance economic performance within the national innovation system (Mani 2004; Hyytinen and Toivanen 2005). Although there are many studies on innovation systems (Lundvall, 1992, 1993, 1998, 1999, 2003; Nelson, 1988, 1993), there is a dearth of study on innovation financing policies based on NIS that needs to be filled (please see more details in Section Research methodology).

Cluster development model and Triple Helix policies

While the concept of national innovation system (NIS) provides rich insights into the role of institutions and policies to support economic development, the cluster model by Porter (1990, 2001) further provides a framework for understanding the determinants of national competitiveness. The cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities (Porter, 1990, 2001). It is an economic development model that promotes collaboration among institutions to facilitate the exchange of information and technology. Porter's Diamond model (Figure 1) provides a framework for understanding collaboration/networking between the government sector and the industry sector in the form of clusters (Porter, 1990, 2001). It is argued that



geographical concentration enhances interaction processes within the competitive Diamond model. The four attributes (1. factor conditions; 2. demand conditions; 3. context for firm strategy and rivalry; 4. related and supporting industries) are self-reinforcing and catalyze the process of continuous innovations. The model focuses upon the conditions that support firm competitiveness at the national scale (Figure 1).

Porter (1998) has pointed to the role of clusters as an important part of the new economics of competition. He argued that the interactions between the various agents of the nation help achieve considerable synergy. Clusters lead to increased levels of productivity, growth, and employment (Porter, 1990, 2001; Feldman 2000; Steiner 1998; Gnyawali and Srivastava 2013). The cluster-based policies can help facilitate innovation and support transdisciplinary research networks among academics and entrepreneurs to promote the clusters' regional advantage (Saxenian 1994, 2006). The national innovative capacity depends on the strength of a nation's institutional factors and infrastructure, industrial clusters (Furman et al. 2002). The connections and interactions within the cluster are important in that a set of institutions and financial policies could support the efforts of R&D institutions and industries towards effective technology commercialization, bringing about business creation and economic growth.

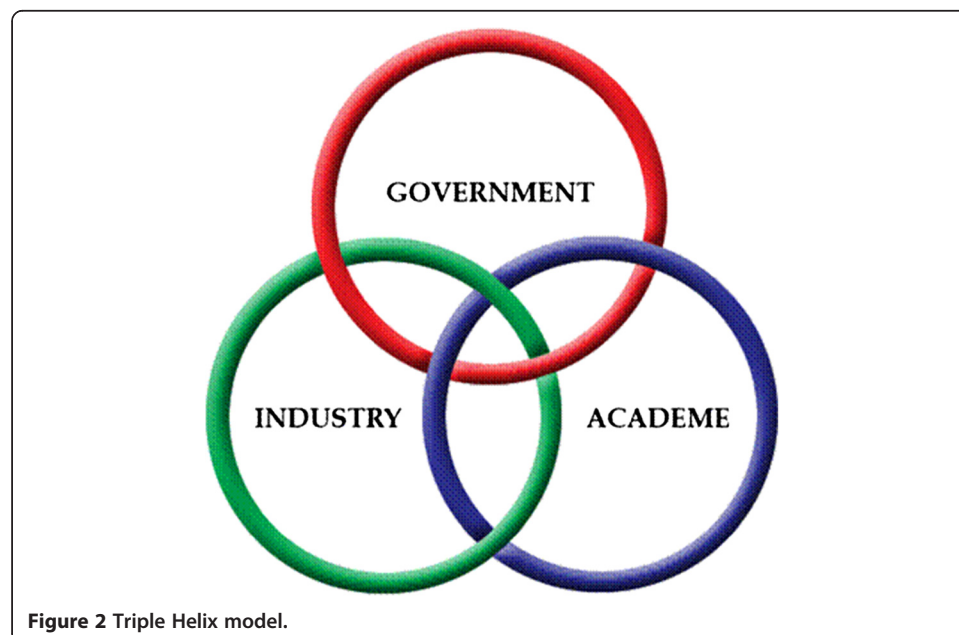
In recent years, developing countries have increasingly paid attention to the cluster model and used cluster-based strategies to support local economic development with government financing policies designed to drive innovation systems (Mani 2004). Innovation financing policies are among the key operational priorities in developing countries to support investment by local firms, especially small- and medium-sized enterprises (SMEs), and transnational corporations investing in these countries. It is interesting to see that the cluster policies (Porter, 1990, 2001) and the Triple Helix policies

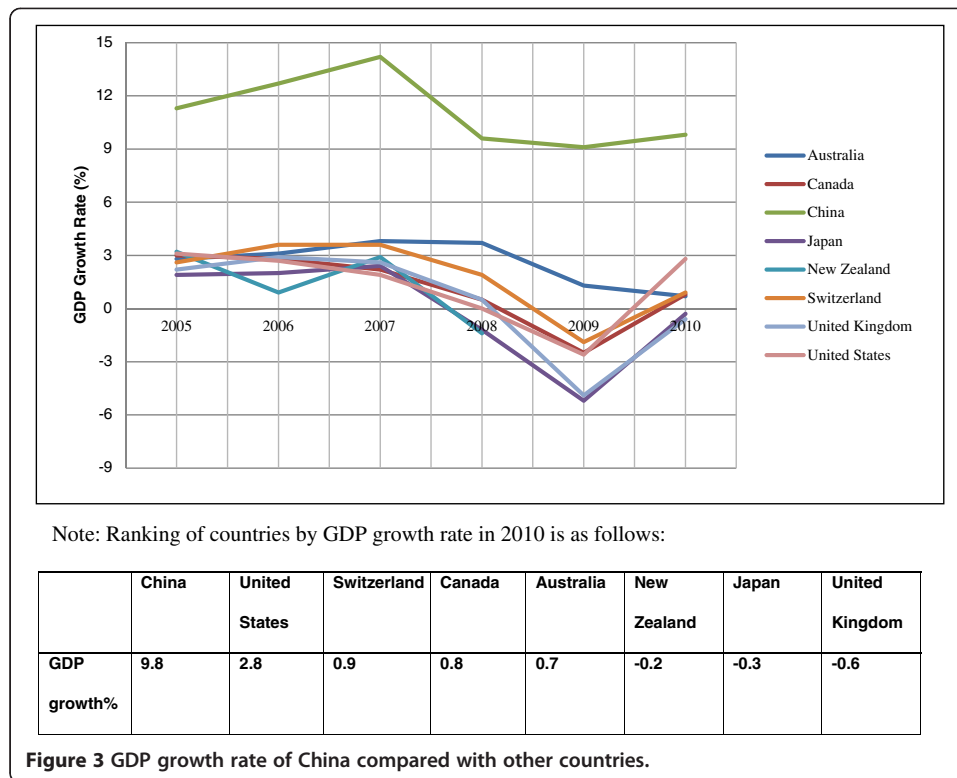
put emphasis on network interactions among university-industry-government to improve the conditions for innovation in a knowledge-based society. The Triple Helix model (Figure 2) embraces interactions among multiple levels of governance, from the local to global. The creation of new arrangements among the institutional spheres fosters the condition for innovation (Etzkowitz and Leydesdorff, 1998, 2000; Etzkowitz 2002; Etzkowitz 2004). A better understanding of various approaches (national innovation system (NIS), Porter's Diamond model, and the Triple Helix model) can help policy makers develop economic development strategies to strengthen innovation systems.

Research methodology

There is a wealth of literature in the national innovation system (Lundvall, 1992, 1998, 1999, 2003; Freeman 1987; Nelson, 1988, 1993; Edquist and Lundvall 1993), but to date only limited research has been carried out in respect of the innovation financing system (for example, the work by Mani (2004) in the area of innovation financing in Malaysian and Singaporean contexts and the work by Malerba (2002) in the area of sectoral innovation system). Even less is available in the area of policies that are essential for strengthening the innovation system (see David et al. 2000; Hall and van Reenen 2000; Hyytinen and Toivanen 2005 on their studies of policies to support entrepreneurial, venture, and economic development). It seems reasonable, therefore, to study this neglected area with a focus on policy perspectives in supporting the innovation financing system in the country case of China. This paper uses China as a country case study because it is one of the world's fastest-growing economies. Particularly, the Chinese government has now placed importance on building national innovative capacity according to the Chinese Dream (President Xi Jinping' open door policies).

Given that the present study is a policy research aimed at offering policy recommendations, the government is thus used as the unit of analysis in this study. The small-





and medium-sized enterprises (SMEs) play an important role in China’s economy since the SMEs account for 99.7% of all enterprises in China^a. This research is thus focused on China’s policy initiatives and strategies to support SMEs. This research employs a case study methodology (Eisenhardt 1989; Yin 2013). The research fieldwork and interviews were undertaken in Beijing and Shanghai, major financial centers in China, with the use of semi-structured interviews to explore the policies/programs in strengthening the innovation system. The interviews were carried out by the major financial institutions in China. The details of interviewees are shown in the Appendix. The researchers also collected evidence from various documentary sources. The conduct of fieldwork interviews in the financial sector of China was coordinated by the Bank of Thailand, the Securities and Exchange Commission and the Thai Chamber of Commerce in China.

The key questions guiding the research are:

- What are the Chinese government’s strategies to strengthen the innovation financing system?
- What innovation financing policies support the innovation system under the NIS framework in China?

In order to provide a cross check on internal validity, interview data are supported by an examination of secondary data. The conduct and analysis of the country case studies have enabled the development of conclusions and recommendations for the research. A comparative analysis of China and the USA in respect of the innovation financing policies provides lessons and insights which would be useful for other emerging economies to use the policy guidelines in strengthening the innovation financing system.

Results and discussion

Before discussing the case of innovation financing system of China, it would be particularly useful to compare China with the USA. This is because USA is the world's most innovative economy according to the International Institute for Management Development (IMD) competitiveness ranking (US is in the first place in IMD's 2013 world rankings). More importantly, the US innovation system is the most developed of the world whereby many governments attempt to replicate the success of the US high-tech sector. The overview of economic and innovation performance of China and the USA is shown in Table 1.

Case of USA

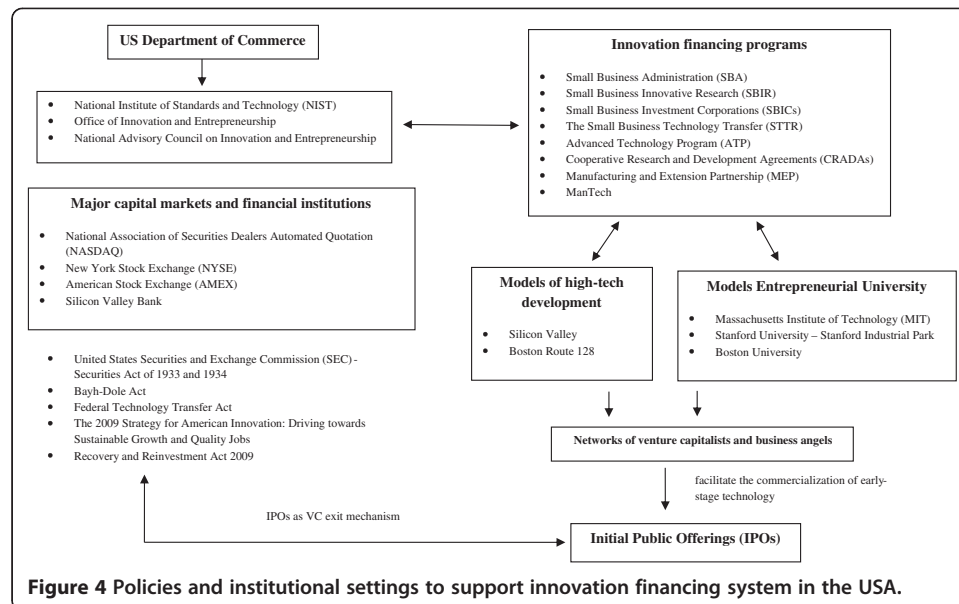
The progress of US economic growth has shown that clusters are an effective economic development model. Silicon Valley and Boston Route 128 (New England) represent the dynamic model of high-tech innovation and have become a symbol of technopreneurship that governments around the world attempt to emulate their success. The high-technology regions of Silicon Valley and Boston Route 128 are the centers of innovation and commercialization where these high-tech economies have taken full advantage of the interaction process among the institutions within the regional innovation system. In other words, the economic transformation is the result of collaborative networks between the scientists of the high-tech industries and entrepreneurs to bring new ideas to market (Saxenian 1994, 2006; Wonglimpiyarat 2006).

Figure 4 depicts the policies and institutional settings to support the innovation financing system in the USA. The success of US economic growth is a result of its entrepreneur's risk-taking culture to drive the innovation system. The US government has

Table 1 Overview of economic and innovation performance of China and the USA

Indicator	Year	China	US
Population	2012	1.343 billion	314 million
Gross domestic product (GDP)	2012	USD 8.28 trillion	USD 15.685 trillion
GDP growth (%)	2012	7.8	2.2
IMD world competitiveness ranking	2013	21	1
	2012	23	2
WEF competitiveness ranking	2013	29	7
	2012	26	5
Knowledge Economy Index (KEI) ranking	2012	84	12
KEI	2012	4.37	8.77
Percentage of R&D expenditure to GDP (approximate)	2012	1.6	2.8
Number of patent applications			
Residents	2011	415,829	247,750
Non-residents	2011	110,583	255,832
Total researchers in full-time equivalency (FTE)	2011	2,882,903	n/a
	2007	1,423,381	1,412,639
Number of scientific journal publications (Scopus database, Elsevier B.V.)	2011	373,756	519,573

Source: the authors' design, based on the World Competitiveness Scoreboard (various years) by International Institute for Management Development (IMD), World Economic Forum (WEF) Global Competitiveness Report, World Bank, United Nations Conference on Trade and Development (UNCTAD), and OECD Main Science and Technology Indicators.



launched various policy initiatives to fill the funding gap. The federal policy initiatives of Bayh-Dole Act of 1980 and the Federal Technology Transfer Act of 1986 help facilitate the commercialization of early-stage technology. There are many government programs to support the financing of innovations. The major programs to support the firm in early stages are, for example, Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) program. The major programs to support the firm in later stages are, for example, Advanced Technology Program (ATP), Defense Advanced Research Projects Agency (DARPA), and Dual Use.

The US capital markets provide strong support for early stage and high-tech ventures. In particular, the National Association of Securities Dealers Automated Quotations System (NASDAQ) stock market was established to support technology-based firms and facilitate the formation of start-ups. Realizing that venture capital (VC) financing is an important mechanism to drive the economy, the US government promotes the VC industry and entrepreneurial innovation through tax policies - lowering tax rates on capital gains. The US government provides favorable tax policies e.g. tax-exempt capital gains and pension funds as investment incentives to facilitate the development of VC market (Wonglimpiyarat 2006). Given the importance of private sector as a strategic driver of economic growth, the US government recently launched the 2009 Strategy for American Innovation: Driving towards Sustainable Growth and Quality Jobs as a strategy to promote market-based innovations. The present government under President Obama administration has simplified the research and experimentation tax credit in order to spur productive entrepreneurship and economic performance of the innovation system^b.

Case of China

In China, small- and medium-sized enterprises (SMEs) are defined as follows, according to the 12th Five-Year National Economic and Social Development Plan 2011-2015 by the Ministry of Industry and Information Technology. Realizing the importance of SMEs in economic development as they constitute more than 90% of all firms in China,

the Chinese government has placed importance on SME development to drive the national economy.

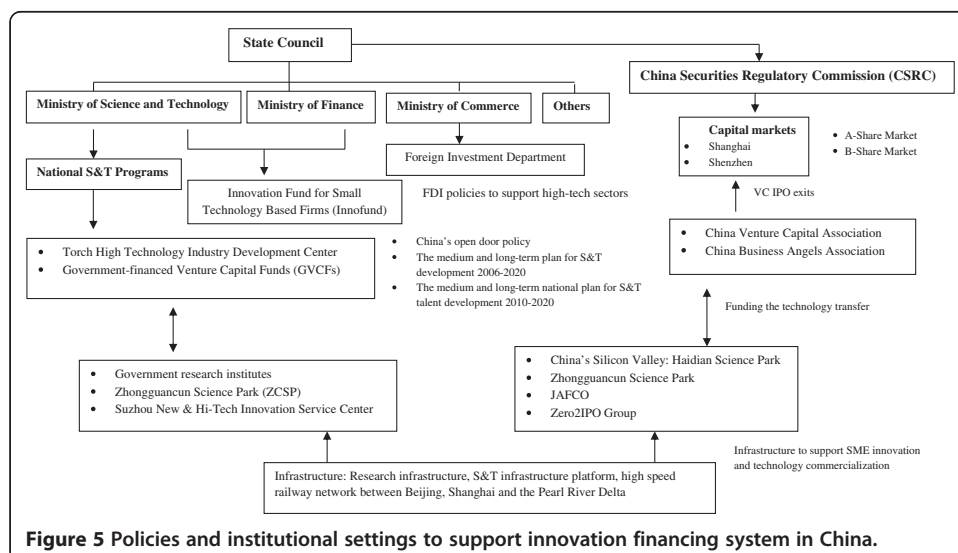
Small-sized enterprises: Companies that employ fewer than 300 people and earn less than RMB 20 million in annual sales revenue.

Medium-sized enterprises: Companies that employ 300 to 1,000 people and have annual sales revenue of RMB 20 to 400 million.

After China joined the World Trade Organization (WTO) in 2001, China has launched various innovation policies to catch up with leading-edge countries. Realizing the importance of SMEs in economic development as SMEs account for 90% of the total number of companies in China, the Chinese government has implemented SME policies to drive the innovation system. Taking into account the important role of banks in providing the capital and credits to emerging enterprises in China, one major strategy of the Chinese government was implementing financial sector reforms and establishing national policies to accelerate the development of innovation system. The 12th National Economic and Social Development Plan (five-year plan) is the major government policy that places a specific emphasis on supporting SMEs in terms of creating an environment conducive to entrepreneurship and innovation for SMEs.

The Chinese government has intensified its effort to attract foreign direct investment (FDI) to support the industries. To put it another way, the FDI policies have helped the country access foreign capital and technologies. The open door policy has enabled China to remodel itself from an agriculture-based economy towards an innovation-driven economy. Considering the economic and innovation performance of China and the USA (Table 1), it can be seen that the percent of R&D expenditure to GDP is 1.6 compared to the USA of 2.8 in 2012. However, China plans to invest 2.5% of its GDP in R&D in 2020. Regarding the innovation indicator of publications, China also has far fewer number of scientific journal publications than the USA.

Figure 5 depicts the institutional policies and settings to support innovation financing system in China. The government plays an important role in developing policies and strategies to support the innovation system, for example, the Decision on Developing



High-Tech and Realizing Industrialization (CCCP) sets forth the tenth plan (2001–2005) to promote S&T-based innovation commercialization. The Guideline for Developing National University Science Parks provides a plan to promote the development of university science parks. The government policy in encouraging R&D can be seen as a result of adopting Deng Xiaoping's open door policy to encourage foreign investments and attract new technologies. The major policy of the Ministry of Science and Technology includes the guidelines on national medium- and long-term program for science and technology development during the period of 2006 to 2020.

Currently, the national industrial policy has placed a greater emphasis on strengthening clusters of special economics and high-technology zones as the government realizes their important role in offering infrastructure for implementing the innovation strategies. The government has reduced the corporate income tax rate and value-added tax (VAT) to promote high-technology enterprises. Recently, the Ministry of Science and Technology has proposed State Council of 2009 to strengthen the science, technology, and innovation system in response to the global financial crisis. The analysis of policy aspects below presents a structured development path to strengthen the innovation system of China.

Triple Helix perspectives - innovation financing policies/programs

The innovation financing policies under the political leadership of President Hu Jintao can be seen as a continuation of using an open door policy to improve financing mechanisms and provide financial funds to support SMEs. The Chinese government provides grants, loans, and other incentives (such as tax incentives for R&D and low income tax rates for high-technology enterprises) to drive innovation and growth. The innovation financing policies can be seen as a result of government intervention in the financial market to fill SME financing gap.

The Ministry of Science and Technology plays a significant role in the design and implementation of national innovation policies. The special economic zones (SEZs) and science parks were established to foster new technology development. In particular, the Torch program was developed to support the creation of industrial clusters. The national science and technology industrial parks (STIPs) were established to support high-technology enterprises. Up to now, there are 54 national STIPs established by the Torch program to promote the development of innovation clusters and advance upgrades in high technologies. Although China has introduced various policies to support technology development, the process of technology transfer and commercialization is not very successful due to weak links and interactions between the university and industry (lack of dynamic Triple Helix interactions within the university-industry partnerships).

China has recently launched the financial programs to promote innovative SMEs according to President Xi Jinping's open door policies. Interestingly, innovation is one of the policy aspects (the Chinese Dream) that President Xi Jinping emphasizes: 1) patriotism (aiguó); 2) innovation (chuangxin); 3) inclusiveness (baorong); and 4) morality (houde). Table 2 compares the major sources of funding to support SME innovations in China and the USA. The Chinese government encourages innovation in SMEs through the enforcement of financial policies. Particularly, the SME Innovation Fund and SME Development Fund were set up to provide financial assistance to SMEs and encourage SME technological innovations. The similar programs in the USA are the Small

Table 2 Funding programs to support SME innovations in China and USA

	China	USA
<i>Major programs to support SME innovation</i>	SME Innovation Fund and SME Development Fund	Small Business Innovative Research (SBIR) program, Small Business Technology Transfer (STTR) program
<i>Year of establishment</i>	The SME Innovation Fund was established in 1999, the SME Development Fund was established in 2011	The Small Business Innovative Research (SBIR) was established in 1982, the Small Business Technology Transfer (STTR) was established in 1992
<i>Goals of the programs</i>	The SME Innovation Fund and SME Development Fund aim to provide financial supports to technically advanced start-up firms in order to accelerate SME technological innovations.	The SBIR/STTR program aims to stimulate entrepreneurship, technological innovations of small US businesses. The program also has the main purpose of increasing the commercial application of research results.
<i>Budget</i>	The budget of SME Innovation Fund is RMB 500 million to RMB 1 billion (or approximately USD 80 to 160 million)/ the budget of SME Development Fund is RMB 15 billion (or approximately USD 2.4 billion)	The SBIR/STTR program budget provides approximately USD 2.5 billion per year to support small business development.
<i>Business angel financing networks</i>	China Business Angels Network (CBAN) was established in 2008.	The Angel Capital Association (ACA) was established in 2004.
<i>Angel investments</i>	The amount of angel investments totaled USD 201.23 million in 2013. The angel investments were mainly concentrated in Beijing and Shanghai.	The amount of angel investments totaled USD 1.1 billion in 2013. The angel investments were mainly concentrated in California (Silicon Valley) and New England.

Source: the authors' design, based on the US Small Business Administration (SBA), Small Business Innovative Research (SBIR), China Business Angel Network (CBAN), PEData of Zero2IPO Group, Zhongguancun Angel Investment Report 2013, Silicon Valley Bank, and the Angel Resource Institute.

Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) funding programs providing supports to small innovative businesses with potential for commercialization.

In China's innovation financing system, commercial banks also play an important role in financing SMEs. Apart from the SME Development Fund and SME Innovation Fund, China Minsheng Bank, Shanghai Pudong Development Bank, and Evergrowing Bank are major commercial banks providing funding assistance to SMEs in China. These commercial banks have placed an emphasis on providing innovative loan programs to support SMEs (the banks' practice of giving innovative loan programs is in line with the 12th Five-Year National Economic and Social Development Plan 2011-2015). The central government has encouraged the commercial banks to increase SME lending portfolio. Such policy implementation attempts to ease SMEs' difficulties in accessing finance and decrease their reliance on black market lending system.

From the interviews with commercial banks and public authorities in China's innovation system, the banks said that their policy decisions to lend out SME loans were greatly influenced by the central government. They had to follow the government rules in setting up the SME Special Unit to provide SME financing. According to the interviews with the Credit Department Manager of Huaxia Bank and Deputy General Manager of China CITIC Bank, they said that the banks had to readjust the direction of loan policy towards SMEs (policies on credit provision to support SMEs) to be in line with the 12th Five-Year National Economic and Social Development Plan. Furthermore, they had to follow the rules and guidelines from the government in extending credit loans at lower interest rates and fees to technology-based firms in Beijing's

Zhongguancun Science Park. However, despite the government policy to support SMEs, the banks had to control the loss rate on SME loans. From the interviews, the banks said that the introduction of the 12th five-year plan caused difficulties in implementation since the government expected that there should be no loan losses from SME lending. The banks in China's innovation system were thus conservative in providing loans or credits to SMEs in order to maintain lower loan to deposit ratios (75% loan to deposit ratio limit for all commercial banks according to China's Commercial Bank Law). For example, from an interview with the Deputy General Manager of China CITIC Bank, one of the banks established during China's reform, it was revealed that the bank could allow SME loan losses by only 2% to 5%. According to the interviews, most of the banks viewed that although the government has encouraged the banking sector to extend credits to SMEs, however, if there were loan losses, the banks would be under scrutiny by the state officials over their policies on SME lending/bank lending standards. They stated further that being examined by the government official would affect the banks' relations with the government in the future. This is because the plan to extend banking operations or launch new banking services might not get the government approval.

The empirical results have shown the weaknesses of the Triple Helix interactions within China's financial innovation system. From the Triple Helix policy perspectives, the Chinese government has undue influence over the banking operations. Interestingly, the case of China has shown an early stage of Triple Helix model development whereby the linkages and interactions among the spheres are still weak and the government plays a predominant role among the three institutional spheres. These findings are in line with the study of Etzkowitz et al. (2001) showing the dominant role of the state in innovation and high-technology development.

Policies to reform the banking system

The policies to develop the financial centers, particularly the policies to reform the banking system, were guided by the central government. The reform of banks is aimed at providing the newly emerging enterprises with the needed capital. The big five banks providing a major source of credit for SMEs in China are Industrial and Commercial Bank of China, Agricultural Bank of China, China Construction Bank, Bank of China, and Bank of Communications. Table 3 shows the performance of the Big Five accounting for 47.3% of total market share.

As a result of the 12th National Economic and Social Development Plan, the Beijing municipal government supports Chinese financial institutions in setting up SME credit departments. The policies of Beijing municipal government put greater emphasis in upgrading small-scale financial institutions into commercial banks so as to facilitate SME access to finance. Table 4 shows the granted credits in China. As a result of the implementation of this credit policy, it can be seen that the total loan amounts granted to SMEs account for approximately USD 3.53 billion (from total credits granted of USD 7.06 billion in 2011).

Venture capital policies

The financing problems of SMEs are one of the major constraints faced by entrepreneurs in China. Venture capital, therefore, plays an important role to provide source of finance for new start-ups. However, the VC industry in China is not well developed and

Table 3 Performance of the Big Five (USD million)

Bank	Total assets		Operating income		Total loans		Growth rate per annum	
	2010	2011	2010	2011	2010	2011	2010	2011
Industrial and Commercial Bank of China	2,195,534	2,524,775	62,124	76,770	1,107,750	1,270,619	22.68	23.32
Agricultural Bank of China	1,686,363	1,904,988	47,676	61,950	781,078	880,728	22.23	20.26
China Construction Bank	2,003,562	1,763,510	52,771	64,778	901,472	1,031,842	22.45	22.36
Bank of China	1,706,340	1,929,864	45,158	53,534	903,387	1,011,931	18.68	18.10
Bank of Communications	644,632	752,231	17,004	20,711	364,915	417,904	20.08	20.49

Source: China Securities Regulatory Commission.

limited in scale due to regulatory restrictions of fund raising. The China Venture Capital Association (CVCA) was established in 2002 to promote government policies conducive to the development of VC industry. The government-financed Venture Capital Funds (GVCFs) was established in 1993 in Guangdong, Jiangsu, Zhejiang, and Shanghai together with the formation of university-backed Venture Capital Funds (UVCFs) to provide university-incubating services and encourage the process of technology commercialization. At present, the VC industry is dominated by international VC funds. The international VCs have helped build the high-tech industries of internet, networking as can be seen from the successful enterprises like Lenovo and Huawei Technologies.

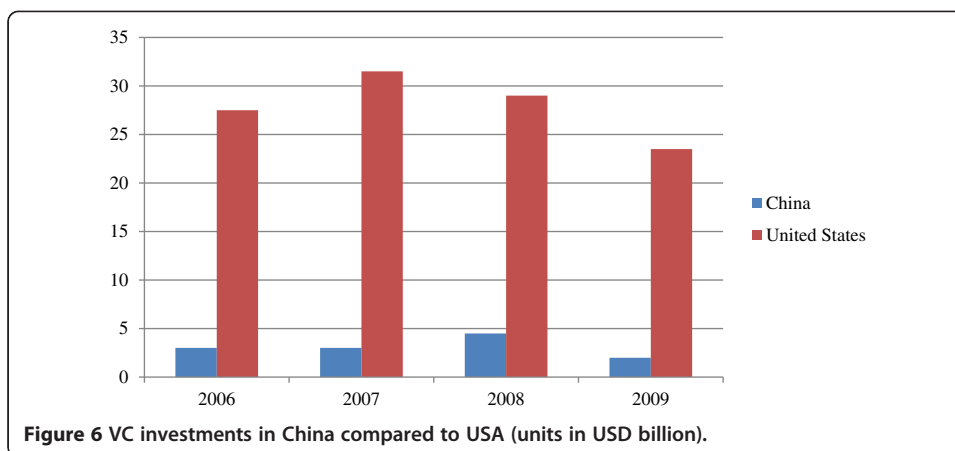
Figure 6 presents comparative VC investments in China and USA during 2006 to 2009. Most of the VC investments are in the sectors of internet, clean technology, electronics and optoelectronic equipment, telecom, and value-added services. The centers of VC industry are Beijing, Shanghai, Chengdu, and Shenzhen. Zero2IPO Capital is the major VC corporation among others (such as Accel Partners-Beijing, Redpoint Ventures-China, Sequoia Capital-Beijing, GSR Ventures-Beijing-China, Eastern Bell Venture Capital, Walden International-Shanghai-China, Warburg Pincus-Beijing-China, VantagePoint Venture Partners-Beijing-China, and Vivo Ventures-Chengdu-China), targeting investments in high-potential and high-growth companies.

At present, China's Ministry of Commerce has issued regulations allowing foreign-invested venture capital firms to invest in China. The Ministry of Finance has also eased the regulations regarding the capital requirements of international VC firms - lowering the capital requirement by USD 10 million as well as easing stringent regulations of foreign VC structure. Nevertheless, the venture capitalists still have difficulties in exiting their investments in the VC market. Currently, the development of VC industry in China is still at the initial development stage. To drive the innovation system for future economic growth, the country needs the policy supports in terms of VC financing, private equity funds, and capital markets for technology-based firms.

Table 4 Credits granted in China (Units in USD billion)

Credits granted to	2008		2009		2010		2011	
	USD	%	USD	%	USD	%	USD	%
Small enterprises	0.71	21	0.93	22	1.20	24	1.74	24.7
Medium enterprises	1.12	32	1.40	33	1.66	33	1.79	25.3
Large enterprises	1.61	47	1.90	45	2.16	43	3.53	50
Total	3.44	100	4.23	100	5.02	100	7.06	100

Source: China Monetary Policy Report.



Conclusions

This study explores the innovation financing system of China with regard to the Triple Helix policy perspectives. The analysis is based on the national innovation system approach and the Triple Helix model. Table 5 summarizes the Triple Helix perspectives of China’s innovation system. It also offers policy recommendations to improve the conditions for innovation development in China. The analyses based on the Triple Helix approach have clearly shown that the role of Chinese government has outweighed the role of university and industry (government-led innovation system). Table 6 provides interesting insights on policy aspects and characteristics of the innovation system by comparing China, the fastest growing economy in Asia, and the USA, the most innovative economy in the Western developed countries.

In particular, the government should establish the selective VC program similar to Israel’s Yozma program to fill a supply gap of VC financing for SMEs. However, to encourage crowding-in effects, the Chinese government should reduce its role in the economy and encourage the private sector to gradually take part in the development of the VC industry. Taking into account Israel’s Yozma program as a model of competitive

Table 5 Triple Helix perspectives of China’s innovation system

Triple Helix perspectives	
University	The university activities as well as R&D activities are mainly controlled by the Chinese government through the Ministry of Higher Education. However, after the open door policy to participate in the World Trade Organization (WTO), the government has encouraged the university to make a transition into a new role of promoting innovation. Based on the Triple Helix perspective of innovation system, the universities need more interactions with the market to promote university-affiliated enterprises and business spin-offs.
Industry	The Torch program has greatly supported high-tech industrial development in China. Nevertheless, the industry including science parks and incubators is largely controlled by the central government. China needs more market incentives (including financial and tax incentives) and supportive policies to compete under the increasing competitive environment after WTO accession. In pursuit of the open door policy, the industry has now increased cooperation with universities and research institutes to exploit technical knowledge and improve knowledge transfer which would thereby enhance the national innovative capabilities.
Government	The analysis based on the Triple Helix model has shown the government-led national innovation system. The Chinese government guides the innovation development through the 12th Five-Year National Economic and Social Development Plan 2011-2015. However, China still needs the policies to support SME cluster development as well as specialized financial institutions to support the development of SMEs. The local government should improve financing platforms to support innovation and private sector development.

Source: the authors’ design.

Table 6 Policy aspects and characteristics of the innovation system - China and the USA

	China	USA
<i>Characteristics of innovation system</i>	<ul style="list-style-type: none"> • Innovation system driven by government policies (state intervention) 	<ul style="list-style-type: none"> • Innovation system driven by market forces (private sector driven)
<i>Culture of innovation</i>	<ul style="list-style-type: none"> • Entrepreneurship style of using imported goods and ideas to create innovations 	<ul style="list-style-type: none"> • Entrepreneurship style of risk-taking and tolerance for failure
<i>Basis of innovation</i>	<ul style="list-style-type: none"> • Commercial copying and replication 	<ul style="list-style-type: none"> • Research-based innovation (The launch of innovations relies heavily on research as a result of R&D investments)
<i>Intellectual Property (IP) policies</i>	<ul style="list-style-type: none"> • Insufficient protection of intellectual property rights (ineffective government policy to punish piracy and infringement of IPs) 	<ul style="list-style-type: none"> • Effective intellectual property (IP) policies provide key incentives to stimulate innovations
<i>Productivity factor</i>	<ul style="list-style-type: none"> • Cheap labor costs enable the capability to undercut prices in market competition 	<ul style="list-style-type: none"> • High labor cost lead to labor-saving technology and innovations
<i>Capital market operation</i>	<ul style="list-style-type: none"> • The operation of Shanghai Stock Exchange and Shenzhen Stock Exchange to provide money-raising channel for SMEs but their functions are not NASDAQ equivalent 	<ul style="list-style-type: none"> • The capital markets are highly developed (such as the New York Stock Exchange (NYSE), Boston Stock Exchange, Cincinnati Stock, etc.) with the operation of the National Association of Securities Dealers Automated Quotations System (NASDAQ) Market Center to support technology-based firms
<i>Business angel and venture capital (VC) industry</i>	<ul style="list-style-type: none"> • China has the formal business angel market but its business angel community is still small • The Chinese VC industry is growing but still needs incentive programs to foster the developing economy 	<ul style="list-style-type: none"> • The US has the formal angel investing networks which provide not only finance but also mentoring to newly formed businesses. • The policies comprise the state and federal level to promote angel investing. • The US VC market is highly developed to support technology-based firms

Source: the authors' design.

VC industry, the Zero2IPO group and other private VC firms may initiate the venture capital program by setting up the funds of funds to induce innovation and entrepreneurship in China. Each fund of funds should invest in different potential technologies (high potential areas that are important to China's economic growth such as biotechnology, internet, clean technology, and telecommunication). These types of funds would promote early stage VC development and support the creation of VC ecosystem.

The results show the country-specific configuration of interacting institutions to promote industrial technological capabilities. In the case of USA, the government plays a catalytic role to induce private sector investments and entrepreneurial development (launching various funding programs such as SBA, SBIR, and SBICs). Also, effective interactions among the parties of the Triple Helix model (university-industry-government) also assist the growth of high-tech sector development. In the case of China, public policy plays a key role in building an innovation system. Whereas China's innovation system is directly driven by government intervention policies, the US innovation system is driven by market forces, indirectly influenced by government policies and programs. The analyses have shown weak links and interactions among institutions underlying the innovation system in the case of China. The findings are in contrast to the US model emphasizing the creation of industrial clusters to strengthen the innovation system and showing strong Triple Helix interactions within the clusters (according to the studies by Porter (1990, 2001) and Etzkowitz (2002, 2004)).

Building innovative capabilities of the nation is highly regarded as a very important factor for increasing and sustaining the national competitiveness. It is argued that dynamic interactions within China's innovation system should be further strengthened. The development of the innovation system needs incentives to support SMEs as there is a lack of finance to support high-technology industries and VC mechanisms are not fully developed in China. Further, the government policies should encourage the private sector to take up more VC investments to build high-tech SMEs for improving national competitiveness.

Endnotes

^aThe National Bureau of Statistics of China.

^bA Strategy for American Innovation: Securing Our Economic Growth and Prosperity, National Economic Council, Council of Economic Advisers, and Office of Science and Technology Policy, The White House, Washington, 2011.

Appendix

List of institutions providing research interviews

Name of institutions	Names and positions of interviewees
1. Bank of Beijing	LR - Beijing Management Department, Deputy General Manager; HJF - Beijing Management Department, Investment Banking and Financial Market, Customer Manager; WY - Beijing Management Department, Assistant General Manager
2. Huaxia Bank	Credit Department Manager
3. China CITIC Bank	WJG - Deputy General Manager
4. United Overseas Bank or UOB	WGQ - Assistant Vice President, Commercial Banking
5. Bank of China	ZZ - Director, Corporate Banking 1 Department; SY - Relationship Manager, Corporate Banking Department; ZC - Deputy Section Head, Corporate Banking Department
6. Bank of Shanghai	L.Z.H. - Deputy General Manager
7. Bangkok Bank China Co., Ltd.	YP - Business Development Division Manager
8. Siam Commercial Bank Public Company Limited	MS - Executive Vice President and Head of China A Sharing Research
9. Thai Chamber of Commerce in China	KA - Vice President; OR - Executive Director; FZ - Project Manager; DZ - Event Manager
10. Bank of Thailand	Head of Economic Intelligence Unit
11. The Securities and Exchange Commission	SS - Director, Research and Development Department; CI - Director, Corporate Affairs Department

Source: the authors' design.

Additional file

Additional file 1: Translation of the abstract into Arabic.

Acknowledgements

This work was supported by the Higher Education Research Promotion and National Research University Project of Thailand, Office of Higher Education Commission. The authors are also grateful for the funding from the Thailand Research Fund. We are thankful to Mr. Yanathip Techawiset (Thammasat University), Miss Kesrin Ariyaponges (Thai Chamber of Commerce in China) and Professor Shufen Dai (University of Science and Technology Beijing) for useful suggestions and advice on the research in China and Professor Barry Unger and Professor Kip Becker, Boston University in supporting the research in the US.

Received: 23 March 2014 Accepted: 14 October 2014

Published online: 28 February 2015

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