Editorial

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1 Introduction

All eyes are on China, which has experienced dramatic economic growth during the last three decades and has become the world's third largest economy, right after the USA and Japan. The economic growth has benefited from many progresses that China has made during its transition from a planned economy to a market one, including its promotion of non-government-owned businesses, its success in attracting foreign investments and its efforts in promoting export, among many others. China has become 'world's factory'.

Nevertheless, China's economy still heavily relies on cheap factor inputs and such a growth model is not sustainable, as exhibited by the many environmental incidents, labour disputes and tensions with other countries on international trade, among numerous others. Despite its tremendous economic success, China has largely failed in capacity-building for indigenous innovation. The recent world financial crisis and the declining export have further demonstrated the weakness associated with such a model of economic growth. For sure China's people and government are not complacent about its current 'world's factory' status and have tried to make another transition from the current 'made in China' to the potential 'created/invented in China'. Tremendous efforts have been made to reform its national innovation systems. In 2006, the central government once again initiated its middle and long term plan with a very ambitious goal for China to become an innovative nation by 2020. This plan has a few specific objectives including raising the R&D investment/GDP ratio to 2.5%, the contribution rate of 60% or more to economic growth by progress in science and technology (S&T) and reducing the degree

of dependence on foreign technologies to 30% or less. Thereafter, different agencies associated with the central government have announced a number of measures to implement the plan. It is not the purpose of this special issue to give a detailed review or assessment of the plan. Instead, the special issue will focus on the progress that China's businesses and governments have made in innovation. We hope that these studies will shed new light on innovation in China.

Studies in this special issue can be grouped into three categories, which examine issues from business innovation strategies, to foreign R&D, and national S&T policies. In the following sections, we will summarise the major findings of these papers.

2 Business innovation strategies

Before the reforms in the 1980s, businesses, government-owned research institutes and laboratories, and universities were separated from each other in China's national innovation systems (Liu and White, 2001; Sun, 2002). Chinese Government has tried to build an innovation system centred on businesses. Nevertheless, the results are mixed. Except a handful of successful cases such as Huawei, ZTE and Lenovo (Gao et al., 2006, 2007; Fan, 2006; Xie and White, 2006), China has largely failed to build innovative businesses, compared to South Korea, Japan and others. In the first part of the special issue, we have collected a number of studies that examine the related issues.

Peilei Fan's study clearly demonstrates the critical importance of an innovation-oriented strategy for the successful catch-up of industrial firms through the examination of the ups and downs of three generations of mobile phone manufacturers in China. China's domestic mobile phone manufacturers first experienced rapid ascending from 1999 to 2003 with their share in China's domestic market grown from 3% in 1999 to 56% in 2003 then drastic descending from 2003 to present with their market share back to 31% in 2007. Earlier leaders such as PEG, Eastcom, TCL and Bird have become less competitive while new players such as ZTE and Huawei have become important players in the mobile phone market. A key finding from Fan's paper is that innovation capability is critical in understanding the success of the recent players such as ZTE and Huawei as well as the failure of the earlier players such as PEG and BIRD. Her research also shows that simple collaboration with multinational corporations will not enable domestic firms in emerging economies to develop key technologies. Non-innovation strategies based on marketing, price wars and others may work in earlier stages of an industry when the market was highly unsaturated and profit margins are high. But innovation-oriented strategies are critical in a mature and saturated market where competition is very intensive.

Nevertheless, recognising the importance of innovation is one thing and successfully doing it is another. Catch-up is a very difficult process, particularly in an increasingly globalised and more competitive environment. Xielin Liu in his article argues that the openness of the world technology market, coupled with the vast, quick-changing and unique Chinese domestic market and a strong government, could afford Chinese firms unique opportunities to catch-up. He proposes a market-oriented strategy consisting of three components: innovation for the low-end market, innovation for niche market and innovation in a fast changing market/industry. Critical to the success of Chinese firms' catch-up is their intimate knowledge of the Chinese domestic market and their integration

capabilities which allow them to utilise the open technology market. He argues that such an approach is different from what Japanese and Korean firms did during their catch-up process, where they relied on incremental process innovation. A critical question out of Liu's research is how Chinese firms can upgrade from the low-end to high-end market, and how they could reduce reliance on foreign technologies and develop their own key technologies, when the role of Chinese government is constrained after becoming a member of WTO.

As Liu pointed out, foreign technologies are important sources of innovation for Chinese enterprises to develop products for the unique Chinese market. Nevertheless, absorptive capabilities are always an issue for firms in emerging countries. Without internal absorptive capabilities, foreign imported technologies can hardly contribute to building indigenous innovation capability. Xibao Li and Guishen Wu confirm this observation through statistical analyses of China's high-tech industries. Interestingly, they also demonstrate that Chinese firms have little difficulty in absorbing domestically transferred technologies. Meanwhile, they show clear regional and industrial differences regarding the sources of innovation. For firms in more developed regions in eastern China, in-house-R&D and competition seems to have stronger impacts, while firms in middle and western China are more reliant on domestic technology transfer.

Taking a different approach, Douglas B. Fuller examines the chip design industry in China and argues that in addition to access to global capital and talents, China's firms catch-up experience cannot be well understood without recognising the importance of China's domestic environment, particularly the relationship between the state and firms. Based on the interplay between the politics of finance and firms' operational strategy, Fuller develops a typology that identifies four types of firms: neglected domestic firms, favoured domestic firms, hybrid foreign invested enterprises (FIEs) and regular FIEs. He argues that the hybrid FIEs (most often founded by Chinese overseas returnees) that combine foreign finance with a commitment to China will drive China's technological development, while other firms will not perform well. Such a study is stimulating, although it is unclear if this model can be extended to other sectors. As demonstrated by the cases of ZTE, Huawei, Lenovo and others, some Chinese domestic firms have achieved significant technology and business success, though they are Chinese indigenous, not foreign hybrid firms.

Qunhong Shen and Kaidong Feng provide an interesting study comparing two groups of firms in China's power distributed control system (DCS) sector, and argue that China's trading market for technology (TMFT) policies in the early days have succeeded in building up manufacturing capacities but have failed to nurture domestic firms' technological capability. In particular, the Chinese government's hope to develop core technology competencies through joint ventures between state-owned-enterprises (SOEs) and foreign companies has failed. Surprisingly, one group of firms that started as distributing and service agencies of foreign firms without governmental support have successfully built up their core technology competencies and achieved significant market success based on their deep insights of the Chinese market, the weaknesses of the existing imported products, and the opportunities offered by the new digital technologies. Particularly important in the process is the organisational learning contingent on the strategic intents, authority of resource allocation and institutional arrangement of mobilisation and integration. Such a study demonstrates the importance of organisational learning in technology catch-up. Meanwhile, it reveals the inconsistence and lack of

coordination among the different government agencies in promoting indigenous innovation.

While the above four studies have focused on the innovation strategy of Chinese firms, Dan Chen and Azhdar Karami turn to the inter-firm technological cooperation issue, which many believe is getting increasingly important in increasingly competitive environment. They examine the factors that affect the effectiveness of such inter-firm cooperation based on data collected from small and medium enterprises (SMEs) in Shandong, China. Their study reveals that SMEs are extensively engaged in inter-firm technology collaboration, which is surprising given that SMEs in China are technologically weak and previous studies have focused on cooperation between SMEs and universities or government laboratories. They further found that the success of inter-firm collaboration depends on factors related to the necessary inputs for cooperation. Particularly important factors include 'trust, communication and reciprocity', 'top leader commitment', 'well-documented agreements', 'sufficient cooperative resources' and 'safeguards in place for protecting core technology'.

Xudong Gao, Jiang Yu and Mingfang Li approach the catch-up of latecomers from a different perspective. They identify three types of challenges that local firms in emerging economies such as China are facing, including environmental complexity, transformation (from small to big firms) complexity and latecomer disadvantages. How to overcome such disadvantages? Gao et al. argue that the traditional thinking such as ownership difference, lack of competition, niche market strategy, organisational change (incumbent versus new entrants) and leadership are insufficient in explaining the different catch-up experiences. Based on the cases of domestic telecom equipment firms within China, they propose that whether or not adopting the dialectical thinking could deepen our understanding of the different catch-up experiences. The dialectic thinking includes properties such as taking a holistic perspective, balancing the short-term and long-term goals, managing the dynamics of transformation, sticking to the middle way of thinking and emphasising continuous learning and innovation. They argue that such a multi-dimensional thinking is more effective than the over-simplify perspective in designing and implementing business strategies in dealing with complex challenges.

Added to the above studies with a focus on innovation in Mainland China, Shari S.C. Shang, Se-Hwa Wu and Chen-Yen Yao offer a study on Taiwanese firms. They propose a dynamic innovation model (DIM) to build enterprise capabilities of continuous innovation in a dynamic business environment. The DIM combines the concept of entrepreneurship and resource management and highlights the importance of co-evolving relationships among different capabilities. Through the examination of two PC manufacturers in Taiwan, Atech and Bymove, they argue that the foresight of business leaders must be accompanied by insights about the development of the required capability for innovation, and the cycle of building dynamic capabilities must be linked with the business foresight for effective innovation.

3 R&D globalisation

The second group of articles in this special issue focuses on the issues of globalisation of R&D, which has received increasing attention since the 1990s, though research on global R&D in developing countries is a recent phenomenon. China has become one of the most attractive locations for global R&D (Gassmann and Han, 2004; Sun and Wen, 2007a,

2007b; Sun et al., 2008; von Zedtwitz, 2004) and recent research has examined issues from drivers, activities, locations, and management challenges of foreign R&D in China.

While most previous studies have relied on case studies and interview data, Yifei Sun uses the recently released Chinese economic census data and re-examines foreign R&D investment in China. He shows that foreign R&D in China is much broader than what has been reported before. Foreign companies are more likely to engage in R&D than Chinese domestic enterprises though they are committing less resource to R&D than their Chinese domestic counterparts. He also reveals that market demand and the availability of qualified labour, not seeking technology, are the major drivers for foreign R&D investments in China. Furthermore, Sun analyses the relationship between foreign R&D and their comparative advantages. On the one hand, he shows that foreign companies are less likely to conduct R&D in sectors where they have already mastered strong technological advantages against China's domestic firms. On the other hand, he finds positive relationships between foreign R&D and their shares in China's domestic markets. Such results may suggest that the Chinese governments and domestic firms should not expect to benefit much from foreign R&D activities in China. Instead, they should focus on building up indigenous innovative capabilities: the majority of foreign firms will invest in R&D only when they feel the competition from domestic firms.

The implication of Sun's finding is unfortunate for the Chinese government, which has hoped that knowledge at foreign R&D labs will spill over to Chinese domestic industrial as well academic communities. In her research, Xiaohong Quan further examines the knowledge diffusion from MNC R&D labs in host countries, a critical aspect that has not received much attention in the literature on foreign R&D. She investigates the interactions between MNC R&D labs and local universities in Beijing and identifies five different models: pure image-building, outsourcing, sponsored research, internship and training programs, and the joint lab model. She argues that the joint lab model is most effective in transferring knowledge, particularly tacit knowledge, from foreign R&D labs to local universities.

With increasing foreign companies making R&D investment in China and growing efforts of Chinese domestic agencies in beefing up their innovation efforts, competition for qualified R&D staff has become increasingly fierce. Accordingly, effective recruiting and retaining of R&D professionals have become a critical issue for both foreign and domestic businesses. Zheng Han and Fabian Jintae Froese focus on human resource management in foreign R&D facilities in China. On the one hand, they find that materialistic needs and monetary rewards are important in recruiting and retaining such R&D professionals. Such findings are similar to what has been found in studies on more advanced economies. On the other hand, they also reveal that equally if not more important than such extrinsic factors, are intrinsic consideration such as career development, learning opportunities and challenges at work in recruiting and retaining R&D professionals in China. Also important in China is the specific consideration of 'face' (*Mianzi*) in the Chinese culture. Such a study should offer many useful recommendations for both foreign as well as domestic firms in their efforts of recruiting and managing R&D professionals in China.

Compared to the number of recent studies on global R&D in China, studies on global R&D from China is very limited. Jingjiang Liu, Yi Wang and Gang Zheng examine

global R&D from two leading Chinese telecom firms Huawei and ZTE. Specifically Liu et al. focus on two major issues: the driving forces of behind the R&D globalisation of Chinese firms and their R&D organisational configuration. As expected, the primary driver for these two Chinese firms to establish R&D sites in foreign countries is to 'learn' and to take advantage of the more advanced technology capabilities in more advanced countries. Their study also has revealed that R&D configurations within these two firms have experienced the transitions from ethnocentric centralised R&D to geocentric centralised R&D, and more recently to the R&D hub model. They argue that the R&D configuration is strongly affected by the corporate R&D strategy at the corresponding stages, from single-product strategy, multiple-product strategy, to more recently global R&D strategy.

4 Assessment and government policy

The third part of the special issue addresses issues at the macro level and includes three articles that examine China's innovation capacity, its policies on technology standards, and intellectual property rights (IPR) respectively.

Rongping Mu, Zhongbao Ren, Hefa Song and Fang Chen assess national innovation capacity and innovative development in China with a view to monitor related recent progress. They define two concepts: national innovative development and national innovation capacity and devise two corresponding indices for their measurements. In their definition, innovative development refers to development driven by innovation. The national innovative development index is defined as the weighted sum of five categories of indicators including industrialisation, informatisation, urbanisation, education and health, and science and technology development. In comparison, national innovation capacity is defined as the ability of a country to conduct scientific discovery, technological innovation and related commercialisation activities. The national innovation capacity index consists of four categories of indicators: innovation input, innovation output, innovation condition and innovation performance. Mu et al. also differentiate the national innovation capacity index into two components: innovation strength index and innovation effectiveness index. The results of their research shows that China is still far behind in many other advanced countries in terms of national innovative development, though the gap between China and advanced economies has been narrowed down in recent years. China's innovation capacity index has grown very quickly in recent years, mostly benefiting from its fast expansion in economy, R&D resources as well as improvement in innovation infrastructure. However, China's innovation system is still far less efficient than that in many countries, which will become a major bottleneck for its further development in the future.

As introduced before, the Chinese government has initiated a very ambitious program to promote indigenous innovation and has announced a number of detailed measures for the implementation of the program. Among all the policy tools, technology standard has become a very important one. China has tried to change from a 'standard adopter to a standard maker'. Ailan Zhan and Alex Tan examine the case of time division-synchronous code division multiple access (TD-SCDMA), a Chinese home-grown third generation (3G) wireless standard in light of China's recent efforts to build indigenous innovation. It is clear that the TD-SCDMA standard has been affected by many factors, and the Chinese government has played a central role in this process

through sponsoring research and development (R&D), securing foreign partners, building domestic industry alliance, and protecting the domestic market, among others. The standard has been used by the Chinese government and businesses as a powerful bargaining chip to nurture its strategic industry. However, as the trial services have launched in some Chinese cities, market reactions have not been as vibrant as expected. It remains to be seen if this major Chinese created industry standard can achieve expected successes at home and abroad, given the fierce competition among the three 3G standards: WCDMA, CDMA2000 and TD-SCDMA.

Zheng Liang and Lan Xue analyse the IPR system and its impacts on the patenting behaviours and strategies of multinational corporations, another important issue related to China's innovation policy and environment. Weak IPR protection in China has become a major source of tensions between China and many other countries. However, as Liang and Xue demonstrated, China has gradually strengthened IPR protection over the time and both foreign and domestic businesses and individuals have responded positively and become more active in applying for patents in China. In addition, foreign companies have developed a number of strategies to deal with the uncertainties in China's IPR systems, including 'patenting in advance', licensing, litigation, and alliance and standard. Their research shows that on the one hand, foreign companies' strategies have worked very well and enabled them to establish favourable positions in the Chinese market. On the other hand, they argue that foreign firms' patenting strategies have stimulated innovations in local firms.

5 Discussion and conclusions

Clearly, China has made tremendous progress in science, technology and innovation. The selected studies in this collection have examined a number of significant topics. Here we will focus our discussion on a few issues including the 'market for technology' policy, the role of foreign investments, particularly the role of foreign R&D investment, Chinese firms' catch-up strategies, and policy implications for the Chinese Governments.

First of all, it seems that China's early 'market for technology' policy has failed. Both Fan's study of the cell phone industry and Shen and Feng's study of the power equipment industry have demonstrated this. Particularly, the earlier joint ventures established between Chinese enterprises and foreign companies have failed to cultivate indigenous innovative capabilities. The major weakness with that approach was structural: joint ventures have rarely been found to be effective for technology transfer and no foreign companies are willing to give up their advantages and transfer their proprietary technologies to potential competitors. The failure of the joint-venture approach was associated to the legacy of China's planned economy, including the lack of innovation motivations among the domestic state-owned enterprises and their associated monopolistic power in the market. The private businesses in China did not receive significant support from the government due to some ideological concerns in the earlier days of reforms.

In addition, the role of foreign companies/investment in China's innovation needs to be reassessed. There is no doubt that such foreign investments and firms have made significant contributions to China's economic growth. However, we are uncertain if we can extend such conclusions to their role in China's innovation. The failures of the earlier

joint ventures demonstrated this. Other studies have also shown that foreign companies are investing less in R&D than their domestic counterparts, because of their ready access to advanced technologies within their parent companies. Most often such technologies are developed in countries where their parent companies come from, though recently more foreign companies have started R&D activities in China. We should not overstate the role of foreign R&D activities in China, as most R&D activities by foreign companies in China are adaptive in nature as revealed by many studies. Foreign companies are less likely to make R&D investment in China if they possess strong advantages against their Chinese competitors. The interactions between foreign R&D centres and Chinese domestic academic communities and enterprises are to a great extent rather limited. In some sense, many of them have become 'enclaves of innovation' in China. With that said, we do not suggest that China should limit such foreign R&D activities, since such foreign activities do have the potential to help upgrading local capabilities through labour mobility in the long term.

The above observations lead to our further conclusion that the hope of China's innovation depends on the further development of its non-government owned businesses. Successful examples such as Huawei, ZTE and Lenovo have revealed the potential of such a path. Meanwhile, the very small number of such successful cases also demonstrates to some extent the failure of the Chinese government in promoting indigenous innovation, despite the tremendous economic success that has been achieved. In particular, the Chinese government's rather restrictive policies/attitudes towards private businesses in the early periods were particularly problematic, though such policies/attitudes have changed significantly in recent years. Chinese governments need to be more supportive towards private businesses.

For Chinese firms to catch-up in increasingly competitive global environment, the process is surely a very challenging one. A few successful examples of Chinese firms all point to the importance of the market-oriented strategy: they all took advantages of their intimate knowledge of the differentiated Chinese domestic market in the early stages, despite their relative weak technology capabilities. They all focused first on the niche market/the marginal market that once was overlooked/ignored by foreign companies. Overtime, they have expanded into foreign markets, established their international R&D networks and built international alliances through leveraging their technological capabilities. From there, they have gradually upgraded their innovative capabilities and narrowed the gap with the global leading firms.

With that said, the niche market is not the only strategy available to Chinese domestic firms. Also significant is the government-supported R&D programs associated with universities and public research institutes. Almost all the leading Chinese innovative firms have benefited from various government programs and preferential policies. However, government-supported R&D programs are only part of the solution. More importantly government should focus on building an innovation-friendly environment. Without a proper institutional set up, simply pouring more money into the various governmental programs will not generate innovations as expected. The Chinese government should build better coordinating mechanisms among the different government agencies which may have competing/contradictory interests/objectives. It should also build a structure that conducts continuous monitoring and assessment of its various programs, policies, and initiatives in order to improve the effectiveness and efficiency of its innovation efforts.

To conclude, China is on the path to become a superpower and has made great progress in science and technology as well as innovation. However, making a transition from an economy built upon cheap factor inputs to one on innovation is very challenging. Whether or not China can achieve its goal of becoming an 'innovative nation' will not only affect its own development trajectory, but also have serious implications for the world at large. With so much at stake, studying innovation-related issues in China surely will become a fertile field. We hope that the special issue will generate more interest for future investigation into China's innovation.

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