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While there is a general view in the literature that despite China's very significant pace of economic growth in GDP terms since adopting an 'open door' policy in 1978, the level of innovation is till rather low. For the years 1995 to 2005, China was the fastest improving country in terms of innovation, but was still ranked only 34 in 2005.<sup>1</sup> More recent data indicate that while China continues to be considerably behind the EU27 in many indicators, it is the only BRICS country to show that it is closing the innovation gap with Europe.<sup>2</sup>

Bearing in mind criticisms of various innovation indicators, data from *The Global Innovation Index* for various years provides some indication of China's evolving progression in relation to various indicators of innovation compared with the emerging economies of India and Brazil.<sup>3</sup> While India and China are of similar size in terms of population, with Brazil having less than 200 million people, GDP per capita at \$12, 038 is higher than that of China and significantly more so than that of India (Table 1). The

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<sup>1</sup> Commission of European Community, European Innovation Scoreboard 2008, January 2009, p. 26

<sup>2</sup> Commission of the European Community, Innovation Union Scoreboard 2013, p25

<sup>3</sup> Soumitra Dutta and Bruno Lavin, The Global Innovation Index 2013, Johnson Cornell, INSEAD and WIPO, 2013  
<http://www.globalinnovationindex.org/content.aspx?page=GII-Home>

overall ranking of all three countries has slipped somewhat since 2009, but China remains considerably ahead of both India and Brazil. China's best performing indicator is scientific outputs, ranking number 2 globally in 2013, while its worst performance relates to institutions and creative outputs. Considering the on-going extent of state involvement and control in both the market and in many areas of industry, it is not too surprising that China performs more poorly than either India or Brazil in these areas. On the other hand, China outperforms both India and Brazil in relation to market sophistication and human capital and research.

It is clear, therefore that China has been making significant strides in science and technology, and particularly in terms of growth in R&D investment. While R&D activity has been dominated by Europe, the US and Japan for the past 40 years, in 2011, China had surpassed Japan's spending. By 2018, it is expected to surpass the combined spending of Europe's 34 countries and by 2022 it is likely to exceed the R&D investments of the US in absolute terms.<sup>4</sup>

Although China's expenditure on R&D is highest among countries of a similar level of development, its spending on R&D is around 60% of US spending. A major difference between R&D funding between these two countries is that while only 28% of such funding in the US comes from government sources, 70% of China's R&D funding is sourced from the government.<sup>5</sup> Boutellier, Gassmann and Von Zedtwitz predicted that

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<sup>4</sup> R&D Magazine/Battelle, R&D in China, 12.9. 2013 <http://www.rdmag.com/articles/2013/12/r-d-china>

<sup>5</sup> R&D Magazine/Battelle, Emerging economies drive global R&D growth, December 2009 <http://www.rdmag.com/articles/2009/12/emerging-economies-drive-global-r-d-growth>

within a few years China will become the second most significant location for foreign R&D labs and that already it has become an important source and provider of global technology.<sup>6</sup> Many interviewees, however, felt that despite the significant expenditure on R&D that China was still in very much in “catch-up” mode and that it would take many years before China reached the average level of innovation of more developed regions.

While almost 80% of R&D investment comes from within China and particularly its enterprise sector, foreign investment, which has been very important in China’s increasing integration into the global economy, also plays a significant role. This chapter will focus on that role, particularly in relation to R&D FDI in Shanghai. Attention will also be given to the evolution of China’s policy towards attracting FDI and particularly more recently R&D investment. While it is clear that China has had a very significant dependence to date on importing foreign technology, policymakers are particularly concerned to reduce this dependency and to increase indigenous innovation. The implications for the growing significance of foreign R&D in China and the dominant role played by foreign multinational companies in high technology sectors will also be considered.

During the 1980s foreign investment in China was primarily associated with exploiting China’s large supply of low cost labour to establish a manufacturing export platform. Initially, much of the investment came from the ‘Greater China’ and particularly from

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<sup>6</sup> Roman Boutellier, Oliver Gassmann and Maximilian Von Zedtwitz, *Managing Global Innovations – Uncovering the secrets of future competitiveness*, 3<sup>rd</sup> edition, Berlin, Springer, 2008, p 74

Hong Kong, which relocated most of its manufacturing activity to the mainland. Later Taiwan relocated much of its electronics manufacturing to the eastern urban regions of China and China also became a significant location for other Asian Pacific countries, particularly Japan and Korea. Over time the overall profile of FDI in China was quite broadly based, with significant investment from the US and Europe. In addition to becoming the world's 'global factory', China's rapid economic growth over a period of almost 30 years made it a particularly attractive emerging market for the world's largest multinational companies. Investment from the key Fortune 500 companies expanded significantly over time. With China becoming the third largest recipient of FDI in 2005, European policymakers are increasingly concerned about the EU's ability to compete with China for such investment.<sup>7</sup>

While this initial phase of China's recent period of economic expansion succeeded in bringing hundreds of millions of formerly poor rural dwellers out of poverty, and set China on the road to becoming a major economic power, the environmental damage associated with this rapid pace of growth, and the low level of profitability associated with much of China's manufacturing activity made it clear that major changes were required in long-term economic policy if growth was to be sustainable. The most significant change in policy in recent years has been a refocusing on the promotion of indigenous innovation as a means towards creating a sustainable economy. The rationale for this strategy arose from a growing concern with China's predominantly low cost export platform, which relied on low labour costs and resulted in low profit levels from

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<sup>7</sup> Lars Oxelheim and Pervez Ghauri, EU-China and the non-transparent race for inward FDI, *Journal of Asian Economics*, 19, 2008, p. 359.

exports. China's development to date has also been characterised by a culture of copying product development and design from other countries. Although the new approach was more focused on promoting indigenous innovation, there is also the acknowledgement of the continued role of foreign investment and the hope of increased technology transfers to the local economy. China used the attractiveness of its huge and growing market to try to leverage technology transfer from multinational companies in the initial stages, by insisting on the formation of joint ventures with local companies and building alliances with China's enterprises. With the more recent accession to the World Trade Organisation in 2001, China has been obliged to open its economy to a greater extent to outside investors and the initial emphasis on joint ventures has gradually given way to wholly-owned enterprises by outside investors.<sup>8</sup> Saxenian suggests that perhaps the greatest transfer of managerial and technical skills in human history accompanied the migration from to Shanghai of the entire Taiwanese integrated circuit (IC) supply chain, including equipment manufacturers, designers, wafers and other input suppliers and packaging and test specialists.<sup>9</sup>

While some foreign multinational companies have been involved in China for more than a century, most were forced to leave for a period during the Cultural Revolution between 1966 and 1976, with many of them returning in 1979 with the new opening of the economy. After the suppression of student demonstrations in Beijing's Tiananmen Square in 1989 some foreign multinational companies pulled out of China for a short

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<sup>8</sup> Linda Yeuh, *The Economy of China*, Cheltenham: Edward Elgar, 2010, p. 103

<sup>9</sup> Annalee Saxenian, *The New Argonauts: Regional Advantage in a Global Economy*. Cambridge, Mass.: Harvard University Press, 2006

period, but most of them returned at a later date. Most of the current foreign investment in China, however, is of recent origin, with the earlier period being mainly focused on manufacturing and sales and marketing, and the more recent period being characterised by a growing level of R&D investment. To some extent this changing profile of foreign investment in China reveals a fairly typical pattern of evolution, with most companies initially seeking to exploit the emerging Chinese market and in many cases using China as a significant export platform for low cost manufacturing. Chen argues that multinational investment in China has gone beyond 'cost-driven' R&D activity and has resulted in the relocation of the whole spectrum of innovation.<sup>10</sup>

In the earlier stages of foreign investment to China after the opening up in 1978, much of the investment resulted from companies in the 'Greater China' of Hong Kong, Taiwan, Macau and Singapore relocating manufacturing activity to the newly created export processing zones in the southeast. Many of the earlier investments were in the form of Joint Ventures with local Chinese companies because of regulatory restrictions imposed by the Chinese government at this stage. Over time, however, the profile of foreign investment in China expanded to include major Asian sources of investment particularly from Japan and Korea and from Europe, the United States and other parts of the world. The more recent period has also seen a shift from the more restrictive joint venture model to wholly-owned enterprises, allowing greater freedom to foreign investors in their business models.

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<sup>10</sup> Chen, Yun-Chung, Changing the Shanghai innovation systems: The role of multinational corporations' R&D centres, *Science, Technology & Society*, 11(1), 2006, p. 99.

The more recent period has also seen considerable expansion of investment to the major urban centres, particularly Beijing and Shanghai, and increasingly to lower tier cities and lower cost locations in the western regions. Because of policy changes in relation to FDI, including tax incentives, there has been a significant push for higher value added investment in high tech sectors, and the share of manufacturing FDI, which was 70% for the period 2002 to 2004, has been rapidly declining. Foreign capital is no longer seen as a source of funding or a means of job creation but of bringing in advance technology and expertise.<sup>11</sup> Despite reaching a new high of US\$711 billion in 2011, FDI attraction has been losing its former high priority with a greater emphasis on quality as opposed to quantity.<sup>12</sup>

Boutellier, Gassmann and Von Zedtwitz refer to three modes of entry of foreign R&D investments in China: as wholly-owned independent labs, as R&D departments of a Chinese operation or as a joint venture with a Chinese partner, or as a form of cooperation with Chinese research universities or institutes.<sup>13</sup> They suggest three main objectives of these investments as acting as a link between China's market and the technology of their parent company; making an important contribution to R&D generally, or demonstrating their commitment to the Chinese government. Various authors have referred to this latter motivation arising in some cases from pressure by the Chinese

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<sup>11</sup> Economist Intelligence Unit (2012) *Serve the People – the new landscape of foreign investment in China*, p 6 [www.eiu.com](http://www.eiu.com)

<sup>12</sup> Davies, Ken, *Inward FDI in China and its policy context 2012*, Columbia FDI Profiles, October 24, 2012, p. 1 [http://www.vcc.columbia.edu/files/vale/documents/China\\_IFDI\\_final\\_18\\_Oct\\_0.pdf](http://www.vcc.columbia.edu/files/vale/documents/China_IFDI_final_18_Oct_0.pdf)

<sup>13</sup> Roman Boutellier, Oliver Gassmann and Maximilian Von Zedtwitz, *Managing Global Innovations – Uncovering the secrets of future competitiveness*, 3<sup>rd</sup> edition, Berlin, Springer, p 64

government on multinationals to carry out R&D in China. In addition to their significantly lower cost of R&D talent in China, many foreign R&D centres in China have global mandates for products and technologies, although proximity to the Chinese market together with the plentiful supply of competent talent are also important factors. Boutellier, Gassmann and Von Zedtwitz conclude that the management of foreign-owned R&D operations in China were not that prepared to learn from Chinese science and technology, and that the general tendency was one of a short-term profit-maximising strategy. Around 67% of all foreign R&D sites are located either in Beijing or Shanghai, with more of an emphasis on research in Beijing and a greater focus in development in Shanghai.<sup>14</sup>

The foreign investment experience in China during the past 30 years has gone through various stages of evolution, and it has been an unusual experience compared to other regions of the world in that it has been part of the evolution of a major political economy experiment with China's one-party socialist state becoming in some senses more capitalist than societies with a more social-democratic composition. While the opening up of China's market presented many foreign companies with major opportunities for expanding their market share, particularly in infrastructural sectors such as telecommunications, some companies took considerable time to develop profitable operations. Some early bird investors in the telecoms sector such as Alcatel (now Alcatel-Lucent) had very high levels of profitability in the early stages of investment, with most of the competition coming from other foreign companies like Ericsson,

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<sup>14</sup> Roman Boutellier, Oliver Gassmann and Maximilian Von Zedtwitz, *Managing Global Innovations – Uncovering the secrets of future competitiveness*, 3<sup>rd</sup> edition, Berlin, Springer, p 67

Motorola, and Nokia. More recently companies like Alcatel have been experiencing very significant competition from emerging Chinese companies, and particularly Huawei, which has become an important player in telecoms equipment internationally. One of the primary expectations of the Chinese state during this early period of foreign investment was the transfer of technology from foreign to Chinese companies, and this was an important reason for the emphasis on creating joint ventures. One of the most successful of these joint ventures was Alcatel Shanghai Bell, which became a significant manufacturing arm for Alcatel in its early period of existence. Although the Chinese government have not been particularly happy with the level of technology transfer from foreign companies since the opening up of China, many technology companies during the initial stages of investment in China, not only obtained huge infrastructural contracts, but also added to their profitability by charging very high royalty payments for transferring technology to their Chinese subsidiaries. The more recent period, however, has seen cut-throat competition, not only between the foreign multinationals themselves, but also with Chinese companies, thus reducing significantly their margins.<sup>15</sup> The more recent phase of investment in China has also seen a growth in R&D investment in China by foreign multinationals, which has resulted in a reduction in the need to transfer technology from their headquarters.

To some extent the changing pattern of foreign investment in China reflects an evolution in the political economy of innovation in China, with China initially leveraging its huge

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<sup>15</sup> Loren Brandt and Eric Thun, The fight for the middle: upgrading, competition, and industrial development in China, *World Development*, 38(11), 2010, p. 1565

and growing market size to attract foreign investment, to insist on technology transfer by means of joint ventures with foreign multinationals, and more recently by insisting that foreign multinationals increase R&D investment in China. Since this most recent phase of policy development has also been accompanied by the shift from joint ventures to wholly-owned foreign subsidiaries (also known as foreign invested firms), the actual location of some of their R&D activity in China by foreign firms does not necessarily mean that China's ultimate objective of shifting its economic model from low cost manufacturing to a greater level of indigenous innovation will be easily facilitated. There is a general perception among both Chinese and foreign actors that interaction between foreign and domestic R&D is not as strong as it might be.<sup>16</sup>

The early stages of China's innovation policy was based on the assumption that the constraints placed on multinational companies requiring them to form joint ventures (JVs) would result in significant technology transfer, and since this has not happened to any great extent there are some signs that China may be re-evaluating its policy options.<sup>17</sup> China is no longer prepared to function as the "world's factory", which is an innovation model based on low levels of innovation and low levels of profitability.<sup>18</sup> In place of the rather vague specifications about transferring technology from foreign companies in the earlier phase of FDI, the most recent phase associated with "indigenous innovation" is

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<sup>16</sup> Roman Boutellier, Oliver Gassmann and Maximilian Von Zedtwitz, *Managing Global Innovations – Uncovering the secrets of future competitiveness*, 3<sup>rd</sup> edition, Berlin, Springer, p 72

<sup>17</sup> Denis Simon, China's new S&T reforms and their implications on innovative performance, Testimony before the US-China Economic and Security Review Commission, May 10, 2012  
<http://www.uscc.gov/sites/default/files/5.10.12Simon.pdf>

<sup>18</sup> Shulin Gu, Bengt-Ake Lundvall, Ju Liu, Franco Malerba & Sylvia Schwaag Serger, China's system and vision of innovation: an analysis in relation to the strategic adjustment and the medium-to long-term S&T development plan (2006-20), *Industry and Innovation*, 16 (4-5), 2009, p 372

much more specific that only products and services with a certain level of “indigenous innovation will be eligible for the public procurement market. By insisting that the Chinese entity must fully own the IP or must first register the trademark in China, this creates the problem for foreign companies of being restricted to selling products in a market in which IP has been developed.<sup>19</sup>

Some of the early bird foreign investors in China, such as Alcatel and Motorola showed considerable willingness to work closely with the Chinese government and to some extent become ‘Chinese companies’ at least in China. In other cases, notably Microsoft, becoming profitable in China was a slower and more difficult process. Microsoft has also learned how to work very closely with the Chinese government by developing close links with major third level institutions and developing a significant R&D operation mainly in Beijing and Shanghai. Like many other companies, the initial approach of Microsoft was to exploit the Chinese market by selling its popular software at prices similar to those charged in other regions. During the 1980s and 1990s, however, Microsoft together with other foreign companies in China encountered a culture of intellectual property piracy, where there was little implementation of regulations protecting IP. This has been an ongoing problem for foreign companies in the Chinese market, and while the government has introduced more stringent regulations recently, the issue of vigorous implementation which in the view of some is related to the absence of an independent judiciary, remains a problem. Because of their fear of losing IP to competitors in the Chinese market, some companies were only prepared to use middle range IP in China, and their main objective

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<sup>19</sup> Seamus Grimes and Debin Du, Foreign and indigenous innovation in China: some evidence from Shanghai, *European Planning Studies*, 21(9), 2013, p 1364

was to gain market share without compromising their IP.<sup>20</sup> Lundvall argues that Europe and the US should acknowledge the benefits being derived from the significant Chinese investment in providing science and engineering talent for their companies operating in China.<sup>21</sup>

This problem of Intellectual Property Regulation (IPR) reflects characteristics of emerging markets which are also found in other regions and in most regions in earlier stages of development. The Chinese market, like other emerging markets, is strongly segmented in tiers, with a large low margin tier and a growing, but relatively modest middle class tier. To overcome the problem of software piracy rates in excess of 90%, Microsoft, for example, has been forced to opt for very low charges for its software packages in China. In the opinion of an interviewee from Microsoft, the only way for success in the Chinese market was to develop a partnership with a local company through a JV or through developing an alliance with a state owned enterprise (SOE) such as China mobile in Microsoft's case.

Although there is considerable rhetoric among foreign multinational companies about developing innovative activities in China and contributing towards making China a more innovative economy, the reality is that the multinational model of innovation is very

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<sup>20</sup> Timothy Moran, Foreign manufacturing multinationals and the transformation of the Chinese economy: new measurements, new perspectives. Working Paper 11-11, Peterson Institute for International Economics, Washington DC, 2011.

<sup>21</sup> Bengt-Ake Lundvall, The changing knowledge landscape and the need for a transatlantic vision and a new pragmatism. Presentation to Aalborg University and Sciences Po, Paris.  
[http://transatlantic.saisjhu.edu/partnerships/Cornerstone%20Project/cornerstone\\_project\\_lundvall\\_paper.pdf](http://transatlantic.saisjhu.edu/partnerships/Cornerstone%20Project/cornerstone_project_lundvall_paper.pdf)

much about controlling intellectual property within the boundaries of the corporation, while at the same time sharing knowledge creation between subsidiaries in different regions of the world, but also ensuring that there is no leakage to potential competitor companies. Traditionally, R&D investment was concentrated close to the headquarters of the corporation, but with increasing globalisation and with the growing significance of emerging markets in Asia and elsewhere, corporations have been decentralising their R&D activity to a greater extent in recent years, partly to develop products closer to their customers in increasingly important markets like China, but also to tap into the lower cost surplus of intellectual talent in these emerging markets. Very often R&D investments in locations like China have begun being focused on more basic activities related to the local market such as technical support, localisation and adaption of products to the local market. Over time, however, with increasing experience of the growing capabilities of the local labour force, together with improved infrastructure and policy incentives, R&D investment has become more innovative, and in some cases has moved significantly up the value chain to the complete production of new products. In the pharma sector, for example, Roche have evolved their activity in China from an initial focus on drug development to highly innovative projects with emerging Chinese biotechnology companies.<sup>22</sup>

Although the growth in R&D investment which has characterised the more recent period of FDI in China is not disputed, there is considerable scepticism about the nature of the activity involved and its level of innovation. Some of this investment has resulted from

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<sup>22</sup> Bethan Hughes, China spurs pharma innovation, Nature Reviews Drug Discovery 9, (August 2010), p 581 <http://www.nature.com/nrd/journal/v9/n8/full/nrd3238.html>

government pressure on companies to move beyond the market for technology transfer stage towards making a greater contribution to local innovation. There is little doubt that China has invested hugely in growing its R&D investment in recent years, and part of this results from attracting foreign high technology companies. A large number of science and high technology industrial parks have been developed in the major cities in recent years and together with attractive low rates of corporation tax and other financial incentives, China has been very successful in increasing this investment. In addition to its emphasis on high technology, China's policy has also sought to cluster much of the R&D activity in science and industrial parks in the major cities.

Despite China's obvious success in attracting a significant volume of R&D foreign investment, and also increasing at a very rapid rate its own expenditure on R&D, questions remain about how successful this policy has been to date in raising the level of indigenous innovation. A major thrust of China's current policy in science and technology is to reduce its technology dependence on foreign companies, currently estimated at about 50% to about 30%.<sup>23</sup> As Chinese technology companies such as Huawei have emerged as serious competitors for foreign technology companies in China and elsewhere, there is a growing commitment by the Chinese government to implement intellectual property rights. While this is acknowledged by many foreign companies, the traditional culture of IP infringement in China is a major barrier towards introducing core technology to their R&D activities in China. It is argued therefore that many R&D

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<sup>23</sup> Economist Intelligence Unit (2009) Unlocking innovation in China – An Economist Intelligence Unit Report sponsored by Cisco  
[http://graphics.eiu.com/marketing/pdf/Cisco\\_Innovation%20in%20China\\_English.pdf](http://graphics.eiu.com/marketing/pdf/Cisco_Innovation%20in%20China_English.pdf)

operations in China remain focused around adapting products for the local market, or carrying out outsourced projects on behalf of the parent corporation. While multinational companies, who have been successfully penetrating the Chinese market have many reasons for extending their investment in R&D activity, a strategy of splitting various R&D operations is often used to ensure that China does not acquire access to their integrated core IP. A similar type of strategy may also be used at the local level in China in R&D operations, by not allowing researchers full access to the complete process being developed.<sup>24</sup> Thus while the Chinese government and foreign-owned companies may have complementary objectives in increasing the level of R&D investment in China, there are clearly major differences and possible areas of tensions between the objectives of the two major actors involved. In general, the multinational model will seek to restrict the sharing of knowledge-creation within the boundaries of the organisation and between its various subsidiaries, an important objective of the Chinese government is to increase the level of indigenous innovation, which appears to give rise to a tension between these two sets of objectives. While it is difficult to quantify the contribution of multinational companies to building management and other capacities of local firms by their operations in China, the extent of actual technological spillovers does not appear to be every extensive.<sup>25</sup>

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<sup>24</sup> Adam Segal, *Advantage: How American innovation can overcome the Asian challenge*, New York, WW Norton & Company, 2011, p 98

<sup>25</sup> Yifei Sun and Debin Du, Domestic firm innovation and networking with foreign firms in China's ICT industry, *Environment and Planning A*, 43, 786-809; Segal, A, *Advantage: How American innovation can overcome the Asian challenge*, New York, WW Norton & Company, 2011, p. 88

## The Chinese market – capitalism within a socialist state

While there are some exceptions, many of the foreign multinational companies which established R&D centres in China in recent years already had previous involvement in the market in marketing or service provision. Both the size and the rapid growth during recent decades of the Chinese market has proven to be a major magnet for attracting foreign investment to China, but foreign companies have had to adapt their operations to an emerging capitalist system within a socialist state. The Chinese market, therefore, more than those in the West, is characterised by significant involvement of the state in the functioning of the economy, and particularly major sectors such as energy, telecommunications service providers and banking, which continue to be dominated by State Owned Enterprises (SOEs). Although China has been gradually opening up its economy to the outside world since 1978, and particularly since its accession to the World Trade Organisation in 2001, some sectors such as the aforementioned remain for the most part closed to foreign investment.

The role of the state is also strongly present in relation to innovation policy, as it is in most countries, but the approach taken by China to date is very much a top-down model, based on a strongly technocratic belief in technology, together with the provision of very significant investment in the provision of science park and high technology infrastructure on the assumption that the clustering of high technology activity will generate higher

levels of innovation in the economy. To some extent China is adopting policies that appear to have some measure of success in more developed regions of the world, but a common criticism of the approach is the over-reliance on the hardware side of the equation, while paying too little attention to key software factors such as the role of the university education system in innovation. Despite the limitation of the Chinese approach, some argue that emerging countries need to ensure that effective innovation policies are in place to avoid the negative effects of inward investment in R&D.<sup>26</sup>

### Market evolution

During the 1980s and 1990s China's plentiful supply of low-cost labour made it one of the most attractive locations in the world for contract manufacturing, both within the Asia Pacific region, and increasingly for global operations. Thus China's economy and market have become steadily more integrated globally, providing significant opportunities, not only for low-cost manufacturing but also as the increasingly most important supply base for major global corporations. With the increasing purchasing power of China's very large population, its market has become increasingly significant for such corporations. Over time, China has also been producing an increasing proportion of the world's science and technology graduates, hence making it an attractive location for establishing R&D operations. To some extent, all of these factors have been working together and creating major opportunities, but also very significant challenges for global corporations.

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<sup>26</sup> Dieter Ernst, *Indigenous innovation and globalization: The challenge of China's standardization strategy*, UC Institute on Global Conflict and Cooperation and the East-West Center, 2011, p.23  
<http://www.eastwestcenter.org/publications/indigenous-innovation-and-globalization-challenge-chinas-standardization-strategy>

Not least of these has been the need for corporations to work closely with the Chinese state in order to achieve their objectives, which don't always necessarily coincide with China's major policy objective of developing indigenous innovation.

An understanding of the evolution of China's market during the past three decades helps to explain the context in which foreign multinational investments have developed to their most recent phase which has been associated with rapid growth in R&D activity. Just as the initial stages of the most recent phase of foreign investment in China during the 1980s and 1990s has been associated with exploiting China's lower cost manufacturing advantages to achieve greater competitiveness in the global marketplace, the most recent R&D phase has also had a similar objective particularly in terms of exploiting China's rapidly expanding talent pool of science and technology graduates. However, as China's market itself has become more integrated into the global economy, with a gradual expansion in its overall purchasing power, this has also had an impact on the focus of R&D activity of multinational companies in China.

In the initial phase of their investment, multinationals for the most part were competing with each other for China's expanding market in those sectors which had been opened up for competition. In the most recent phase of development, foreign multinational companies are not only competing with each other for China's market, but they are facing increasing competition from local Chinese companies. Part of their R&D strategy, therefore, is to develop products that are more suitable for China and more generally for Asia, and to retain their market position through being more innovative. This, however, is

proving in many cases to be quite challenging. In the earlier stages of FDI in the 1980s and 1990s, earlybird foreign multinational companies in China had the market largely to themselves, with significant opportunities for major contracts and high profit margins. More recently, China has become a much more competitive and challenging marketplace, with foreign multinationals struggling to preserve their profit margins. Despite the more challenging nature of China's market, however, most major multinationals accept that their ability to compete in China will impact greatly on their ability to compete globally in the future. What has changed significantly is not only does China play a key role for locating lower cost manufacturing, but that the rapid growth of the Chinese market itself is impacting greatly on the nature of the global marketplace. Gadiesh, Leung and Vestring argue that winning China's 'good enough' segment is critical to success on China, but may also have global implications.<sup>27</sup>

#### Evidence from Shanghai-based foreign multinationals

The telecommunications sector reveals some of the important changes in the Chinese market over the past 30 years. Telecommunications services remains monopolised by three major state-owned enterprises, China Telecom, China Mobile and China Unicom. While this particular segment of telecommunications has not yet been open to competition from foreign companies, there is growing competition within the sector. Telecommunications equipment, however, was opened up to outside competition, with multinationals such as Alcatel-Lucent, Motorola, Nokia and Ericsson being early entrants

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<sup>27</sup> Orit Gadiesh, Philip Leung, and Till Vestring, The Battle for China's good-enough market, *Harvard Business Review*, September 1., 2007, p 82

in the market. Motorola made significant investments in China from the 1980s onwards and was one of the first major technology companies to develop R&D centres in China. But its success in the market was restricted mainly to the early stages of analogue technology, losing out to Huawei, one of China's most successful indigenous companies, during the more recent digital and GSM technological stages.

In the earlier stages of development China's telecommunications market, with no significant local Chinese companies present, foreign multinationals monopolised the market and obtained profit margins as high as 45%. The telecommunications market in China, with an annual growth in the region of \$200bn provided considerable opportunities for foreign companies. But from 2005, the main state service providers have centralised their procurement, thus significantly reducing profit levels for the multinationals by increasing competition. Thus while Alcatel-Lucent was very successful in the earlier period, succeeding in doubling its market share, that share has now fallen more recently to only 4% because of increasing competition from Ericsson and Nokia, and particularly from Huawei. Alcatel-Lucent's poorer performance in recent years is also partly explained by the merger in 2006 of Alcatel and Lucent Technologies.

While Huawei is one of the most successful of a small number of Chinese companies to have emerged in recent years, is currently ranked the largest telecommunication equipment maker in the world after taking over the leadership position from Ericsson in 2012, and has succeeded in going international (with 60% of its revenue coming from outside China. The success of Huawei within China in competition with foreign

multinationals is partly explained by its ability to respond more rapidly to the market, by having products with superior features, and adopting a longer-term approach towards profit levels, being willing to accept lower margins in the short-term. The earlier period had been characterised by very high levels of technology dependence by China on imported technology, for which they had to pay high royalty fees. In 2000, foreign-invested enterprises (FIEs) accounted for more than 85% of all high technology exports. Thus the so-called ‘market for technology’ policy has not resulted in the level of technology spillovers from foreign to Chinese enterprises that policymakers had hoped for. This is reflected in the fact that foreign multinational companies were responsible for 96% of all Advanced Technology Products (ATP) exports since 2002.<sup>28</sup> Moran concludes that Chinese exporters are not even “keeping up” let alone “catching up” with foreign companies.

### An evolving market

It is clear, therefore, that over the past 30 years, both the Chinese market itself, and the nature of foreign investment in China have been evolving. The chief executive of Philips operation in Asia Pacific, which is based in Shanghai, summarised the evolution of their activities in terms of three stages: the first was ‘global to local’ with global products being sold in China. This stage was characterised by a rather restricted ‘high-end’ market. The second stage was ‘local to local’, with the development of products locally for the Chinese market, and the third stage was ‘local to global’, with China being used as an

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<sup>28</sup> Timothy Moran, Foreign manufacturing multinationals and the transformation of the Chinese economy: new measurements, new perspectives. Working Paper 11-11, Peterson Institute for International Economics, Washington DC, p 10

export base for global production. This suggested model of FDI evolution in China, while being broad-based is only suited to explain the development of some business segments, since many corporations have long been using China as a major export platform for manufactured goods.

Whatever about the particular stages of the evolution of different sectors, it is clear that the most recent phase of development has been increasingly characterised by increasing competition within the Chinese market from local companies. Global corporations are becoming aware that the future of global competition for market share will increasingly be impacted by the Chinese market itself, which is already very large and has been until the past year or so expanding much more rapidly than other regions of the world. With more sophisticated procurement strategies in China and the growing competition for market share from local companies, global corporations accept that their performance in China will have an important impact on their ability to compete internationally in the future.

Historically, China's market had two tiers. At the top was a small high end segment, served by global corporations who benefited from high growth rates and high margins. At the bottom was a large low-end segment served by local companies offering low quality products at prices which were often 40-90% cheaper than the high end goods. The newly expanding market in recent years is the economy segment or what is referred to as the 'good-enough' market.<sup>29</sup> In the earlier 'global to local' phase of multinational

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<sup>29</sup> Orit Gadiesh, Philip Leung, and Till Vestring, The Battle for China's good-enough market, *Harvard Business Review*, September 1., 2007, 80

involvement in China, companies like Philips in the healthcare sector were importing very expensive hospital equipment such as MRI and x-ray equipment. The affordability in China for such expensive equipment was restricted to top tier hospitals. To address the rapidly growing economy segment of mid-tier hospitals, Philips established a joint venture with Neusoft, a Chinese company, with greater familiarity with the local market. GE Healthcare have also used a line of reliable but less expensive machines targeted at China's remote and financially constrained second- and third-tier cities.

Thus while foreign multinational companies are gradually moving down from the top tier market to the middle segment, they are meeting more and more Chinese companies that are moving upwards from the lowest segment of cheap products. Multinationals see this middle segment of the market as a major battle ground for capturing future market share, and it may also play an important role in the battle for innovation in China between foreign owned R&D centres and attempts by the state to promote greater levels of innovation among Chinese companies.

#### Foreign R&D activity

In many cases (though not all) R&D investment in China has been the most recent stage in the evolution of company involvement in the country. Much of the R&D investment by foreign-owned companies has occurred in recent years. Company cases studies in Shanghai provide some background to the evolution in these R&D investments and

reveal their efforts to carve out a role within their corporations, with a focus primarily in many cases on the market in China. These recent investments in Shanghai also reflect some level of restructuring of activities by the corporations within the Asia Pacific region, with a greater focus on the more rapidly growing market in China. With increasing decentralisation of investment by large corporations, including R&D activity, there is a trend towards investment growth outside their home countries, and in some cases this may include the decentralisation of headquarter activity as multinational companies become more globalised.

DOW Chemical Company, the third largest chemical company in the world, opened its business and innovation complex for Asia Pacific, the Shanghai Dow Centre in Shanghai Zhangjiang High Tech Park in 2009. In 2011, China accounted for \$4.45 billion or 7% of its global sales.<sup>30</sup> With markets in other parts of Asia Pacific such as Malaysia, Indonesia and Singapore in decline, Dow is focusing more on the growth potential of China, which close to becoming its second largest market. As the Chinese government seeks to attract more high technology investment, locations like Singapore are losing out to the more attractive Chinese market. In developing the Shanghai centre part of the objective is to build a global knowledge centre, but concentrating very much on applications for the local market, such as paying attention to the different texture of Asian people's hair in personal care products. In the early stages of developing this centre, discussion centred on the extent to which Dow should become a 'Chinese' company, and how much resources should be diverted from their headquarters in the US.

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<sup>30</sup> Presentation at International Advanced Coal Technologies Conference, Xian, 4 June 2012  
<http://www.uwyo.edu/ser/files/docs/conferences/2013/china/peng%20ningke.pdf>

Philips had been in China since the 1920s, but restarted their more recent activities in 1985, having returned after the Cultural Revolution. They began with sales activities ('global to local'), then progressed to manufacturing and sourcing in the mid-1990s ('local to local'), and have evolved more recently to an organisation where all business functions are present, including marketing, and R&D. Their R&D activities in Shanghai are connected with those in Bangalore.

Microsoft adopted a three-fold approach to their involvement in China, involving three stages which they describe as 'crawl, walk and run'. In a market where piracy rates for computer software have been estimated to be in the region of 90%, Microsoft's early entry into China in the 1980s, which was focused on sales and marketing, was not particularly successful. It was also one of the first foreign technology companies to establish R&D activity, initially in Beijing in 1984 and more recently in Shanghai and other centres. The three-stage approach refers to initially employing relatively young and inexperienced university graduates in software engineering and helping them become familiar with product development. In the early stages Microsoft brought expatriate managers (often returnee Chinese) from their Redmond headquarters to China to mentor the newly-formed research teams and build up their expertise. After a period of two to three years they moved to the 'walk' stage where the team was more involved in a focused area, involving part of the product, and they become very immersed in the product life cycle. At this point they have a greater understanding of what it is like to be at the coalface and how the product is developed. They can now see how their own

contribution feeds into the development of the product. It should be noted that most foreign companies carrying out R&D activity in China fragment the various processes to avoid problems of intellectual property theft. The last stage of development is when the company has sufficient trust in the ability of the R&D centre to produce the complete product in China, and none of the Microsoft teams have yet reached that stage.

While each company has had its own unique evolutionary path in China, associated with the company's overall fortunes both globally and regionally, each of the foreign subsidiaries in Shanghai have had to prove their capabilities to their parent company to ensure their growth and development. When the major German software company SAP established its Labs China in Shanghai in 1998, its first area of assigned tasks was related to the localisation and translation of software modules for the local market and also building in local legal requirements into the software. Between 1998 and 2002 they received a lot of project-based development, including developing solutions for the Chinese and Japanese markets and to some extent for the global market. From 2002, the Shanghai lab built considerable confidence with their headquarters and moved on from project development to the development of standard products such as financial services software. In 2003 they employed only 300 people, but in the subsequent period of boom they have grown to 1,200.

While the China market is and will continue to be a major focus of this operation, they have in more recent years been making a significant contribution to the global activities of SAP, creating cost-effective solutions for a range of markets, including the US, Brazil,

Japan, the Philippines, Thailand, India, Pakistan, Russia, France and Germany. In the early stages of the Labs China, competence in the English language was an issue for global activity, and while there is still dependence on help from other subsidiaries in the area of documentation, the overall competence has improved considerably. The Shanghai lab has also the advantage of access to talent which can deal with other Asian countries such as Japan and Korea.

With the establishment of Labs China, SAP now had 10 R&D labs worldwide, and with this trend toward decentralising R&D activity to regional centres, corporations like SAP are faced with the task of managing the sharing of knowledge created by these different centres. SAP together with other companies interviewed, however, made it clear that the emphasis within the corporation was more on collaboration than competition. Each centre was expected to develop its own area of expertise and to avoid overlapping with other centres. Rather than having a bidding process for projects, SAP had a systematic approach towards allocating projects based in the specific expertise of different centres. Thus SAP, like other globalising corporations were evolving towards a network form of organisation of R&D centres around the headquarters, with headquarters being mainly focused on more advanced technologies.

The Fortune 500 US company 3M has been in China since 1984, but it was only in 2005 that it established a \$40m R&D centre, already having six manufacturing plants in Shanghai, Suzhou and Guangzhou. Since its establishment the R&D centre which employs 400 has produced 950 inventions, 110 Chinese patents, and 60 global patents,

which is unusual because of the general reluctance of multinationals to file patents in China. Its activities evolved from lower level tasks including technical support, localisation and product modification, to producing new products for the Chinese market. Activities to date range from fundamental research, and product development and commercialisation across 45 technology platforms, with the lab achieving self-sufficiency in certain areas which means that they are capable of piloting technology in these areas. Partly because of China's world leadership in high voltage technology, 3M in Shanghai are becoming a world class centre in electrical cable capacity within the corporation. Another interviewed R&D centre, established by the French energy company, Areva (now part of Alstom), is also building on local Chinese expertise in long distance electricity transmission, indicating that such niche areas of technological expertise provides an additional attraction for such companies together with the rapidly growing a potentially very large Chinese market in this sector. Synergies have also been developed with world leadership in coal-gassification technology and GE's R&D centre in Shanghai.

## Conclusion

Although China is still in the 'catch-up' phase of investment in R&D, there is little doubt about the state's commitment to providing the necessary conditions, both in terms of infrastructure and skills, to facilitate rapid growth in innovation in China. The private sector, including major successful companies such as Huawei and BYD are major investors in R&D. Yet, questions remain about the overall level of outputs in China from

the rapid growth in R&D investment. Much of this has been recent and bringing about major shifts in levels of innovation usually take decades. Some suggest that the dynamic nature of China's strong economic growth creates a market where short-term innovations based around cost and affordability are rewarded more than the longer term strategies based on basic research.

It is clear that the first 30 years of foreign investment in China after its opening, when China became the primary centre for manufacturing offshoring from the developed world has created a very significant level of dependence on foreign technology, costing China major payments in licenses and royalty fees. This model is no longer satisfactory for China, and the current policy of 'indigenous innovation' shows a determination to reduce this technology dependence significantly. It is both understandable and admirable that China would also want to shift its development model away from the environmentally destructive phase of basic manufacturing offshoring to a more sustainable and environmentally friendly one. The low level of added value accruing to China from its significant high technology exports is also a major factor driving the new policy to seek to have greater local ownership of intellectual property production.

The urgent environmental challenges facing China because of its predominant focus on being an offshore location for manufacturing are creating a significant push for the development of greener technologies in a wide range of sectors, from the electric car and other more environmentally-friendly forms of transport, to the development of solar and wind energy technologies. The scale of the challenge is resulting in a very concentrated

level of state and private sector investment in these new technologies, which could give China some edge in these important areas of innovation.

It is likely, however, that China will depend to a considerable extent for some time to come on foreign technology, and that foreign R&D centres in China can make an important contribution to solving many challenges associated with the future development of this enormous country. The evolving innovation policy is placing increasing pressures on foreign companies to increase their level of local innovation as a prerequisite for gaining greater access to one of the most promising markets in the world. Depending on the sector, China is rapidly moving upwards in terms of its ranking for many multinational companies for revenue generation and market growth. Most multinationals are acutely aware that they must grow with China and learn to compete in a market where there is considerable emphasis on affordability. The challenge for multinational companies with their established model of proprietary intellectual property creation will be to develop ways of raising local capabilities without compromising their core IP. The evolution of this unprecedented relationship between the dominant western multinational IP model and the powerful bargaining position of a state with a huge market presents a fascinating topic for on-going research. With the growing significance of China's rapidly developing market, China is in a very strong bargaining position in relation to multinational companies who are determined to be part of China's future growth, and despite their traditional experience of determining the shapes of markets globally, in most cases they will be willing to negotiate some level of compromise with a state that is firmly in control of its own destiny.

Table 1 Innovation Index for China, India and Brazil

	China		India		Brazil	
	Score	Rank	Score	Rank	Score	Rank
Global Innovation Index 2013	44.7	35	36.2	66	36.3	64
2011	46.4	29	34.5	62	37.7	47
2009		37		41		50
Institutions 2013	48.3	113	51.9	102	53.8	95
2011	51.7	98	52.3	94	54.1	87
Human capital & research 2013	40.6	36	21.7	105	30.3	75
2011	39.9	56	26.9	104	33.9	76
Infrastructure 2013	39.8	44	27.5	89	37.2	51
2011	35.4	33	27.7	63	32.2	45
Market sophistication 2013	54.2	35	49.5	49	44.9	76
2011	54.1	26	44.6	45	35.7	80
Business sophistication 2013	42.9	33	28.3	94	38.0	42
2011	49.3	29	30.8	84	41.5	46
Knowledge & Technology 2013	56.4	2	34.5	37	26.5	67
Scientific outputs 2011	52.7	9	24.8	60	25.2	58
Creative outputs 2013	31.9	96	38.6	65	37.2	72
2011	40.9	35	40.3	38	46.9	12
Population (millions) 2013	1,374.0		1,267.6		201.5	
GDP per capita \$ 2013	9146		3851		12038	
GDP (US\$ bns) 2013	8250		1946		2425	

Source: Dutta, S and Lavin, B (2013) The Global Innovation Index 2013, Johnson Cornell, INSEAD and WIPO <http://www.globalinnovationindex.org/content.aspx?page=GII-Home>

