Chapter 2

Technology Policy, R&D, and Innovation in China Traditional Approaches, and New Challenges

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Abstract: China's long term development path has always been strongly influenced by its own ways of innovation and invention. Though around one thousand years ago China had been undoubtedly the most advanced country in the world, by the 17th century Europe had surpassed it. And when the PRC was founded in 1949, it was only a poor, severely underdeveloped country without adequate, modern technologies. In the last three decades, however, the country has achieved remarkable success in economic terms: China has become the second largest economy in the world, and its new economic, financial and trading power has made it clear that the dominance of the USA and Europe has passed. At the same time China is still lagging behind technologically. Though there are huge efforts to narrow the gap, it is extremely difficult to build up a new technological and innovation system without deep, organic foundations. China, however, has rich experience of innovations from the past, and the question is whether it is possible to use them to formulate a new technology policy. In this paper I will try to examine China's technology system, its functioning and its prospects, while comparing it with the traditional ways of innovations in China. I would like to show that current technology policy is, at least partly, based upon traditional values, and that high tech research, R&D, and state of the art innovations can be reconcilable with several thousand-year-old approaches.

Keywords: China, Innovation, R&D

Introduction

China's economy has been performing extraordinarily well in the last three and a half decades. The new approach, called reform and opening up, have transformed the entire economy. Central planning has been gradually substituted for market forces, while state (or, as it is called in China, common) by private property. The systemic transformation, however, has been quite different from those in Central and Eastern Europe, because the political structure in China has remained more or less intact. The Communist Party has been very successful at preserving political power, while the economy has been going through a fundamental shift from a command economy to a market economy. From a developing country China has become a fast growing emerging one, with growth rates in the region of 10 percent. In 2011 the country became the second largest economy (in Purchasing Power Parity), and the largest exporter in the world. Journalists, politicians and scientific researchers all regard China as the Workshop of the World. There are also estimations about the exact date when China will overtake the United States, and will be the largest economy. To be a real superpower, however, a country needs much more than a fast growing economy and an unparalleled number of inhabitants. Per capita income, technological and innovative capacities, military power, purchasing power, living standards, and the state of the environment (to name a few) are fields where China has huge deficits. In this paper we address the area of technology policy, R&D, and innovations, trying to assess the results, and the problems of the country. We will look back to Chinese history to seek for continuity of approaches, especially from the era of the so called Chinese Renaissance, and the decades of pre-reform communism.

In the first part of the paper we will assess the huge success that China achieved between the 10th and the 15th century in the field of technological progress. At that time China was more advanced than Europe, in fact, it was the most advanced country in the world. One of the most enigmatic questions of history is: Why did the industrial revolution occur in Europe, and not in China (Nielsen 2010: 23)? According to some historians China was in the threshold of this breakthrough in around 1400. The breakthrough, however, happened in Europe, and China slowly fell behind. What were the main causes of this decline? Are there any similarities between the conditions existed nearly one thousand years ago, and the setup of today's system? We will conclude that the approach to innovations and the way the state bureaucracy handles them are not totally different from the traditional patterns. Of course, to understand the functioning of the Chinese innovation system it is interesting, but not at all enough to sketch some distant historical analogies.

Therefore, we will seek for other sources of explanations, too. Because every area of the Chinese economy is strongly influenced by political considerations, R&D expenditures and innovations are not exceptions, too. On the contrary, these are areas where strategic interests of the Party often overwrite economic rationality, and where inherited institutions of the past can still determine the ultimate directions of the processes. As Baark states it: "*emerging institutional fabric governing innovation in Chinese society represents an evolving synthesis of values and routines that have been formed over centuries on the one hand, and new principles introduced as part of ongoing political and economic change on the other hand*" (Baark 2007: 338-339). In the second part of the paper, therefore, we will analyze the evolution of the Chinese innovation system in the reform era, and will show how communist reflexes affect today's processes.

Because the title of this paper promises some insights into the Chinese innovation system, we cannot avoid presenting some current tendencies and some basic statistical data. In the final part of the paper we will assess how the legacies of the past influence current trends and approaches, and how these affect the prospects of China's technological progress. We will show that technologically China still lags behind the most advanced countries quite fundamentally, and it is not probable that this lag will disappear in the foreseeable future. We are also skeptical that technological development from above can be much more successful than development based on market competition. In fact, the more involved the state is in the processes, the more probable it is that some fundamental problem may occur in the system. While we are truly amazed by the economic success of China, according to our analysis the country is not ready yet to achieve better results in the field of technology and innovations than the West.

The Rise and Fall of Chinese Technological Leadership

Due to favorable circumstances technological development in China accelerated to an unprecedented high level in the 10th-11th century. By the beginning of the 13th century China had become the most advanced civilization in the world. China at that time was far ahead of Europe, and when Marco Polo arrived in the country in 1275, he was astonished. Almost every aspect of life was affected by the new innovations, and living standards rose steadily despite rapid population growth. Both domestic and foreign trade was flourishing, countless luxurious goods were sold at local markets, and the infrastructure was highly developed. Though the

empire was held together by the army and the class of the bureaucrats, it was the market and the fierce competition between the participants that provided the country with such a high dynamism. Of course, the role of the state was very significant, too. Besides upholding law and order, the state was responsible for maintaining and expanding infrastructure. In a country where feeding the people is of the highest importance, the state of the canals and other irrigation devices is perhaps the most fundamental service the government should supply. We will see that four or five centuries later exactly this will be the field where the state will fail, causing stagnation and starvation.

Technological advances of this era are so numerous that it would take a long book to count them all. Therefore, as an illustration, we mention here only some of them. As always, everything started with the transformation of agriculture. Improvements in cultivation of rice were the main cause that contributed to this ancient "green revolution". Wet field techniques and hydraulic engineering allowed rapid spread of rice cultivation in areas throughout the country. Other very important agricultural innovations include the use of the iron plow, seed drills, weeding rakes, and the deep-tooth harrow (Mokyr 1990: 209). These tools were designed to achieve higher output on a given plot, and to feed more people in a given village. The main goal in applying them was not to save on labor, but to save on land. From this perspective these agricultural innovations were quite different from those in Europe, which were rather labor-saving in nature. Paths of innovation always reflect the needs, the goals, and the problems of a society, while new tools and new solutions address the factor of production in short stack. In this case, in China, the scarcest resource was land. It is not surprising therefore, that peasants, engineers, and state bureaucrats were all striving to increase the yield of the plots.

After the first millennium increasing productivity in agriculture made it possible to regroup labor force to other activities like trade or industry. Although industries in these centuries were totally different from modern ones, the main goals were the same: to produce goods. As population grew the needs for different goods were growing, too. To match this demand new techniques and processes were developed, and traditional technologies were transformed as well. The most important changes came from iron smelting. The use of blast furnaces to cast iron, and to refine wrought iron from pig iron dates back to the 3rd century B.C. Techniques were continuously improved, and in the Middle Ages the overall production of iron in China far exceeded that of in Europe, even on a per capita basis. In textiles, Chinese developed spinning wheel at about the same time as in Europe, but it spread much faster than in the West. They used waterpower for various purposes, and developed water clocks for measuring time. This invention,

however, was not supposed to use by the commoners, rather it was a masterwork of Chinese engineers for the ruling elite (Mokyr 1990: 210-213).

Perhaps one of the most well known Chinese inventions was the compass. Along with ocean-going junks it allowed maritime trade, and even exploration of distant lands. In the 14th and 15th centuries Chinese led huge expeditions to India and East Africa. The main goal of these adventures was to spread the glory of China, and, unlike Europeans, they were not interested in goods of other countries. Chinese invented paper, at least one millennium earlier than it reached Europe. The use of paper for writing was very common in China, but they also used it for clothing, as toilet paper, wallpaper, and paper money. This latter invention indicates that economic activity, and especially trade between distant cities, reached a level, where adequate financial intermediaries became absolutely necessary. Finally, we should mention some advancement in chemistry, too. Genuine porcelain, lacquers, explosives, and pharmaceuticals all signaled the very high level of practical knowledge that Chinese craftsmen possessed. Considering all these developments, it is very difficult to imagine how China could not stay in the forefront of technological development for the following centuries.

Approximately at the same time when Renaissance started to appear in Italian city states, the pace of technological development in China gradually slowed down, and by the 17th century it stalled completely. Technological stagnation, on the other hand, didn't mean economic stagnation, because China has been able to feed a rapidly growing population since then. True innovations, however, has not appeared any more. Until the end of the 19th century economic growth was based upon population growth, increase in arable land, and extensive growth of domestic trade. As we stated before, technological development and innovations in China were depended on the state bureaucracy. We do not say that centralized policy is less potent in achieving success; it is possible that an extremely talented ruler can over perform competitive markets. The problem is that extremely talented rulers are very rare phenomena. And because technological development is a long run undertaking, a centralized system would need numerous talented rulers to follow each other: "*The absence of political competition did not mean that technological progress could not take place, but it did mean that one decision maker could deal it a mortal blow*" (Mokyr 1990: 231). Such "bad" rulers, of course, existed in Europe, too, but their power and ability to undermine development was much less. Innovators in Europe were able to move from one court to another if the political climate deteriorated severely.

The slowing down of technological development, at least partially, may be attributed to the conservative approach of the leaders in China. Big changes in technology always induce social and economic changes as well, which can have deep destabilizing effects upon the society. Therefore, the ruling elite, the Mandarins, were not interested in introducing fundamental innovations; instead, they were interested in maintaining the status quo. Some historians say that there is an inherent tendency in Chinese society towards social harmony and avoiding deep conflicts. Chinese history, however, shows no clear evidence that could prove this thesis, and as we saw earlier, there were centuries when technological progress was exceptionally fast. It is much more probable that it was only the ruling class who were interested in slowing down progress to preserve the power. And because it was the elite who was only able to carry out successful research projects (like dams and canals), technological progress was depended upon their intentions. When priorities changed, and technological progress became less important, it was not so surprising that important innovations slowly died out. The incentive system of the Chinese society was designed to preserve social structures also through the education and employment of the bureaucrats. Formal education always rested upon studying ancient texts, and there were no room for new ideas or innovative thoughts. After stepping up the ladder, all the bureaucrats became the main defenders of the status quo, without too much interest in carrying out innovative projects.

Considering all these factors it was almost inevitable that this highly bureaucratized system was not able to maintain the technological edge that China enjoyed between the 10th and the 15th centuries. Though it is eventually possible that a centrally governed innovation system with a well-educated and efficient bureaucracy has the potential to be better than a system based on competition, it is highly improbable that the former system would be very durable. There are, of course, rulers who understand the importance of technological progress, but there are also ones, who are simply not interested in innovations. In China the radical change in the approach to innovations came in the 15th century. The state bureaucracy were not interested in spending so much money to promote innovations, and there were no other groups in the society who could have undertaken this task: "*By the fifteenth century, the role of the imperial government in both invention and innovation was far less remarkable than it had been in medieval times, and no other entity in China was in a position to replace the state in promoting technological progress*" (Mokyr 1990: 238).

R&D Policy in the Reform Era

The leaders of the People's Republic of China have treated R&D as a strategic sector of the economy. Due to the very limited resources available, however, they selected some strategic areas where investments were made. As an ambitious military power China poured money into nuclear development, but traditional military technology also was prioritized. The first atomic bomb had been finished by 1964, and the first hydrogen bomb by 1967. These achievements propelled the country to a highly illustrious club of great powers. In the 50s China followed the Soviet Union in almost every respect, so it is not surprising that all the new technologies came from the "Big Brother". The aid from the Soviet Union was eventually more than simple technology export; it incorporated export of the whole innovation system, too. As the first step of this process, the Chinese Academy of Sciences was founded. The main goal of this decision was to centralize both the scientific life and the R&D efforts of the country, but it was also very important to coordinate the various actions according to the priorities of the Chinese Communist Party.

After the break with the Soviet Union in 1962, China was left alone in the field of technological development. There were no new partners available, who could have helped the country to achieve its ambitious goals. From that time, along with other sectors, China had to accommodate itself to a self-sufficient, autark technology policy. Two main strategies helped this approach: the first was importing complete factories with technologies embodied in it, which they tried to imitate, while the second was home-made developments of existing Soviet technologies. The success, however, was very limited, and technological backwardness of the country had increased significantly until the mid 70s. The growing lag increasingly annoyed the party leaders, and contributed to the adoption of the strategy of Reform and Opening Up.

After 1978 China had no uniform approach to R&D and innovation policy, rather we can talk about the coexistence of various strategies. Though these strategies have been present for decades, the emphasis moved from one to another as new possibilities and directions opened up. To assess the importance of these strategies Naughton (Naughton 2007) divided them into seven groups. Each approach was viable in itself, but the main factor behind the success of this policy was the pragmatic interaction between them. In the first group we can find self-sufficient developments like the two bombs. Although these projects were highly successful, they had no side effects in the economy, and remained isolated. With no spill-

over effects the significance of this strategy was continually diminishing over time. Research under the aegis of the Chinese Academy of Sciences has remained isolated as well. They have actually managed to create the first Chinese supercomputer, but it was rather the apex of the performance of the Chinese scientific elite than the fruit of an efficiently working national innovation system. Thus it became evident that other strategies were needed to narrow the gap between China and the West.

At the end of the 70s it seemed that China had huge oil reserves which could be exploited fairly easily. Based upon possible future revenues party leaders began to formulate highly ambitious and costly policies in various areas. In technology policy this meant a new wave of imports of key technologies that was very much needed to accelerate catching up. They spent huge amounts of money to modernize existing plants, and to buy new ones as well. This strategy, however, turned out to be inefficient and very expensive at the same time. Because most of the projects were approved at a lower level, and were not centrally planned, without coordination the same technology were often bought several times. Soon it turned out, unfortunately, that the planned oil extraction had no real foundations, so sources to buy new technologies dried up abruptly.

As a result of the policy of Reform and Opening Up more and more multinational companies have entered China. Party leaders have soon realized the huge possibilities appearing in their negotiating position, and started to demand key technologies from the companies in return for access to the Chinese market. The biggest companies, however, were not ready to give up their monopolistic access to these technologies. Though China was a huge market, at the end of the 80s it was not totally different from other South East Asian economies. Negotiations between the Chinese government and the huge multinational companies were, therefore, very long, and the standpoints remained quite distant from each other. Problems were also arising after the signings of the contracts, due to different legal approaches, and the different interpretation of the texts. Successful negotiations were rare, and they were rather exceptions to the general failures. Some companies, like Alcatel (Mu-Lee 2005), however, as first movers, were able to break into the Chinese market. Chinese leaders soon realized that it was more profitable to create competition between foreign firms during the different rounds of negotiations. Despite these considerations the bilateral approach remained quite strong in the upcoming decades, particularly in some areas, like talks about atomic energy (Naughton 2007).

The failure of the oil project had a severe impact upon direct purchases of technology, and it made the party leaders reconsider the functioning of the whole innovation system. Financing the largest state research institutions was

very expensive, and the results were far from satisfactory. As a consequence, the government reconsidered the administrative distribution of research funds, and, like in the economy as a whole, they started to give way for market forces in the technology sector. A new system of tenders was introduced which was coordinated by some huge agencies. The most important of them was the National Science Fund. Despite promoting competition in the innovation system, the influence of the government remained exceptionally strong in carrying out its priorities. The main difference between this new and the old system was the directness of state intervention.

Inadequate technology diffusion to other sectors of the economy, however, still remained a serious deficiency. As a new approach research institutes and universities were given freedom in selecting their partners. They were allowed to cooperate with business enterprises, and to create affiliates. In this way new enterprises were born, which were assumed to promote priorities of the state, but in a much more indirect, competitive way. They also enjoyed more freedom in shaping their policies than ordinary state owned enterprises. One of the biggest Chinese technology companies, Lenovo, has followed the same path. It was born as an affiliate of the Institute of Computer Studies of the Chinese Academy of Sciences in 1984. In the beginning it sold computers, but soon started to take part in the low technology processes of manufacturing. After a little more than a decade Lenovo became one of the most important players in the world. By 1995 Lenovo had reached a market share of 3, and by 2005 a share of 10 percent in the world. The main sources of the enormous success of the company were the low costs and the imitation of existing technologies. In 2004 Lenovo successfully bought up the personal computers division of IBM, becoming a truly global company. This was a sign of the aggressive expansionist policies of the largest Chinese firms (Naughton 2007).

The most important strategy of the policy of Reform and Opening Up was, for sure, the partial and controlled liberalization of capital inflows. In the beginning foreign companies were only allowed to form joint ventures with Chinese state owned enterprises, and only in geographically designated areas. These were the so called Special Economic Zones which were enclaves in China, and had very little linkages to the mainland economy. These small and restricted areas, however, began to increase both in size and numbers, and by the 90s they had become the engines of growth of the whole economy. With the transformation of the zones the institutional setup of joint ventures has also changed. Majority ownership of the Chinese parties was no more required, and full foreign ownership was also allowed some years later. Despite the huge capital inflows technology diffusion

and technology absorption have been limited, and most of the innovations and patents were attributable to foreign firms.

Finally, the government has been continuously subsidizing domestic enterprises. Although, this type of funding was the most common in the socialist era, subsidies related to research and development in the reform era became available to a much wider spectrum of enterprises than before. Now it is possible for also non-state enterprises to get subsidies, and it is also possible, that a private enterprise becomes a true national champion. The most common means to promote R&D are tax alleviations and low-interest credit. Though the government seemingly retreated from this sector as a participant, through both direct and indirect funding it still controls the processes (Naughton 2007: 361).

Results and Future Challenges

To evaluate the role of China in worldwide technological progress, we need to approach the topic from different perspectives. In this paper we have analyzed the historical and institutional background of the question. Now we first assess the results that China has achieved in the field of technology and R&D; and after that we turn to the problems and challenges that are yet to be solved. These latter factors either have a huge adverse impact upon development prospects, or sometimes they make it impossible to achieve a true breakthrough. Although the main goal of the Chinese elite currently is only to narrow the gap between the country and the developed west, in the long run they obviously seek to secure the leading role. Therefore it is very important to assess the main factors that may affect this goal. We also try to highlight the relationship between innovation systems of the past and the current institutional setting. These links are the primary evidence that path dependency and institutional continuity are much more important in understanding today's processes than we would have thought.

Since 1979 China has been performing very well in the field of technology and R&D. More than half a century ago China was one of the most underdeveloped and poorest countries in the world. By now it is the second largest economy in the world after the USA and in front of Japan (at Purchasing Power Parity). The change has been very large, even on a per capita basis. As a result, China has become a middle-income country. Technological development has always been treated as a prominent feature of the Chinese economy: technology import and acquiring of new technologies have been of high importance. Despite these commitments R&D

expenditures show mixed patterns. According to the latest available figures (NBSC Web) in the 80s and in the first part of the 90s they were decreasing, and it was only after 1995 that the numbers began to rise. In the pre-reform era science and technology expenditures were at about 1 percent of the GDP. Due to the inefficient and wasteful system, however, the results were disappointing. As the reforms gained momentum R&D expenditures fell to 0.57 percent of GDP. This could be mainly attributed to fiscal problems of the central government. While direct contributions from the government were cut back, private enterprises were not yet strong enough to provide new sources. In Central and Eastern Europe, where the systemic transformation was much more complete, and the political system was transformed as well, private R&D expenditures quickly surpassed government spending. In China, however, these large firms remained under state control, and were not in a position to finance research and development. It turned out that no other players could undertake it, like five centuries ago, only the government. After the tax reform of 1994 (Wu 2005) new sources became available, and the government began to increase R&D spending once again (though mainly through indirect ways). While direct subsidies to the large state owned enterprises were reduced substantially, R&D expenditures rose significantly, surpassing 1.4 percent of GDP. This rapid increase is remarkable, because GDP has also been rising at a breathtaking pace.

In 2006 the R&D expenditures to GDP ratio was at about 1.5 percent in China. How can we assess this result? The same data for the USA was 3.4, for the EU25 1.8, and for Japan 2.6 percent (OECD 2008: 496), which means that despite the rapid development, there is still a considerable gap between China and the West. According to data, in 2006 the two thirds of the expenditures could be attributed to business enterprises, compared to less than half of them in 1995. The business sector became much more important than before not only in financing, but also in performing R&D. In this respect business enterprises reached 70 percent. In the R&D sector there were about 700 thousand workers in 1995, while in 2006 the number of researchers surpassed 1 and a half million. This number is comparable that of in the whole European Union. There is also a huge increase in the number of graduates which increased to 3 million in 2006 from 800 thousand in 1995. As China has moved upwards in the technology ladder high tech exports and imports have also increased substantially to 12 and 10 percent, respectively. One more striking data: during this time period the number of scientific and technical publications have increased from 26 thousand to 150 thousand, which is almost 7 percent of the world output.

As we saw, China had significantly raised R&D expenditures, and by 2005 it became the sixth largest country in the world in this respect. Beside this huge success, however, there are circumstances that could seriously hinder further development. As China is becoming more and more advanced, potential for further extensive development is shrinking. Obviously there will be a point where China has to transform its extensive growth to an intensive one. And preconditions of intensive development are very different from current ones. What are the most problematic aspects of China's national innovation system? Research papers (e.g. Schaaper 2009) point to two areas where the difficulties are especially large. The first one is the inadequate supply of human resources. Despite the increasing number of graduate students, the pool is still not big enough, and the excess demand for quality labor force is growing. At higher levels of technological development there is a need for even more specialized and sophisticated knowledge, which can be obtained only from a well-structured and flexible higher education system, and from motivated business enterprises. These are, however, not yet present in large numbers in the Chinese system. The second area where experts find serious deficiencies is the institutional background that defines the processes of knowledge transfer and innovation. This includes antitrust laws, protection of intellectual property rights, financial practices, and methods of corporate governance.

The proper functioning of markets requires adequate antitrust regulation. Extensive subsidies and unpredictable, discretionary policies from the part of the government may bias fair competition. This can have a detrimental effect upon economic efficiency and on the pace of technological development in particular. Everybody knows that the protection of intellectual property rights in China is much weaker than in Europe or in the USA. We mean not only the illegal copying of products and software, but the lack of protection in innovation processes. Efficient functioning of the innovation system also requires that benefits of new innovations remain at the innovator, and be protected by laws. As long as private developers are not fully protected, and there is a danger that their innovations can be stolen, incentives to pursue innovative activities are diminished significantly. Beside these problems there exists a structural one as well. The Chinese innovation system is far from coherent. There are huge leaks and differences both in regional and in functional respects. It is very difficult to link advanced and seriously underdeveloped areas, or technologically not compatible businesses. There are lots of "innovative islands" in the economy with no real linkages to their environments. This creates a gap between the producers and the consumers of knowledge.

Our results also show that while Chinese R&D expenditures are increasing very fast, new, innovative enterprises appear in the horizon, and the country is

rapidly reducing the existing technological gap, numerous problems jeopardize the prospects of a truly successful technological giant. What is more, these deficiencies seem to be the same as those of some hundred years earlier. Since the 15th century due to the inadequate institutional setup China has begun to drop behind in the technological competition, and failed to maintain its edge over Europe. The single most important handicap of the Chinese system has been the lack of real competition. And without fierce competition prospects of new, fundamental innovations are very slim. This is one rare point in economics where the most authors concur that the most important incentive of innovative activities is competition (e.g. Kornai 2011: 146). In the absence of competition momentum will be vanishing in the long run, and the pace of technological progress inevitably will be reduced. The studying of processes in medieval China strongly supports this thesis, and the fall of Chinese leadership from the 15th until the 20th century can be explained very well by this theory. Considering all these factors we argue that the transformation of the Chinese innovation system from the current stage of extensive growth to a more sophisticated, intensive stage can only be possible if a proper competitive environment is created with all the institutions we mentioned earlier. This could be the only way for China to be a true technological superpower regaining its earlier glory.

On the other hand, complete liberalization and the creation of a truly market based institutional framework might undermine political stability. There are no other sectors in the Chinese economy where the reforms have been so deep, and there are no signs either that we could anticipate such a breakthrough in any areas. This, of course, reflects the logic of the political processes in China. Political control is much more important for the leaders than efficiency. It is common knowledge that in the field of technological development and R&D the true propelling force is competition, but too much competition can harm political stability and the power of the Communist Party. Therefore, party leaders are very reluctant to give way to full liberalization, and are interested in maintaining bureaucratic coordination rather. Similarly to the way bureaucracy handled innovations some seven or eight hundred years ago, radical innovations from private businesses are not truly welcomed. Innovations, of course, are good things, but only up to the point where they do not endanger political and social stability, and the leading role of the Party. We argue that until the Chinese political system is so centralized and bureaucratic, there are no real prospects for the technology sector to be a true challenger in the international field. Nevertheless, it is possible that it can achieve huge success in case of existing technologies, but really groundbreaking innovations and technologies possibly will be developed elsewhere.

Conclusions

In the last three decades China has achieved extraordinary success in economic terms. From an underdeveloped, poor status it has become a fast growing, middle-income country. As China was becoming a more and more important player in the international field, the need to modernize the national innovation system became a pressing concern. The Communist Party decided to make special attention to R&D and innovations, and attempted to transform the system. They gave way to market forces, but the ultimate control remained with the Party. As a result of the reforms, extensive development accelerated, and China started to narrow the technology gap. Building upon this success a new, highly ambitious goal began to evolve in the Party elite. They wanted China to be the new technology leader of the world in the foreseeable future. They think that if it is possible to overtake the United States in terms of GDP, it would be also possible to take the lead from them in the technology field.

To assess the chances of this objective we have turned to the past, and studied the roots of the rise and fall of technological leadership China had been witnessing between the 10th and 15th centuries. We have found that agrarian innovations led to increased output in the countryside, which enabled faster development in the cities. Specialization increased, and an unprecedented era of prosperity emerged. Innovations were burgeoning, and the state just did what it had to do: it created and maintained the proper framework for development. After several external and internal shocks, however, the pace of development decreased. The imperial government was less and less interested in innovative processes, and from the 18th century it has failed to provide even the basic infrastructural environment. By the 20th century China had became a poor, severely underdeveloped country.

The next huge modernization wave in China began after the foundation of the People's Republic. It was at least partially based upon the relative success of the 20s and 30s, and was helped by the Soviet Union. Despite the efforts, China was not able to reduce its backwardness, and by the late 70s it became evident that it needed an entirely new approach. The main problem was the highly inefficient innovation system, which was controlled by the centralized state bureaucracy. To enhance the functioning of the system the Party leaders made an attempt to substitute planning for some market competition. This was achieved, at least partially, by opening up the economy to foreign direct investment. The resulting system became a hybrid one, with elements of central planning, and competitive forces as well. Although results have been promising, several serious deficiencies have been remaining. Quality

human resource supply is still narrow. Inadequate antitrust regulation along with discretionary and unpredictable government subsidies cause reduced competition and innovation. Deficiencies, on the other hand, in the incentive system make it difficult for businesses to plan and successfully introduce innovations. This is mainly because of the lack of protection of intellectual property rights, which almost always undermines the efforts of innovative forces. Finally, there is a problem arising in the field of corporate governance. Although some improvements can be found in this regard, organizational processes are still pervaded by traditional reflexes.

Why not to transform the whole system, then, into a market based competitive one? The answer lies in the logic of the political system. The innovation system can not be completely transformed, because due to potentially radical changes it could undermine social and political stability, and, what is more, could endanger the power of the ruling elite. This would be by far a too expensive price for the Communist Party to pay. Instead, to preserve the power structure by any means is the main priority of the Party. This priority is eventually the most important as well, and it constitutes the fundamental base of the current Chinese system. Considering all these factors, we can argue that until political structures are intact, the national innovation system cannot be improved significantly. Thus if China wants to be a technological superpower in the future, it should carry out a more complete transformation of its innovation system, even if it could endanger the political stability. Without this decision the country probably remains only a really good follower of the technology leaders.

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