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The Chinese Indigenous Innovation System and its Impact on Foreign Enterprises

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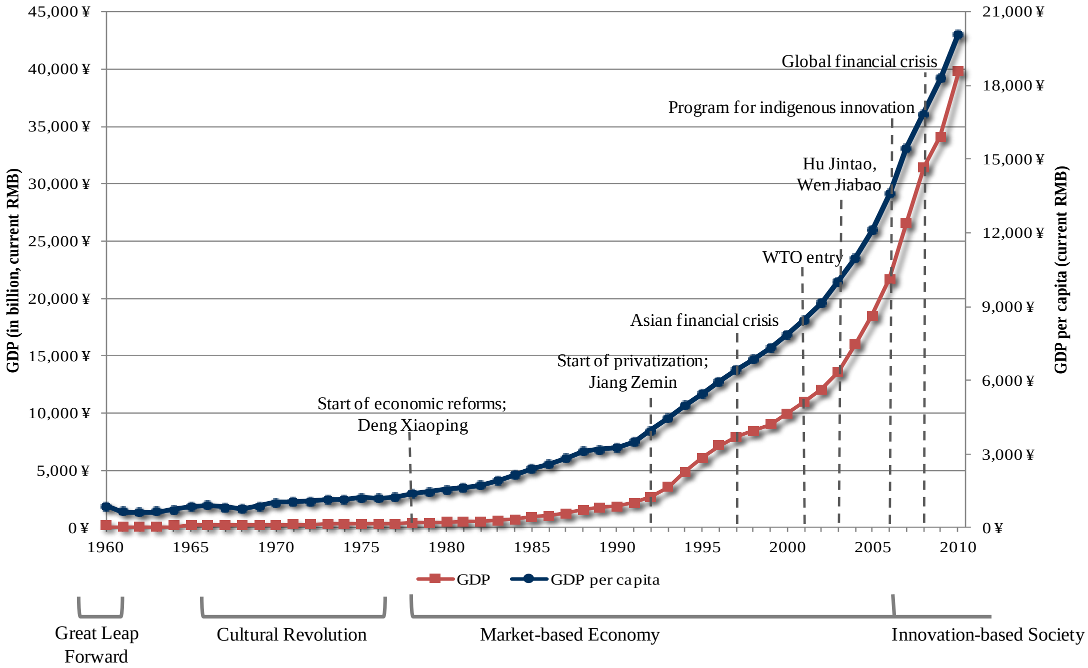
China's economic development and its need for innovation

China has become the world's workshop with the second highest GDP after the U.S. (in 2010 (PPP); according to the World Bank and International Monetary Fund (IMF)) and the world's biggest exporter (in 2009; according to the WTO) in just 30 years after the start of the process of opening up under Deng Xiaoping. China is considered to be one main engine of growth in Asia and worldwide as its demand for imported goods and services increases rapidly (cf. Brandstetter et al. 2008, 668 et seq.). While China managed to become the second biggest economy in terms of absolute GDP, its GDP per capita ranks only between positions 94 and 100 (in 2010 (PPP), according to the IMF and World Bank). With a 2010 GDP per capita of about 7,500 to 8,000 USD (PPP), it is well behind nations like Russia, Brazil, Mexico or South Africa. Illustration 1 presents the development of China's GDP in the last 50 years including important historical incidents and key points during that period of time.

Illustration 1: Development of the Chinese Gross Domestic Product (absolute and per capita) including Historic Events (1960-2010) (own illustration, data source: World Bank 2011)



To maintain suitable economic growth – as export-led growth has its limitations – China started to introduce policies in 2006 to push for homegrown technologies. China wants to move its economy from "Made in China" to "Innovated in China". As the pool of cheap labor is drying up, the young population shrinking and the new generation demanding more from their jobs, a change of mindset in China is necessary. In 2006 China released the "National Medium and Long-Term Program for Scientific and Technological Development" (MLP) (2006-2020), which states that China wants to become an "innovation oriented society" by 2020 and a "world leader in science and technology" by 2050 (Cao et al. 2006, 38 et seq.).

Defining "indigenous innovation" in the context of China

The term "indigenous innovation" is mainly linked to China's innovation policy. The term became widely used with the introduction of the "National Medium and Long-Term Program for Scientific and Technological Development" (2006-2020) in early 2006, which primary focuses on China's change into a global powerhouse in science and technology by improving its capacity to generate indigenous innovation (cf. AeA 2007, 1 et seq.). The promotion of 自主创新 (zizhu chuangxin, indigenous innovation) is the core concept of the future Chinese economic reforms and has a great influence on medium-term economic development initiatives. The term 自主 (zizhu) thereby can be translated as "self-governed" or "self-determined", while the term 创新 (chuangxin) means "innovation". As academics and science have not yet agreed on a common English translation, many different terms are used to translate "zizhu chuangxin", whereof the most popular include (but are not limited to) indigenous innovation, endogenous innovation, independent innovation and homegrown innovation. The United States Information Technology Office in Beijing describes the term "indigenous innovation" – as used in the Chinese MLP – with three adjectives: "independent", "self-reliant", "indigenous". Indigenous innovation thereby combines three different forms of gaining scientific knowledge and of forming the innovation process (cf. AeA 2007, 2):

- 原始创新 (yuanshi chuangxin): original, genuinely new, independent innovation
- 集成创新 (jicheng chuangxin): integrated, combining existing technologies in a new way innovation
- 引进消化吸收再创新 (yinjin xiaohua xishou zai chuangxin): assimilated, making improvements to imported technologies innovation

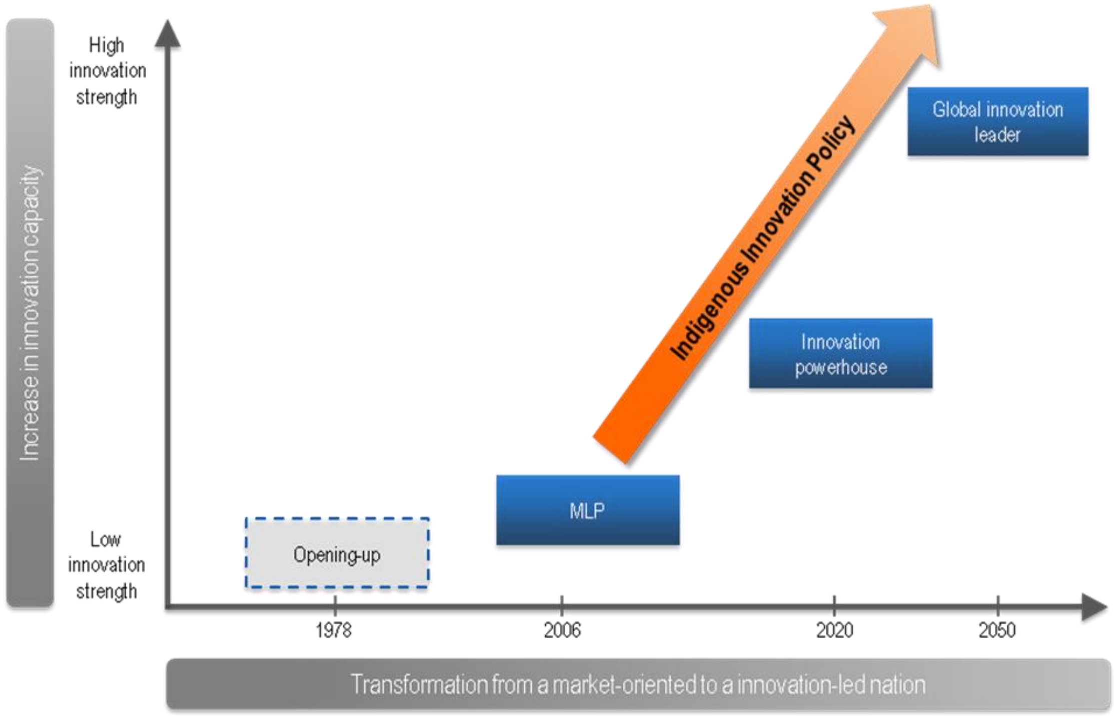
The Chinese Ministry of Science and Technology (MOST) in cooperation with the Chinese National Development and Reform Commission (NDRC) issued a document in 2006 which defines products that are considered indigenous innovations with the following attributes (cf. OECD 2008a, 578):

- Developed mainly by domestic companies
- Domestic ownership of the intellectual property rights
- Leap in technology compared to existing products

The "National Medium and Long-Term Program for Scientific and Technological Development" as the basis for future innovation strategies in China

As mentioned above China issued the "National Medium and Long-Term Program for Scientific and Technological Development" (2006-2015) in 2006, which focuses on the transformation of China into an innovative society promoting independent indigenous innovation (see illustration 2). To achieve this goal, a larger share of the GDP will be distributed to R&D activities. By 2020, 2.5 percent of the GDP should be allocated to R&D expenditures, meaning a massive increase in absolute terms due to the current and future high growth rates of GDP of around 10 percent annually. Secondly, China will reduce the reliance on foreign technologies from 60 percent to less than 30 percent and instead promote national innovation capabilities. Thirdly, the main driver for creating indigenous innovation will be the business sector. Favorable tax policies and various other fiscal incentives will increase investment in R&D and enhance the innovation capabilities in the enterprise sector. Fourthly, innovation should contribute 60 percent to GDP growth in the future (cf. Schwaag Serger et al. 2007, 144 et seq. and Liu et al. 2008, 27 et seq.). Shortly after the announcement of the MLP, 99 supporting policies were presented which define concrete action plans to implement the program. To reach the main objectives of the plan, each supporting policy is under the responsibility of one lead government institution (cf. Schwaag Serger et al. 2007, 151 et sqq.). Main priority is given to the development of technologies on energy conservation, water resources, environment protection, biotechnology, space and aviation, on the mastering of core technologies, on the comprehension of intellectual property in the manufacturing sector and on the strengthening of basic and strategic research (cf. GOV 2006). Alongside the identification of priority fields for future research activities in detail, the plan also defines 16 key projects (megaprojects) which will be launched by 2020, for example sending a Chinese astronaut to the moon or developing the next generation of large planes.

Illustration 2: Objectives of China’s Indigenous Innovation Policy (own illustration)



Until today, China strongly depends on foreign technology and foreign firms. Since the beginning of the 21st century foreign-invested enterprises have been responsible for 85 percent of the overall high-tech exports (cf. Liu et al. 2008, 26 et seq.). For a long time China encouraged foreign enterprises to locate R&D activities in China in the hope of knowledge and technology spillovers. The weak success of this “market for technology” policy caused great frustration among domestic enterprises as foreign firms impose high royalty fees for using their patents, crowd out domestic firms in the competition for high potentials, monopolize technological standards and block knowledge and technology spillovers pushing domestic firms into the role of simple producers. To improve technological capabilities, especially domestic business enterprises are encouraged to take a leading role in the new innovation framework (cf. Zhang et al. 2009, 2). The S&T plan comprises to improve China’s innovation capabilities to develop indigenous efforts in R&D and in home-grown standards. These efforts aim to bring China to the forefront of technological development in new technology fields such as nanotechnology and to reduce the dependency on foreign technology, especially in strategically important fields like information and communication technologies (ICT).

Additionally China needs a growing indigenous innovation output to be able to keep up extraordinary sustainable economic growth in the future, which can in the long-term not solely be created by capital and labor accumulation and manufacturing (cf. Schwaag Serger et al. 2007, 146 et seq. and Liu et al. 2008, 27 et seq.). Recognizing that even successful scientific research does not automatically lead to innovation and improved living standards for the society without commercialization, induced China's leader to move away from a pure science and technology system to a system that actively facilitates innovation.

While the framework for the indigenous innovation strategy was introduced in 2006, the Chinese government did not push to implement supporting policies until 2009. The global financial crisis proved that pure reliance on the growth of manufacturing exports as the main GDP driver is dangerous and that the liberalization of financial markets as an alternative model for development is discredited. Therefore, the role of indigenous innovation elevated as the main driver for further economic development and 2009 marked a strategic opportunity for China to proceed and accelerate the implementation of the indigenous innovation program (cf. O'Brien 2010, 118 et seq.).

The structure of China's Innovation System

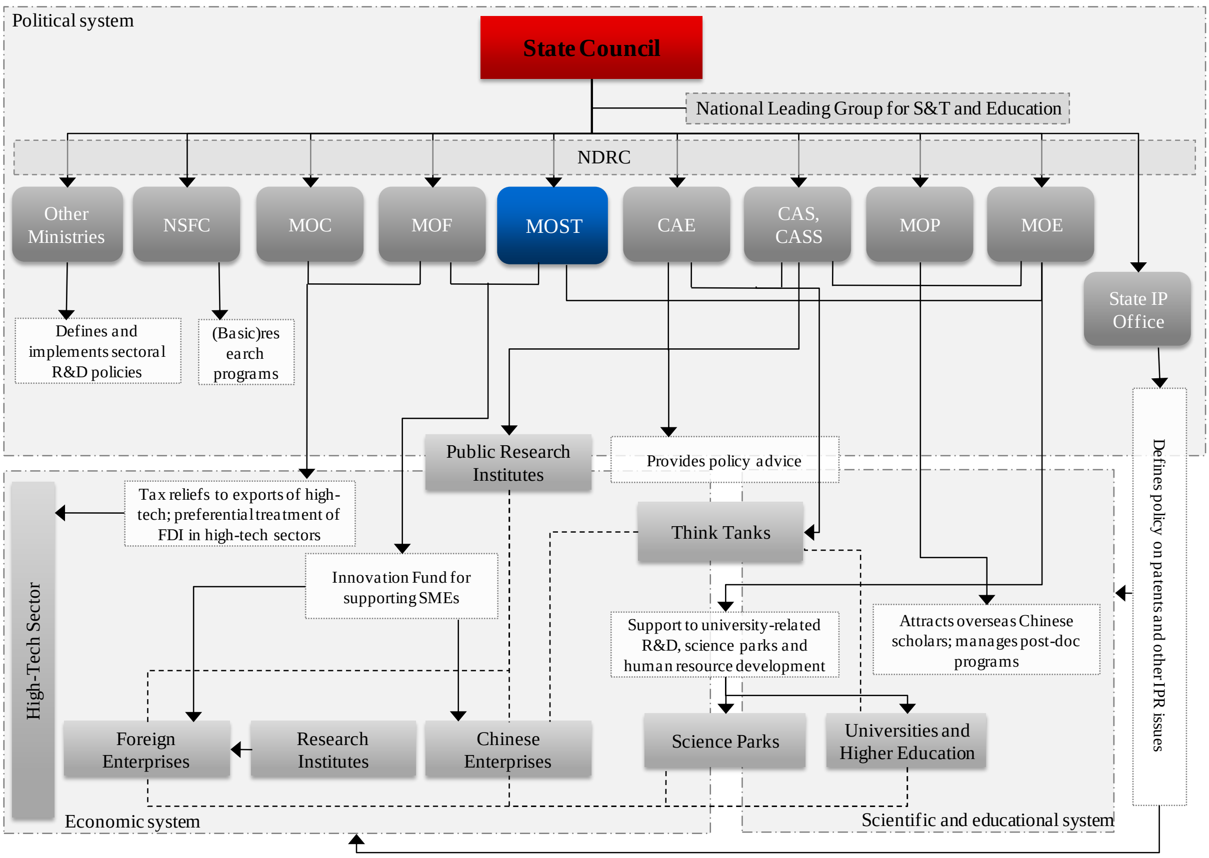
The following section describes the characteristics and the structure of the innovation system in China today, which presents the framework for indigenous innovation. As the S&T- related infrastructure develops slower than the monetary investments in R&D, the improvements in innovation performance are not fully developed yet. It is important that the government continuously upgrades and adapts the National Innovation System (NIS) to react to new developments and policies. China's political and institutional structure has faced some major changes over the last decades, which are continuing today. While the shift to a market-based economy happened faster than the adaption of political and institutional changes, China's leaders push to match the structure of the system with the internal and external competitive pressure of an open economy. Two main aspects of governance reforms were implemented in the support of indigenous innovation policies: organizational changes of the government body and the enhancement of rule of law (cf. OECD 2008a, 427).

The current system of innovation in China originated from an S&T framework, which was formed under a centrally planned economy and some of its features are still influencing the current governance of innovation. Therefore, the innovation system is still strongly centralized under the control of the country's leaders and under various central institutions, which are responsible for the design and implementation of science and technology policies and reforms.

The main decision power for S&T and innovation in China lies with the State Council as the head of administrative bodies (cf. OECD 2008a, 426 et sqq. and Nerb et al 2007, 18 et sqq.). The development of S&T politics, the coordination of important decisions and their implementation is controlled by the Leading Group on Science, Technology and Education. On the second tier level there are the ministries and the main academic bodies. The National Development and Reform Commission (NDRC) is responsible for the design of strategic, short (five-year) and long-term (15-year) plans. These guidelines help China to allocate their resources according to long-term goals. The Ministry of Science and Technology (MOST) is in charge of decisions on policies and their implementation in science, technology and innovation, especially meeting the requirements of the long-term plans. Other ministries are responsible for the realization of policies in their field of competence, but they also have, to some extent, influence on the definition of new national innovation policies. China's main academic organizations such as the Chinese Academy of Engineering (CAE), the Chinese Academy of Sciences (CAS) and the Chinese Academy of Social Sciences (CASS) are positioned at the same hierarchical level as the ministries. CAE's main task is consulting and giving policy advice for decision-making in important issues concerning S&T. Furthermore, they promote the Chinese S&T system in public and accumulate international knowledge about technological science through exchange. CAS and CASS are in charge of conducting research in natural and social sciences. The Ministry of Education (MOE) is responsible for all forms of education and the design of strategies, policies and plans for educational reforms and development as well as their implementation. Within the innovation system, MOE's special focus lies – in cooperation with MOST – on the support of science parks, university-related R&D and the development of human resources. The Ministry of Finance (MOF) administers macroeconomic policies and oversees the national annual budget as well as being responsible for fiscal policies, economic regulations and government expenditure. In the context of innovation MOF together with the Ministry of Commerce (MOC) is responsible for financial incentives in innovation like tax reliefs for exports or favorable foreign direct investment (FDI) treatment. There are also some other ministries and bodies which play a role in the governance of innovation in China, like for example the Commission of Science, Technology and Industry for National Defense. Their main task is, alongside maintaining research institutes, to define and implement R&D policies in their field of competence. The National Natural Science Foundation of China (NSFC) funds basic research and allocates financial resources of the research programs in the natural scientific sector.

Illustration 3 maps the – simplified – current institutional profile of the Chinese innovation system. While collaborative and instructive linkages are shown in the illustration, they might not be drawn conclusively and in full. MOST is the main body in designing national S&T programs and maintains tight relations to many bodies of the national innovation system, from research institutes and universities to think tanks and also to the regional S&T administrations. MOST's main tasks are to formulate policies, strategies, laws and regulations for S&T, to design the reforms of the S&T system and to promote the national innovation system. Furthermore, it designs programs and strategies to strengthen basic and applied research, to encourage firms to innovate, to support high-tech development and to shape the supporting elements of the innovation system like incubators and science parks. MOST uses the R&D programs discussed above as tools to foster the national innovation capabilities. As much as 17 percent of total public S&T expenditures were distributed to the main programs in the first half of the last decade (cf. OECD 2008a, 429; 442 et sqq.).

Illustration 3: Institutional Profile of the Chinese Innovation System (own illustration, based on OECD 2008a, 429; Nerb et al. 2007, 20, 29)



------ Collaboration ⟶ Cash flow, instructions

NDFC: National Development and Reform Commission
NSFC: National Natural Science Foundation of China
MOC: Ministry of Commerce
MOF: Ministry of Finance
MOE: Ministry of Education
MOP: Ministry of Personnel
MOST: Ministry of Science and Technology
CAS: Chinese Academy of Sciences
CASS: Chinese Academy of Social Sciences
CAE: Chinese Academy of Engineering

Fields of competencies are clearly defined in the Chinese innovation system with sectoral administrative bodies having some competencies in their respective fields. The actual planning and implementation of the central policies and strategies concerning innovation is managed in a three-level administrative system. The advantage of this system is the adaptability of instructions from the national bodies to regional conditions and requirements, which vary in a significant way in different regions in China (cf. Nerb et al. 2007, 20 et seq.).

China's innovation capabilities in a global context and the country's indigenous innovation profile

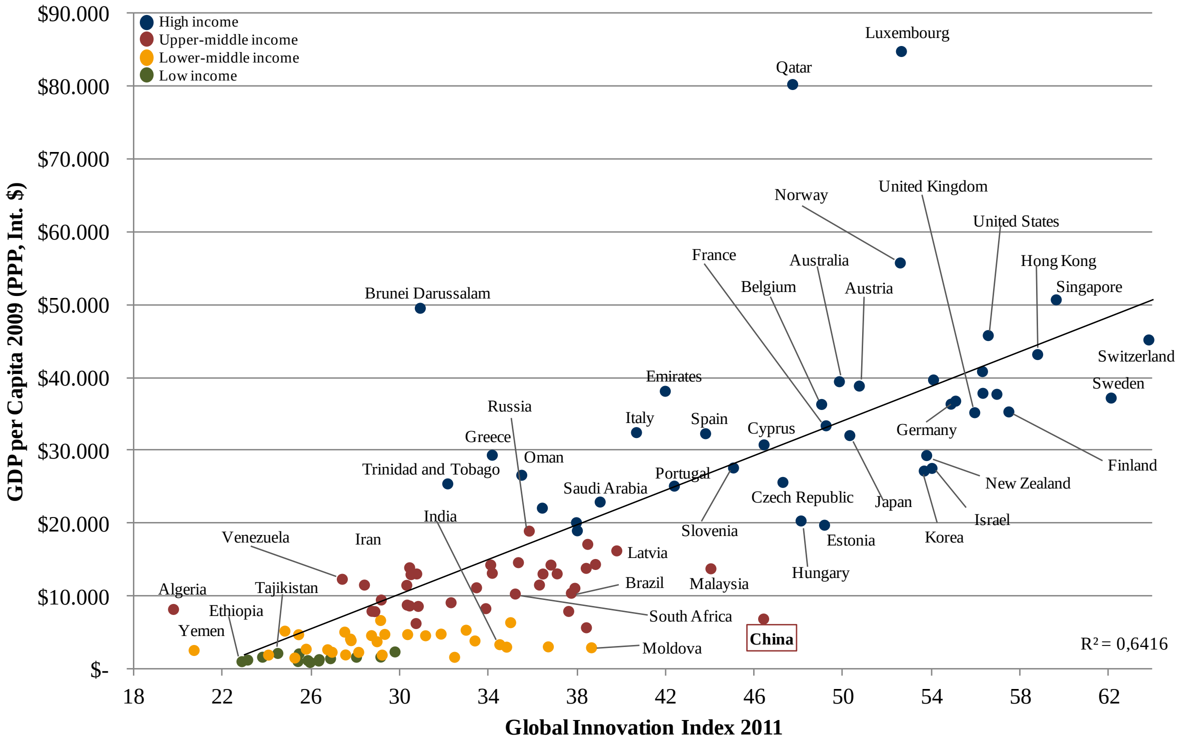
The enhancement of the innovation system requires the interaction of many government agencies and bodies on the central as well as sub-central level. China's key policies are still strongly designed by a top-down approach. China's leaders decide on the program and impose it on all other governmental authorities. For the future, it is important to have clear procedures of division of labor in policy-making processes between different levels of governments and also to include the private business sector in designing policies in a more efficient way. Due to the short history of industrialization, the Chinese government lacks some experience and capacity to create and implement S&T policies, which makes it necessary to learn from international best practices to overcome this bottleneck. Furthermore, the evaluation of innovation policies needs to be strengthened as it plays an important role in the learning process. It also helps to ensure the accountability, efficiency, and transparency of implemented programs (cf. OECD 2008a, 80, 84).

China has managed to significantly increase its innovation capacities by mobilizing resources for S&T activities and it is now one of the biggest players in R&D worldwide although still lacking efficiency. China needs to continue on its way of increased investments in R&D, education and the business sector as well as learn from international good practice and improve framework conditions in the legal and finance sector to face remaining institutional and structural weaknesses. Alongside the improved innovation infrastructure, the government also needs to strengthen the capabilities of the main creators (business, education and public research sector) of innovation to eventually become a high performer in the international innovation framework.

The following two illustrations plot the relationship of 120 countries between an innovation index and their GDP per capita and a competitiveness index respectively. The Global Innovation Index (GII) by INSEAD Business School is based on innovation input and innovation output each calculated from different pillars. Institutions, human capital and research, infrastructure, market sophistication and business sophistication are defined as the input factors and scientific output and creative output present the output factors. Furthermore, each pillar is divided into sub-pillars and each sub-pillar is composed of individual indicators. The Global Competitive Index (GCI) by the World Economic Forum is determined by a weighted average of 12 pillars: institutional environment, infrastructure, macroeconomic environment, health and primary education, higher education, goods market efficiency, labor market efficiency, financial market development, technological readiness, business sophistication, innovation.

The relationship between the innovation index and the GDP per capita – shown in Illustration 4 – is strongly correlated with a Pearson correlation coefficient of 0.80. Countries near the regression line follow a very balanced development, meaning that their innovation capacity is growing at the same pace as GDP and they move along the regression line in their economic development (cf. Porter et al. 2001, 15). Countries above the regression line are able to generate a higher GDP per capita than can be explained by their innovation capacity. This is mainly due to natural resources and favorable geographic location. For example, many oil-exploiting countries like Norway, United Arab Emirates or Qatar are experience such a development.

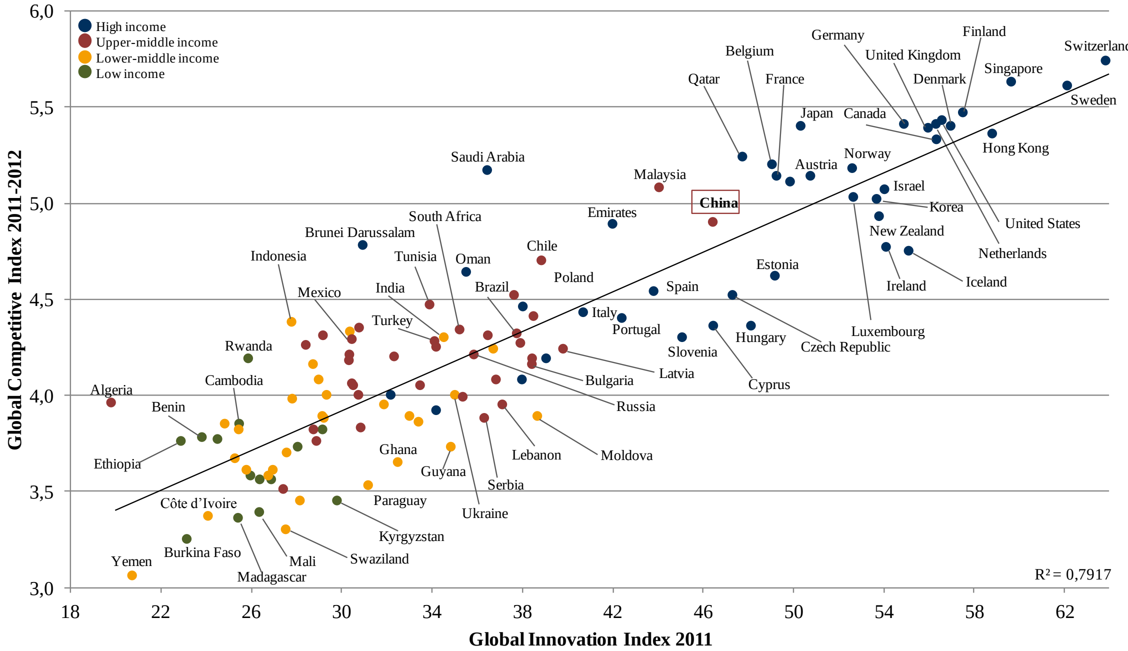
Illustration 4: Relationship between GDP per Capita and Innovation Capacity (2011) (own illustration, data source: World Bank 2011, INSEAD 2011)



China's position is well below the regression line, meaning that its model of development is to increase the domestic capacities for innovation ahead of the subsequent economic development as it takes time to transfer an improved innovation environment into a higher GDP. China relies on innovation as the main driver for further growth in economic output and living standards. This conforms to and underlies the effort of the Chinese government to increase future economic development by strengthening China's indigenous innovation capabilities. In general, countries implementing growth led by innovating tend to grow faster than countries relying on their natural or location advantages (cf. Porter et al. 2001, 15).

A similar pattern can be seen when plotting the GII and the GCI, as shown in Illustration 5. The correlation is even stronger with a Pearson coefficient of 0.89, meaning that a favorable innovation framework is crucial for sustaining overall competitiveness. Countries above the regression line are disproportionately competitive because, for example, of natural resources or low labor cost (e.g. Chile, South Africa, Saudi Arabia, United Arab Emirates). Countries below the line have a strong focus on innovation or have a high proportion of scientists, engineers and research facilities, but fail to create a competitive business environment (e.g. former Soviet countries) (cf. Porter et al. 2001, 12).

Illustration 5: Relationship between Competitiveness Index and Innovation Capacity (2011) (own illustration, data source: INSEAD 2011, World Economic Forum 2011)

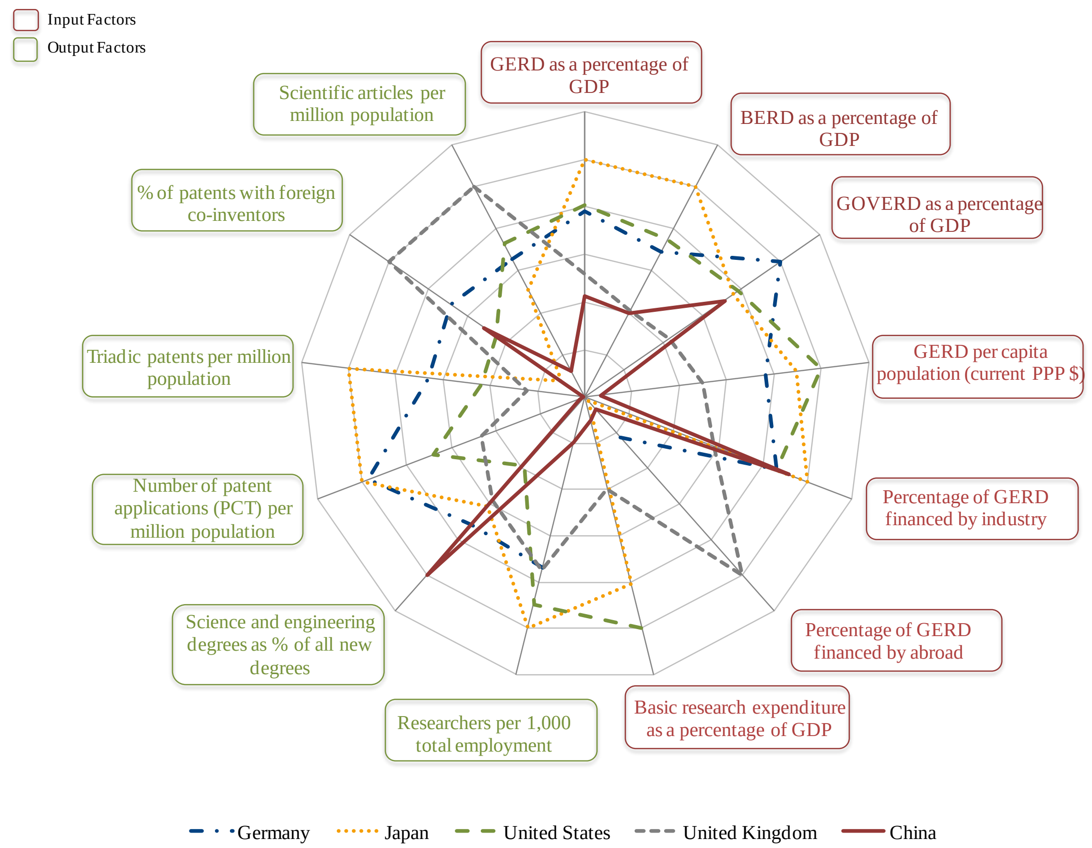


China is situated fairly close to the regression line indicating that its effort as far as innovation is concerned results in an adequate international competitiveness. The location of China slightly above the regression line attributes China a slightly higher competitiveness than can be explained through the indigenous innovation system which is still evolving. This might be caused by other competitive advantages China has, such as low labor costs or the deposits of natural resources (e.g. rare earth elements). In addition China's competitiveness benefits from the business and innovation activities of foreign MNCs done in China.

Both illustrations show that China has the highest innovation index of all upper-middle income countries and even a higher index than many developed countries (e.g. Spain, Italy), which acknowledges the effort of the Chinese government to foster the domestic innovation system. However, the Chinese push for innovation is not reflected yet with a proportional growth of the GDP per capita. Apart from that, the innovation input and output, which is incorporated in the innovation index, mainly measures the quantitative amount and not the quality. On the other hand, China improved the inputs and general conditions of its innovation system so quickly that time is needed until researchers and scientists can fully make use of this new framework and are able to create true and advantageous indigenous innovation, which will then be reflected in an increase of its GDP. Nonetheless, China is already very competitive compared to its innovation status, which might incorporate that it already produces indigenous technologies which are competitive on the global market. However, a more likely explanation for China's competeveness are the low labor costs, the favorable environment for manufacturing companies and the extensive business activities of foreign MNCs.

China's innovation capabilities in comparison to other highly developed countries can be evaluated by summing up and combining the input and output indicators which determine China's innovation profile. Illustration 6 shows that China is converging to international standards in some categories, but it also shows that China still has a long way to go to truly becoming an innovative country. While absolute input factors, especially GERD, did and will grow significantly, China's innovation efforts per capita are still low compared to OECD countries. GERD per capita or researchers per total employment are considerably lower than in developed countries. China's focus in R&D activities still mainly concentrates on applied research and especially experimental development. Basic research, which might not have immediate commercial success but which is seen as the fundament for progress and the foundation for innovative products, is still a neglected field in China. Spending on basic research as a percentage of the GDP is ten times lower than basic research expenditures in the United States, for example. As discussed above, China's innovation output factors like scientific articles and patent applications are increasing rapidly in their quantity. However, relative indicators like patents and scientific papers per population are maintained on a low level compared to developed countries and also quality issues remain, as pure quantity is no indication for a true enhancement of the indigenous innovation capacities in China.

Illustration 6: Relative Strengths of China's Indigenous Innovation System (2011) (own illustration, data source: OECD 2010, 2011)



Many of the reasons which were responsible for the initial creation and implementation of the MLP are still valid (cf. Nerb et al. 2007, 114 et seq.). The impressive number of R&D institutes and R&D personnel is lacking quality, as many of the best educated and skilled Chinese still prefer to work abroad. Additionally, the dependency on imported foreign technologies continues to be very high, especially in the high-tech sector where China's main task is still the assembling of imported parts. The ability to create indigenous innovation therefore maintains a low level, even if the input factors for innovation, mainly GERD, have significantly expanded in the last couple of years.

Furthermore, due to the weak protection of IP, the incentives for Chinese enterprises to make big investments in R&D are low. Copying of technologies continues to be cheaper and faster and commercial success can be achieved with fewer risks. Competition, which is one main driver for firms to invest in R&D, is often limited due to regulations and the focusing on few national champions. There is a small number of Chinese enterprises which are approaching the global technological frontier by innovative strength, but the broad pictures shows that most domestic companies are still mainly based on low labor costs and scale of production (cf. Zhang et al. 2009, 13).

Furthermore, the Chinese government has not yet managed to encourage the demand for and consumption of innovation. While the supply side is heavily addressed by government's policies, more incentives to reduce the barriers to market for new, innovative products with no track record must also be implemented (cf. Jia, 2009, 137). The enhancement of ingenious innovation capacities is crucial to secure future economic growth and to face national and international challenges especially in the fields of health, environmental protection and energy with solutions (cf. Cao et al. 2009, 249 et seq.). The government's actions and strategies to support innovation in general are adequate and conform to international methods, but China's lack of a market-oriented industrial tradition still handicaps indigenous innovation and the creation of proprietary technologies. Most technological progress is still based on FDI, but China has not managed to absorb (not copy) foreign technologies in a sufficient way, which would be a strategic measure to support the enhancement of its own innovation capacities. Chinese innovations are therefore still mainly limited to imitation and reverse engineering (cf. Fu 2008 and Cohen et al. 1990). The expenditure on the absorption of foreign technology is around five percent of R&D expenditure of LMEs and has not seen any significant change since 2005 (cf. NBS 2010).

While China and its firms are still mainly in the stages of technology acquisition and technology assimilation, it is crucial for long-term sustainable economic growth to eventually proceed to the stage of indigenous technology innovation. Imitation has brought impressive results to the export performance in recent years, but only in low-margin industries and commodity high-tech sectors. Chinese firms need to overcome the vicious circle of technology imports, lag behind, import again, lag behind again and face the challenges of exploring and engaging in research and development to be able to step up on the technological ladder and to realize greater returns on capital with homegrown innovation in the international market (cf. Xie 2006, 236).

A few Chinese companies already show the path into the future by seeking access to foreign R&D capacities not only through foreign R&D institutes in China but also by acquisition of foreign firms and R&D facilities and the establishment of R&D and design labs abroad (see Table 1). In 2010 188 outbound M&A transactions worth 38 billion USD took place which is a 30 percent increase compared to 2009. M&A targets are widespread globally with one focus on the United States, but also on the European Union, Asia, Africa and developing countries with strong R&D infrastructure such as India (cf. PWC, 2011). Additionally, the Chinese government actively tries to bring back overseas Chinese high potentials and also to define science co-operations with abroad. Such co-operations, for example with the European Union, include visits and exchanges for scientists and technical experts, trainings and workshops as well as exchange and sharing of equipment etc. (cf. Nerb et al. 2007. 89). The development of their own innovation system is therefore actively supported by the adoption and integration of foreign knowledge stocks and competencies.

Table 1: Selection of Chinese R&D and Design Labs Abroad and Outbound M&A Deals of China (own table, cf. OECD 2008a, 36)

Chinese Overseas R&D and Design Labs	
Chinese Firm	Activity/Location
Glanz Group	• R&D centre in the United States
Foton Motors	• R&D centers in Chinese Taipei, Germany, Japan
Haier	• R&D centers in Germany and United States • Design centre in United States
Huawei	• R&D centers in India, Netherlands, Russia, Sweden, United States
Kelon	• Design centre in Japan
Konka	• R&D centre in United States
ZTE	• R&D centre in Sweden, India

M&A Deals by Chinese Firms	
Chinese Bidder	Target Foreign Firm/Unit
Holly Group	• Philips Semiconductors, CDM hand-set design, US
TCL International	• Schneider Electronics AG, Germany
TLC International	• Thomson S.A., Television manufacturing unit, France
BOE Tech Group	• Hyundai display technology, Korea
Shanghai Auto Co.	• Ssangyong Motor, Korea
Lenovo Group	• IBM, PC Division, US
Nanjing Automotive	• MG Rover Group, UK

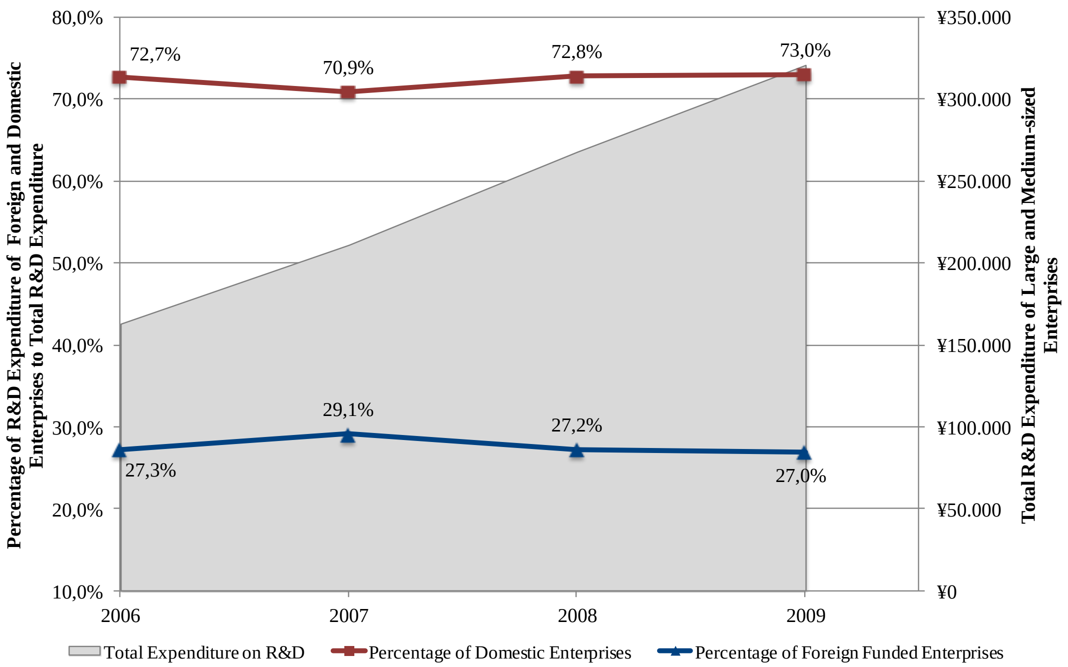
Globalization of R&D Activities – Offshoring Innovation to China

Offshoring and outsourcing are well-known phenomena in the phase of global value chains. Since 1960 manufacturing and sales networks in particular have been offshored from developed to emerging countries. Since the 1990s enterprises have started to move away from simply relocating business activities due to cost advantages, and are now focusing on becoming globally integrated enterprises with close ties to partners, suppliers and customers. Since the late 1990s the internationalization of industrial research has been seen as "one of the most dynamic elements in the globalisation process" (OECD 2008b, 12). While the R&D function of MNCs, as one main core function of many enterprises, used to be centralized and home-based, a growing share of MNCs' R&D is now carried out in foreign countries (cf. Bruche 2009, 267). According to a survey of the Economist Intelligence Unit (EIU) in 2007, 65 percent of large firms have had some of their R&D activity offshored. By 2010 this share will have increased to 84 percent (cf. EIU 2007, 7). While technology transfer was first used to exploit the company's assets worldwide, newer trends of international R&D activities are based on "strategic asset-seeking" motives where subsidiaries are actively involved in the creation of innovation and know-how (cf. Moncada-Paternò-Castello et al. 2011, 6 et seq. and cf. Gugler et al. 2010, 67).

MNCs need to access, mobilize and leverage knowledge from around the world to secure competitive advantages which are increasingly based on the access and creation of new knowledge within a dynamic environment. Only with a global innovation network can enterprises benefit from worldwide local expertise, talent pools and spillovers from clusters (cf. Bruche 2009, 268). While at the beginning of the globalization trend of R&D the U.S., Western Europe and Japan were the preferred locations for cross-border R&D, MNCs now often shift their innovation processes to developing countries, especially to China and India (cf. UNCTAD 2005, 153, EIU 2007, 7). As analyzed above Chin has in its effort to become an innovation-led country implemented ambitious plans and policies to upgrade its innovation system and attract significant R&D activities of foreign companies (cf. Bruche 2009, 268).

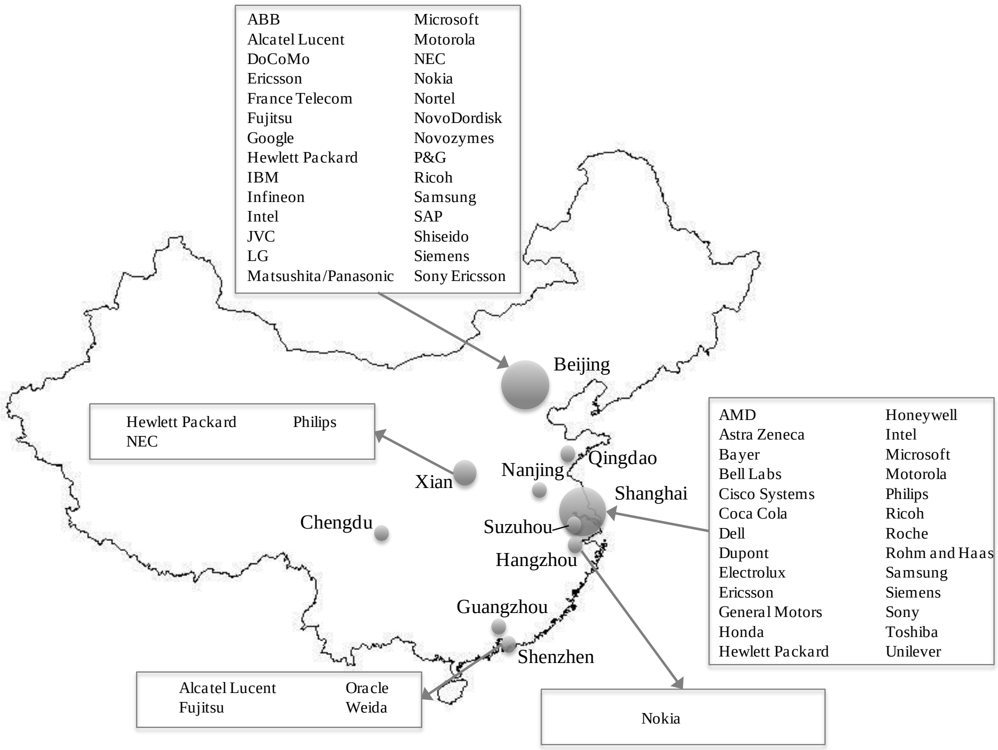
For a long time R&D in China was cost and production-driven or enforced by local requirements (technology for market access), which resulted in mainly subcontracting low-end R&D activities and concentrating on production-related development. Most foreign companies claiming to carry out R&D in China essentially concentrate on the "D" to adapt products to the Chinese market. Due to the effort of the Chinese government to promote the national innovation system and infrastructure and become an innovation-led society, especially since the implementation of the MLP, some foreign R&D centers in China have advanced and now focus on the search for "true" innovation. There is a trend towards more "R", still the investments compared to development are rather small. However, Western enterprises recognize the power and opportunities created by emerging markets and agree with the lasting role of China as a future global lead market. FDI in China has been increasing by an average annual growth rate of 13 percent since 2006 (cf. NBS 2010). While previously most FDI was used for greenfield investments or acquisitions in production and distribution facilities, today an increasing portion of foreign investments flows into the development of R&D facilities. The percentage of R&D expenditure of foreign-funded LMEs stays constant at around 27 percent, while domestic LMEs spend around 73 percent of total LME expenditure on R&D (see Illustration 7).

Illustration 7: R&D Expenditures of Foreign and Domestic Large and Medium-sized Enterprises in China (2006-2009) (own illustration, data source: NBS 1996-2010)



This is remarkable because the overall average annual growth rate for R&D expenditure of large and medium-sized enterprises has been more than 25 percent since 2006. This shows that foreign enterprises make use of the improved Chinese innovation system and are increasing their R&D activities in China at the same pace as domestic firms. Nonetheless, as of today the Chinese innovation system is still not a complete system and is rather fragmented. A large portion of foreign spending on R&D is concentrated in a few regional clusters in China namely Shanghai and Beijing (see Illustration 8 for an exemplary illustration of foreign R&D centers in China). However increasing R&D investments in other provinces (Guangdong, Jiangsu, Tianjin) create a close link to the concentration of MNC investments in production capacities (cf. OECD 2008, 281). The number of foreign R&D centers in China increased drastically from around 50 in 2000 to approximately 1,100 at the end of 2007 (cf. Bruche 2009, 275). While there are still many obstacles to overcome, China and its innovation capacity is developing in a very fast and dynamic way.

Illustration 8: Examples of Global R&D Centers in China (own illustration, cf. Schwaag Serger 2009, 52 et sqq.; Schwaag Serger 2006, 246 et sqq.; Chen et al. 2005, 112 et sqq.)



Chinese Efforts for Indigenous Innovation and their Impact on Foreign Enterprises: Chinese Policies on Government Procurement

The Chinese indigenous innovation strategy has already impacts on the business activities of foreign enterprises. In the Chinese government's effort to encourage firms to innovate, one main measure is a public procurement strategy that stipulates the "first choice" of indigenous innovation, but that also has a negative influence on the business activities of foreign companies. The demand of the national and regional governments presents a huge potential for accelerating the diffusion of indigenous innovation. The Chinese market for government procurement was valued at about 88 billion USD in 2008, presenting two percent of China's GDP and even valued close to 200 billion USD when including public works projects (cf. USITC 2010, 5-9). In the MLP public procurement is mentioned as one major tool to support indigenous innovation. Even public demand is only a small part of the overall demand, it shows spillover tendencies to the private sector, which often adapts to the behavior of the public sector (cf. OECD 2008a, 564). The difficulty with government procurement is to stimulate indigenous innovation on the one hand, but to also maintain open markets and international linkages on the other hand. Therefore, many foreign companies fear the coupling of government procurement and indigenous innovation, which might raise barriers to open markets. China first published procurement laws in

2002 to start regulating the government procurement market and increase efficiency. This also marks a first important step for China in signing the WTO Agreement on Government Procurement (GPA). The GPA aims at non-discrimination and transparency and rules that foreign and domestic products and services are treated equally. Until now China's two applications as a GPA member have been rejected (cf. O'Brien 2010, 122).

With the announcement of the MLP in 2006, the Chinese government began to promote the concept of indigenous innovation and issued "Trial Measures for the Administration of Accreditation of National Indigenous Innovation Products" to define criteria which classify a product as a national indigenous innovation product (NIIP). In 2009 the Chinese government released new draft regulations for the implementation of the public procurement strategy. Some problems identified in these regulations were the preferential treatment of domestic entities and, even worse, of national indigenous innovation products, which both violate global GPA standards and best practices (cf. Ahrens 2010, 3).
In late 2009 the Chinese government presented the "Circular 618". MOST, MOF and NDRC will create a national catalogue including all indigenous innovation products. Only if a product is accredited as being "indigenous" by the National Certification Administration can it be accepted into the catalogue and receive preference in government procurement decisions. Furthermore, the supporting policies of the MLP also favor indigenous innovation products in price-based bidding processes (cf. USCBC 2011b, 4 and cf. McGregor 2010, 19 et seq.). For the first national catalogue, the government identified six areas which conform to the indigenous innovations program, four in the ICT area (computers and application equipment, telecom products, modern office equipment, software) and two in the new-energy area (new energy equipment and high-efficiency energy-saving products) (cf. Lonborg et al. 2010, 3). To be eligible for the indigenous innovation catalogue the product must, among other criteria, have full ownership of IP in China and have a trademark that is owned by a Chinese company registered in China (cf. Lonborg et al. 2010, 3 and cf. O'Brien 2010, 119). The first national catalogue was planned to be released by the end of 2010. Foreign MNCs seemed surprised by the requirements and the sudden pace of the Chinese government and were afraid of losing their piece of the Chinese public procurement market and of possible negative spillovers to private markets.
After international protests, the Chinese government released the "Draft Circular" based on the "Circular 618" in April 2010 addressing some but not all concerns of foreign companies. One major change is that now companies are only required to have the lawful right to use the IPR, for example by licensing IP for the use in China from overseas, and they do not need to own relevant patents in China. Furthermore, the trademark and brand no longer need to be first registered in China and the products do not need to be owned by a Chinese entity. Applicants only need to have the exclusive rights to the products' trademark or to use the trademark in China (cf. Lonborg et al. 2010, 4; USCBC 2011b, 4).

In December 2010 China promised a number of statements which will further decrease the threat of indigenous innovation to Western companies and delink government procurement and indigenous innovation to some extent. For example, the location of development or the ownership of IP of a product will not be a criteria for accreditation anymore. In addition, all innovative products produced in China will experience equal treatment in public procurement decisions, independent from the catalogue, and China will also start a new attempt to sign the GPA (cf. O'Brien 2010, 122).
In July 2011 MOF disposed three key measures that delink indigenous innovation and government procurement. First, accredited indigenous innovation products no longer enjoy advantages in the government pro-

curement process. Second, rules and regulations for government entities to use state funds to procure accredited products have become void and third, measures for government entities to use state procurement contracts to promote indigenous innovation have been discontinued (cf. USCBC 2011a). Though many other accreditation criteria, inconsistencies and linkages of indigenous innovation and public procurement remain and the danger of preferential treatment of products with Chinese patents is still existent. For example, the relationship between delinking indigenous innovation from public procurement and the validity and use of local and provincial NIIP catalogues, which are based on the former discriminatory accreditation criteria, remains unclear. Since 2006, 22 provincial and municipal-level governments have released 69 separate regional indigenous innovation products catalogues. Random examination of some catalogues shows that almost none of the products are made by foreign-invested enterprises. The catalogues are based on provincial and local accreditation criteria which often are in conflict with the revised regulations of April 2010 and still include factors like IP restrictions and import substitution. These discriminate against foreign-invested firms and their products (cf. USCBC 2011c, 1). This fragmentation between central level and sub-central authorities in procedures concerning public procurement and indigenous innovation remains of concern of Western companies and governments. However, it appears that the Chinese government will not issue a national catalogue on indigenous innovation products in the near future (cf. EUCCC 2011).

Alongside the problem of linking government procurement and indigenous innovation, the Chinese government also tends to issue contracts to the cheapest tender (often Chinese companies) and not to the most economically advantageous one (often foreign MNCs). This mainly favors cheaper low-quality products and does not take into account innovative criteria such as quality, energy efficiency, cost of usage, maintenance cost or total lifetime cost, even if high-quality, innovative products might be economically superior over their entire lifetime compared to low-quality products with low initial costs (cf. Ahrens 2010, 16).

Chinese Efforts for Indigenous Innovation and their Impact on Foreign Enterprises: Web of Chinese Indigenous Innovation Policies

As said before, the linkage between government procurement and indigenous innovation and the setting of China-specific standards coupled with a discrimination against foreign enterprises are the main concerns of Western companies. The implicit goal of China’s effort to enhance indigenous innovation is the capture of market space for domestic companies. For example, the official goal of the so-called “1225 strategy” (Next Generation Wireless Broadband) as one megaproject of the MLP is to capture 25 percent of the telecom semiconductor market and 20 percent of the global broadband hardware market (cf. McGregor 2010, 18). No industry has been specifically excluded from the indigenous innovation policy, still a priority lies in emerging frontier industries like biotechnology, lasers, new materials, in megaprojects and in facing urgent national needs (e.g. energy, environment) (cf. USITC 2010, 5-4).

China has issued a variety of industrial policies, strategies and programs to develop firms into Chinese national champions in innovation. China’s government is still attracting foreign investments in the hope for technologic spillovers, while restricting ownership in some strategic sectors like telecommunications or new energy equipment. Furthermore, some policies allow Chinese companies to take action against foreign companies with “junk patents” (utility model patents, design patents) and impede foreign products from the Chinese market by compulsory certification and standard requirements. The Chinese government even created a bigger web of interrelated policies by issuing requirements for the disclosure of foreign proprietary technologies and by controlling standards, testing and certification (cf. McGregor 2010, 22 et seq.). China also enacted an "Anti-Monopoly Law" in 2008 to foster competition and avoid monopolistic markets. The law exempts monopolies in sectors which are dominated by SOEs and in sectors where monopolies are deliberate by the state as they are critical to the Chinese economy. It focuses on mergers and acquisitions, monopolistic agreements and the abuse of a dominant market position giving judiciary agencies a certain discretion which could be used to protect domestic companies and support indigenous innovation by discriminating against foreign firms. One action supported by the law is, for example, a form of forced technology transfer, as foreign firms still enjoy high market shares in some industries, which can be seen as a violation of the AML, especially as the MLP aims to reduce and replace foreign technologies. The main concern of foreign businesses lies not so much on the regulation itself though but on the enforcement and implementation strategy of the law (cf. USITC 2010, 5-20). Other policies of the ICT sector which raise the concern of foreign businesses and government over discriminations and IP issues are the "China Compulsory Certificate" (CCC) program and the "Multi-level Protection Scheme" (MLPS). The CCC program deals with the safety approval for tech and industrial products and affects around 20 percent of US exports to China. This program forces foreign companies to disclose technological details like encryption secrets to the Chinese government. The MLPS determines that the core technology and key components of a computer system with high sensitivity for security technology must be based on Chinese IP (cf. USITC 2010, 5-17 et seq.).

Therefore, foreign-invested firms are concerned about the way indigenous innovation policies which seem to extend the protectionism of local companies to support the discrimination of foreign technologies and encourage IP theft are implemented. Governments of developed nations worry that indigenous innovation is a "techno-nationalistic" strategy to transfer and "steal" foreign technology under the pretext of a relevant policy. The explicit request in the MLP in particular to reduce Chinese dependency on foreign technology and to replace foreign technologies in Chinese critical and strategic fields raises concerns over the true purpose of the innovation policy of China (cf. McGregor 2010, 35). Severe trade disputes with Western nations might be the consequence of China's indigenous innovation policies. As China benefits from increasing globalization and the location of foreign R&D activities, raising the barriers for business activities of foreign companies on the Chinese market will lead to international interference and possible counter-measures entailing the danger of a vicious circle of measures and counter-measures.

Many of the policies concerning indigenous innovation issued by China are overlapping or contradictory. Many government ministries are assigned to implement certain policies of the MLP and their main goal is to fulfill their mandate and support the indigenous innovation movement. This leads to a sometimes uncoordinated and incoherent web of policies, especially between central and provincial governments, and often to a discrimination of foreign companies (cf. USITC 2010, 5-8).

Western nations often express additional suspicion of "new" policies of the Chinese government due to the negative preconception towards a communist country. Nationalism plays an important role in China – as in many countries – and the protection of domestic development and prosperity enjoys priorities. However, global integration and mutual understanding will support China's path into the global mainstream and China's goodwill to accept and act according to global best practices and norms. China is still an emerging country facing many problems and challenges in upgrading its economic situation and facilitating higher living standards for its people (cf. Zhou 2008, 174 et seq.). Western countries should not expect the same behavior from China and the adhering to global rules, which are mainly formed and defined by developed countries. They need to include China in a global community, where communication and interaction will eventually lead to new agreed standards and frameworks. China sees its effort towards indigenous innovation as a legitimate and necessary strategy to face challenges in its economic development. The eventual goal of Chinese leaders with their indigenous innovation policy is to shift the living standard of around one billion people to a middle-class lifestyle before the Chinese population turns gray (cf. McGregor 2010, 36 et seq.). Around one quarter of the Chinese population is estimated to be older than 60 in 2050, consequently resulting in a shrinking workforce which then must provide economic growth and support the elderly population. This can only be achieved by dismissing GDP growth caused by cheap labor and introducing growth by innovation.

While the pure ambition of China to foster indigenous innovation should not be seen as a threat or hazard but as competition, the way of implementing policies and measures can favor local firms in an unfair and non-transparent way. As shown above, homegrown innovation is needed to maintain sustainable economic growth and lift China up the wealth ladder. By focusing on indigenous innovation and improving technological capabilities, Chinese companies can not only face foreign competition at eye level but also break the existing paradigm of the global division of labor where China is trapped with low-profit and low-value added manufacturing activities. Chinese companies are still trying to converge to the technological level of high-developed countries mainly through imitation but for some special sectors, China’s objective is to leap forward and even overtake developed countries. This is only possible by generating true indigenous innovation. While the Chinese government’s effort to provide support and incentives to companies in their shift towards indigenous innovation is comprehensible, successful and competitive technology cannot be created “behind closed doors” (Zhou 2008, 169). As China has once already failed with a push for a great leap forward, it must be kept in mind that closing the gap in technological capacity, knowledge accumulation and innovation capability requires many little steps of success forward, but also some disappointment and setbacks. The attempt of one big leap forward might even result in harmful, impatient actions and drawbacks. (cf. Droege 2007, X et sqq.). While a substantial amount of resources is now being devoted to supporting indigenous innovation, exaggerated expectations might impede China of becoming a true leader in research and merely generate a few “commanded” breakthroughs.

List of Abbreviations

AML	**A**nti **M**onopoly **L**aw
CAE	**C**hinese **A**cademy of **E**ngineering
CAS	**C**hinese **A**cademy of **S**ciences
CASS	**C**hinese **A**cademy of **S**ocial **S**ciences
CCC	**C**hina **C**ompulsory **C**ertificate
FDI	**F**oreign **D**irect **I**nvestment
GCI	**G**lobal **C**ompetitiveness **I**ndex
GDP	**G**ross **D**omestic **P**roduct
GERD	**G**ross **E**xpenditure on **R**esearch and **D**evelopment
GII	**G**lobal **I**nnovation **I**ndex
GPA	WTO **A**greement on **G**overnment **P**rocurement
ICT	**I**nformation and **C**ommunication **T**echnology
IMF	**I**nternational **M**onetary **F**und
IP(R)	**I**ntellectual **P**roperty (**R**ight)
LME	**L**arge and **M**edium-sized **E**nterprises
MLP	National **M**edium and **L**ong-Term **P**rogram for Scientific and Technological Development (2006-2020)
MLPS	**M**ulti-**l**evel **P**rotection **S**cheme
MNC	**M**ulti**n**ational **C**orporation
MOC	**M**inistry **o**f **C**ommerce of China
MOE	**M**inistry **o**f **E**ducation of China
MOF	**M**inistry **o**f **F**inance of China
MOST	**M**inistry **o**f **S**cience and **T**echnology of the PRC
NBS	**N**ational **B**ureau of **S**tatistics of China
NDRC	**N**ational **D**evelopment and **R**eform **C**ommission of the PRC
NIIP	**N**ational **I**ndigenous **I**nnovation **P**roduct
NIS	**N**ational **I**nnovation **S**ystem
NSFC	**N**ational Natural **S**cience **F**oundation of **C**hina
OECD	**O**rganisation for **E**conomic **C**o-operation and **D**evelopment
PPP	**P**urchasing **P**ower **P**arity
R&D	**R**esearch and **D**evelopment
S&T	**S**cience and **T**echnology
WTO	**W**orld **T**rade **O**rganization

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