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INTERNATIONAL TECHNOLOGY TRANSFER AND DEVELOPMENT OF CAPABILITIES IN CHINESE STATE-OWNED MANUFACTURING ENTERPRISES:
LESSONS FROM 20 YEARS OF CASE RESEARCH

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ABSTRACT
Technological capabilities in Chinese manufacturing have been transformed in the last three decades. However, the extent to which domestic market oriented state owned enterprises (SOEs) have developed their capabilities is not clear. Six SOEs in the automotive, steel and machine tools sectors in Beijing and Tianjin have been studied since the mid-1990s to assess the capability levels attained and the role of external sources and internal efforts in developing them. Aided by government policies, acquisition of technology and their own efforts, the case study companies appear to be broadly following the East Asian late industrialisation model. All six enterprises demonstrate competences in operating established technology, managing investment and making product and process improvements. The evidence suggests that companies without foreign joint venture (JV) collaborations have made more progress in this respect.

Keywords: Chinese manufacturing, latecomer strategies, capability development.

1 INTRODUCTION
With a share of world manufacturing output at almost 19 per cent in 2010, China inched ahead of the USA to become the world’s largest producer of manufactured goods (calculated from UN Statistics Division (undated) data). The manufacturing sector in China employs about 10 times as many people as in the USA to produce a similar level of output. This difference can partly be explained by the concentration of labour-intensive production in China. Nevertheless, given the substantial progress China has made in export performance (Vaidya et al, 2007) and in meeting the growing domestic demand, questions remain on the extent to which Chinese manufacturing is continuing to rely on low labour costs or developing more advanced technological capabilities.

An important question is whether China is following patterns of technological catch-up identified by Matthews (2001) in other East Asian countries, notably Korea and Taiwan, which started from manufacturing competence acquired from low-tech labour intensive sub-contracting. While export-oriented sectors in China have followed this pattern (Lall and Albaladejo, 2004), the situation is more complex because of the diversity of manufacturing, the importance of the domestic market and the large number of SOEs. Following the initiation of the Open Door policy, China encouraged acquisition of foreign technology and know-how by SOEs through a range of channels. As Matthews (2001; 2006) and Kim (1997) show, developing internationally comparable capabilities requires progressing beyond reliance on imported technology to deepen firm level capabilities through learning and R&D (Bennett and Vaidya,
2005). Matthews (2006) highlights the importance of the three Ls, leverage, linkage and learning, in developing capabilities by latecomers.

While the development of advanced capabilities is evident in Chinese companies such as Konka, TCL, Haier, Huawei and Lenovo in dynamic high-tech sectors, it is the manufacturing SOEs in mature markets which face greater challenges in becoming competitive. The focus of this paper is therefore on how and to what extent domestic market oriented SOEs have developed their technological capabilities.

2 THE STUDY APPROACH AND ISSUES INVESTIGATED

Having studied the nature, motivations and value of international technology transfer to Chinese enterprises in the 1990s, we take a longitudinal case study approach to track six manufacturing SOEs since the mid-1990s to assess changes in their technological capabilities, the role in the changes of external sources and internal efforts and of policies. The case study enterprises are located in Beijing and Tianjin, two in the automotive sector (Beijing Benz Automotive Co Ltd, a JV subsidiary of Beijing Automotive Industries Holding Co (BAIC) and Tianjin FAW Xiali Automobile Co Ltd), two in the steel sector (Shougang Group Corporation and Tianjin Pipe Corporation (TPCO)), and two in the machine tools sector (BYJC Machine Tool Co Ltd in Beijing and Tianjin Tianduan Press Company Ltd).

In our initial studies in the 1990s, the focus was on the role of international technology transfer. Since 2000 it has shifted towards understanding the process of capability development. Semi-structured interviews were conducted with representatives of the six companies in 2006 and 2012. Contextual questions about changes in governance, major products and markets, sales, profitability and number of employees were followed by questions about technological capability (e.g. extent and nature of R&D and the number of patents taken out by the company). Company representatives were then asked to identify the most important technologies the company had developed independently and acquired from external sources. Information was also sought on the levels of the technologies developed and used by enterprises (i.e. whether they offered a lead over international or Chinese competitors, were comparable or less advanced).

<table>
<thead>
<tr>
<th>Capability stages: Competence based on knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 Manufacturing competence (production including shop floor experience and learning by doing).</td>
</tr>
<tr>
<td>Stage 2 Investment competence (installing new production capacity, expansion or modernisation of capacity).</td>
</tr>
<tr>
<td>Stage 3 Adapting and stretching competence (engineering and organisational adaptations for continuous and incremental upgrading of products, performance features, and process technology).</td>
</tr>
<tr>
<td>Stage 4 Innovation competence (product and process innovation and creation of new technology).</td>
</tr>
<tr>
<td>Levels of attainment</td>
</tr>
<tr>
<td>Very High</td>
</tr>
<tr>
<td>High</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>Low</td>
</tr>
</tbody>
</table>

Table 1: Capability stages and levels of attainment

In the case-study analysis we adopt the East Asian latecomer development model (Bennett and Vaidya, 2005) to comprise four stages with a sequential progression from Stages 1 to 4. For each case the level of capability attained in each of the stages was assessed. The stages and levels are set out in Table 1. An inductive approach has enabled us to investigate: (a) whether there is a sequential and progressive relationship between the stages, (b) whether relying on collaborative relationships (especially JVs) and developing internal capabilities are mutually exclusive, and (c) whether developing manufacturing excellence and innovative competence are compatible (Gao et al, 2007).

3 CASE ANALYSIS

Since the case study companies are in the automotive, steel and machine tools sectors, developments in these sectors and industrial policies influencing them are briefly described as context. All three sectors
have experienced rapid growth and China is the largest producer of cars, steel and machine tools. During the 1980s and 1990s, the automotive and steel sectors became highly fragmented with many provinces promoting and supporting old and new enterprises. The machine tools sector did not see a similar proliferation of new enterprises but they were locally protected. The “modern enterprise” reform process initiated in the 1990s reduced the SOEs’ social obligations and facilitated their transformation into more commercially oriented corporatised enterprises (Yi-min Lin and Tian Zhu, 2000). Alongside these reforms, central government started addressing the fragmentation of the key manufacturing sectors. In broad terms, the approach was to identify leading enterprises in each sector and support them in taking over smaller or weaker ones with a view to improving them or rationalising production (Nolan, 2001).

Even when manufacturing output in these sectors was growing in the 1980s and 1990s, it was recognised that China as a latecomer lagged behind in manufacturing knowhow. Following the latecomer model, the broad approach was to learn from more advanced foreign knowhow and use it as a base to develop indigenous capabilities by engaging in product and process development and R&D. However, the specific approaches to learn from foreign knowhow differed between sectors. In the automotive sector, formation of JVs with foreign enterprises was the dominant mode. In the steel sector, the focus was on importing the most advanced production equipment, reverse engineering and R&D. In the machine tools sector, a wide range of modes of foreign technology acquisition, purchase of equipment, licensing, co-production and JVs have been used, to be complemented by internal efforts.

In the sectoral context outlined above, Tables 2 and 3 summarise the case study findings with Table 2 outlining developments in governance, restructuring and production and Table 3 presenting the technological capability appraisal based on the framework introduced in section 2. All case study companies have been influenced by the “modern enterprise” reform referred to above. Tianjin Tianduan is the smallest case study enterprise and a subsidiary of a holding company, formerly a Tianjin Municipality line ministry. Tianjin FAW Xiali is also a subsidiary of a larger company but of one of the largest Chinese automotive groups formed under the restructuring of the automotive sector. BAIC (Chinese parent of Beijing Benz), BYJC and Shougang are large group enterprises. TPCO was created in 1989 by Tianjin municipal administration with central government support to produce pipes for the oil and gas sector to reduce import dependence. While TPCO has made rapid progress as a producer and in its technological capabilities (Table 3), it has needed very substantial financial support and restructuring to convert debt into shares owned by state asset holding companies. All enterprises have seen rapid growth in sales over the period (Table 2). However, only Shougang and TPCO, both steel companies have exports of any size. BYJC has overseas sales but from Waldrich Coburg, its German subsidiary acquired in 2005.

All the case companies have attained Very High manufacturing competence (Table 3) implying either having attained internationally comparative competence or approaching it. Investment competence is also High or Very High in the companies as evidenced by the management of capacity expansion and location change implemented by the case companies. All the case companies stated that they acquired the most advanced equipment for their new plants. Shougang Group had the capacity to design and construct some of the plant while TPCO collaborated with a supplier of equipment in developing it.

Stage 3 capability in Table 2 refers to adaptation as well as development of processes and products relying on known technology with limited innovation. This is a departure from Bennett and Vaidya (2005) which specify process and product adaptation as Stage 3. This modification is an outcome of the inductive case study approach during which it has been observed that all the companies have developed products based on a combination of acquired knowhow and internal learning and adaptation without engaging in a high level of innovation. We argue that the adaptive and development capabilities require manufacturing and investment competences which deepen understanding of production processes and product features.

The stages approach implies that “Stage 4: Innovation” is sequentially dependent on the previous stages. Having acquired stages 1 to 3 capabilities, all companies recognise the need for R&D and have internal R&D complemented by links with research institutes or universities. We categorise Tianduan, Shougang and Tianjin Pipe in the High to Very High category because of the level of their R&D activity and the number of patents they have registered. They are not in the unequivocal Very High category because all three acknowledged that there were some vital technologies in which they lagged behind international leaders. With the acquisition of Waldrich Coburg, BYJC has the potential to attain High to Very High innovation competence but keeping the German subsidiary at arm’s length may impose constraints. Of the two auto companies, BAIC has a more ambitious R&D programme but the companies are not strictly comparable because Tianjin FAW Xiali is a subsidiary of a large group and innovative initiatives are likely to be at the group level.
<table>
<thead>
<tr>
<th>Sector</th>
<th>Company</th>
<th>Background and governance</th>
<th>Products, sales, exports and profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>Beijing Benz Joint Venture Co Ltd and BAIC</td>
<td>Formerly Jeep between Beijing Automobile Works (now subsidiary of BAIC) and American Motors (later acquired by Chrysler Corp). The Chrysler Daimler merger in 1998 gave Daimler entry into the JV. Chrysler exited the JV after the failure of the Chrysler Daimler merger in 2007.</td>
<td>Production increased from 26,000 in 2006 to 93,000 in 2011. Expected to be 300,000 to 350,000 by 2015. JV's profit in 2011 was RMB 3.9 billion.</td>
</tr>
<tr>
<td></td>
<td>Tianjin FAW</td>
<td>Formerly Tianjin Micro Car Factory which became Tianjin Automotive Co in 1997 and was listed on the Shenzhen Stock Exchange in 1999. One of the largest five auto enterprises in China, continues to collaborate between FAW and Toyota.</td>
<td>Production of seamless pipes. About 3-fold increase in production between 1997 and 2009. Sales revenue in 2008 was RMB560m, with a profit of RMB 18m in 2010.</td>
</tr>
<tr>
<td></td>
<td>BYD Machine Tool Co Ltd</td>
<td>Formerly Beijing No. 1 Machine Tool Works. In the 1990s started transitioning from a traditional SOE to commercial operation.</td>
<td>Produces a wide range of products with improved quality and large expansion after the US anti-dumping action. A wider range of products with improved quality and large expansion after the US anti-dumping action.</td>
</tr>
<tr>
<td></td>
<td>Shougang Machine Tool Co Ltd</td>
<td>In the mid-1990s, one of the largest Chinese machine tool manufacturers. An integrated producer of high-cost engineering components and oversize components.</td>
<td>A wider range of products with improved quality and large expansion after the US anti-dumping action. A wider range of products with improved quality and large expansion after the US anti-dumping action.</td>
</tr>
<tr>
<td></td>
<td>Tianda Press Industry Co Ltd</td>
<td>着重于为钢铁等传统产业提供先进的自动化解决方案。</td>
<td>A wider range of products with improved quality and large expansion after the US anti-dumping action. A wider range of products with improved quality and large expansion after the US anti-dumping action.</td>
</tr>
<tr>
<td></td>
<td>Tianda Pipe Industry Co Ltd</td>
<td>Tianda Pipe Industry Co Ltd specializes in seamless pipes for the oil and gas sector. In 2008, Tianda announced plans to produce 40% of total crude steel output per annum.</td>
<td>A wider range of products with improved quality and large expansion after the US anti-dumping action. A wider range of products with improved quality and large expansion after the US anti-dumping action.</td>
</tr>
</tbody>
</table>

Note: RMB is Renminbi, Chinese currency. US$1 was approximately RMB 6.4 in July 2012.

Table 2: Case study companies: Background, governance and general information.
Table 3: Case study companies: Assessment of capability development

<table>
<thead>
<tr>
<th>Company</th>
<th>Stage 1: Investment</th>
<th>Stage 2: Adaptation</th>
<th>Stage 3: Innovation</th>
<th>Stage 4: Capability Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shougang Group</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>BYJC Machine Tool Co Ltd</td>
<td>Very High</td>
<td>High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Tianjin FAW Xiali</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>BAIC</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Very High</td>
</tr>
<tr>
<td>Beijing Benz (JV)</td>
<td>Not relevant</td>
<td>Not relevant</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Waldrich Coburg</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>Tianjin Metal</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>Tool Co Ltd</td>
<td>High</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>Tool General Works</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Shaping Group</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
<td>Very High</td>
</tr>
</tbody>
</table>

Notes:
- There are different types of patents in China.
- Patents are for new shapes or structures of a product made to change functionality and not just for aesthetics.
- A "utility" or pragmatic product invention is one that is not just for aesthetics.
- A "utility" or pragmatic product invention is granted for a new technical solution relating to a product or process.
4 SUMMARY AND CONCLUSIONS

Returning to questions posed at the end of section 2, the progressive relationship between stages holds up with the following caveat. Product development can take place without groundbreaking innovation and could therefore either be subsumed in Stage 3 competence or be added as an additional stage between stages 3 and 4. This raises a broader question about the nature of industrial innovation in the latecomer context which requires further investigation. On the issue of compatibility between JVs and developing internal capabilities, three of our case companies (BAIC, Tianjin FAW Xiali and BYJC) show that these are not mutually exclusive. All three demonstrate internal learning and progress in innovation. Arguably, if JV subsidiaries contribute substantial profits, as is the case in all three, they are cash cows which may finance innovation expenditure. Having said that, these three companies have been categorised lower in their attainment of Stages 3 and 4 competences than the other three case companies. Therefore, there is evidence to support the hypothesis that the pace of capability development is slower with foreign JV participation, though less sharply than demonstrated by Gao (2011). On the third question of manufacturing versus innovation competence, according to the sequential capability development model, the latter has to be built on Stages 1 to 3 competences and an understanding of the market and valued product features derived from these. This appears to be valid for mature sectors but may be less so for sectors with short product life cycles or disruptive technologies.

This paper has provided a summary of the findings from the study. The next stage is to examine the capability development processes and the associated accumulation and role of skills in more detail, incorporating the nature and relative importance of the 3 Ls [leverage, learning and linkage]. To complement the 3 Ls of Matthews (2006), we propose 2 Ms, motivation (to reflect what drives SOEs to develop capabilities) and money (to represent access to financial resources) - both required for the capability development process.

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