Corporate Governance, Finance, and Technological Capability in Newly Industrialising Economies: A Framework and Evidence from Auto and Electronics Industries in China

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Abstract

Based on empirical research in two of China's biggest and most important manufacturing sectors: Auto and Electronics, this study develops an analytical framework to understand, how firms in newly industrialising economies (NIEs) develop their technological capabilities, and how this is affected by the situation of finance and the practice of corporate governance (CG). Particularly, by further adaption of the theory to the Chinese context, it attempts to answer the questions: 1) 'What is the situation of technological capabilities in the firms in the Chinese Auto and Electronics Industries?'2) 'How has the development process of technological capabilities been?' 3) 'What is the situation of corporate governance and finance in Chinese Auto and Electronics firms?' and 4) 'How can the capabilities developed be explained from the finance/corporate governance aspect?'

Two frameworks are developed on the basis of previous research on technological capabilities and corporate governance. Three Propositions are derived from these frameworks. Five case studies are conducted in both sectors, and seven hypotheses are then generated from the findings of case studies. They are tested through a questionnaire survey of 195 firms in the Chinese electronics industry.

This thesis makes several theoretical contributions and has several policy implications. Primarily, this study contributes to the literature on the development of technological capability in NIEs by: 1) creating a better understanding of firm-level technological capability in the Chinese auto and (especially) electronics sectors; 2) providing a thorough account and explanations of how Chinese firms with typically flawed corporate governance (CG) fail to develop dynamic capabilities; how those with better CG succeed, and why there are not more of them. In addition this study has adapted the theoretical framework (the effect of corporate governance on technological development) to the Chinese situation and enriched it. It will enlighten future applications of such theory to the wider context of NIEs in general. For policy makers, the crucial implication is that any improvement in the governance factors studied in this study will significantly boost the development of technological capability.

Acknowledgement

When I started this thesis, I was advised by my ex-PhD friends that never write the acknowledgement before the main body is done: "it is the only part where you can write whatever you want and not to worry about the examiners' comments, and you MUST save the best till last!" However, I am not finding this any easy - Sisyphus' ordeal has always been a consolation to my PhD study, in which he pushes a rock up a hill for eternity; but now I envy him for not having to condense his feelings in just one page.

Nevertheless, my immense gratitude first goes to Professor Andrew Tylecote. He has not only been an enlightening supervisor and academic, but also a friend and mentor for life. I would also like to thank Professor Noel O'Sullivan, Phil Wright, Stuart Macdonald, Dr. Jo Padmore and Gill Musson, for their timely inspiration and encouragement. I am equally grateful to all members of staff at Management School, who have provided me with generous help and support over these years, thank you Mandy, Loo, Kenneth, Kath, Pauline, and Hilda.

I am very lucky to have shared my PhD journey with many nice and interesting friends. Anna, Nicki, Shuping, Raquel, Nazia and Thomas, I will always remember and cherish those sunny (and rainy and gloomy) afternoons when we chatted over a cuppa. I also thank my old friends in China - Aiqing and Xiang Hua - for their continuous companionship; and my new and best friends in UK – Alex, Marian, Moritz, Steve, and Rado, with whom my stay in the UK is no longer only a period of study, but a true experience of life.

My study would have been impossible had it not been for my parents, my sister and my parents-in-law. Thank you for your love, support and faith, and thank you for whole-heartedly sharing my moments of joy and more importantly, putting up with me during times of frustration.

Finally I dedicate this thesis to my husband Jun, who has also recently finished his PhD. Having two broke PhD students under one roof can be so difficult, and I sincerely believe that the hardest times are now finally behind us.

The majority of research reported in this thesis was based on an ESRC-funded research project led by Professor Andrew Tylecote (Project title: Corporate governance and technological development in China. Project reference: RES-000-22-1504), for which I was the research assistant. Part of the results of the project have been published or presented at academic conferences as joint efforts between me and Professor Andrew Tylecote. Specifically, the case study on the three auto companies reported in Chapter 6 is now a journal article in Industry and Innovation which includes Appendix V (see Liu & Tylecote, 2009). I am immensely indebted to Professor Tylecote for writing section 1.3 and 2.3.5 of this Chapter. All potential errors and mistakes are however entirely mine.

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Abbreviations and Acronyms

ADB	Asian Development Bank
AMC	Asset Management Company
BAIC	Beijing Automobile Industry Corporation
BERD	Business Expenditure on Research and Development
CAAM	China Association of Automobile Manufactures
CBRC	Central Banking Supervisory Committee
CGFS	Corporate Governance and Finance System
CCP	Chinese Communist Party
CHTF	China Hi-Tech Fair
CKD	Complete Knock Down
CNAIC	China National Automotive Industry Corporation
CSRC	China Securities Regulatory Commission
DMC	Dongfeng Motor Corporation
DSP	Digital Signal Processing
DTI	Department for Trade and Industry
DUI	Learning by Doing, Using and Interacting
DVD	Digital Versatile Discs
ESRC	Economic and Social Research Council
EVA	Economic Value Added
FAB	Fibre-wafer Fabrication Facility
FAW	First Auto Works
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GSM	Global System for Mobile Communications
IC	Integrated Circuit
ICT	Information and Communications Technology
IJV	International Joint Venture
IP	Intellectual Property
IPO	Initial Public Offering
IPR	Intellectual Property Right
LCD	liquid crystal display
LME	Large and medium enterprise
MASOE	Majority State-owned Enterprise
MBO	Management Buy-Out
MCS	Management Contract System
MEI	Ministry of Electronics Industry
MII	Ministry of Information Industry
MISOE	Minority State-owned Enterprise
MMI	Ministry of Machinery Industry

MNC	Multinational Corporation
MOFCOM	Ministry of Commerce
MOF	Ministry of Finance
MOFTEC	Ministry of Foreign Trade and Economic Cooperation
MOST	Ministry of Science and Technology
NBS	National Bureau of Statistics of China
NDRC	National Development and Reform Commission
NKE	National Key Enterprise
NIE	Newly Industrialised Economy
NPL	Non-performing Loan
NSI	National System of innovation
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturing
PBOC	People's Bank of China
PC	Personal Computer
PCC	Productivity Promotion Centre
PDA	personal digital assistants
PHEVC	Plug-in Hybrid Electric Vehicle
POE	Private-owned Enterprise
R&D	Research and Development
RMB	Renmibi (Chinese Currency)
SAIC	State Administration for Industry and Commerce
SAIC	Shanghai Automotive Industry Corporation
SAMI	State Administration of Machinery Industry
SASAC	State-owned Assets Supervision and Administration Commission
SETC	State and Economic Trade Commission
SEZ	Special Economic Zone
SIPO	State Intellectual Property Office
SIS	Sectoral Innovation System
SKD	Semi Knock Down
SOE	State-owned Enterprise
SSCSTE	State (National) Steering Committee of S&T and Education
SSE	Shanghai Stock Exchange
STI	Science- and Technology-Based Innovation
SZSE	Shenzhen Stock Exchange
TVE	Town and Village Enterprises
USPTO	United States Patent and Trademark Office
VC	Venture Capital
WCDMA	Wideband Code Division Multiple Access
WTO	World Trade Organisation
ZTE	Zhongxing Telecommunication Enterprise (China)

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Chapter 1 Introduction

This research responds to China's recent quest to build an innovative economy and develop *'indigenous' or 'home-grown' technological capability - the ability to assimilate, adapt and in increasing measure create new technology*[1]. It aims to understand, for the auto and electronics sectors, how the development of technological capability in Chinese firms is affected by the situation of finance and the practice of corporate governance. The analytical framework developed in this research and empirical findings generated are believed to have valuable implications for other newly industrialising economies (NIEs).

China's pursuit to catch up[2] with developed countries since 1979 has followed the conventional wisdom of 'buy-absorb-innovate'. The government's logic was, by giving out some market to foreign multinationals, and through encouraging them to invest directly or to set up joint ventures in China, the domestic firms could acquire more advanced technology from these firms[3], they then understand, absorb and assimilate the knowledge and new technology; then gradually develop their own capability to improve the imported technology, and finally reach the stage of generating their own product or/and process technology. However, many China-based scholars (Liao, 1999; Shi, 2001; Liang, 2004) has confirmed that Chinese firms' technological capability has not benefited much from the imported technology: the ratio of complete sets of equipment in technology acquisition

[1] The Chinese notion of 'indigenous technological capability' is thus consistent with that of 'dynamic technological capability' in the literature (Teece *et al*, 1997; Eisenhardt & Martin, 2000; Winter 2003). As such, the term 'indigenous' will be replaced with 'dynamic' in the rest chapters of the thesis, which makes it more comparable to the theoretical literature.

[2] The notion of catch up should not be only viewed in a linear way. '*As long as technology is understood as a cumulative unidirectional process, development will be seen as a race along a fixed track, where catching up will be merely a question of relative speed. Speed is no doubt a relevant aspect, but history is full of examples of how successful overtaking has been primarily based on running in a new direction*' (Perez and Soete, 1988, p. 460). Indeed, in many developing countries instead of making efforts to move to the scientific frontiers, they plan to apply the acquired knowledge in developing products that are most relevant to local needs. Examples in China can be found in Lu (2005). Just as Lall (2000, p.13) noted: '*the process of technological change in developing countries, is one of acquiring and improving on technological capabilities rather than of innovation at frontiers of knowledge. This process essentially consists of learning to use and to improve technologies that already exist in advanced industrial economies.*'

[3] The form of acquisition varies: it can be done through tempering intellectual property, such as reverse engineering, or through capital-embedded transfer, such as purchase of plant, equipments, or through Foreign Direct Investment or setting up joint ventures. The last two forms of transfer are most prominent in China (Wang & Zhou, 1999)

has been increasing over the last decades (from 89% in the 1950s, 91% in the 1960s to 95% in the 1990s). Survey by Xu and Chen (2000) also shows that 90% of the 200 sample firms have not significantly improved their technology five years after the transfer, and the rest 10% have only 'partially' enhanced their technological capabilities. It seems that the vicious circle of 'acquisition-lag-reacquisition-relag' is the problem faced by most industries in China, where indigenous technological capability has not been substantially developed.

In the literature there are two types of explanations to the unsuccessful story: one is that in the past Chinese authorities have unduly protected and subsidised large state firms so that they could survive in a competition–free environment, therefore these firms have lost incentive and finally the ability to effectively acquire and develop dynamic capabilities (Lu & Feng, 2004). They therefore argue that the Chinese government should have just left it to market forces to decide which firms emerged to challenge the world in higher-tech industry. Yet South Korean experience shows that many favoured firms, such as Samsung in electronics and Hyundai in motor vehicles, did extremely well – as did the 100% state-owned firm POSCO in steel (Tylecote, 2006). The other main-stream criticism is towards the inconsistent industrial and technology policy that has curbed development of firms in medium/high-tech sectors (Nolan, 2001; Qian, 2002; Lu & Feng, 2004; Xie & White, 2004). However, in spite of general 'failure', there are a small number of 'bridge-head' firms that not only survived but also flourished, such as Lenovo, Huawei, Chery and Guizhou Tyre (Lu & Feng, 2004; Xie & White, 2004; Liu & Tylecote, 2009). In this context, it is pertinent to raise the following question: *why has the performance of enterprises varied so much under similar policy and market conditions?*

Drawing on the arguments mentioned above, and the theoretical framework of corporate governance, finance and technological development, this research project seeks to address the following questions: from the finance and corporate governance angle, 1) why the majority of the firms failed to develop technological capability that generates technical change and enhance competitiveness; 2) how the minority succeeded and why there are not more of them. It also aims to identify and examine the elements of corporate governance that have impact on a firm's technological capability; whether these effects are direct or indirect, and if indirect then how they are mediated. Any improvement in these will greatly enhance firms' technological capability development and hence general performance in the long run. Therefore findings from this research will help address the two predominant issues in China's way up – 'technological catch-up' and 'modern enterprise (corporate governance) system'. By the same token, such lesson and experience will be transferrable to other NIEs and shed light on their technological upgrading and reform of corporate governance and finance system.

1.1 China's challenge in developing indigenous technological capability

The spectacular growth of the Chinese economy commands global attention. From outside China, it is hard to see anything but rapid, remorseless transformation into a modern, high technology economy. Even within China, the spectacular development of parts of the country leads to the easy assumption that big coastal cities such as Shanghai and Hangzhou are simply showing the way. Yet, there is concern in China over the limited extent to which Chinese-owned firms have been able to innovate. Their competitiveness, especially in high technology sectors, has actually been declining (see Chapter 3.1 for detailed evidences).

Thanks to the cheap labour, artificially undervalued currency, protectionist tariff and export subsidies, China's growth pattern until 2001 has apparently worked so as to maintain double-digit GDP growth rate. However, China has largely failed in one very important aspect: to have a medium and high technology industry that can boast strong domestic Chinese firms, which are capable of competing technologically with the best in the world. The tide has now changed. Following China's entry into WTO in 2001, foreign direct investment (FDI) by multinationals from advanced countries can now entre China free of constraint. This means that domestic firms, private and state, are to be faced with fiercer competition on product and labour market. It has now made it harder for Chinese firms to be profitable or even survive without being innovative. Increasing constraint on IP protection also prevents Chinese firms from 'copying' multinationals and not to be punished. WTO rules and international pressure have also made it harder for Chinese government to favour domestic firms through trade barriers and protectionist policies. In addition, demand for cheap 'Made-in-China' low-technology products diminishes as the economic recession sweeps across the world. Chinese firms have no time to waste, and the need for innovation is more urgent than ever.

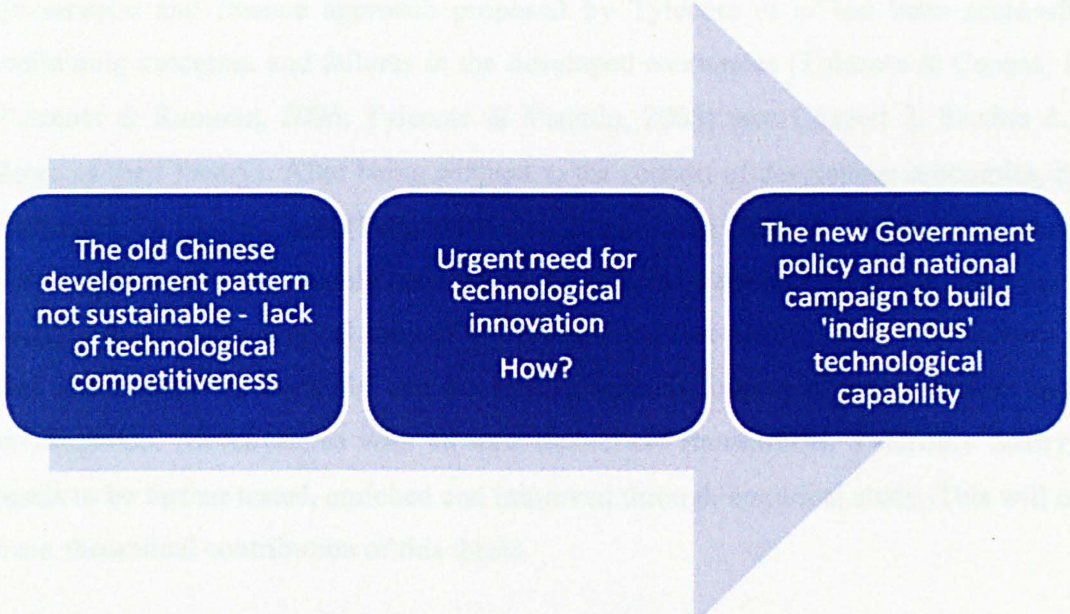

Figure 1-1 The logic of need for indigenous technological capability in China

In fact now there is both political and strategic appreciation in China of the need to encourage innovation to retain the competitive advantage originally bestowed by cheap labour. In 2006 the Chinese government drafted the 'S&T Strategic Plan 2006-2020', which sets out important overarching goal of making China an 'innovation-oriented' society by the year 2020 and – over the longer term – one of the world's leading 'innovation economies'. On the other hand, foreign firms that have already mastered the latest technology are on the doorstep, and modern management education is steadily infiltrating the management cadre. On the face of it, then, Chinese firms seem exceptionally well positioned to acquire the information and capability needed for innovation. Yet, there is no evidence of Chinese firms widely succeeding in acquiring and improving indigenous technological capability in the way that many firms did in Japan in the 60s/70s and Korea early 90s (see Chapter 3, Section 3.1.3). Why not? What is going wrong?

Reflections on industry policy and competitions rules are not sufficient to afford explanation to the general failure (see beginning of this chapter). The corporate governance and finance approach proposed by Tylecote *et al* has been successful in explaining successes and failures in the developed economies (Tylecote & Conesa, 1999; Tylecote & Ramirez, 2006; Tylecote & Visintin, 2008) (see Chapter 2, Section 2.3 for detail of their theory). After being adapted to the context of developing economies, it also worked in the Chinese case (Tylecote & Cai, 2004; Cai & Tylecote, 2005, 2008). However, Cai & Tylecote's work mainly focused on the effects of ownership as a primary factor in shaping firms' technological capability development (see below). Our observations show that other elements certainly can be at least equally important and therefore demand investigation. Moreover, as with all new theoretical frameworks, Tylecote's theory also needs to be further tested, enriched and improved through empirical study. This will be the main theoretical contribution of this thesis.

1.2 *China's challenge in SOE reform*

It is commonly agreed that total privatisation is out of the question in China (see Chapter 3, section 3.1.1 for explanation), therefore argument of this thesis needs to be placed within the limited scope of SOE reform – that is, to identify a mechanism that is both conductible for developing indigenous technological capability, and is acceptable by the Chinese political ideology.

Although China's reform and development in the past 30 years have been accompanied by quick rise of private sector and fast retreat of state-owned enterprises (see Chapter 3, section 3.1.1), the state has had cautious approach in the ownership reform process (historical review of ownership reform from 1949 to date is in Chapter 3, section 3.3.1). Whilst attitude towards the development of private sector has changed from suspicion and suppression to official approval, the Chinese government is determined to continue, and sometimes enhance the dominance of state ownership in sectors – mostly high-technology industries – that are key to the country's development and security (see Chapter 3, section 3.1.1 for list of selected industries). Meanwhile, the state aims at restructuring SOEs by establishing a 'Modern Enterprise System (*Xiandai Qiye Zhidu*), in which corporate governance was the main focus. However, despite the effort to reform and enforce formal arrangements, some fundamental flaws in the governance of Chinese firm, especially of SOEs, remained, and these flaws have had an impact on firms' technological development (Tylecote *et al*, 2010) (see Chapter 3, Section 3.3.1 for SOE and corporate governance reform). Cai and Tylecote (2005; 2008) have made some progress in trying to identify the remedy. In their study in the Chinese telecommunications sector, they compared the firms' levels of technological capabilities among three different ownership types: majority state-owned enterprises (MASOEs), minority state-owned enterprises (MISOEs), and private enterprises (POEs). They found that the new hybrid form – the MISOEs – combines advantages of both the state-owned and private firm, and has therefore out-performed other types of ownership. Their findings are relevant to the research aim of this thesis, and therefore become one of the key jumping off points of the present study.

The situation of POEs in China is very different SOEs. Their corporate governance system, although flawed in other ways, tend to encourage strategies that may lead to the development of more dynamic capabilities (see also Chapter 3, Section 3.3.2 for their corporate governance). However, POEs suffer from an obvious problem that is rarely shared by SOEs – difficult access to finance, as well as land and other resources (Cai & Tylecote, 2005). Lack of funding too often prevents these private firms from technological learning, since return on this type of investment does not meet their need for immediate survival.

To sum up, China's goal to develop dynamic technological capability needs to be pursued in conjunction with the construction of a 'modern, healthy CGFS system'. As such, in many other NIEs, firms' technological capability development should also be reviewed with their CGFS in mind. This hence strengthened the practicality and validity of this thesis, as it aims to do just that.

1.3 Scope of this research

Technological capability can be studied from different levels – firm level, sector level and country level (Lall, 1990). The technological capability of countries ultimately depends on the technological capability of firms, and because firms are the core of any market economy, which China now is, predominantly. This research thus examines technological capability on a firm-by-firm basis. Semi-structured interview-based case studies will be first conducted to facilitate in-depth examination of individual instances to gain a sharpened understanding of the subject matter, and to shape testable hypotheses. Questionnaire survey will then be carried out to reach a wider population and draw more generalisable conclusions. Finally the survey data will be aggregated and analysed at the industry level, which is necessary for hypothesis testing and will improve the general applicability of the findings. (For details of how the two phases of empirical research address our research questions, see next section; for details of methodology and techniques adopted in this thesis, see Chapter 5).

In this project the Chinese auto industry and electronics industry (broadly defined) have been selected for empirical research. Such selection is based on the special features in these two sectors: large, varied in ownership type, finance and corporate governance, and technological capability, and both top-priority sectors for government (NDRC, 2006). It is hoped that through the study of the two biggest and most important manufacturing industries, experiences and conclusions can spill over to at least other high-tech industries. More specifically, the possible difference among firms in finance and corporate governance and capability development pattern, and the mechanism at work would shed new light on the endeavour of Chinese firms to develop indigenous technological capability.

Our empirical work in the auto industry is limited to 'Companies that manufacture and distribute passenger cars, and suppliers of key parts and components, such as engines, tyres and bodies[4]' (according to National Bureau of Statistics' [NBS] classification). The choice of passenger car sector is because it is presumably the largest auto sector, and has the highest technology demand in all vehicle sectors, and is also the most interesting sector in terms of evolution (see Chapter 3, introduction of the Chinese auto industry [section 3.4]). In the past 20 years the Chinese passenger car sector has had very controversial industrial policies and consequently staggered on the road to development (see also Chapter 3 section 3.4). It has thus become the state's determination as well as a nationalist ambition to build China's own-brand car with China's own intellectual property (IP). Since late 2004 the Chinese passenger car industry seemed to have achieved significant improvement. However the notion that the recent success is entirely due to a healthier development environment (the relaxed industrial policy) needs to be challenged; and in turn provides rich soil for empirical study. As for the auto parts sector, the reason for selection is straightforward: it is the up-stream sector of automobile industry. Although not necessary high-technology itself, it lends the researcher a unique lens to study China's medium- and medium-high technology sectors[5] without deviating to an entirely different industry. More importantly, during the search for case study samples in the empirical work, high quality access was provided by a Chinese tyre company, which has proved instrumental in enhancing our insights.

In this study the 'electronics industry' is defined according to the United Nation's 'International Standard Industry Classification of all Economic Activities' (ISIC Rev. 3.1: http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17&Lg=1). It includes: 1) manufactures of office, accounting and computing machinery (sector 30); 2) low-voltage electrical machinery and apparatus (31), 3) radio, television and communication equipment and apparatus (32), 4) electronic domestic appliances (2930), and electronic general-purpose appliances (2919). We checked the compatibility of such definition with the industrial classification of NBS, of which many aggregate data was used in our study. In

[4] Suppliers of electronic parts and components are categorised as electronics firms.
[5] The whole of automotive industry is classified as medium-high technology industry by the Chinese standard, see NBS' definition: www.stats.gov.cn/industrydefinition.htm (accessed in April 2006).

Chinese terms it refers to a two-digit industry codified 40 in the industrial classification, plus some consumer electronics industries, which are in the scope of 'household electronic appliances' industry (code 395) within the 'electric equipment and machinery' industry (code39).

1.4 Research questions

1.4.1 Aims

This research aims to:

1. From the perspective of corporate governance and finance, why have the majority of Chinese firms failed to develop technological capability that such that would enhance their competitiveness in medium and high technology industries;
2. Explain how the minority succeeded and why there are not more of them.
3. Identify elements of corporate governance and finance which influence firms' technological capability; and how these elements take effect.

1.3.2 Research questions and objectives

In order to achieve the above, four research questions with corresponding objectives are developed (see Table 1-1 below). In particular, case studies are used to develop in-depth answers to all of the research questions. Based on findings from the case studies, focuses on the elements of corporate governance are narrowed down to those most relevant to China's situation so that testable hypotheses can be developed for generalisation. It is then followed by questionnaire survey, through which hypotheses are tested to address Research Question 1 (measurement of technological capabilities in a systematic manner); Question 3 (corporate governance and finance of firms); and Question 4 (the effect of corporate governance and finance on technological capabilities).

Table 1-1 Research Questions and sub-questions

Research Questions	*Sub-questions*
What is the situation of technological capabilities developed in the firms in Chinese Auto and Electronics Industry?	• How is the dynamism of the firms' technological capabilities?[6]
How has the development process of technological capabilities been?	• How is the initial technology acquired? • How have strategic decisions regarding technological capability development been reached? • How are the strategies managed and implemented?
What is the situation of corporate governance and finance in the firms in Chinese Auto and Electronics Industry?	• According to the existing theoretical framework[7], how is *stakeholder inclusion* practised in the process of technological change? • How closely do shareholders *engage* with management? And how much *expertise* do they have regarding the technologies and markets relevant to the firm? • How much pressure do shareholders or their representatives exert for *shareholder value*, i.e. increased profit? (And do state shareholders exert pressure for other goals: for example technological change or against job losses?) • To what extent does ownership structure determine corporate governance? • To what extent does ownership structure determine ease of access to finance for technological capability development?
How can the capabilities developed be explained from the finance/corporate governance point of view?	• To what extent can the situation of technological capability in a firm be explained by the firm's technological strategy / behaviour?

[6] For the definition of technological capability, see chapter 2, section 2.1. The framework of technological capabilities used in this thesis is explained in chapter 4, section 4.1. Also, a summary of variables used in the quantitative stage of research can be found in chapter 8.

[7] For detailed explanation of the terms *stakeholder inclusion*, *engagement*, *expertise* and *pressure for shareholder value* and their relevance to technological capability development, see Chapter 2, section 2.3.2)

1.5 Significance and Contribution

This study will potentially make the following four contributions:

- Theoretically, it will add to the growing literature on management of technology in general, and on industry development in Newly Industrialising Economies (NIEs) in particular. Specifically, it will improve the theoretical framework of the effect of corporate governance and finance system (CGFS) on technological development. The association between CGFS and technological capabilities is an organic instead of mechanical one; however empirical studies in the past have not successfully explained the intricate effects and mechanism at work. Rather than establishing direct correlations between CGFS and the dependent variable – technological capabilities, this research aims to illustrate in detail, how different strategies and behaviour have influenced the firms' technological capability development; and how specific elements of corporate governance and finance have shaped these strategies and behaviour. Thus, it will achieve a much deepened understanding of the framework, and in the future will provide guidance for confident and skilled applications of such theories to other contexts.
- Combined investigation of the China's two biggest and most important industries (auto and electronics) has rarely been done in the same piece of research before, except by Liang (2004). However his work (on foreign direct investment [FDI] and industrial development) had different focuses and theoretical stance. In such respect, this thesis will be the first of its kind, and will provide new and valuable insights into understanding of these two industries, and of other manufacturing industries in NIEs in future research.
- By applying both qualitative and quantitative methods, this thesis will make contribution to the research methodology. Qualitative case study method is used to enhance the researcher's understanding of the subject matters, and to generate hypotheses; while quantitative questionnaire survey gathers data which is used to test the hypotheses, and improve applicability of the findings[8].

[8] Although combined methods were also adopted before by Cai (2005), who sets out to consider a number of external factors that are possible determinants of technological development in the Chinese context. The importance of the role of CGFS then emerged at a later stage of her analysis – whereas this research, after

- This thesis will also propose a conceptual framework to measure technological capabilities. By adopting the 'dynamic capability' approach, this research will measure the degree of 'dynamism' in the firms' capabilities, and therefore will develop a generally applicable framework for measuring capabilities in manufacturing sectors. In addition to measuring the capabilities of firms, this research will also measure the innovative performance of firms to gain a triangulated insight into the subject matters.

For companies, this study will again provide them with a greater understanding of how finance and governance have impact on, and even determine their strategic decisions regarding technology development and how these decisions can shape the development patterns of their technological capabilities. Last but not least, this research will contribute to the policy debate, particularly in China and other NIEs, on how best the institutional arrangements and practices can foster technical change and what should be done about the corporate governance and financial system.

1.6 Structure of this thesis

This thesis is organised in the following way (see also Figure 1-2):

Chapter 2 reviews the most relevant prior studies on technological capability. The main issues discussed in this chapter are the definition of technological capabilities, frameworks of technological capabilities and streams of literature about technological capability upgrading in emerging economies. Specifically, it links the array of literature on technological development in developing countries to those on influences of CGFS on technological capability. Chapter 3 describes the Chinese automotive and electronics industry in the context of China's transition. This chapter starts with a review of the general characteristics of China's economic growth and its national system of innovation.

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drawing on her findings and arguments in other literature, will put the analysis of CGFS at centre stage. Therefore analysis of data (qualitative and quantitative) is much more focused and detailed.

Issues directly related to this research are also closely examined – the corporate governance and finance of Chinese SOEs and POEs. Finally it gives background information about the Chinese automotive and electronics industries where empirical work is conducted. Chapter 4 explains the framework of measuring technological capability in this thesis, and how theories about corporate governance/finance and technological capability (from Chapter 2) can be adapted to the Chinese reality (from Chapter 3), and generates 3 propositions for the empirical study. Chapter 5 describes research methodologies used in this study. The philosophical perspectives of positive, interpretivist and relativist approaches are first discussed, followed by the description of the methods of data collection and analysis. Chapter 6 discusses findings from the qualitative phase of the empirical research in the auto and electronics sectors (interview-based case studies), where the existing theory is enriched, and new theories start to emerge. 7 hypotheses are generated from those findings. Chapter 7 and 8 present findings from the quantitative phase of the empirical studies: the evaluation of corporate governance and finance of Chinese electronics firms, and their technological capabilities. Hypotheses are also tested to check the applicability and vigour of new theories developed in the qualitative study. Chapter 9 concludes the thesis, which includes the overall findings, policy implications, contributions and limitations of this study.

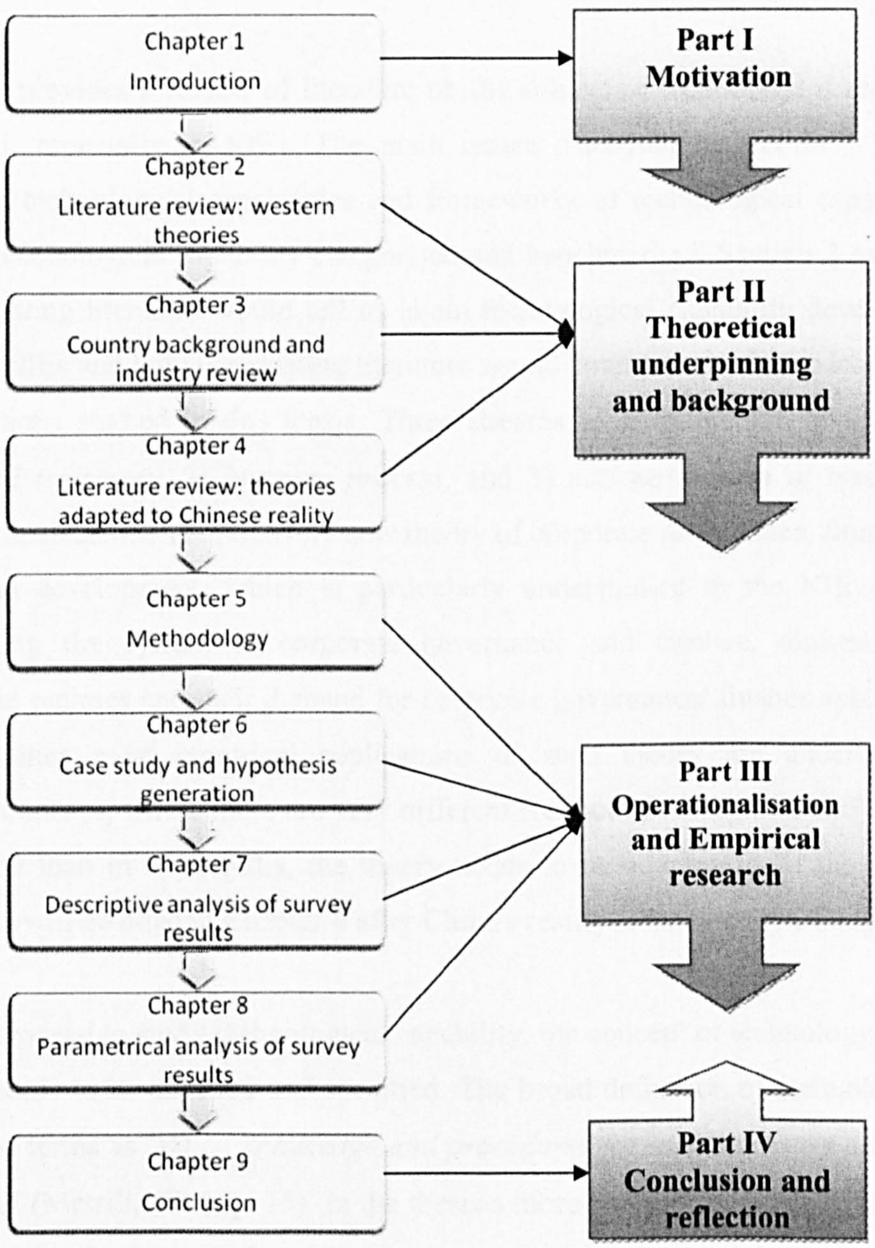

Figure 1-2 Structure of the thesis

Chapter 2 Prior Studies in Technological Capability Development

This chapter provides a review of literature on the subject of technological capability development, especially in NIEs. The main issues discussed in section 1 are the definition of technological capabilities and frameworks of technological capabilities, i.e. how is technological capability categorised and benchmarked. Section 2 examines what the existing literature would tell us about technological capability development for firms in NIEs and how the existing literature would contribute to the understanding of the questions studied in this thesis. Three streams of literature are reviewed: *1) technological trajectory*, 2) *learning process*, and 3) *national system of innovation*. Section 3 is dedicated to the relatively new theory of corporate governance, finance and technological development, which is particularly understudied in the NIE context. After defining the system of corporate governance and finance, dimensions of technological regimes and their demand for corporate governance/ finance systems are examined. Since most empirical applications of such theory are undertaken in developed countries, where there are very different technological regimes and agendas of innovation than in most NIEs, the theory needs to be adapted to fit the Chinese context. This will be done in Chapter 4 after China's reality is examined in Chapter 3.

In order to proceed to study technological capability, the concept of technology used in this thesis needs to be clarified and specified. The broad definition of technology can be in general terms as '*skills, knowledge and procedures for making, using and doing useful things*' (Merrill, 1971, p. 15). In the thesis a more comprehensive understanding of technology has been reached which encompasses at least four components: physical artefacts, information, people-embodied knowledge and organisational knowledge (Hall & Johnson, 1970; Dahlman & Westphal, 1981; Nelson & Winter, 1982; Orlikowski & Robey, 1991).[9]

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[9] Physical artefacts: such as material, products, machinery, equipment, facilities etc. this component was once regarded as the most important part of the technology, since the intangible part of the technology had not been recognised by then.
Information: such as specification, document, instruction, manual, etc. it refers to all kinds of knowledge embedded either in physical equipment or a series of processes which transform inputs into outputs (Hall & Johnson, 1970). Dahlman and Westphal (1981) described this type of information as underlying

Prior to the 1950s, microeconomic analysis of orthodox neoclassical economics assumed that technologies were exogenous factors and were readily available for public use. When considering generating technology, firms compared the cost of the technology with its expected returns; and decisions were mostly influenced by price factors. Once purchased it was assumed that firms would naturally master those technology acquired (UNCTAD, 1996).

From 1950s, different schools of economics have diverged from the mainstream of neoclassical economics. 'Institutional economics' has recognised the important role played by institutions in the process of technological change (Hodgson, 1994). 'Structuralism' has proposed the idea that technology does not occur in isolation, but instead occur in relation to other phenomena which are as a whole defined by structure (UNCTAD, 1996). During the late 1960s and 1970s, the 'development school' or 'evolutionary school' began to treat technology as an endogenous factor and analysed technological changes within a political economy context (UNCTAD, 1996). However the main focus was on the developed countries. Developing countries had been taken as merely passive importers of technology: '*...in the highly simplified models...there is no problem in assimilating the transferred technology; there is no adaptation required; all firms remain equally efficient; firm-specific learning or technical efforts are unnecessary and irrelevant ...*' (Nelson 1987 cited in Lall 1992).

From the late 1970s a number of studies started to emphasise strongly the success of the Newly Industrialising Economies (NIEs) on the development of indigenous technological capabilities. Many firms in developing countries are able to undergo major technological transformations, from imitator to innovator. They did it by making incremental, continuous improvements that adapt new technologies to meet specific

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physical artefacts and giving expression in the technology. This component gives a new meaning to technology transfer and adaptation.
People-embodied knowledge: people play an extremely important role in technology. Their levels of education and technological skills, and their attitudes towards work (such as persistence, diligence, creativity etc.) will largely determine their ability to utilise, modify or improve the existing technologies.
Organisational knowledge: Nelson and Winter (1982) described organisational knowledge as routines. Routines are those norms, regulations and cultures by which organisations carry out day-t-day management and production-associated activities. Organisational routines decide what types of knowledge are legitimate, what kinds of problem-solving methods or tools are used in the creation of new knowledge, or what stocks of knowledge humans draw upon to interpret behaviour and evens (Orlikowski & Robey, 1991). Therefore much of the knowledge that underlies routine behaviour is what might be considered as the 'tacit' knowledge of the organisation, not consciously known or articulated by anyone in particular.

demands (Dosi, 1988; Bell and Pavitt, 1993 b; 1995). Incremental changes at the firm level can generate technological capabilities, and the appropriate macro environment (regulation system, financial system, industrial policies etc) could help to expedite the speed of firms' technological accumulation (Lundvall and Ernst, 2000; Costa, 2001). Technological capabilities could also vary widely among firms even in the same industry under the same circumstance. This is because the effort made to learn new technologies strongly influences the effectiveness with which technologies are assimilated, diffused, and improved.

What are then technological capabilities?

2.1 Technological capability

2.1.1 The definition of technological capability, dynamic capability, and innovation

1) Technological capability

Technological capabilities are the major determinant of industrial competitiveness and also the main source of innovation (OECD 1996; Schacht 1997; Kim 1997, 1999). Study of technological capability in an industry of nation must start from firm level. This is because that firms' are the main locus of technological change in any market economy (Cooper, 1992), and are at the centre of a nation's technological capabilities development. Depending on the aims of the research, definition of technological capability varies in perspective. Lall (1990, p.17) defines technological capability (TC) broadly as *'the entire complex of human skills (entrepreneurial, managerial and technical) needed to set up and operate industries efficiently over time'*. Westphal *et al.* (1985) and Kim (1997) define the term from the aspect of corporate development. According to them, technological capability refers to the ability to effectively use technological knowledge to achieve assimilation, use, adaptation, and change of existing technologies. Probably more importantly, it enables one to develop new products and processes an to create new technologies to survive and compete in a changing environment (Westphal *et al.*, 1985; Kim, 1997). Based on East Asian studies, several scholars recognized the fact that for the bulk of the developing countries: 'it is the ability to efficiently absorb, use and adapt technologies that matters' (Lall, 2001,p. 1501). In the thesis we therefore use the concept of technological capability as below:

Technological capability refers to the capability of a firm to identify, acquire, assimilate, adapt and make effective use of technical knowledge and skills, and then to generate new knowledge and skills. We further distinguish between static capability - capability to make effective use of technological knowledge and skills - and dynamic technological capability - the rest of the capabilities set above, i.e. identify, acquire, assimilate, adapt, and then to generate new knowledge and skills.

It is a broad consensus that 'dynamic capabilities' contrast with 'static (or ordinary) capabilities' by being concerned with change (Winter, 2003). It is also argued that dynamic capabilities are to some degree needed for innovation, at least at the firm level (Collis, 1990; Bell & Pavitt, 1993a). As it is at the very centre of this thesis, the concept of dynamic capability will be clarified below. We will then review the notion of innovation, and how innovation is associated with dynamic capabilities.

2) Dynamic capability

Innovation depends heavily on *dynamic* capability, in other words, moving quickly to sophisticated levels of capability (Bell & Pavitt, 1995). The most cited definition of dynamic capability is by Teece, Pisano, & Shuen (1997), which is quite similar to ours (see above) – the firm's ability to 'appropriately adapt, integrate, build, and reconfigure internal and external skills and functional competences toward changing environment' (Teece *et al.,* 1997, p.515). Pisano (1994) and Grant (1996) address dynamic capability from a resource-based viewpoint, they emphasize the nature of dynamic capabilities as the *organisational and strategic routines* by which managers alter their resource base to generate new value-creating strategies, and this can be done through processes such as resources acquisition, integration and recombination

Pisano and Grant are not alone in founding the concept of dynamic capability on the broader concept of routines. Nelson and Winter's work in 1982 is among the pioneering efforts, where they define 'routine' as behaviour that is '*...learned, highly patterned,* *repetitious, or quasi-repetitious, founded in part in tacit knowledge*' (p. 12). Their definition therefore excludes the phenomenon of brilliant improvisation, or 'general-purpose routines' (Winter, 2000, p. 991) The exclusion of the latter becomes particularly evident when Winter and colleagues define dynamic capabilities not as routines *per se*, but as '*...collective activity through which the organisation systematically generates and modifies its operating routines in pursuit of improved effectiveness.*' (Zollo & Winter, 2002, p.340; italics added). Clearly, distinction needs to be made between those routines that are repositories of dynamic capabilities (*organisational and strategic routines*, as Pisano and Grant's define it), and those that are not. The second type of routine (*operating routine*, by Winter *et al.*'s definition) involves the execution of known procedures for the purpose of ensuring smooth operation for current revenue and profit[10]. It can be brought about by dynamic capabilities, as argued by Zollo and Winter, or in some cases be physically transferred in through purchase of capital goods (Bell & Pavitt, 1993b). In contrast, the first type of routine seeks to generate desirable changes in the existing *operating* routines to enhance effectiveness in the future[11]. In other words, routines that encapsulate dynamic capabilities do not just preserve the past, but also pave the way for deliberate learning within the firm, hence shaping the firm's future development (Dosi *et al.*, 2000; Bottazzi *et al.*, 2002; Zollo & Winter, 2002; Winter, 2000; 2004).

We incorporate this view in our discussion here; in addition, we use the terms *dynamic* and *static* routines, to indicate their corresponding relationship with *dynamic* and *static* capabilities. Dynamic capabilities can be therefore be understood as learned pattern of collective activities embedded in dynamic routines, through which they govern the rate of change of static routines, when the latter manifests the firm's static capabilities. This clarification of terminology is necessary, particularly for developing countries, where gaps of *static* routines among firms – although more significant in these countries than ditto developed countries – do not necessarily reflect the difference in *dynamic* capabilities. It is already noted that firms with state-of-the-art operating routines do not necessarily possess capabilities that are more dynamic than their smaller, less glamorous competitors (see the cases of SAIC and Chery in Chapter 6; see also Liu &

[10] Examples include manufacturing routine, shipping of the ordered goods, and receipt of corresponding payment, etc

[11] Examples include knowledge creation routines whereby managers and others build new thinking within the firm, product development routine, alliance and acquisition routines, etc.

Tylecote, 2009). The distinction of static routine/capability and dynamic routine/capability will thus enable us to identify firms' true levels of static/dynamic capabilities according to their types of routines.

There are two more issues that need to be addressed regarding dynamic capabilities. First, as mentioned above, dynamic capabilities are a combination of highly patterned, structured vehicles of change[12]. Just as cars have different engine sizes and purposes, dynamic capabilities differ amongst each other by the rate of change they govern and the type of functions. Examples of such typology in past research are: Investment Capability by Lall (1992), Strategic Capability by Arnold and Thuriaus (1997); Alliance and Acquisition Capability by Zollo and Singh (1998); and Product Development Capability by Winter (2003) (for details about their frameworks see section 2.1.2). On the other hand, while these capabilities may be distinctively different in details, they do share common features that can be associated with effective processes across firms (Eisenhardt & Martin, 2000). Again, just like driving cars, there are more and less effective ways to execute particular dynamic capabilities. Therefore, for most firms, the competitive advantage does not only lie in a single type of dynamic capability, nor is it a matter of whether these firms have or have not dynamic capabilities, but how 'effective' (quoting Eisenhardt & Martin, 2000) their portfolio of dynamic capabilities are.

Based on the above argument, study of dynamic capability development at firm level should reflect knowledge of its key characteristics. In particular, assessment of dynamic capabilities should be oriented towards measuring 'dynamism' (effectiveness) of dynamic capabilities, and incorporate a combination of routines.

[12] It is quite possible to change without having a dynamic capability. For example, Winter (2003) mentioned '*Ad hoc* problem-solving' behaviour under fire-fighting circumstances which may also bring about change. It however is not routine, neither is it dynamic capability. However this is beyond the scope of our research in this thesis.

3) Innovation

Innovation is widely believed to be a major driving force of modern capitalism and growth (Nelson & Nelson, 2002). In the 1930s Joseph Schumpeter defined five types of innovation, and is often regarded as the first modern economist to draw attention to the importance of innovation (Rogers, 1998):

- 'Introduction of a new product or a qualitative change in an existing product
- Process innovation new to an industry
- The opening of a new market
- Development of new sources of supply for raw materials or other inputs
- Change in industrial organisation' (OECD, 1997, p. 28)

Schumpeter's definition reveals the complex nature of innovation. It varies enormously by industry (Nelson and Winter, 1982; Pavitt, 1998), by degree of novelty and cost (whether it is new to the firm, new to the country or new to the world) (OECD, 1996), by technology (Dosi, 1982) and by type (product, process, organisational, system, Freeman, 1992). There have been some attempts to distinguish different types of innovations. For example, Freeman (1971) ranks innovations on a five-point scale from 'systemic' to 'major', 'minor', 'incremental' and 'unrecorded'. Many authors make a two-fold distinction between 'radical' (or 'major') innovations and 'incremental' (or 'minor') (e.g. Dewar & Dutton, 1986; Stobaugh, 1988). Taxonomy of innovations is difficult, but nevertheless important. Since different types of innovation not only have very different consequences for the economy and the firms which make them, but also embody a very different mix of knowledge and skill (Utterback, 1993). Moreover, to a significant extent the properties of innovation processes vary across countries and specific to technologies or industrial sectors (Malerba and Orsenigo, 1996).

For NIEs, although one does not rule out the possibility of cutting-edge technologies or 'state-of-the-art' products being created, systemic or major innovation is still not a central issue to these countries. For the bulk of developing countries, innovations that are most relevant are innovations that are new to the firm, to the region, or to the country. Consequently, dynamic capabilities that are required, are those that enable them to achieve these goals.

To sum up, there is a hierarchy of technological capabilities – there are capabilities that can operate existing technology (static capability), and capabilities that can generate minor and major technical change (dynamic capability). Dynamic technological capability is normally needed for innovation [13]. It is complex, structured and multidimensional. It is sticky – hard to change in short-term (static capability on the other hand, could be enhanced rather quickly, through acquisition of state-of-the-art equipments, for example). However dynamic capability is also fluid – the dynamism of technological capability – the ability of the capability to generate change, to enhance competitiveness in response to the competitive environment, changes over time (Winter, 2000; Zollo & Winter, 2002). Dynamic capabilities can be categorised according to their functions (Lall, 1992), and firms' competitive advantage may rest in a combination of dynamic capabilities, and their innovation performance is influenced by how effective these capabilities are executed. Finally, dynamic capability in NIEs that are required, are those that enable them to achieve innovations that are relevant to NIEs.

[13] In some rare circumstances, firms with very limited dynamic capabilities may still be able to innovate through total reliance on infusion of technology. However this is beyond our scope of discussion here.

2.1.2 Measurement of technological capabilities

The section above theorises technological capability, especially dynamic capability. This section expands the topic on an empirical stance. In this thesis, technological capability is studied as an outcome of combined determinants: 1) institutional environment (especially corporate governance and finance), 2) strategic decision and technological activities (technological choices and endeavour). As such, technological capabilities cannot be rigorously studied in an industry or country if it is not taxonomized. Taxonomy of corporate technological capability can vary depending on the research purpose, and one of the usual approaches is to place technological capabilities in functional categories (Bell & Albu, 1999). Drawing upon Fransman (1986), Dahlman *et al* (1987) and Lall (1987). Lall (1992) categorizes technological capabilities according to the kind of activities which they facilitate: investment technological capability, production technological capability, and linkage technological capability (see Table 2-1).

In Lall's framework, Investment Capabilities contain skills necessary for identifying, obtaining technology for design, construction and commission of new products/ facilities (Lall, 1992). Investment capabilities have two elements: pre-investment and project execution. Under each element there are sub-elements to measure those ranging from routine to innovative activities.

Production Capabilities decide the productivity of labour and capital as well as efficiency in material and energy used. They have three elements: process engineering, product engineering and industrial engineering. Process engineering includes necessary activities from production. Product engineering are those necessary for production or improving product specifications, such as assimilation of product design, improvement in product quality, and basic research. Industrial engineering involves monitoring and control functions for process and product engineering.

Linkages within the economy involve abilities to organize procurement of goods and services, knowledge and technology transfer with suppliers and S&T links with research institutes, universities and other organizations.

Lall recognized that for most functions, capability may range from doing simple activities to intermediary duplicative, and then to advanced innovative activities (Bell & Albu, 1999). Therefore he also vertically categorized the capabilities into three levels, basic, intermediary and advanced.

Lall's framework allows benchmarking of technological capabilities in a progressive and categorized manner. However, there are some inadequacies in Lall's matrix. The elements included in his framework are only designed to measure intangible technological capabilities e.g. skills, experiences. There are tangible elements of technological capabilities such as plant and equipment etc that need to be taken into consideration. In addition, some elements are not compatible with the definition of functions. For example, 1) training and recruitment of skilled personnel are not only required by project execution, but by all kinds of capabilities; basic process and equipment design are process rather than investment capabilities. 2) As Cai (2005) points out, debugging equipment or process problems sometimes involves highly skilled capability of design or research. Therefore not all trouble-shooting activities are routine or basic. Likewise, assimilation of process technology can vary along a wide range of abilities.

In Lall's framework, firms' linkages only covered external ones, such as with suppliers and S&T links. In fact internal contacts between or among firms' departments (R&D department with production department or with marketing department) are good indicators of their linkage capability. More importantly, a firm's linkage, or networking activities, should not be seen purely as a type of technological capability but also a mediating factor - as it affects the quality and speed of information and knowledge flow, which is key to the development of other technological capabilities (Freeman, 1987; Lundvall, 1992, p.14; Ariffin & Bell, 1999). Therefore treatment of linkage/networking activates should reflect awareness of their mediating effects. For such reason, in this study necessary distinctions are made between firm's internal and external (organisational) capabilities and their linkage/networking activities (see Chapter 4, section 4.1).

Despite the imperfections, Lall's framework does highlight the process of capability generation (from basic to more advanced capabilities) and functions: investment, production and linkages) of firms' operation activities. His classification also makes it possible to further breakdown individual capability, and distinguish basic or routine capabilities from more advanced or more dynamic innovative capabilities. As a result, in this thesis the framework of technological capability will follow the basic notion of classification of Lall's, i.e. according to function and degree of efficiency.

Table 2-1 Illustrative matrix of technological capabilities by Lall (1992)

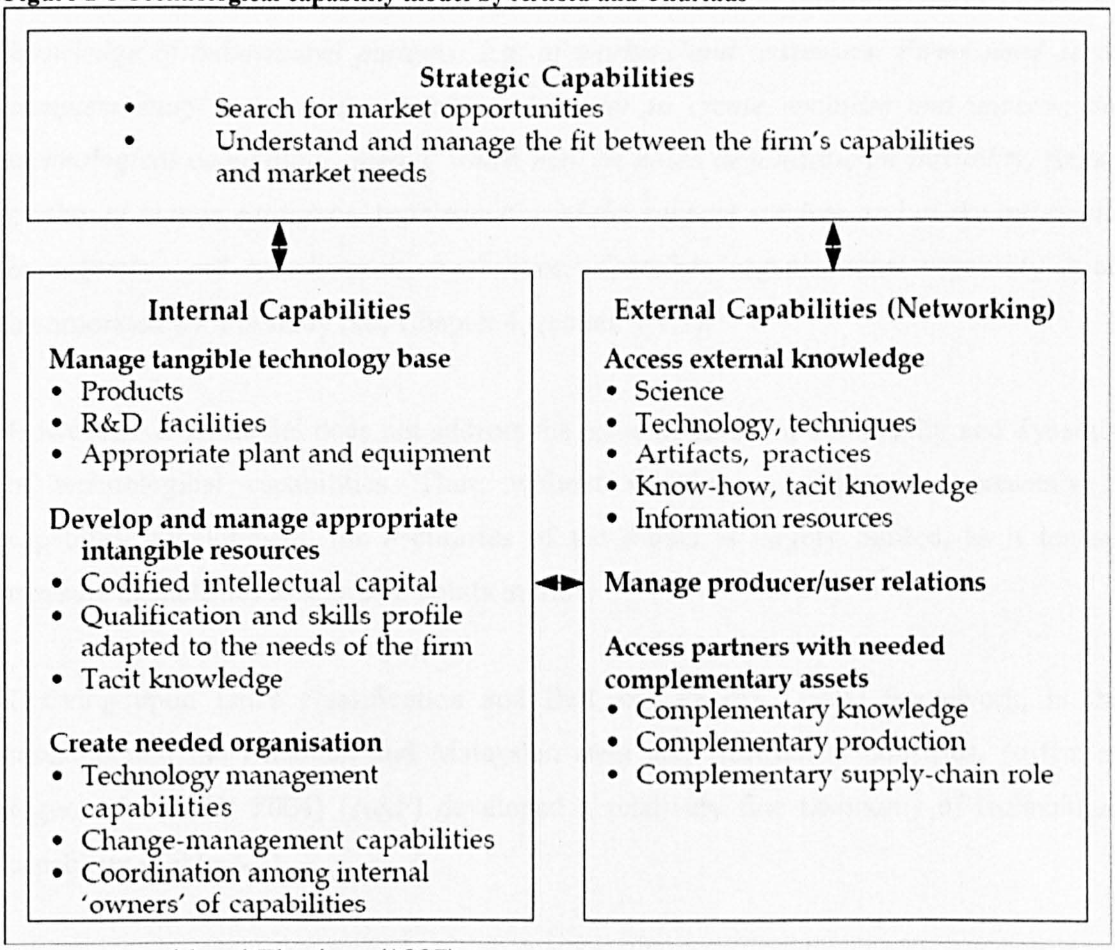
Table 1. Illustrative matrix of technological capabilities

DEGREE OF COMPLEXITY		FUNCTIONAL: INVESTMENT — PRE INVESTMENT	INVESTMENT — PROJECT EXECUTION	PRODUCTION — PROCESS ENGINEERING	PRODUCTION — PRODUCT ENGINEERING	PRODUCTION — INDUSTRIAL ENGINEERING	LINKAGES WITHIN ECONOMY
BASIC	SIMPLE, ROUTINE (Experience based)	Prefeasibility and feasibility studies, Site selection, scheduling of investment	Civil construction, ancillary services, equipment erection commissioning	Debugging, balancing quality control preventive maintenance, assimilation of process technology	Assimilation of product design, minor adaptation to market needs	Work flow, scheduling, time-motion studies. Inventory control	Local procurement of goods and services, information exchange with suppliers
INTERMEI	DIPLICATI VE	technology source. Negotiation of contracts. Bargaining suitable terms. Info. systems	procurement, detailed engineering, training and recruitment of skilled personnel	process adaptation and cost saving, licensing new technology	improvement, licensing and Assimilating new imported product technology	productivity, improved coordination	local supplies, coordinated design, S&T links
ADVANCED	INNOVATI VE RISKY (Research based)		Basic process design. Equipment design and supply	In-house process innovation, basic research	In-house product innovation, basic research		Turnkey capability, cooperative R&D, licensing own Technology to others.

Source:(Lall, 1992)

Arnold and Thuriaus (1997) in their technological capability model defined three types of capabilities: Strategic, Internal and External (see Figure 2-1).

Figure 2-1 Technological capability model by Arnold and Thuriaus



Source: Arnold and Thuriaus (1997)

The strategic capabilities provide the control mechanism with which firms manage its capabilities and exploit them via the market. The internal capabilities consist of three sub-capabilities: capabilities to manage tangible technology base, intangible resources and to create needed organization. The external capabilities concern the relationship between the firm and its outside resources.

One of the Arnold and Thuriaus (A&T) model's contribution is that it recognizes both tangible and intangible capabilities. It also recognizes the importance of Organizational Capabilities in firms' technological capability generation. OECD (1992, p.262) stresses that the notion of technological capability '*...goes well beyond engineering and technical know-how to include knowledge of organizational structures and procedures as much as knowledge of behavioural patterns, e.g. of workers and customers. Firms need certain complementary assets and capabilities in order to create, mobilize and improve their technological capabilities, among which may be noted organizational flexibility, finance, quality of human resources, sophistication of the support services and of the information management and coordination capabilities.*' Therefore organizational capability is also incorporated by this study (see Chapter 4, section 4.1.1).

However A&T's model does not address the issue of levels of complexity and dynamism of technological capabilities. Thus, without showing a progressive perspective of capability development, the usefulness of the model is largely limited, as it tends to measure capabilities as sporadic points in time.

Drawing upon Lall's classification and Bell and Pavitt's (1995) framework, in their research into the Brazilian and Malaysian steel and electronics industries, Ariffin and Figueiredo (2001; 2004) (A&F) developed a relatively fine taxonomy of technological capability (Table 2-2).

Their framework sets apart 'routine' production capability and 'innovative' production capability. 'Routine' production capability is the capability to produce goods at a certain levels of input requirements and efficiency; it may be seen as technology-using skills, or those to achieve organisational arrangements and knowledge. 'Innovative' technological capability is described as the capability to 'improve, change or create products, processes and production organisation, or equipment' (p. 561). Therefore it may also be regarded as capability to generate change. Different levels, or 'depths', are attributed to innovative capability, which can vary from fairly 'basic' levels to 'intermediate' levels and then to more 'advanced' and 'research-based' levels (Arnold and Thuriaus, 2001).

A & F's framework provides a perspective and link to total technological activity particularly in the steel industries in developing countries. As a result, some elements used in their research are also adopted for this project. However, since the objects of investigation in this research range through a wider spectrum of scales and technology types than A & F's (from high-tech telecommunication equipment to medium-tech electronic components and parts, for example), it is not appropriate to measure firms' capabilities with unanimous benchmarking activities. As a result, the framework used in this research adopted a less activity-specific approach, but a more strategy-oriented one (again, for details see chapter 4, section 4.2).

Table 2-2 Selected elements from Ariffin and Figueiredo's capability framework

Types of capability / Levels of capability	Project Management	Equipment	Process and Production management	Product
Routine				
Basic operation Level 1	Construction of basic civil works; Purchase equipment Recruitment	Basic maintenance	SKD (semi-knocked down): parts assembly, only final assembly. Production planning and control.	Routine QC to maintain basic standards
Basic operation Level 2	Simple customizing of existing systems	Routine maintenance Total preventative maintenance	Process flow, line balancing. CKD (complete knocked down): complete assembly	Replication of fixed specifications
Innovative				
Basic innovative capability Level 3	Systems integration. Providing customised software solutions	Repair & trouble-shooting equipment problems.	layout & debugging to optimise production ISO quality control system, MRP or JIT systems	cost-effective, incremental product development for local or different markets
Intermediate innovative capability Level 4	Software development. Project management of large-scale investment projects	Develop automated equipment.	Automation of processes, Flexible & multi-skilled production	Own product design for local or regional markets.
Advanced innovative capability Level 5	Projects management on a global scale. Recognised training & service centres to TNC Group, customers or suppliers.	R&D for specifications and designs of complex automated equipment or production system	Radical innovation in organisation. In-depth Failure Analysis. Patents.	Upgraded to regional or worldwide Design Centres or world product mandates.

Source: Ariffin and Figueiredo (2001; 2004)

The array of empirical research discussed above and many others (Dahlman *et al*, 1987; Lall, 1994; Panda & Ramanathan, 1996; Aw & Batra, 1998; Archibugi & Coco, 2005) have been reviewed and synthesized to form the measurement framework for the current research. Moreover, it is noticed that the above-mentioned also shared a common flaw:

while concentrating on the process of the firms' technological activities, they ignored the importance of performance measurement – The ultimate purpose of technological capability development as a process is to serve the end of developing unique or superior advantages; and such advantage is best manifested by the firm's product (in the manufacturing sector) competitiveness. Chiesa *et al.*(1996) use a combination of two methods to measure both the process and the performance of innovation capability. The process is measured by focusing on the processes through which innovations are achieved. Performance is measured by looking at the effectiveness of the processes, with a focus on their impact on firms' competitiveness. Similar to Chiesa's approach, this study performs a complementary triangulation of capabilities, by measuring firms' technology-related performances (sales growth, innovative performance and product competitiveness). The details are elaborated in Chapter 4.

2.2 Development of corporate technological capability in NIEs – conceptual and theoretical building blocks

This section critically reviews three analytical frameworks that have been used to examine the process of corporate technological capability development in the NIE context – *technological trajectory*, *learning process*, and *national system of innovation*. In spite of their limitations which are discussed below, these frameworks helped to form the theoretical underpinning of this thesis.

2.2.1 NIE's three-stage technological trajectory theory

It is argued in a wide range of research that developing countries take the opposite technological direction from advanced countries, moving from mature technology, through intermediate technology, to emerging technology (Kim, 1980; Westphal *et al.*, 1985; Lee & Bae, 1988; Lall, 1990; 1993; OECD, 1997; Hobday, 1995; Kumar *et al.*, 1999; 2002)

1. Domestic companies in NIEs acquire mature technology from multinational companies (duplicative imitation);
2. Then they absorb the transferred technology, make effective use of it, adapt it and modify, and possibly making incremental improvement to it (creative imitation);
3. They eventually develop their own technology (innovation).

By using his three-stage model (1980), Kim describes the TC development process and analyzes the process of building technological capability in emerging countries (1997). Figure 2-2 illustrates Kim's theory on technological development trajectories in both developed and NIEs.

According to Kim's theory, during the early stage of their TC upgrading, companies in NIEs acquire product design and production technologies from overseas. Production at this stage was mainly concerned with assembly operation of imported components and parts, and the technological focus by the firm was essentially to realise *mastery* of a production operation. Due to the lack of both technological capability and market incentives, there is hardly any indigenous attempt of technological change in products and processes.

As some firms manage to implement transferred design and production technologies from abroad, diffusion of technical know-how quickly take place within the country, resulting in higher number of firms competing in the same market. Accumulated experience in product design and production accumulates then provides a basis for limited indigenous efforts for the *assimilation* of foreign technologies.

Finally, a combined force of: 1) assimilated foreign technology; 2) higher competency of local scientific and engineering personnel together with 3) increased market competition; – would lead to gradual *improvement* of foreign technology. Product improvement and productivity enhancement based on indigenous efforts became more central to competition, leading to a relatively more integrated and developed production system. If they succeed in improving technology, some companies may even eventually develop the technological capabilities to *generate* the emerging technologies independently, and compete with companies in advanced countries on leading-edge innovation (Kim, 1980; 1997).

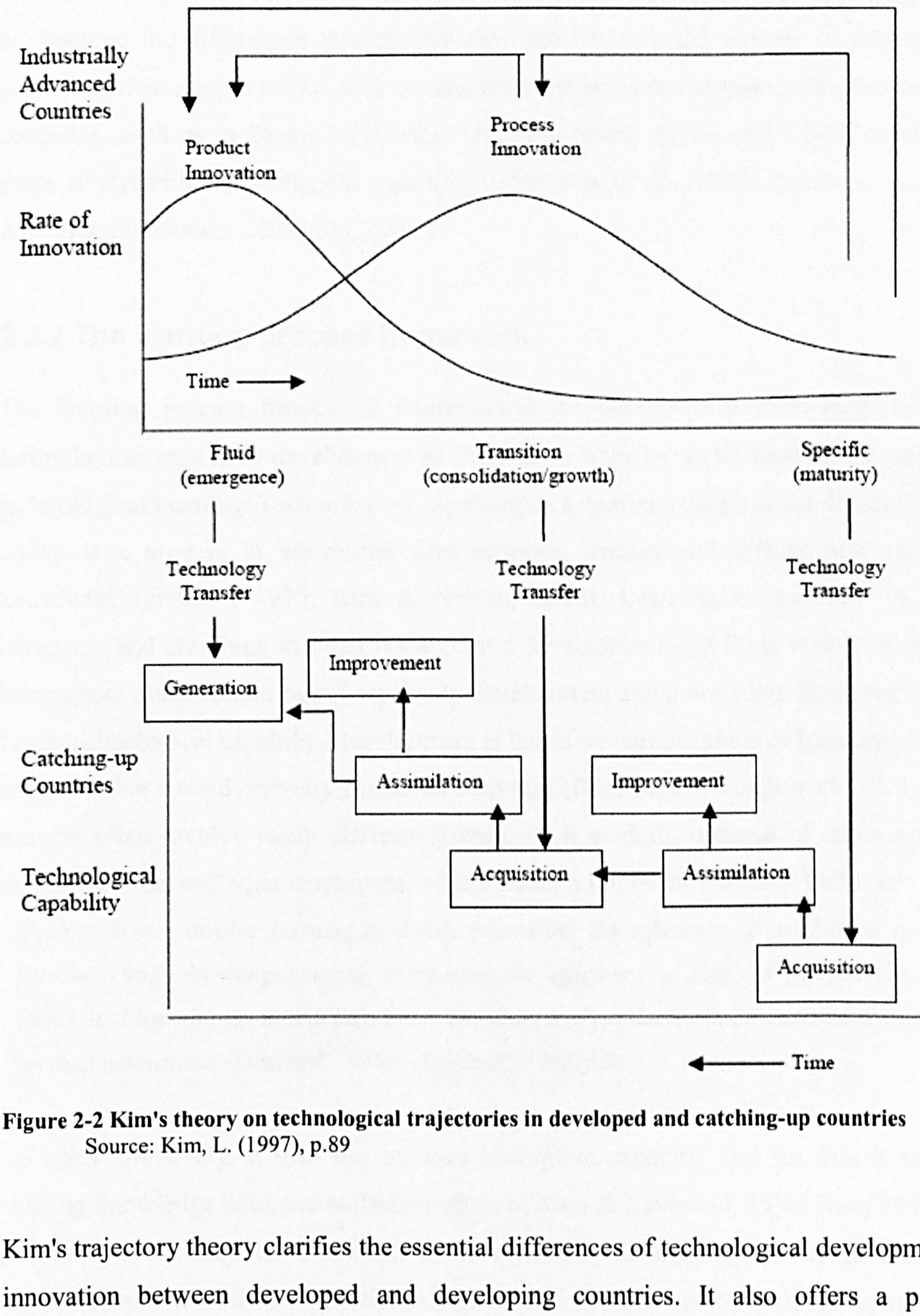


Figure 2-2 Kim's theory on technological trajectories in developed and catching-up countries
Source: Kim, L. (1997), p.89

Kim's trajectory theory clarifies the essential differences of technological development and innovation between developed and developing countries. It also offers a plausible explanation of the victorious cases: the rapid growth of dynamic technological capability in industries such as automobile and electronics industries in Japan after World War II and in Korean and Taiwan since the 1960s. However, we shall argue that Kim's model oversimplifies the process of technology acquisition / technology transfer in the NIEs. It fails to illustrate the differences among countries and firms in the process of technological acquisition/learning; in turn it does not explain why only few companies in other emerging countries, such as in Brazil, Indonesia, Thailand, South Africa and China, reached the stage of dynamic technological capability (Dahlman *et al.*, 1987; Kumar *et al.*, 1999; Ariffin & Figueiredo, 2001; Cai, 2005).

2.2.2 The learning process framework

The learning process framework compensates the conventional three-stage model of technological capability development in firms from NIEs by understanding the process of technological learning. Technological capability is acquired through technological learning, which is a process in which the firm acquires, creates and diffuse new skills and knowledge (Hobday, 1995; Kim & Nelson, 2000). Learning in the form of formal education and searching through research and development (R&D) is widely accepted to bring about much technological capability development and innovation. However, in many cases technological capability development is based on various kinds of learning processes, which evolve around *ordinary* economic activities (Edquist, 1997, italics added). Learning process often involve many different parties, such as daily routines of engineers, sales representatives, and other employees, which matter a lot. In the words of Lundvall:

'Such activities involve learning-by-doing, increasing the efficiency of production operations (Arrow, 1962), learning-by-using, increasing the efficiency of complex systems (Rosenberg, 1982), and learning-by-interacting, involving users and producers in an interaction resulting in product innovations (Lundvall, 1988)'. (Lundvall, 1992, p.9)

To learn effectively, a firm has to have absorptive capacity, and for that it needs an existing knowledge base and sufficient effort (Cohen & Levinthal, 1990; Kim, 1997). The processes of learning start from and are influenced by its existing knowledge base. Firms can increase their ability to understand, assimilate and use new knowledge by increasing their existing knowledge base (Kim, 1999). In developing countries, knowledge base can be increased through technology transfer from advanced countries, or through hiring personnel who already possess the knowledge (Bell & Albu, 1999). However, as argued in the technological learning literature it is nearly impossible for the firms to enhance their knowledge base without exerting effort to internalize the relevant external knowledge (Kim, 1999)

Firm-level effort of learning can have two dimensions for analysis: according to its level of *visibility* (Tylecote & Conesa, 1999; Cai & Tylecote, 2008; Tylecote & Visintin, 2008; Liu & Tylecote, 2009) and according to its degree of *activeness* (Viotti, 1997; 2001)[14]. Formal, explicit efforts such as in-house R&D, formal training or systematic experimentation have high visibility to anyone not involved in the process of learning; and the informal, semi-explicit or implicit efforts such as observation of routine production, repair, maintenance or reconditioning of equipment, are much less visible. Efforts of higher visibility are normally well documented and recorded, and can be relatively easily accredited for the success of a firm's technological development. Whereas efforts of low visibility is much harder to track and understand, especially by those not closely attached to the process and the organization. Such distinctions have significant implications and challenges for the corporate governance and finance system, which will be dwelled on now and revisited in detail in section 2.3.2.

The second dimension to analyse learning efforts by its activeness is widely adopted by scholars such as Amsden (1989), Bell and Pavitt (1993a, 1995), Viotti (1997) and Freeman (2002). Through empirical study of South Korea and Brazil, Viotti (1997; 2001) makes a distinction between *active* learning systems and *passive* learning systems. According to his definition, *active learning strategy* aims at mastering production capability and the capability to improve, whereas *passive learning strategy* is essentially aimed at the simple absorption of production capability (Viotti, 2002).

The above two dimensions of analysis can be integrated, as shown in the graph shown as Figure 2-3. As it indicates, technological learning activities can be located at any point on the two-dimensional graph, ranging from high-visibility and active, to low-visibility and

[14] Firms can also learn through external technological activities, such as interaction with the outside world, or deliberate exchange of information and knowledge, etc (Bell & Albu, 1999). Such interactive methods of learning demands a system approach of analysis, such as system of innovation.. See 2.2.33.

passive. Caution has to be taken when one classifies these efforts – it is important to recognize the complexity and context-specific nature of such learning mechanisms. For example, a *passive form of learning strategy* may be accompanied by an active endeavour to master the technology (though it cannot be assumed to be widespread), therefore becoming the initial stage of a generally active learning process[15]. Therefore examples of learning efforts illustrated in Figure 2-3, such as reverse engineering and formal training, can themselves range across deferent degrees of activeness. On the other hand, the suitability of a learning strategy does not necessarily depend on the level of its visibility; rather, it depends on the nature of the technology regime the firm operates in, i.e. the learning and knowledge environment faced at a given time by firms in a particular sector or sub-sector (Nelson & Winter, 1982). (See explanation in section 2.3 and Chapter 4 for an illustration of Chinese electronics and auto industry).

[15] This seems to be the case, for instance, of some large Korean conglomerates that deliberately utilized OEM (Original Equipment Manufacturing) agreements as just an initial step in an aggressive and active pathway towards technological learning, as described in Amsden (1989) and Viotti (2001).

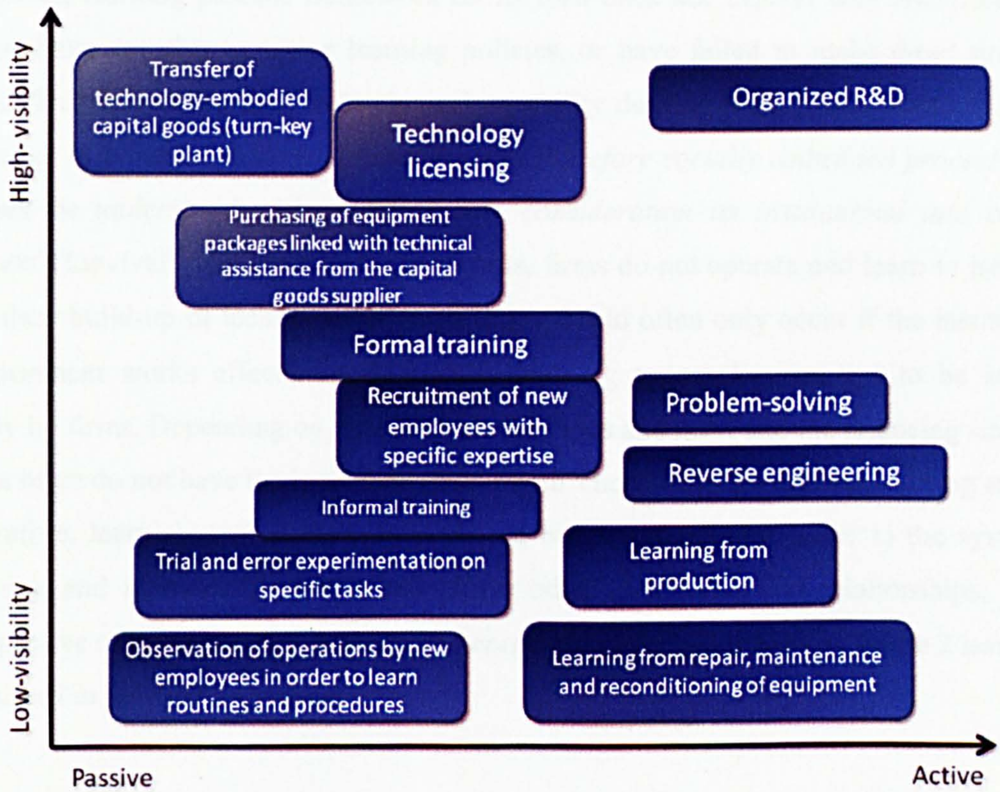


Figure 2-3Technological learning framework – the integrated Model
Source: Own formulation with some examples drawn from Viotti (1997); Bell and Albu (1999)

The learning process approach helps to explain the general failure of most NIEs in developing dynamic technological capabilities – that '*active learning*' (as Viotti defines it) could not be regarded as a natural common feature of firms from these countries (Cooper, 1992, p.15): *'The failure of learning processes in developing countries is in fact quite common. It is reflected in what is often called a 'black-box' approach to production technology encountered quite often in developing country firms which receive technology via license agreements: firms may be unconcerned about how the technology works, provided only that they are able to produce with it'*. Freeman (2002) believes that an active learning strategy proposed by Viottie, Bell and Albu may lie at the centre of a late-comer's approach to addressing its disadvantages.

However, learning process framework on its own does not explain why NIEs including China have not chosen active learning policies, or have failed to make these strategies work. This is because that, technological capability development, which revolves around learning, is '*predominantly an interactive and therefore socially embedded process which cannot be understood without taking into consideration its institutional and cultural context*' (Lundvall, 1992, p.1). In other words, firms do not operate and learn in isolation, and their build-up of technological capabilities would often only occur if the institutional environment works effectively. Moreover, learning approaches are not to be selected freely by firms. Depending on who controls the firms and how, and the financing situation, firms often do not have the incentive, or ability to 'choose' the appropriate learning strategy. Therefore, learning approach in firms should be considered alongside: 1) the system of learning and innovation which incorporates other institutions and relationships; 2) the perspective of 'technological regimes and corporate governance/finance. These 2 issues are discussed in the next 2 sections.

2.2.3 The National System of Innovation framework

From the geographical perspective, the National System of Innovation (NSI) approach has been widely accepted in examining a country's innovative activities (Lundvall 1988, 1992; Nelson 1988, 1993; Niosi *et al.* 2000). The concept, emerged since the early 1980s, was intended to help develop an alternative analytical framework to static standard economics and to criticize its neglect of dynamic process related to innovation, learning and technological development (Lundvall, 2007). One of the general accepted definitions is by Freeman: '*the network of institutions in the private and public sector whose activities and interactions initiate, import and diffuse new technologies*' (1987, p.1). Freeman's definition indicates that NSI involves not only institutions and activities in innovation, but also interactions amongst these institutions. Universities and research institutes are important components in the NSI; so is government, partly because it mostly funds and largely directs these institutions (*e.g.*, Nelson, 1993). However since firms are at the centre of any market economy, they are also at the centre of NSIs. Interaction among these units is also important component of the system. According to Niosi *et al.*, the interaction may be '*...technical, commercial, legal, social and financial as much as the goal of the interaction may be development, protection, financing or regulation of innovation*' (1993, p.139).

An array of academic work about NSI has been produced since the beginning of the 90s. However there does not exist a consensus as to what is to be taken into account when describing a nation's NSI; and the large majority of NSI's studies are focused primarily on innovation based on scientific and technical activities, especially, on R&D (Bell, 2008). This is also true even with the most prominent scholars. In the studies of 15 national systems of innovation co-ordinated by Nelson (1993) – including developing as well as developed economies - he acknowledges that there exists a notional dichotomy of narrow and broad understanding of NSI, whilst the latter, in few studies on the subject, embrace institutions (and relationships) that directly and indirectly influence the innovation and learning process. Narrowly conceptualized NSI has also to a large extent misled policy practice in developing countries, as Bell (2008) puts it:

> *'Bodies responsible for science, technology and innovation policy in developing countries inherited from the advanced countries a preoccupation with R&D as the core focus for policy. This remained the case when concepts of 'innovation system' were wrapped around existing policy approaches and interests over the last decade or so.'*

Therefore, the narrowly-defined NSI framework, which mainly focuses on R&D- and S&T – based activities and institutions, is not sufficient for dealing with the processes of technical change, especially those in developing countries, where R&D and S&T activities have not been, and should not be, the only driving force of innovation. As Lundvall stresses (2007), it is important to rebalance the S&T-based type of innovation (STI), and another important mode of innovation: learning by doing, using and interacting (DUI). Given that innovation in most NIEs display high levels of path-dependence and technological cumulativeness (Bell & Pavitt, 1993b), NSI should be broadly understood, in the context of these countries, essentially as a system of learning (Viotti, 2002). Hence a much more broadly-defined framework needs to be used; it should incorporate any institutions and relationships that are key to the process of innovation as well as learning. Moreover, the research of NSI should be more careful with its normative function. Earlier work by Freeman (1987) on Japan and more recent works by OECD on South Africa and Hungary (OECD, 1997; 2005) acknowledge that regarding NSI, some ways appear to be better than others. However it is believed that more should be done in this direction from developing countries' perspective: to avoid copying or just following the latest policy fashion. For example, a country–specific 'best practice' can be identified through the suggestion of an NSI that meets the requirements of the technological regime its firms operate in.

Last but not least, *'the failure to recognise the firm as the central player in the accumulation of technology has been a major shortcoming of technology policy.'* (Bell & Pavitt, 1992, p.271) This is because countries do not innovate themselves, and it is the firm that can be said to innovate in a capitalist economy (Tylecote & Visintin, 2008). The interaction between capability accumulation and firm development should be seen as a mutual one. In other words, firms do not simply passively receive the benefits from the accumulation of technological capabilities,: they also shape the accumulation process. Therefore policy intended to enhance technological capability has to recognise the central role of firms in industrial upgrading and innovation to effectively enhance technological capability (Juma & Clark, 2002). (A case in point is the car industry in China in the 90s and early 2000s; see chapter 3, section 3.4).

We therefore argue that NSI should encompass institutions, organizations involved in the process of both STI and DUI, and the interactions among them. Moreover, study of a nation's system of innovation should put firms at the centre (see Figure 2-4).

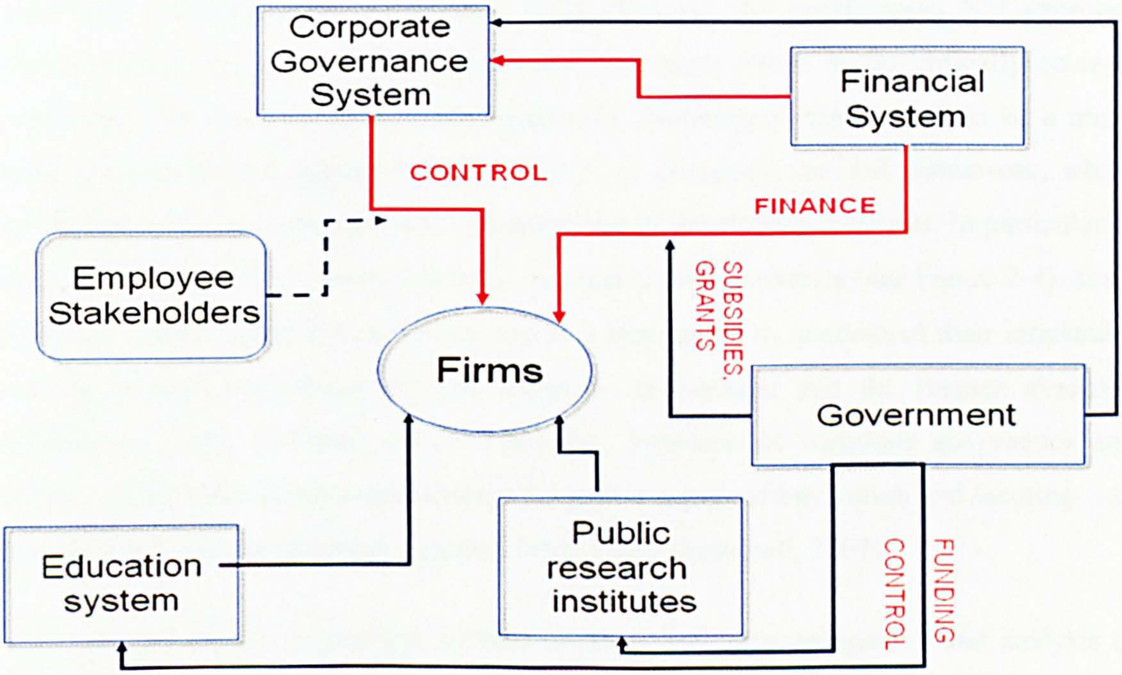


Figure 2-4 National System of Innovation: key players and their relationships

2.3 The system of corporate governance & finance and technological capability development

The National System of Innovation framework proposes an approach to analyzing innovation and learning at the national level. However the conventional NSI approach which mainly focuses on S&T/R&D-based innovation needs to be critically revised, particularly for newly industrializing economics. Particularly, there needs to be a much more broadly defined approach nested within, or alongside the NSI framework, which encompasses the socio-economical characteristics of developing countries. In particular, it should incorporate the system of finance and corporate governance (see Figure 2-4), since firms are central actors in innovation, and it is impossible to understand their innovation activity without knowledge of their corporate governance and the finance available (O'Sullivan, 2000; Tylecote, 2007). Moreover, inclusion of corporate governance and finance systems should also help address the power aspect of innovation and learning – an issue unduly neglected in most empirical NSI studies (Lundvall, 2007).

Over the past decade, a growing number of researches have recognized that analysis of innovation systems should incorporate systems of finance and corporate governance. For instance, in Lundvall's edited book on NSI (1992), Christensen discussed the role of finance in innovation. Pavitt (1999) argued that the manner and outcome of innovation has been decidedly different between the US and UK on one hand and Japan and Germany on the other, because of radical differences in their systems of finance and corporate governance (Tidd *et al.* 2001: 93). Lazonick and O'Sullivan have also written extensively about the role of finance and corporate governance in industrial development (Lazonick, 1991; 2004; O'Sullivan, 2000; 2004; Lazonick and O'Sullivan, 1996; 2000; 2002).

Lazonick and O'Sullivan's research on corporate governance, innovation and economic performance in the EU countries, US and Japan conceptualised a model of 'social conditions of innovative enterprise'. Their theoretical starting point is the proposition that learning process required for innovation is *uncertain*, *cumulative* and *collective*, it '*requires the collaboration of different people with different capabilities, and the* *integration of the work of these people into an organisation': organisational integration'* (Lazonick, 2004: 30). '*The essence of the innovative firm is the organisational integration of a skill base that can engage in collective and cumulative learning*' (Lazonick, 2004, p.34). Moreover, Lazonick and O'Sullivan also proposed that firms need *industrial expertise* to choose the product market to compete in, and the technologies competitive with. Those who exercise strategic control need to '*...be able to recognise the competitive strengths and weaknesses of their firm's existing skill base and, hence, the changes in that skill base that will be necessary*' (Lazonick, 2004, p.34). It can be hence inferred that providers of finance (shareholders) and venture capitalists, who are treated as sharing in strategic control by Lazonick and O'Sullivan, are required to possess the necessary knowledge and understanding of resources allocation in the innovation process.

Lazonick and O'Sullivan's perspective offered a generic understanding of the connection between the system of corporate governance/finance (CGFS) and technological development /innovation. That is, they are saying that innovation always requires x,y, or z from the CGFS. Although they do differentiate sectors according to the type of skill base that needs to be integrated – but as what we show below, higher degree of differentiation is needed to address the issue of innovation in different sectors, and the level of development of the countries. Just as Malerba and Orsenigo (1996) argued, innovation processes often vary across countries and specific to technologies or industrial sectors, which have varied demands on different aspects of finance and corporate governance system. Therefore at the firm level, the technological regime this firm operates in needs to be identified, so do its corresponding demands on CGFS, that improvement in the latter could generate desired positive effects on the former. The part below is going to show that sectors vary in their technological regime (section 2.3.1), and that this affects their demands on the CGFS (section 2.3.2). Moreover the technological regime for a given sector is not necessarily the same in a developing country to what it is in a developed country. Hence Section 2.3.3 adapts the framework mainly developed from experiences in developed countries to the context of NIEs.

2.3.1 Technological regime and its dimensions

A 'technological regime' (Nelson & Winter, 1982) or 'technological paradigm' (Dosi, 1982) defines the particular learning and knowledge environment in which firms operate (Winter, 1984). Technological regimes are important because they shape the pattern of innovation in an industry or sector. Generally speaking, there are two opposite types of regimes identified in the literature. An *entrepreneurial regime* enables entry of new innovative firms or entry of new paradigm of innovation by incumbent firms where competence-destroying is often involved, while a *routinised regime* facilitates innovation firms progressing within an established paradigm (Winter, 1984). This distinction is derived from Schumpeter's innovation theory, which is a result of observation of economic development at different historical phases (Schumpeter, 1934; 1942). Another way of defining these regimes is as, respectively, *Schumpeter Mark I*, and *Schumpeter Mark II* (Freeman 1982: Malerba & Orsenigo 1996; Malerba, 2004).

In the *Schumpeter Mark I* regime, the structure of innovative activities is often disruptive and turbulent, and is often observed in nonelectrical machinery, instruments and traditional technologies (Malerba *et al*, 1997). The *Schumpeter Mark II* pattern of innovation, on the other hand, may be associated with a structure of innovative activities that is concentrated and stable, as observed in chemical and electrical-electronic (Dosi, 1982). These different patterns of innovation among technologies and sectors can be explained by differences in the nature of technological regimes (Malerba & Orsenigo, 1996).

The characteristics of learning play an important part in helping to define a technological regime (Tylecote, 2007). Malerba and Orsenigo (M&O) identify three different properties in learning: cumulativeness of learning; appropriability conditions; and technological opportunity conditions, (Dosi & Orsenigo, 1988; Malerba & Orsenigo, 1996). Technological opportunity determines the available technological solutions for firms to solve problems, and how easily such solutions may be attained. The appropriability conditions are concerned about how easily the benefits of innovation can be protected from imitators (competitors), and the measures of appropriation used by firms. The degree of cumulativeness of innovation describes to what extent the processes of achieving technical solutions by a firm are incremental.

2.3.2 Properties of learning in technological regime, and their demands for corporate governance and finance

Tylecote and Visintin (2008) argued that, in addition to the above three properties proposed by Malerba *et al.*, p.1) degree of cumulativeness of innovation (or in their term: the extent of competence destruction); 2) degree of technological opportunity; 3) appropriability (enriched by Tylecote and colleagues as stakeholder spill-over) of innovation; there is a fourth property of learning which defines technological regime: 4) visibility of innovation and learning (explanation of this concept can be found in section 2.2.2). It is argued by them that the above dimensions have significant indications for finance and corporate governance. Below the corporate governance and finance system will be defined, and the way it influences innovation will be examined according to learning properties of technological regime.

1) System of corporate governance and finance (CGFS) - definition and scope

The term 'corporate governance' came out of a seminal analysis in the 1920s (Berle & Means, 1933), which looked at the increasing separation of ownership and control in modern firms (Monks & Minnow, 2001). When ownership takes the form of dispersed shareholding, and when management structures once dominated by family owners or government are increasingly replaced by professional managers, it is believed that such a separation allows – if it does not actually encourage – the firm's behaviour to diverge from the ideal of profit maximizing (Keasey *et al.* 1997), hence there needs to be a system of control over those managers to ensure that the company is run in the interests of the shareholders and society at large. Therefore in its most commonly referred form, corporate governance studies the structure through which 'suppliers of finance to corporations assure themselves of getting a return on their investment' (Shleifer & Vishny, 1997).

Shleifer and Vishny's definition of corporate governance fits into a simpler and broader conceptualization of governance in general, that of Prakash and Hart (1999): 'organising collective action'. Von Tunzelman (2003) proposes that the scope of 'governance' should include issues of structure, control and process. For him, 'structure' relates to the forms through which decisions are made, 'control' to the power to make them, within the structures, and through 'process', structure and control are implemented.

We welcome Prakash & Hart and von Tunzelman's broader definition of governance, and argue that the system of corporate governance and finance hence deals with the two fundamental issues in any capitalist economies: capital and capitalists. The system of finance is about how is the *capital* provided and allocated. Corporate governance is about *who* controls the firm and *how*. In particular, we study the firm's 'structure' of control (formal as well as *de facto*) and its dynamism of 'power' in the 'process' of corporate decision-making and implementation. For the purpose of this research, corporate decisions mainly refer to those technological ones. However due to the intrinsic nature of any profit-oriented corporations, economic decisions /- investment, production, distribution and exchange - that are inseparable to this issue are also included.

A dominant and important aspect of corporate governance is referred to as 'the agency perspective', or as 'finance perspective' (Jensen & Meckling, 1976; Fama & Jensen,1983). A basic assumption of agency model is that due to human's opportunistic nature, managers of firms will act to further their own interests before shareholders. An overview of agency theory is given by Eisenhardt (1989, p.59), which is presented in Table 2-3:

Table 2-3 Overview of agency theory

Agency Theory Overview

Key idea	Principal-agent relationships should reflect efficient organization of information and risk-bearing costs
Unit of analysis	Contract between principal and agent
Human assumptions	Self-interest Bounded rationality Risk aversion
Organizational assumptions	Partial goal conflict among participants Efficiency as the effectiveness criterion Information asymmetry between principal and agent
Information assumption	Information as a purchasable commodity
Contracting problems	Agency (moral hazard and adverse selection) Risk sharing
Problem domain	Relationships in which the principal and agent have partly differing goals and risk preferences (e.g., compensation, regulation, leadership, impression management, whistle-blowing, vertical integration, transfer pricing)

Source: Eisenhardt, K. (1989) 'Agency Theory: An Assessment and Review'. *The Academy of Management Review*, 14(1), p.59.

The problem long associated with agency problem is *information asymmetry* – between receivers and providers (of finance), and between agent and principal (in corporate governance). The issues is particularly pronounced when the governance mechanism is characterised by 'outside' shareholders or the state, as in such cases management can be assumed to know much more about what is behind the closed door (Jensen & Meckling, 1976; Agrawal and Mandelkar, 1987; Cai & Tylecote, 2006).

2) CGFS and technological innovation - the linkage[16]

Tylecote and Visintin (2008) identified four dimensions of technological regime, which define the pattern and balance of the demands made upon the corporate governance and finance system – the characteristics it needs to have to control and finance innovation within that regime properly. (See Table 2-4). Below they will be explained one by one, showing what they demand from the CGFS.

Table 2-4 Dimensions of technological regimes and financial and corporate governance systems

Dimension	Technological regime	Finance and corporate governance	
1	Extent of competence destruction and consequent need for reconfiguration of firm structure.	*Finance:* Availability of expert finance for new firms in areas affected by radical innovation	*CG:* Pressure from expert owners for higher value-added in such areas
2	Technological opportunity	Availability and acceptability of expert risk capital; management autonomy	
3	Low visibility/slow pay-off of innovation	Shareholder/ financier engagement; management autonomy	
4	Stakeholder spill-overs in innovation	Stakeholder inclusion	

Source: Tylecote and Visintin (2008, p. 15, Table 1.2)

1) If positing innovations of all types on a spectrum of cumulativeness (see Malerba's explanation in section 2.3.1), at the lowest end would be a move to a new technological paradigm which is *competence-destroying*. In contrast to competence-enhancing change which is *paradigmatic, path-dependent* and *cumulative* (Malerba & Orsenigo 1997; Malerba, 2004), competence-destroying change involves radical shifts in direction. To succeed in that, *reconfiguration* is needed: the firm has to reconfigure its organisation and change its methods, technologies and/or workforce (Tylecote & Visintin, 2008). Most firms, especially those successful incumbent ones, would have to push the process through

[16] This section has been largely drawn from Chapter 1, Tylecote and Visintin (2008)

resistance from within their organisation. Empirical evidences have shown two effective ways to overcome such resistance: one obvious way is to set up a new firm, in which case strong and very well-informed *venture capital* will be very helpful (examples include Pixar in digital animated cartoon, and Canon in digital camera); on the other hand, for existing firms to succeed in reconfiguration, it requires *pressure for higher value-added from owners or financiers*. They too need to be well-informed, especially about the industry as a whole.

2) The second dimension is *technological opportunity*. It is widely recognised that the development potential of a particular area of industrial activity – how far and how fast it proceeds – is partly down to the technological opportunities that lie before it (Teece & Pisano, 1997). In other words, technological opportunity represents the likelihood of innovating successfully – profitably – for any given amount of money invested in search. Where technological capability is high, there is often need for high R&D spending and other innovative activities. Consequently, high technological opportunity requires high level of financial input from the CGFS. Moreover, since high level of opportunity is often associated with high level of risk, the provider of finance needs to be prepared to provide generous amount of *risk capital*. On the other hand, sectors of high technological capabilities often does not require the same level of *industry-wide expertise* as for radical reconfiguration, however management autonomy may be sufficient as managers would probably be glad to finance a high level of innovative expenditures with the firm's own cash flow.

The third of 'regime dimensions' is *visibility* (Tylecote & Demirag, 1992; Tylecote & Conesa, 1999). When the visibility of innovation is low (for example, investment of time and money in low-visibility learning activities, see Section 2.2.2), shareholders would only accept heavy spending on innovation and consequent lower profits (possibly for some years) if they had a clear understanding of the inputs and likely outputs of innovation. To achieve that owners and financiers need to *engage closely* with the firm, to develop *firm-specific understanding* - so as to be able to see below the surface to what is really being done for future innovative success. Failing that, a good second best is high *management autonomy*: managers being able to spend more or less as they choose on innovation.

The last of the four dimensions is *stakeholder spill-overs*, which is referable to Malerba *et al*'s *appropriability* dimension. It is concerned about the extent to which employees and related external stake holders (notably customers and suppliers) benefit from and are able to contribute to the firm's technological changes. In some sectors this is of particularly great importance. Von Hippel's (1988; 2005) account of user-led innovation and the situation in 'specialised suppliers' described by Malerba are some of the examples in sight. Clearly for such firms, close and constructive relationships with stakeholders, such as skilled employees and 'lead' industrial customers, are vital. Tylecote *et al* summed up such relationships, with employees and other firms, as '*stakeholder inclusion*'.

Stakeholder inclusion is relevant not only to the generation of innovations, but also to the protecting of them, or appropriation. Teece (1986; 1998) developed four ways of protecting innovation returns: 1) inherent difficulty in *replicating* the innovation (for example, those types of innovation where tacit knowledge is heavily involved); 2) *intellectual property protection* (patents, copyrights, etc); 3) investment in *complementary assets* and technologies such as manufacturing and marketing facilities; and 4) *dynamic capabilities*, which enables the firm to generate a stream of further innovations, making it hard to competitors to catch up. Tylecote (2007) inserted *stakeholder inclusion* into Teece's argument: i) trusted employees can make knowledge tacit, and therefore less *replicable* by rivals. ii) When codification of innovation is necessary, such as formula for a chemical, *patenting* can be delayed if employees can be trusted to keep the secret, therefore increasing the life of the patent after launch (Tylecote & Visintin, 2008). iii) As with *dynamic capabilities,* employee inclusion can also help the firm maintain its competitive edge: with trustworthy employees and well-kept secret, rivals will not be able to find out the firm's innovation in the pipeline. iv) Finally, one can see a relationship of mutual loyalty with suppliers and lead customers as a way of getting by without *investment in complementary assets and technologies*. Again, secrecy is more easily maintained if suppliers and customers are loyal[17].

The whole discussion so far in this subsection has been with reference to developed countries in which 'innovation' is the 'new to the world' variety. As promised earlier in this subsection (before the start of 2.3.1), I will next show that in a given sector, the technological regime that firms face in a developing country/NIE (like China) is likely to be quite different, and therefore adaption of the framework is made accordingly, to address innovation and technological capability development in these countries.

2.3.3 Adaptation of CGFS and technological capability development to the context of NIEs

For NIEs, regardless of sectors, *Visibility* is a central issue in technological development. As argued earlier, for the majority of NIEs, the main objective of technological change is to catch up with the advanced countries. The process of catching-up – of mastering increasingly advanced products and processes and at the same time gaining increasing self-reliance in each successive advance – demands small but complex arrangements of time and money to conduct organisational learning. Technological catch-up takes time, and sometimes there is nothing to show for a firm's effort for as long as a decade (Hobday's [1995] description of Anam is such a case in point). Moreover, the key investments in learning require more effort than money – and the money may have to be spent in a rather low-visibility way. Examples include money spent on adaptation and modification of second-hand equipments, and cost of materials during trial and error for a more efficient production process, etc. Appreciation of the importance of such low-visibility activities could only be possible for those financiers who take a great interest in the process – who are *engaged* to understand what really is happening below the surface of operations.

[17] The extent to which firms can or need to take advantage of stakeholder inclusion varies greatly by sector. For sectors such as pharmaceuticals, the role of stakeholder inclusion is much less important, since a product innovation, is extremely easy to replicate but can be exceptionally well defended by patents.

Spill-overs. For firms in NIEs, employees often benefit the most from spillover: their jobs are more secure and salaries may be higher when product innovation takes place. For firms from less developed regions, where management takes in account of employee interests, it greatly enhances retention of staff and ensures a more stable base of employees, which in turn makes it easier to keep the organizational knowledge tacit. More importantly, if employees reciprocate they will put their energy into the development of new ideas and new products. On the other hand, a relationship of trust and cooperation with local suppliers may not only lead to easier (and often cheaper) facilitation of technical change, but also trigger flow of crucial information for innovation.

The majority of innovations in NIEs feature more cumulative nature of technological change and learning (Bell & Pavitt, 1993a). This means that radical innovation in NIE firms is often along a trajectory experienced by early industrialized economies, but has not happened in the organisations before, therefore they may have competences to destroy to make innovation happen, and the need for *competence-destruction* in NIEs is about accepting new things to the firms. Consequently, in order to achieve innovation that is radical by NIE standard, there is need for *shareholder pressure for value* and (decent) level of *industrial expertise*.

Finally, *technology opportunity* - for developing countries, it's not about how fast and how far the state of the art move forward, but how much behind they are, and how fast they can catch up. '*The most essential aspect of the catching-up process is the rate at which a follower is able to undertake technological imitation*' (Juma & Clark, 2002, p.5). The process of technological imitation is easily intuitively linked to pursuing the same path of development. However technological imitation has a layer of meaning that is beyond simple repetition of the same path taken by industrialized countries (Juma & Clark, 2002). Japanese firms in the 1960s and 70s showed very well how technological imitation works, in a complex series of processes, through recycling traditional ideas, exploring new ideas, nurturing creativity, generating breakthroughs and refining existing ideas (Freeman, 1987).

The government of the imitating country must have conscious policies to guide the imitation. At the industry and firm level, the rate at which it takes place depends very much on existing technological capabilities, and institutions. It also greatly challenges CGFS. For poorer developing countries, the challenge mainly lies in the availability of finance. For firms (especially well-financed ones) in more industrialized developing countries like China, finance availability becomes less of a constraint[18]. Therefore it is more relevant that decision-makers/financiers of innovative activities possess the necessary *expertise* to choose wisely among competing technological options – often between import of most advanced technology embodied in the stock of capital goods (given sufficient funds), and technology that is appropriate for the current stock of capabilities in the firm.

2.4 Summary

This chapter reviews the literature related to main topics studied in this thesis. The concept of technological capability used in this thesis is defined as the capability of a firm to identify, acquire, assimilate, adapt and make effective use of technical knowledge and skills, and then to generate new knowledge and skills. It combines various definitions in the innovation literature, with the nature of innovation in NIEs in mind. We further distinguish between static and dynamic technology capability in a way that is similar to that of Teece *et al* and Pisano's, i.e. dynamic capabilities are associated with change – with which firm resources can be acquired, shed, integrated and recombined to generate new value-creating capabilities. Whereas static capabilities are concerned with the ability to make effective use of current knowledge and skills – they are firm's given capabilities at a point in time. The concept of dynamic capability inspires the empirical stage of the research, where firms' technological capabilities are to be measured based on critical review of popular measurement frameworks (see Section 2.1.2).

[18] As of 2008, the total capital stock of Central Enterprises supervised by SASAC (State Asset Supervision and Administration Committee) has amounted to 25 trillion.

As for the process of technological capability development in the NIE context, three analytical frameworks in the literature have been examined. Particularly, Kim's *trajectory theory* clarifies the essential differences of technological development and innovation between developed and developing countries, which the latter often reverses the direction of technology trajectory in advanced countries. Therefore innovation in these countries are not mainly concerned with the introduction of ground-breaking new science and technology, but about generating things that are new to the firm, the region, and the country. Furthermore, in order to understand the mechanism behind success and failure of innovation in NIEs, the instrumental role of learning is reviewed in the *learning process framework*. Learning can be done in both formal and informal manners, and many different kinds of actors and agents are involved in these learning processes. Moreover, we propose analysis of learning in NIEs in two dimensions: activeness and visibility of learning efforts. Although they are at the centre of innovation, firms do not operate and learn in isolation. This chapter hence reviews the *National System of Innovation* framework. We argue that a system of innovation should be understood essentially as a system of learning, which not only includes R&D and S&T activities and institutions, but also those institutions and relationships key to firms' innovation. Particularly, it should incorporate the system of corporate governance and finance (CGFS).

In the rest of this chapter, the properties of learning in technological regime and their demands for corporate governance and finance are analysed based on Malerba and Tylecote's framework. Specifically, four properties of learning and four corresponding challenges to the CGFS are reviewed, namely: 1) the extent of competence destruction and the demand for shareholder pressure (and expert finance); 2) degree of technological opportunity and the demand for expert risk capital and management autonomy; 3) low-visibility of innovation and shareholder/financier engagement; and 4) stakeholder spill-overs in innovation and the demand for stakeholder inclusion. Further, we adapt the theory to the context of NIEs according to the nature of innovation in these countries.

Chapter 3 China's Automotive and Electronics Industries in the Context of Transition

This chapter reviews the empirical reality of China, especially those aspects, as argued in Chapter 2, which are important to China's technological capability development. It starts with a general description of the Chinese economic transition – the macro-environment in which the Chinese electronics and automotive industries evolve and operate. Section 1 tries to map out the major characteristics of China's general economic condition: 1) partial privatisation with persistent state ownership; 2) FDI-pulled and export-led growth; and 3) slow competitiveness upgrading. Section 2 describes China's national system of innovation (NSI). China, which is in transition toward a market-oriented economy, particularly requires examination on how its technological performance is affected by its institutional context, where the government is still playing a crucial role. Section 3 is dedicated to the corporate governance and finance of Chinese firms, particularly of state-owned enterprises (SOEs) and private-owned enterprises (POEs). Sections 4 and 5 introduce the two selected industries, namely, the electronics and automotive industries, in which the empirical study was undertaken. Section 6 summarises the chapter.

3.1 Characteristics of China's economic transition and technological development

In less than three decades, China has transformed itself from a centrally planned poor economy into a lower-middle income emerging market one, and has become one of the fastest-growing economies in the world. Between 1979 and 2006, China's per capita GDP has more than quadrupled. Both China's growth rates in Real GDP and GDP per capita are higher than the global average for the past 15 years (see Figure 3-1). The number of people living in absolute poverty has reduced by 235 million in the past 30 years (*People's Daily*, 05/11/2008).

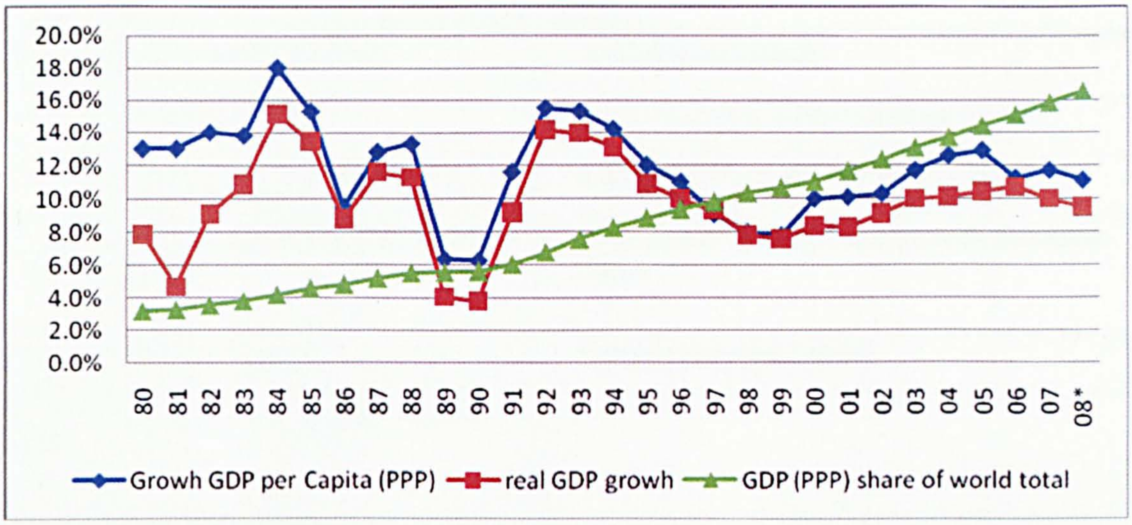


Figure 3-1 Growth Rate of China's Transformation Economy

Source: Data calculated according to the IMF World Economic Outlook Database: http://www.imf.org/external/pubs/ft/weo/2008/02/weodata/index.aspx (September 2008)

Note: All growth figures are based on data quoted in US$.

China however is not simply another 'East-Asian Miracle'. As the largest developing economy, its transition features distinctive patterns: 1) partial privatisation alongside the persistence of state ownership; 2) export-led growth; and 3) reliance on foreign technology transfer and slow competitiveness upgrading.

3.1.1 Growth of private sector and the persistence of state ownership

The general opinion is that, to a very large extent the driving force behind China's spectacular economic growth has been the emergence of non-state-owned sectors, especially of an active private sector (Asian Development Bank [ADB], 2003). Partly through privatization, and largely through organic expansion, the private sector has become a significant and still fast growing proportion of China's economy. China's National Bureau of Statistics (NBS) reports data for 7 different classes of enterprise ownership: from individual ownership, private ownership to state ownership, (see Table 3-1). (The evolution of ownership types is explained in section 3.3.1) Although the information is not uniformly available about all of the indicators of these classifications, it has been generally agreed that the non-state-owned sector has increasingly become an important source of the dynamics of the Chinese economy[19] (Cao *et al*, 1999; Qian, 2002).

[19] The term 'non-state' in China denotes a larger category than 'private,' since the former category encompasses urban and rural collectively owned enterprises, known famously as the township and

Table 3-1 Classification of Enterprises by Ownership

Wholly Domestically Invested	**Foreign-invested***
State-owned enterprises	Joint ventures with domestic firms
Collectively owned enterprises	Cooperatives with domestic firms
Shareholding enterprises based on a collective system	Shareholding corporations with domestic firms
Limited liability companies	Wholly foreign owned
Joint ventures of domestically owned firms	
Shareholding corporations	
Private-owned enterprise	
Other	

*These include enterprise invested by foreign investors and investors from Hong Kong, Macau and Taiwan. Although the regulation makes this distinction between these two groups of investors, for all practical purposes, these firms face similar policies and regulations and share many common characteristics. Source: (Fei, 2004)

Since 1985, the non-state-owned sector has made an increasing contribution to the growth of industrial output. As Figure 3-2 shows, non-state ownerships, including individual firms, private firms, joint ventures, and collective-owned enterprises and other forms of ownership, have comprehensively outpaced the state-owned sector. Accompanying such surge is the declining role of China's state-owned enterprises (SOEs) since the late 1970s. At that point they produced 75 % of output, while 'collective' enterprises produced the rest; by 1999 their share was down to about 28 %, with the private and other sectors rising from 0.5 % in 1980 to 44 % in 1999 (NBS, 2000; Tylecote and Cai, 2004).

village enterprises (TVEs), which fueled rapid industrial growth in rural PRC and absorbed millions of surplus farm workers. In the data for the PRC TVEs are classified outside the state sector, and yet cannot be considered part of the private sector in a strict sense of the word. To complicate things further, many essentially 'private' firms have embraced collective ownership. They made themselves 'collectives' by sharing ownership with local governments in order to obtain the security and privileges that those governments extend to collective firms.

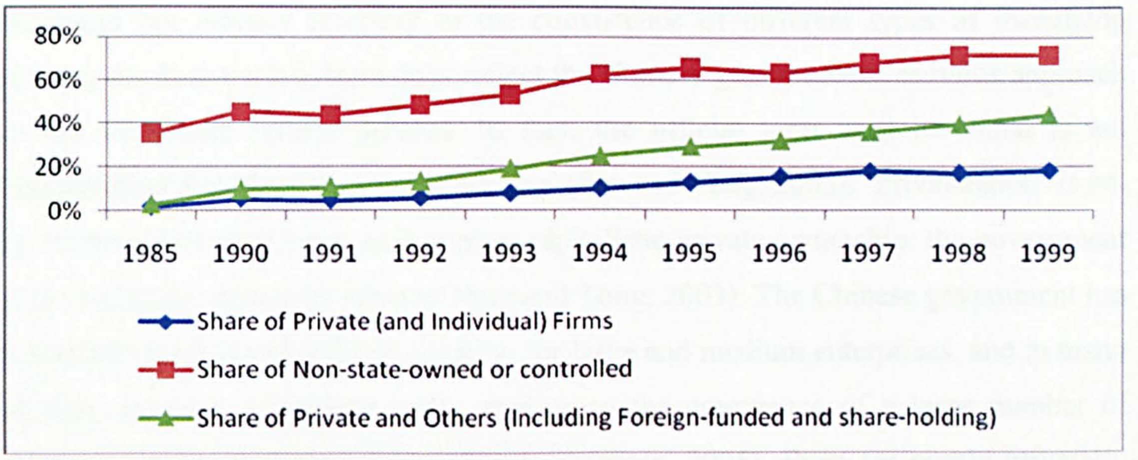


Figure 3-2 Growth Rates of Real Industrial Output in China, 1985, 1990-1999

Notes:

1. 'Other types' include foreign-funded firms and non-state-controlled shareholding corporations.
2. Since 2001 the China Statistical Yearbook does not report total industrial output data by ownership; this figure therefore covers only the period up to 1999.

Source: *China Statistical Yearbook*, 2000.

However, despite the general lack of dynamism and efficiency, the state-owned firms, no matter *majority* or *minority* (see Chapter 1 for definition), will continue to exist in China. Unlike the `Big Bang' approach adopted by countries in Eastern Europe, China still maintains a communist regime. Its economic reform so far still has limited effect on the political aspect of the system and pursues a 'dual-track' approach (Sun *et al.*, 2002). That is, alongside implementing to a certain degree market mechanisms – the 'market track'; the planned economy has not been, and will not be entirely abolished – the 'plan track'. The basic principle of the dual-track approach is as follows. A market track was introduced under which a gradually expanding proportion of the goods sold at free-market prices, compared with a shrinking proportion of the goods sold fixed quantities at fixed plan prices as specified in the pre-existing plan (Lau *et al*, 2000). By 2006, only 5.6 % of industrial capital goods were sold at fixed prices and 2.3 at government guided prices (National Development and Reform Commission [NDRC], 2007, http://www.sdpc.gov.cn/xwfb/t20071213_178607.htm). However, the price of some essential goods (e.g. water, coal, electricity, mobile services) is still highly regulated (NDRC, http://www.ndrc.gov.cn).

Although not directly referring to the coexistence of different types of ownership system, the dual-track system does reflect the Chinese government's cautious approach in the ownership reform process. In fact, the official term used in China is not 'privatization' but 'share ownership scheme' (Sun and Tong, 2003). 'Privatization' is not an accepted term in China, as it implies capitalistic private ownership: the government calls it a 'share ownership scheme' (Sun and Tong, 2003). The Chinese government has a practical wariness of full privatization for large and medium enterprises, and in many of them keeps a substantial stake, leading to the emergence of a large number of *minority state-owned enterprises* (Cai & Tylecote, 2005). Even for purely privately-owned firms the government tends to intervene (Huang, 2008). Moreover, the state retains close controls over high-technology/ 'pillar' industries such as Information Technology, Automotive, Aviation, Oil, Electricity, etc. (*China Daily*, 20/06/2004) How did, and more importantly how will such government ownership work, is key to understanding China's growth pattern and perspective, and hence is a highly relevant element when studying the two industrial sectors (Electronics and Auto) scoped in the thesis (see also Chapter 1).

3.1.2 Internationalisation and export-led growth

China experienced a rapidly increasing economic openness during the reform period. It has emerged as the fourth largest trading nation. Since 2002 China has also become the largest recipient of foreign direct investment (FDI) in the world (Ministry of Commerce [MOfCOM], www.mofcom.gov.cn).

China's exports rose more than tenfold, between 1985 and 2001 – while world trade merely tripled. (OECD, 2002). According to WTO, in 2007 China has overtaken the United States and become the second largest merchandise exporter of the world, after Germany[20]. The share of China's exports in the total volume of the world increased from 1 % in 1985 to 8.7 % in 2007 (WTO Trading Statistics, http://stat.wto.org/StatisticalProgram/WSDBViewData.aspx?Language=E,accessed in April 2008).

[20] Caution has to be taken as to the significance of such progress - the difference in value-added between China and Germany is much bigger.

The landscape of China's exports also substantially changed: Between 1985 and 2006, exports of primary products and resource-based manufactures fell from 40 % of all exports, to less than 10 %, while non-resource-based manufactures rose to 94 %; the percentage of high-technology products in China's exports jumped from 3 % in 1985 to 29 % in 2006, while the percentage of high-technology products in its import accounted for 31.2 % (UNITED, 2002; NBS, 2007). In manufacturing exports, the share of electric and machinery products, including electronic products, demonstrates high growth rate (see Figure 3-3).

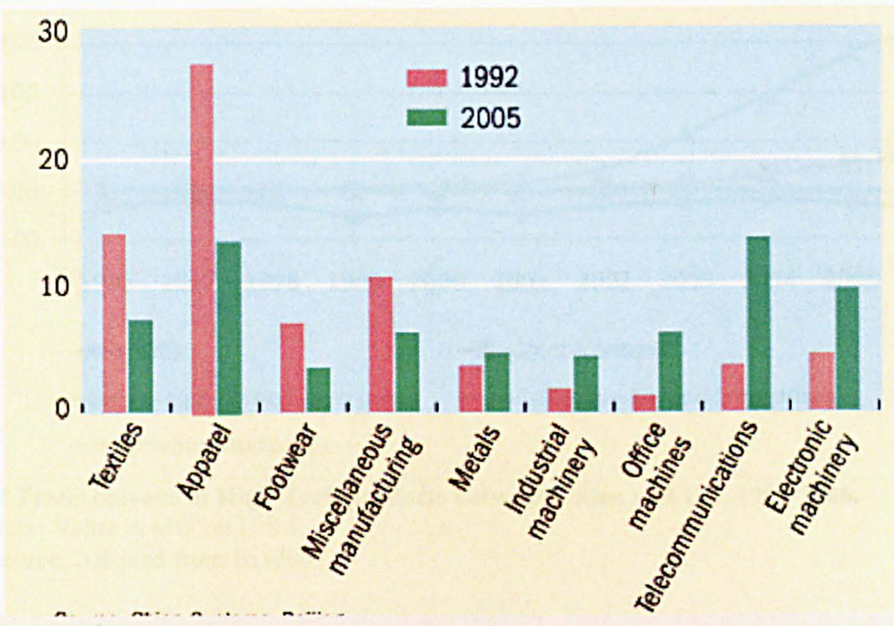


Figure 3-3 Break-down of Chinese manufacturing exports, 1992 and 2005 (% of manufacturing exports)

Source: China Customs website, http://www.customs.gov.cn

Note: The above sectors account for around 70% of all manufacturing exports

However, the boosting effect of artificially undervalued exchange rate to China's export was significant during the 1990s (Yue & Hua, 2002), more importantly, behind the export boom was the role of inward FDI[21]. Gu and Lundvall (2006) found that in higher-technology categories such as computer and IT products – export are mainly manufactured Western and Taiwanese invested factories. In 1988, foreign subsidiaries produced less than 9% of exports; in 2003 fully foreign-owned and partly foreign-owned firms produced respectively 61.9% and 21.4% of high-tech exports (Gu &

[21] See Zhang and Felmingham (2001) and Liu *et al.* (2001) for discussion.

Lundvall, 2006: citing China S&T Indicators 2004). Meanwhile, between 1998 and 2005 the share in exports of high-tech products of Chinese-owned firms (excluding international joint ventures) fell by more than 50% (www.sts.org.cn/sjkl/kjtjdt/data2006, Fig 2-10).Although China's high-tech product trade surplus to U.S. increases rapidly since 2002, it has been mainly, and increasingly so (at least up till 2006), contributed by foreign-owned and foreign-invested enterprises (see Figure 3-4). In sharp contrast, domestic enterprises, especially SOEs, are constantly in deficit.

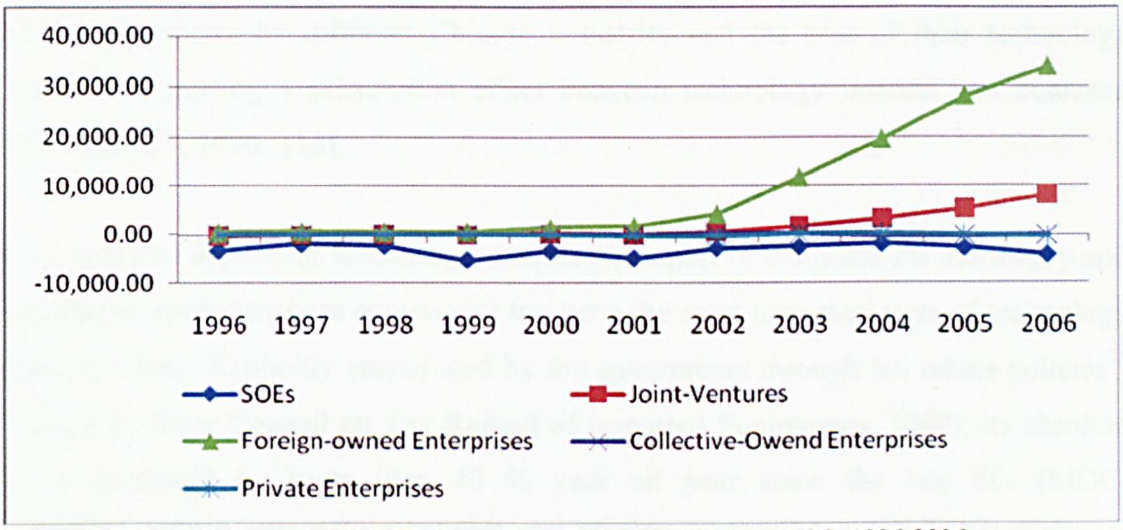


Figure 3-4 Trade balance in High-Tech products between China and U.S. 1996-2006.
Note: Value in Million U.S $.
Source: Adapted from Bi (2007).

3.1.3 Dependence on foreign technology transfer and slow competitiveness upgrading

Since the opening of its markets in the late 1970s, the Chinese economy has increasingly integrated into the world economy. Although China's insertion into the global value chain through mass production of commodities has been overwhelming, the industrialization process has not brought about a widespread and robust indigenous innovation capability in Chinese firms (Gu & Lundvall, 2006).

The general approach to acquiring foreign technology by Chinese firms can be described as 'dependent' technology strategy (Freeman, 1992). They focus was on getting production capability through licensing or joint venture deals with advanced 'Northern' firms. A good indicator of China's reliance on foreign technology transfer would be the ratio between technology imports and the R&D expenditure of Chinese industry. For all years in the 1990s, the expenditure on technology imports was well above R&D expenditure by Chinese industry, as well as for China as a whole (OECD, 2002), and the gap further widened until 1999[22] (NBS Statistics Data on Science and Technology Development, 2006, http://www.stats.gov.cn/tjsj/qtsj/kjtjjmzl/2006/). Moreover, statistics at the industrial level show an inverse relationship between the R&D expenditure by different Chinese industries and the cost of their technology imports, suggesting a substitution effect between technology imports and domestic R&D (MOST, 1999: 116).

As a result of dependent technological strategy, import of complete-set machinery and equipment (including core equipment) has been the most important item of technology trade in China. Explicitly encouraged by the government through tax rebate policies[23] (Notice by State Council on Tax Refund of Imported Equipments, 1997), its absolute value increased by more than 40 % year on year since the late 80s (MOC, http://zhs.mofcom.gov.cn/tongji.shtml), representing highest increase of all forms.

Although firms with foreign investments serve as a main channel of technology imports to China, in most cases the core technology involved is still controlled by the foreign partners of the joint venture, or by their headquarters (OECD, 2002). In China, foreign invested firms perform some parts of the manufacturing process with little technological innovation of product design (Liu & Wang, 2003). This channel of technology diffusion is thus rather limited. The lack of effort on the Chinese side to promote diffusion of imported technology has certainly further weakened the impact of foreign technology transfer on domestic technological capability (Chinese enterprise technological performance will be discussed in Section 3.2.2). Low absorption has reduced the opportunity for improving the technological capabilities of Chinese

[22] Such a switch might be partially explained by China's reforms in its R&D system by merging about 200 state-owned R&D institutes with state-owned enterprises (Sun, 2002).
[23] In Chinese: *Guowuyuan guanyu tiaozheng jinkou shebei shuishou zhengce de tongzhi, available on line: http://www.people.com.cn/zixun/flfgk/item/dwjjf/falv/6/6-1-08.html*

industry through transfer. As imported technologies become outdated over time, China will need to rely on new imports, thus falling into a vicious circle of 'import-lag-re-import-relag'. The limited efforts made in technology diffusion have also resulted in a limited 'spill-over effect', preventing more enterprise from benefiting from the imported technology. In fact only under 1% of Chinese domestic firms own the IPR of the core technologies they use (*Xinhua*, 01/03/2006)[24].

Also weak is China's patenting record. As can be seen in Table 3-2 Chinese patents granted by USPTO (US Patent and Trademark Office) have gone up in absolute numbers as well as in proportion of non-US patents. However, the degree of patenting is still low- its absolute number in 2006 (272) is still lower than that of Taiwan in 1987 (411), and represents just about 0.3% of all patents granted to non-US applicants, compared to more than 3.5% by the much smaller country of South Korea in 1997.

Table 3-2 Patents granted by USPTO by region, 1995-2005,

	1977	1987	1997	2000	2002	2004	2006
Patents of non-US origin	24,837	41,682	54,224	79,072	87,299	87,191	94,170
China, PR	***1***	***23***	***66***	***266***	***261***	***255***	***272***
Japan	6,500	17,294	24,191	32,922	36,339	37,032	39,411
Taiwan	53	411	2,597	5,806	6,730	7,207	7,920
South Korea	7	105	1,965	3,472	4,009	4,671	6,509
India	14	12	48	125	123	115	127
Brazil	22	35	67	100	105	102	88
%							
China, PR	-	-	***0.12%***	***0.34%***	***0.29%***	***0.29%***	***0.29%***
Japan	26.17%	41.49%	44.61%	41.64%	41.63%	42.47%	41.85%
Taiwan	0.21%	0.99%	4.79%	7.34%	7.71%	8.27%	8.41%
South Korea	0.028%	0.25%	3.62%	4.39%	4.59%	5.36%	6.91%
India	0.06%	-	0.08%	0.16%	0.14%	0.13%	0.13%
Brazil	0.08%	0.08%	0.12%	0.12%	0.12%	0.12%	0.09%

Source: Author's calculation according to U.S. Patent and Trademark Office: http://www.uspto.gov/go/taf/cst_allh.htm.

[24] Only 0.03% Chinese Firms Have Own Key Tech, *Xinhua*, 3 January 2006, http://english.people.com.cn/200601/03/eng20060103_232376.html

On the macro level, China has not accomplished the transition from production to innovation. A 1996 sample survey on technological innovation conducted by the government reveals that only 5.8 % of new products (under Chinese definitions) are such by international standards new products accounted for only 3.3 % of export sales compared to 10.1 % share of new products in the total sales revenues (MOST 1999, p. 69). The survey also shows that the performance of state-owned enterprises lagged behind other types of enterprise in terms of introduction new products, share of new products in sales revenue, and percentage of new products sold to export markets.

After China entered into WTO in 2001, on the macro level, technological innovation as a driving force of economic development still remains inadequate. According to the calculation by the Institute of International Economic Research (Bi, 2007), in China capital formation, labour input and technology advancement contributed 83.6, 13.9 and 3 %, respectively, to the growth of industrial value added from 2000 to 2005, implying that industrial growth has been propelled by factor input, and technological advancement has not become a main driving force for economic growth. It is therefore not a surprise that major indices (such as the Global Competitive Index and Innovation Capability Index) do not include China as strong in innovative (see Table 3-3).

Table 3-3 China's in the Global Competitiveness Index (GCI) and UNCTAD Innovation Capability Index (ICI).

Country (region)	GCI in 2008 (N=134)	Higher education and training	Technological readiness	UNCTAD ICI (1995, N = 117)	UNCTAD ICI (2001, N=117)
China	***30***	***64 (99)****	***77***	***72***	***74***
Taiwan	17	13 (8)	15	17	15
S. Korea	13	12 (9)	13	20	19
Brazil	64	58 (61)	56	64	48
India	50	63 (107)	69	81	82
Russia	51	46 (32)	67	23	24

* Quality of higher education in parentheses
Source: Compiled according to World Economic Forum (2008) and UNCTAD (2002)

On the other hand, despite of the disappointing overall performance of Chinese firms, a small number of bridge-head companies are becoming highly innovative and globally competitive. Huawei (Telecommunications); Haier (Consumer electronics); Lenovo (PC); Chery (Automotive); and BYD (Battery and Auto) are those with the highest profile. A common feature of these more innovative firms is that they adapted an alternative approach to technology transfer (and upgrade); termed as 'imitative strategy' by Freeman (1992), in which learning takes place more independently, with little help from the firm(s) being imitated, and even without their permission. (The reason why they were able to go a different way and succeed largely lies in their different corporate governance and finance system, which will be explained in detail with the help of case study of Chery in Chapter 6).

Obviously, the indicators above are not going to paint a full picture of China's really technological strength.. To understand and to assess China's progress in moving from static production capability to more dynamic, innovative capabilities, we need to not only evaluate the outcome, but to assess the input. We also need to achieve an understanding of the organisations, institutions and their relationships (namely, National System of Innovation, see Chapter 2, section 2.2.3), which have shaped the development trajectory of China's technological development: under what circumstances did (or rather, did not) the transformations take place? How do policy networks and institutions of such an emerging economy contribute? Moreover, we need to review the situation of corporate governance and finance system (CGFS) in China, to help us develop our theoretical framework: how much adaptation is needed to apply the theory of (CGFS and technological capability development) developed in the Western context to developing countries, such as China. Historical review of China's national system of innovation as well as corporate governance finance system will be presented in the next 2 sections, followed by Chapter 4 - adaptations of western theory to the context of China.

3.2 China's national system of innovation

3.2.1 Historical Overview of China's NSI and the role of the state

The empirical reality of China's NSI[25] has two defining characteristics: 1) a dominant role played by the government, and 2) highly uneven regional distribution of resources and activities which are mainly concentrated in the coastal regions and big cities. The former feature persists and feeds to the latter, so that past reforms and transformations have been relatively unsuccessful in addressing this problem (Huang, 2008).

- Pre-reform era: 1949-1979

Before the reform started in 1979, the industrial organisation structure of China features high degree of centralisation and state ownership. During that time China's NSI focused on the development of weaponry, particularly strategic weaponry (Sun, 2002). Consequently, the civilian industries were largely neglected and poorly managed, lacking incentives for the development and adoption of new technologies (Suttmeier, 2002). Moreover, there was a clear separation of activities among industries, governmental laboratories and universities. For example, industrial enterprises (factories) were centre of production; governmental laboratories focused on research and development; and universities with few exceptions[26] were education centres (Liu and White, 2001; Sun,2002). There was little spontaneous interaction among the three – industries, universities, and research institutes. Governments, particularly the central government, funded and controlled all R&D activities (Sun *et al*, 2003).

- NSI in transition during the reform: 1979-2009

In March 1978 Deng Xiaoping promoted the status of 'science and technology as the primary force of productivity' at the National Science and Technology Conference. In the same year the National Science and Technology Development Plan (197801985) was issued, marking the start of S&T system reform in China. In 1999, after Zhu Rongji was appointed Prime Minister, the central government issued the 'Decision on

[25] Definition of National System of Innovation adopted in this study can be found in Chapter 2, section 2.2.3).
[26] Research and development in universities were mainly for weapons, see Sun *et al* (2003).

Strengthening Technological Innovation, Developing High-Tech Firms, and Realizing Commercialization of New Technologies.' The decision called for the creation of a national innovation system, recognizing the intricate relationship among reforms in the economy, S&T, education and innovation. In 2005 Hu Jintao and Wen Jiabao made important speeches on the National Science and Technology Conference and established a long–term objective of constructing 'an innovative country'. Innovation, especially indigenous innovation was elevated to national strategic level.

The reform of China's NSI thus has been a gradual process, consisting of a number of successive policy changes and adjustments. The reform experience resembles a process of institutional learning based on results and lessons learned from previous policies (Gu, 1999; Sun, 2002), which does not exclude the possibility of regression – after 1989 (Huang, 2008). Some trends can be identified: 1) a change from piecemeal reform to the recent more systematic approach, 2) a shift in emphasis from government research laboratories to individual enterprises; and 3) growing market orientation and increased (although still insufficient) participation of industry (Sun, 2002). Despite the government's intent to create an enterprise-centred innovation system, the state is still central to China's innovation system..

The rest of the section will describe the role and performances of particular actors, institutions and policies, with a view to include the distribution of these activities within the system, where do organisational boundaries lie, how is the mechanism coordinated, and what do all these mean for a system to effectively introduce, diffuse and exploit technological innovation..

3.2.2 The main actors of innovation

The primary actors and the distribution of activities in the current Chinese innovation system are illustrated in Figure 3-5, and the sources and destinations of R&D funding in China's NSI is depicted in Figure 3-6. The activities in NSI include: (1) research and development (including basic, developmental and engineering), (2) implementation (manufacturing and operationalisation), (3) end-use (customers of the product or process outputs), (4) linkage (bringing together complementary knowledge and activities) and (5) education. (Rosenberg, 1982; Mansfield, 1991; Teece, 1987; Freeman, 1992; Lundvall, 1992; Anderson and Lundvall, 1997; Liu and White, 2001).

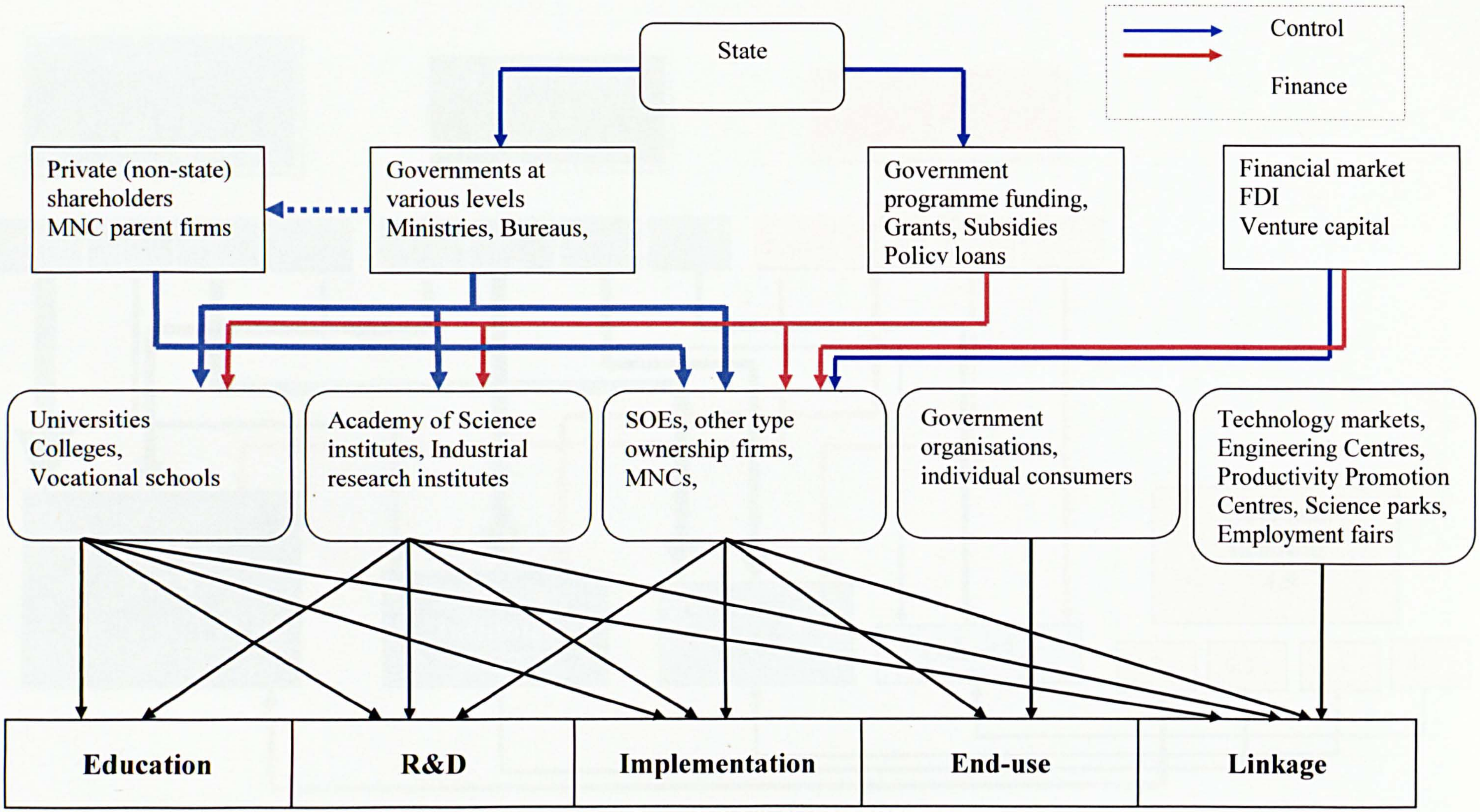


Figure 3-5 Primary actors involved in China's current innovation system and distribution of activities

Source: Adapted from Liu & White (2001)

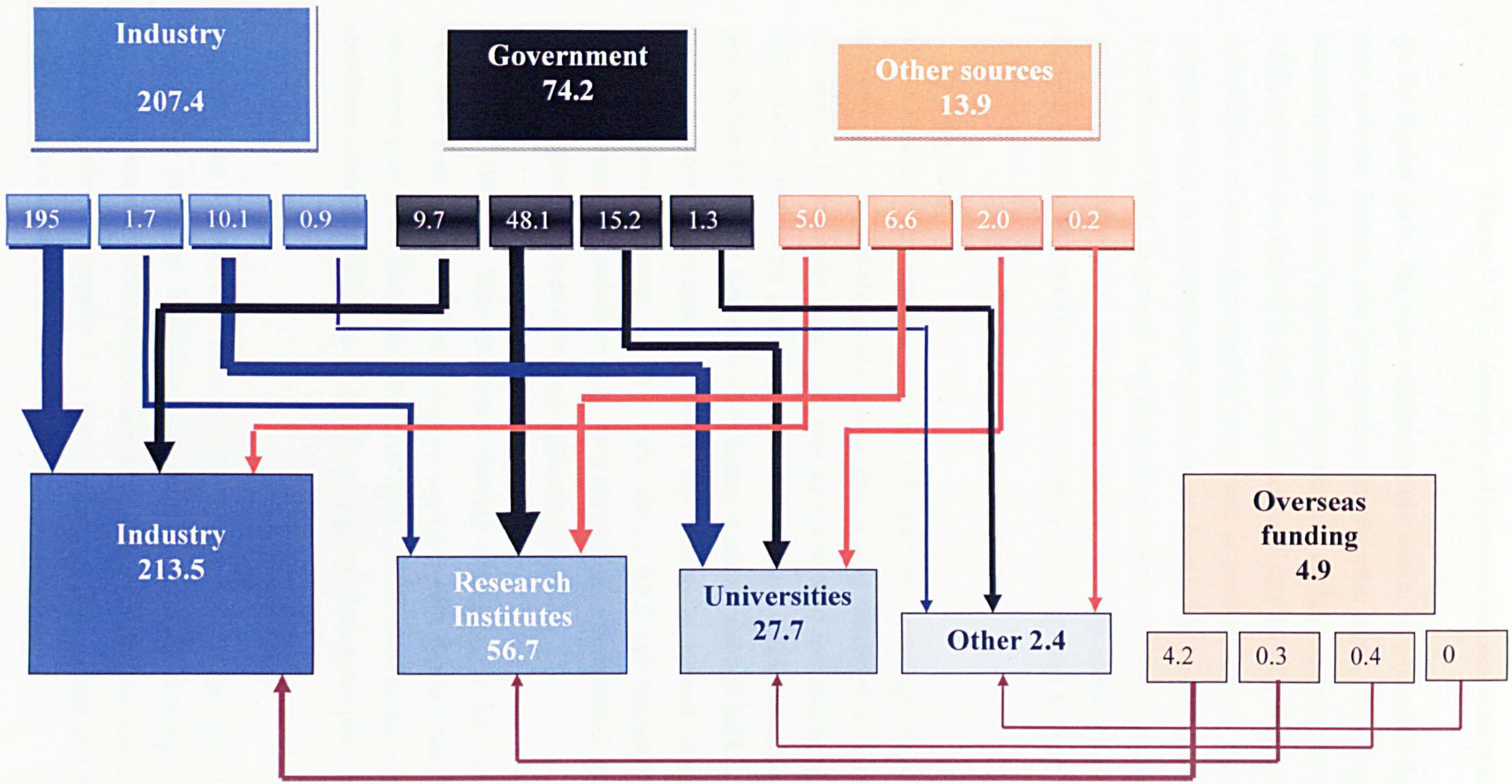


Figure 3-6 Sources and destinations of R&D funding in China's NSI (2006) (billion RMB)
Source: NBS (2006)

As the figures show, the state orchestrates the system of innovation through control over policies, finance, and governance. On the other hand, firms are increasingly becoming the centre of innovation: they are now performing over two-thirds of total R&D, up from less than 40 % at the beginning of 1990 (OECD, 2008). However their contribution to innovation remains weak, and is confined by the flawed corporate governance and finance. Research institutes are mainly involved in basic research; and their share of R&D in general has declined from almost half to less than one-quarter from early 1990s to 2004. The relative weight of higher education institutions has changed little (OECD. 2008). Below their roles and performance are each reviewed.

1) The state

After a decade of restructuring, although China's NSI increasingly feature heightened enterprise participation and greater cooperation among industries, universities, and the government, however the state is still playing a dominant and guiding role (Sun *et al*, 2003). In addition to the persistence of state ownership in high-tech and key sectors (see section 3.1.1), the government's influence is mainly through S&T and innovation policy, corporate governance of SOEs, and finance in general. In this part our discussion mainly focuses on the state's role in S&T and innovation policy. As corporate governance and finance are the main subjects of research in this study, they will be separately reviewed in the next section (section 3.3).

Founded in 1998, the State (National) Steering Committee of S&T and Education (SSCSTE, *Guowuyuan keji jiaoyu lingdao xiaozu*) is most superior body in charge of innovation policy in China. The Premier of State Council also has the responsibility to coordinate strategic policies, such as S&T strategy, education and policies at the local level.

Since 1998 the Ministry of Science and Technology (MOST) has been designated as the principal participant in China's technological endeavour. Through its executive body, it implements several programmes to fund basic and applied R&D, support and guide innovation in enterprise. It is also in charge of management and promotion of incubators and science parks, and S&T human resource plans..

However, in practice MOST is not the only body, or even the most important body in issuing and implementing key policies in the Chinese innovation system. As shown in by Sun *et al* (2007), in August 2006 over 40 departments were participating in technology policy-making, and the department issuing most policy documents is not Ministry of S&T, but Ministry of Foreign Trade and Economic Cooperation (see Figure 3-7). Although Ministry of S&T and State Intellectual Property Office are departments most relevant to technological development, their role in technology policy making has not been central. It was the departments with key economic and administrative resources and power that have been crucial departments for technology policy issuing, such as State Economic and Trade Commission, Ministry of Foreign Trade and Economic Cooperation.

Financially, the central government remained the primary source of S&T funding until 1992 when it was overtaken by industry (Sun *et al*, 2003; see also Figure 3-6). Since the 1980s the Chinese government has been utilizing a series of programmes with different priorities as a mechanism to fund S&T activities. Such as the 863 programme, Key Technology R&D Programme, and 973 Programme (Huang *et al*, 2004)[27]

Although China is a mostly agricultural country, the Spark programme is the only programme that targets China's agricultural and rural area. Initiated in 1986, it is commissioned to promote technology transfer to, and development in the rural region. Unlike other programmes in which the central government is the main financier, in fact, the projects sponsorship mainly takes the form of bank loans. In 2006 only 16.8 % of project funding was from bank loans (see Huang *et al*, 2004, Table 4).

[27] For details of these Programmes, see .(Huang *et al*, 2004), and Appendix III

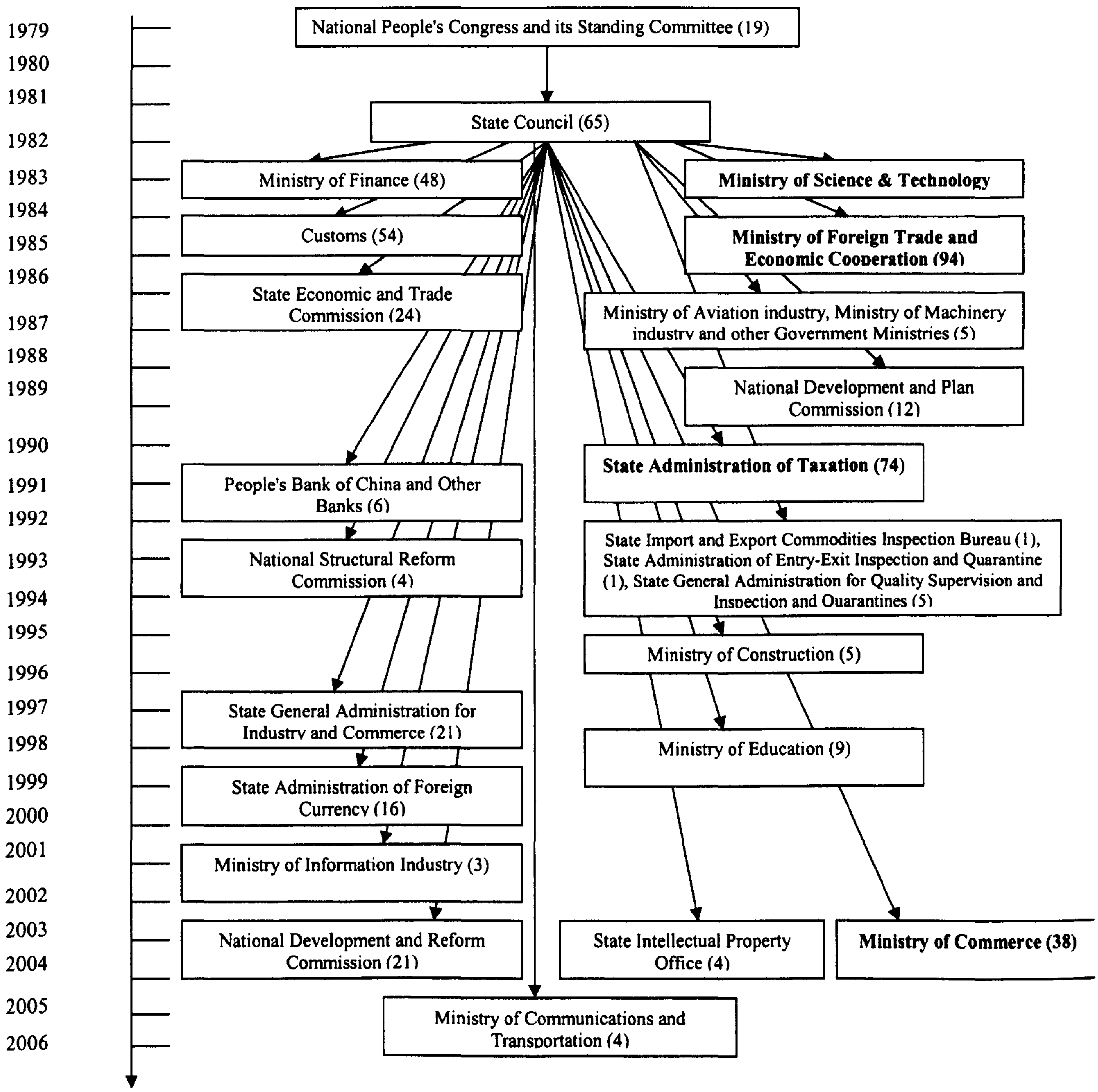


Figure 3-7 The framework of Chinese technology policy according to Sun *et al* (2007)

Note: The year on the vertical axis is the time when the relevant department started to be involved in S&T policy-making. Numbers in parentheses are total amount of policies issued by the department. For example, State Administration of Taxation started to participate in S&T-related policy-making in 1990, and since then have issued 74 of such policies. Source: Sun, *et al* (2007)

2) The firms

Although firms are becoming the principal R&D spenders in China (see Figure 3-6), they remain a weak part of the country's innovation system. In reality, improving the performance of the industrial sectors and innovative capacity has been one of the most difficult challenges (OECD, 2008).

Domestic firms

Before the reforms, Chinese firms were state-run factories with minimal research and development. The past decades however saw vast progress; particularly in the firms' R&D input (see Table 3-4 and Figure 3-6). The share of R&D input by enterprises has gone up from 19 to 70 % between 1991 and 2006. The share of R&D personnel employed by enterprises has also risen steadily from 50 to 66 % between 2000 and 2006. (The remaining were mainly in R&D and higher education institutes). The absolute number of R&D personnel employed by enterprises, has also increased from 481,000 in 2000 to 988,000 in 2006, while R&D personnel in research institutions only gained a marginal increase over the same period, from 229,000 to 232,000. (http://www.stats.gov.cn/tjsj/qtsj/kjtjjmzl/2007/t20071130_402448644.htm).

Table 3-4 Relative role of the three main actors of innovation, year 2002

% share of	Firms	Research institutes	Higher education
R&D expenditures	62.4	25.9	10.5
Basic research	9.0	53.5	37.6
Applied research	25.9	45.3	28.8
Technological development	77	19	4
Technology market	48	18	10
Patent application	63	14	22
Government funding	59.9	18.6	17.3

Source: Table 2.1, OECD Review of Innovation Policy, China (2008)

However, the level of R&D by domestic firms in China is disproportionate to the scale of its economy. The majority of Chinese companies, especially those in the high-technology industries, continue to have much lower R&D intensity than their counterparts in most OECD countries. The overall R&D intensity in high technology in China was just 4.6% in 2004. The comparable 2002 figure for the US was 27.3% and for Japan 29.9% (www.sts.org.cn/sjkl/kjtjdt/data2006). The breakdown by sector is even more instructive: for electronic and telecommunications equipment, the corresponding figures were 25.4% for the US and just 5.6% for China. In computers and office equipment, the figures were 32.8% for the US and only 3.2% for China. Together these two sectors made up 72% of the value added of high technology industry in China in 2004. In 2006, only 4 Chinese companies were list as top 500 global companies in terms of R&D investment: Petro China (185), China Petroleum (260), ZTE (298) and Lenovo (356) (UK DTI global scoreboard, 2006) [28].

In addition to low R&D intensity, the spending structure is problematic. In many SOEs more R&D money was spent on importing technology than in developing their own. If we break down R&D expenditure by class of activity, the costs of acquisition for *embodied* technology, such as machines and production equipment, account for about 58% of the total, compared with 17% internal R&D, 5% external R&D, 3% marketing of new product, 2% training cost and 15% engineering and manufacturing start-up (Guan, 2000). This has applied particularly to state-owned firms, which have good access to finance and other resources – most particularly to the 'insider' firms (Lu & Feng, 2004) or the 'national team' (Nolan, 2001) which have had the best access.

As already revealed in section 3.1.3, Chinese large and medium enterprises (LMEs, almost all of which SOEs) are under investing in technology absorption, which has proved to be critical for developing countries to effectively utilise imported technologies (Mowery *et al*, 1998; Bell & Pavitt, 1997). Chinese LMEs spent around US$ 4.0 billion on technology imports in 2006, but just US$ 1 billion on technology absorption and diffusion (NBS Statistics Data on Science and Technology Development, 2006). Although the 1/0.25 ratio of technology import/absorption

[28] Huawei as one of China's most innovative firms was not on the list; this is possibly a result of Huawei's reluctance to disclose its operational details.

improved from 1 / 0.06 in 1997, it compared badly with those of more than 1/3 in other industrialised countries in Asia in the 80s (Zhang, 1998).

Many of the private firms on the other hand actively seek to implement new technology. They also undertake vital R&D even with resources constraints. However since these firms mainly operate in the low-tech sectors, the scale of R&D investment is very limited (MOST, 1999; Liu & White, 2001).

Chinese firms in general have not shown an increase in R&D outputs that is comparable to their growing input. For example, Liu and White (2001) point out that firms' increase in share and account for total patents is concentrated in design patents (their Table 2 and Table 3). Although their R&D units and spending keep grow, it is not matched by an enhanced performance in technologically intensive invention or utility patents. In fact Chinese firms accounted for only 23 % of the total domestically granted invention patents, much lower than R&D institutions (33 %) and universities (26 %) (NBS Statistics Data on Science and Technology Development, 2006).

Multinational corporations (MNCs)

As argued above, despite higher R&D expenditure than foreign-funded enterprises (Table 3-5), the Chinese domestic enterprises have not become the main force of innovation. On the other hand, dynamism of overseas R&D centres in China varies case by case, and their spill-over effects within Chinese industry are hard to measure.

Table 3-5 R&D expenditure proportion between Chinese and foreign invested enterprises

	Share of R&D expenditure by domestic enterprises	**By foreign-invested enterprises**
All industries	72.78%	27.22%
Electronic and telecommunication equipment	52.15%	47.85%
Medical and pharmaceutical products	74.87%	25.13%
Aircraft and spacecraft and transport equipment	67.88%	32.12%
Electrical machinery and equipment	76.11%	23.89%

Source: China National Economic Census 2004, cited in China Daily, 08/01/2005

China's activist inward FDI strategy means that multinational corporations are no longer peripheral to its NSI. By the end of 2006, around 750 world industry leaders such as Microsoft, Samsung, Volkswagen, and Toyota have set up R&D facilities in China (*China Daily*, 12/12/2006). These MNCs employ not only highly experienced extrapolate staff, but also well educated (and cheap) local personnel. However, some believe that for many multinationals in the 1990s, setting up R&D centres in China was a way of getting market access, or gaining favour with the government (Reuvid & Li, 2005). Such argument is supported by statistical data, as foreign-funded enterprises have much lower R&D expenditure than Chinese ones, even in electronic and telecommunication equipment manufacturing sector, in which the former accounts for 83.5 % of total sales (see Table 3-5 and section 3.1.3), indicating that their R&D activities are mainly conducted abroad. This is due to cultural and political mismatches, and more importantly the fear of technical details seeping to local competitors (von Zedwitz, 2004), and surely also due to the general tendency to keep R&D, as a rather strategic activity, close to home base.

Others argue that MNE's have emerged as important actors providing a new propeller for innovation activities within China (Liu & White, 2001). Through case studies in the auto glass industry, Huang (2008) found that whether joint ventures or wholly-owned subsidiaries, they often have more demanding specifications than local firms for inputs.

It means that local suppliers may loose out to their peers if they failed to innovate or at least to adopt innovations developed by other firms. It is becoming more common place that MNEs work closely with local suppliers with new technology, so that the latter can meet their specifications. It is argued that at the macro level China's innovation system has been improved as a result of such activity.

On the other hand, multinationals posed great challenges to local companies and research institutes in the competition for highly skilled labour and R&D human resource. More and more local talents in China flowed to multinationals since the latter are often more active in researches concurrent with the world trend and offer high salaries. Reports show that almost 40 % of China's graduates worked in foreign-invested enterprises (*Asia Times*, 03/01/2007). A survey conducted in foreign-invested research agencies based in Shanghai also reported a near 40:1 ratio of Chinese researchers to expatriate R&D staff (*Nanning Daily*, 30/01/2007).

However, the training provided by multinationals can in the long term help improve China's domestic research and development potential. Locally educated scientists and R&D staff tend to be well-taught in terms of academic knowledge, but lack creativity and practical experience. The well-trained talents in multinationals could actually be potential human resources for the Chinese local companies, once these companies grow stronger.

3) Research institutes

Before China's reforms, research institutes were the primary performers of R&D and other technology-related activates. Any technology brought in from abroad came to them, in the form of technology licensing or sample machine procurement: they then 'fed' the enterprises, particularly the capital goods producers, whatever innovation or technological change took place (Tylecote *et al*, 2010). In the reform process of the 1980s and 1990s, the government reduced its financial support to force the institutes to seek funding outside of the governmental channel. The government stopped giving support, in 2000, for the operating budgets of over 5000 research institutes (Liu & White, 2001). At the same time, the institutes' activities were liberated – they were encouraged (tacitly) to engage in commercial technology services, such as licensing, consultancy, etc. Some others managed to capitalised on their in-house technology by setting up production facilities or creating spin-outs (Gu, 1999; Liu & White, 2001). Meanwhile, the public research system was also downsized both in number and size of institutes, rebalanced in favour of universities. In 1999, the R&D expenditure of research institutes was 43.4% of national R&D spending, while that of enterprises was 41.6% (NBS, 2000). In 2005 these two ratios have changed to 19% and 71% respectively (Figure 3-6)[29].

Currently, public-owned research institutes in China still play an important role in supporting strategic and basic research, as well as commissioned research (OECD, 2008), mainly in the high-technology-related and natural sciences areas.

4) Universities

- Universities as Institutes of Higher Education

Human capital has been widely recognised as one of the crucial resources of development (Wernerfelt, 1984; Peteraf, 1993; Teece *et al*, 1997), and a crucial source of human capital is formally organised education system. Since Cultural Revolution in the late 1970s, China has not established a strong education system to support its technological upgrade. According to OECD (2002), in the whole of 1990s China's education constantly received fiscal appropriation that is disproportionate to its economic growth)[30]. In addition, since the 1990s there exists an increasing tendency of policy discrimination in favour of universities in general and universities in developed coastal regions in particular. Meanwhile, the development of secondary and primary education and vocational education as well s education in the rural areas have been unduly neglected (Huang, 2008). As a result, preparation of human resource for the innovation system has been mainly undertaken by universities in China. Table 3-6 gives some headline statistics of China's current situation in higher education:

[29] The change appears to result in part from the conversion of government research institutes into SOEs (as described in the previous page)
[30] The Education Law stipulates that the government at various levels have the legal obligation of enforcing that 'the increase of education expenditure of government at various levels shall be at a higher rate than the growth of normal financial revenue'. However, in 1996, 1997 and 1999-2001 the central government itself failed to fulfil this legal obligation.

Table 3-6 A snapshot of China's higher education situation

	Quantity	Year	Sources
S&T workforce	2.25 million scientists and engineers	2004	NBS/MOST S&T Statistics. URL: http://www.stats.gov.cn/tjsj/
	1.15 million person years spent on R&D	2004	
Enrolment in higher education	15 million	2004	Ministry of Education Statistics of Higher Education. URL: http://www.moe.edu.cn/edoas/website18/level2.jsp?tablename=2234
Enrolment in postgraduate programmes	1,104,653	2006	
Number of science, medicine and engineering undergraduates	6,508,541	2004	
Number of science, medicine and engineering postgraduates	662,903	2006	
PhDs awarded	36,247 (72% in science-related subjects)	2006	
Number of students studying abroad (1978–2007)	1.2 million	2007	
Number of returning overseas students (by 2007)	319,700	2007	
Number of colleges and universities	1,867	2006	
Number of graduate schools/research institutes	767	2006	
Number of universities in global top 200	6	2008	Times Higher Education Supplement. URL: http://www.timeshighereducation.co.uk/hybrid.asp?typeCode=243&pubCode=1

Source: own calculation based on above data source, with certain criteria draw from Wildson & Keeley, 2007)

Boosted by relatively larger amount of higher education investment[31], China's higher education has achieved remarkable development in the recent years, especially in applied science and engineering subjects. According to Liu & White (2001). graduates in the sciences and engineering increased from 38% in 1991 to 49% of all graduates by 1995, while 75 % were engineering graduates.

[31] The current ratios of about 10:2:1 in China's government per-student spending on higher, secondary and primary education, respectively, are already high compared to the USA, Korea, Chile and Mexico. (World Bank, 2003).

In 2006 more than 500,000 postgraduates were from science, medicine, and engineering subjects, and 72% of 36,000 PhDs were in science-related subjects (see Table 3-6). However, there are questions about the efficiency of the current workforce. During the rapid expansion of China's higher education system since 1998, a large amount of vocational training institutions were converted to colleges and universities. As a result, the quality of newly-qualified scientists and engineers is questionable, while well trained and innovation-capable technical workers and technicians are in short supply (OECD, 2008).

- Universities as Institutes of Research

The higher education system has developed significantly over the ten years as a research performer. Although about 700 higher education institutes are recorded as active in R&D (OECD, 2008), the number of significant players is still very small, and only a few of them enjoy international reputation as major research universities. The Ministry of Education collaborates with other organisations to devise a number of funding regimes to attract Chinese researchers around the world to work in China, mainly in universities and public research institutes. This is accomplished by rewarding the leading researchers (with competitive packages of remuneration and project funding), who are expected to enhance the level of some key research projects. Figure 3-8 describes the priorities of the programmes.

First Tier	Cheung Kong Scholar Programme (*Changjiang Xuezhe Jiangli Jihua*)		
Second Tier	University Young Scholar Award (*Gaoxiao Qingnian Jiaoshi Jiang*)	New Century Talents Training Programme (*Kuashiji Youxiu Rencai Peiyang Jihua*)	
Third Tier	Promising Young Scholar Funding Programme (*Youxiu Qingnian Jiaoshi Zizhu Jihua*)	University Key Scholar Funding Programme (*Gaoxiao Gugan Jiaoshi Zizhu Jihua*)	Overseas Returnee Scientific Research Fund (*Liuxue Huiguo Renyuan Keyan Qidong Zijin*)

Figure 3-8 Ministry of Education's research funding programmes
Source: Ministry of Education website: www.MOE.gov.cn

However, the lack of accountability in the Chinese research system and highly quantitative incentive policy means that plagiarism and research misconduct are common place, even in high profile research programmes such as the Cheung Kong Scholars Programme[32]. The highest profile case involved Jin Chen, head of Shanghai Microelectronics Research Institute, ,who had received government praise for his work and was the recipient of over £7.5 million from Cheung Kong Programme research grants. He was found to have placed his company logo on Motorla's chips. (Leadbeater & Wilsdon, 2007).

> 'Again, it's the result of politics getting mixed up with science... There are policies to encourage people to generate publications and patents and prizes. You get a score and if you are an 'A', you get 25 % more salary. It's easy to understand why this leads people to

[32] The Cheung Kong Scholars Programme is jointly established by the Ministry of Education and Li Ka Shing Foundation. It is regarded as the highest ranking of all externally funded programmes for university scholars and has an ambition of funding China's most prominent scholars and their ground-breaking projects.

> plagiarise results. Every university has this problem. I've suffered from it myself. Some ex-students of mine took my data and published it in Science. This happened only five months ago.' (Ze Zhang, Vice President of Beijing University of Technology, in an interview recorded in Leadbeater & Wilsdon, 2007: 17)

There is concern, that this sharp rise in plagiarism is corroding the culture of research within institutes and universities (Leadbeater & Wildson, 2007). '*Collaboration becomes very difficult. You can't trust people not to steal your work. Everyone works with the door closed, in secret. This is very bad for innovation.*' (Ze Zhang, see above).

- Foreign Universities - brain gain from overseas returnees

In the past five or six years, the trickle of overseas returnees, or vividly described as 'sea turtles ('*Haigui*') has become a steady flow. The annual number has soared from only around 6000 per year in 1995, to over 40000 in 2006. Mostly from US (Silicon Valley), UK, Germany, Japan and Australia (MOE website, accessed 2007), many of the returnees were attracted by some combination of China's abundant economic and business opportunities, national sentiment, family ties, and government incentives. Among the returnees, those with established entrepreneurship in the west are most valued with their creativity, managerial expertise, networks and access to venture capital, even though the most benefited areas are those already-rich coastal cities (Leadbeater & Wilsdon, 2007).

5) Linkage and supporting structure

The dynamism of an innovation system largely depends on its ability to generate new activities in existing firms, create new firms, and to promote knowledge diffusion and absorption within the system (Feinson, 2003). China since the mid 1990s has started to adapt the internationally prevalent approach to linkage and supporting structures, such as science parks and incubators.. There are already over 400 business incubators and 53 high-tech zones set up at the national level (Huang *et al*, 2004) (the name of high-technology development zones could be referred to as science parks in Chinese translation [Deloitte Research, 2003]). These are mainly supported by a government technology diffusion scheme called 'Torch Program' (see Appendix III: China's current S&T Programmes).

Moreover, China Hi-Tech Fair (CHTF) as an intermediary event receives strong support from the central government. It functions as a linkage between Chinese and overseas high-tech industry sectors. Since 1999, the fair has been held annually in the South-China hub of international trade and technology,Shenzhen, and is currently the largest and most important exhibition and trade fair in China for high-tech achievements (Huang *et al*, 2004). According to its official website, in year 2006 alone CHTF secured a contract value of 13.6 billion USD from over 20 attending economies (China Hi-Tech Fair website, accessed 2006).

Another important intermediary is Productivity Promotion Centres (PCCs), it is established in 1992 by a group of intermediary and consulting to support innovation in the business sector (Huang *et al*, 2004). As of 2006, there are over 800 PCC at provincial, municipal and county levels, providing consultancy, technology promotion, product testing and other technology related services. (CPPC website, accessed 2008).

Table 3-7 Chinese science park and incubator development

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total revenue of the 53 national high-technology zones[1]	8.73	23.09	56.36	94.26	152.9	230.03	338.78	483.96	677.48	920.93	1192.84	1532.64
Output value of the enterprises inside 53 national high-tech zones[1]	7.12	18.68	44.73	85.27	140.28	214.23	310.92	433.36	594.36	794.2	1011.68	1293.71
Output value at current prices of high technology sector across China[1,2]					409.8	490.9	597.2	711.1	821.7	1041.1	1226.3	
Output value at current prices of manufacture sector across China[1,2]					4870	5130.1	5998.5	5966.8	6395.4	7510.8	8442.1	
Ratio of output value of the enterprises inside 53 national high-tech zones to output value at current prices of high-tech sector across China					34.23%	43.64%	52.06%	60.94%	72.33%	76.28%	82.50%	
Ratio of output value of the enterprise inside 53 national high-tech zones to output value at current prices of manufacture sector across China					2.88%	4.18%	5.18%	7.26%	9.29%	10.57%	11.98%	
Number of incubators	43	61	61	73	73	90	100	77	110	131	280	436
Number of tenants	500	1,013	1,500	1,390	1,854	2,476	2,670	4,138	5,293	7,693	12,821	23,373
Number of graduated tenants				190	364	648	825	1,316	1,934	2,770	3,994	6,927

Note: 1. The unit is billion RMB. The values are treated as current price values.

Source: (Huang *et al*, 2004), Torch Program website: http://www.chinatorch.gov.cn/

3.3 Corporate governance and finance system in China

In China, the corporate governance issue started to arouse attention in the late 1980s and the concept became more familiar to China in the late 1990s (Fei, 2004). The discussion related mainly to state-owned enterprises. Private enterprise on the other hand, since almost always managed by the owners, tend to suffer more from financial shortage rather than corporate governance defects.

3.3.1 Corporate governance of state-owned enterprises in China

The current corporate governance of Chinese SOEs faces the following challenges, which will be each elaborated below. Their effects on technological capability development will be illustrated in Chapter 4, Section 4.2:

- Multiple-level *agency problem*. Government officials supervise SOE executives, who are officials (or are viewed as officials) themselves. They often do not possess, or have the incentive to acquire *industrial expertise.*
- Managers' career paths as officials – that they are prone to the problems of shortermism and lack of *engagement*
- Executives have to spend much time to cultivate and maintain relationship with officials, hence are weak in relationship building with employees and shareholders – poor *stakeholder inclusion.*
- Managers' remuneration scheme based on short-term financial data means that managements' incentive to pursue longer-term development through investment in technological innovation is lacking.

Since the above issues have been rooted, mostly since the early 1950s, it is necessary to understand the causes by examining the four stages of SOE corporate governance in China.

Stage One: Mass nationalisation of private enterprises: 1956-1966

From 1956 to 1966 China went through a massive nationalisation of enterprises (*gong si heying*), entrepreneurs were forced to sell their businesses to the state in return for shares and fixed dividends (both benefits were abolished by the government since 1966). Business corporations were gradually but completely delegalised and became state-owned enterprises. SOEs were however, not complete business enterprises. '*State ownership deprived them of legal independence, and the state planning apparatus deprived them of economic independence.*' (Meyer & Lu, 2004: 60) Most SOEs were referred to as factories (*Gongchang*); which had only production function, and were were administered geographically as government branches (Meyer & Lu, 2004). In each SOE there was a committee of the Communist Party (*Dangweihui*), trade union (*Gonghui*) and meeting of employees' representatives (*Zhigong daibiao dahui*) who exercised monitoring rights over SOEs' managers. The government agencies were the authorities to hire and fire SOE managers, and the latter were paid as government officials themselves (Meyer & Lu, 2005).). They functioned as government officials as well, with neither obligation nor incentive to behave as entrepreneurs.

Stage Two: Management Contract System: 1979-1993

In order to revive a struggling public sector accounting for over 70% of the nation's economy, in the late 1970s Chinese authorities aimed at restructuring SOEs by establishing a 'Modern Enterprise System' (*Xiandai qiye zhidu*). The SOE reform started in 1979 had no intention to abolish state ownership. Rather, it was intended to consolidate and enhance the efficiency of state ownership. The dominant policy from mid 1980s to 1990s was the management contract system (MCS) – contracts of profit sharing rules and decision rights which were agreed between the firm and the governing authorities (administrative as well as financial departments) (Zhang, 1998). The length of a contract varies between 3 and 5 years, and typically contained conventional performance indicators including profit and tax target, debt repayments, asset appreciation, and utilization of retained profits (Zhang, 1998). However, in most cases, only profit target were weakly enforced and other only used as indicative, and in many cases the same set of contracts were adapted by various firms by simply changing name (Zhang, 1998; Firth *et al.* 2006).

Under the management contract system, although SOE managers have gradually received more business operational autonomy, the reform did not lead to generally enhanced SOE performance in the early 1990s. World Bank conducted a survey in 1994 and found that those SOEs with management contracts appeared to even performance worse than those without. This survey also reported lower capital and labour productivity, plus more over-employment and more bank-finance by those with management contracts (World Bank, 1997). If the direction of causation does come from contract to performance, then it does require managers to have the expertise and access to information to secure benefit from decentralized decision-making (Carlsson & Eliasson, 1994), which the conditions were missing in Chinese SOE (Zhang, 1998):

- First, under the MCS system it was the officials from line ministries or regulatory bureaus who had the right to select and dismiss SOE managers, and they did not have to worry about the consequences of their selection. This implies that, they had no adequate incentive to search for, or install good managers. Observation suggests that officials often based their selections on *guanxi* (personal connections) rather than *yeji* (performance) (Zhang, 1998). Naturally, SOE managers behaved more like officials than entrepreneurs – they did not have the needed ability, nor did they have the incentive to acquire such ability.

- Second, although the MCS system intended to mitigate government intervention in enterprise operation, in fact local governments often were reluctant to lose influence over these SOEs. Meanwhile, firms also actively sought good relationships with the local authority for access to various state-controlled resources. In return, they would inevitably suffer political intervention. Normally the size of the firm is positively correlated to the degree of political benefits as well as political intervention it suffers (Cai, 2005). The autonomy of managers was thus less than was intended. Moreover, manager's contract term was normally 3-5 years, and their benefits from the firm did not extend beyond departure. Consequently the short-term pressures could all too easily arise. This induced managers of SOEs to invest in quick pay-off projects rather than in long term R&D and other productivity-enhancing projects (Huang *et al.* 2004). In many cases, abnormal short-term profits made at the large expense of long-term productivity (Broadman & Xiao, 1997).

Stage Three: Corporatisation and Company Law: 1993-2003

During the 1990s and early 2000s, Chinese planners tried to merge state firms to create big 'national champions' (Nolan, 1996, p12). Moreover, state firms were pushed onto the stock market as a quick way to pump money from the public into state firm investment. However, those efforts were accompanied by the old communist regime and organisations (Batjargal, 2005), and relatively little improvement in the governance practice.

Since the early 1990s Chinese policy makers started to look to the models of corporate governance in western countries, in order to address the SOEs governance problems in a way compatible with the market economy. The corporatization policy was formally introduced by the Party in 1993 with some caution, but it soon became a law for SOE reforms (Lin & Wei, 2006; Zhang, 2007). The guiding principle was later summarised as '*zhua da, fang xiao*' or, grasp the big and let go the small. In so doing the government hoped to concentrate resources on nurturing the larger SOEs, while gradually loosen state control over smaller SOEs. Through methods of government initiated bankruptcies, mergers and divesting of small and medium SOEs, SOEs' number has been significantly cut, from over a quarter of a million in 1995 to under 150,000 in 2005[33] (Imai, 2006, p.5). Most small SOEs quickly transformed their ownerships into (employee) shareholding and POEs, while Medium SOEs and large SOEs were transformed from straight state-owned into limited liability or stock companies. By late 1997 around 9,000 SOEs had gone through the process (*Xinhua*, 18/12/2006), which allowed them to issue and list shares on the two stock exchanges in Shanghai and Shenzhen, which were opened in 1990 and 1991 respectively. (Listed firms and Chinese stock market will be described in detail in section 3.3.3) As of end 2003 there were 1287 enterprises listed on the exchanges, of which 940 were SOEs (Hua *et al*, 2004).

In 1993 Company Law was introduced to help the firms build their modern enterprise systems. According to the Company Law, the organisational structure of a share-holding company should consist a shareholdings' meeting, a board of directors and a supervisory board. In theory such structure of *xinsanhui* (the 'three new organisations')

[33] During the same period, 3,484 SOEs were closed down as part of government-funded programs, with 6.67 million employees affected (Naughton, 2005)

would replace the *laosanhui*, the 'three old organisations' (Communist Party committee, labour union and employee representative meeting).

The Chinese government has also taken other measures, which can be regarded as market-orientated in its bid for good corporate governance. For example the China Securities Regulatory Commission (CSRC) adopted a detailed corporate governance code in 2002 to promote best practice in terms of governance structure, shareholder voting, board composition, and the conduct of board and shareholders' meetings etc[34] (Zhang, 2007) (see Appendix IV. The formal corporate governance system of China).

Despite the emergence of new rules, regulations and organizations, fundamental corporate governance flaws in the Chinese SOEs remained unaddressed. For example, the Company Law requests that the board of directors 'appoint, dismiss and decide on the remuneration of the company's general manager' (Company Law, 2006), most top managers of Chinese listed SOEs were still selected or nominated and approved by government authorities (Chen & Huang, 2001). According to a survey conducted in 2000, from 1979 to 2000 around 80% of SOEs top managers were appointed by government authorities (http://www.cess.gov.cn/dcyj/diaocha.html).

Stage Four: State Asset Supervision and Administration Committee: 2003 to date

In 2003, State Assets Supervision and Administration Commission of the State Council (SASAC) was set up. For the first time China has a dedicated body to be in charge of the control and administration of state asset with distinctive and bold initiatives. This demonstrated the strong determination of the central government to deal with the unresolved problems and remaining challenges of Chinese SOEs (Altenburg *et al*, 2008).

Officially, SASAC as a 'special entity' at the ministry level is able to report directly to the State Council (*Guowuyuan zhishu teshe jigou*). According to Naughton [2004, p.

[34] The CSRC & the State Economic and Trade Commission, Corporate Governance Code for Listed Companies (9, January 2002).

12], this special status enables SASAC to bypass the legal and administrative constraint of the National People's Congress.) It was even rumoured that State Councle has exclusively creative this organisation category for SASAC (Mattlin, 2007).

According to Interim Regulations on the Management of Enterprise State-Owned Assets, SASAC's mandate includes drafting laws and regulations regarding state-owned assets, managing and restructuring state assets, and hiring and firing the executives of SOEs under its supervision, whilst the ultimate authority over key appointment is still retained by the Party Committee).

The establishment of SASAC indicates the central government's attempt to both decentralise and centralise. On the one hand, SOEs along the hierarchy of administrative levels were clearly separated, and control over local SOEs was handed over to local SASAC offices. Meanwhile, SASAC is commissioned to take over several functions formerly dispersed among different government authorities and party organisations. For the first time in modern China, there is a unitary administrative organ to manage the state assets. Central SASAC's other key function is regulation and supervision of more than 100 'Central Enterprises' (see below). Those are the mammoth SOEs hand-picked by the central government in hope to foster China's future global competitors (see below).

As of end 2009, there were 141 'central enterprises' under the direct management of central SASAC[35]. Although relatively small in number, these central enterprises possess more resources than all of the other SOEs combined, and have crucial importance to the national economy. Financially, central SASAC firms account for roughly 70% of all SOE profits, which equals 20% of government revenue (Mattlin, 2007), and more than 30% of the entire valuation of China's domestic stock market is from listed central SASAC subsidiaries. Together these firms have an asset value of more than 1.6 trillion USD (*Xinhua*, 25/01/2007).

As mentioned above, local SOEs are controlled by SASAC offices at the corresponding administrative level. For the first time, *'independent power over SOEs are delegated to*

[35] This list can be found in Chinese on SASAC's website at www.sasac.gov.cn/n1180/n1226/n2425/index.html . The number of firms is slowly dropping due to SASAC-supervised restructuring and merging efforts.

the local level' (*Central Enterprises Investment Supervision and Management* [trial directive], July 2006; see also Naughton 2006, pp. 3, 16).

Structure of Control

The establishment of SASAC as the first non-governmental representative of state ownership in P.R. China's history clearly demonstrates the central government's intention to separate state asset ownership from political administration. However, it is still difficult to map out a standardised structure of control, i.e. the relationship between central and local SASAC, local SASAC's relationship with local governments, and the actual distribution of power (ownership) over most SOEs among central/local SASAC. The reasons are listed below:

1) The multi-centric, or 'fragmented authoritarianism' (Lieberthal, 1995) system of decision-making has made it impossible to clarify the distribution of state-asset ownership at different levels (Naughton, 2006). Before the reform, power distribution among government authorities was highly intricate: it has both vertical hierarchy as well as horizontal cross-over (*tiao and kuao*). Mandates of departments/authorities were defined in an *ad hoc* manner: they could either by type of activity (such as education), industry (such as pharmaceuticals, machinery, and electronics) or institution (such as pricing) (Liu & White, 2001).. Moreover, the overall authority of State Planning Commission at that time was more formal than real. During the reform, authority of most of Chinese industries has experienced several decentralising and recentralizing arrangements. For example, the administration of Chinese automotive industry has been assigned to a sequence of 7 different authorities between 1982 and 2003 (Liang, 2004: Table 6-1). Consequently, the ownership structure of SOEs in terms of 'who has invested, when, and by how much' is further complicated.

As mentioned above, for the first time SASAC is no longer in the established ministerial structure (or at least it is intended not to be one). The relationship of central and local SASACs is also not simply hierarchical; since the latter are also independent special organs representing governments' state asset ownership at the local level – they ought to answer to the commissioners of the ownership. Paradoxically, the 'Provisional Ordinance of Enterprise State Asset Administration' (2006) requires the central

SASAC to guide and supervise local SASACs. '*The central government is in a dilemma on the issue of separating state-ownership from government authorities – without clarification of the duties and rights, the central SASAC can intrude the decision-making of any local SOEs as it wishes, and thus become yet another government authority. The relationship between central and local SASACs will also remain much entangled.*' (Li Shuguang, member of State Asset Law drafting committee: http://finance.people.com.cn/GB/1037/5559925.html).

Efforts and achievements

Compared to its predecessors (industrial ministries at the central level and bureaus at the local level), SASAC has more expertise in external supervision over the firms' operational activities. We can expect that SASAC officials, given that their responsibility is mainly about supervising firms, would be able do a better job. For example, SASAC has become increasingly active in the restructuring and strategic management of large SOEs, putting heavy emphasis on developing indigenous technological capabilities. According to the 11th five-year plan, this is in accordance with China's current development priority (Guidelines for the 11th five-year plan, 03/2006). Also, since its foundation in 2003, SASAC has been trying hard to formulate systematic incentive mechanism and performance measurement for its SOEs (see Table 3-8). Meanwhile, it attempts to include innovation performance in the comprehensive assessment system. To this extent, there should be a positive impact on firms' technological strategy.

Table 3-8 Portfolio of performance assessment in central enterprises by SASAC

Financial Performance (70%)						Managerial Performance (30%)	
Content and Weight (%)		Basic indices	Weight (%)	Reference indices	Weight (%)	Assessment Item	Weight (%)
Profitability	34	Net asset earning ratio	20	Sales profit rate	10	Strategic management	18
				the surplus cash cover ratio	9		
		Return on asset	14	Profit/cost of capital (EVA)	8	Development and innovation	15
				Rate of earnings on equity	7		
Asset quality	22	Total asset turnover	10	NPL ratio	9	Operational decisions	16
				Current asset turnover	7		
		Acct. receivable turnover	12	Cash/asset ratio	6	Risk management	13
Debt risk	22	asset/liability ratio	12	Quick ratio	6	Basic management	14
				Cash ratio	6		
		Paid interest/debt	10	Ratio of liabilities to interest	5	Human resource management	8
				Contingent liability ratio	5		
Operational growth	22	Sales growth rate	12	Sales profit growth	10	Influence in the industry	8
				Growth rate of total asset	7		
		Ratio of value maintenance and appreciation of capital	10	Technological input ratio	5	Contribution to society	8

Source: Translated from Central Government of People's Republic of China website: http://www.gov.cn/gzdt/2006-10/27/content_425677.htm . Also published in Tylecote, Cai and Liu (2010)

Financial performance of central enterprises directly supervised by SASAC has had a marked improvement. Profit increased more than 30 % at these enterprises in the first quarter of 2005. The total value of the SASAC-run companies increased from around RMB7 trillion at the SASAC's creation in 2003 to over RMB 9 trillion in early 2005 (SASAC official website). Under these circumstances, the SASAC can certainly argue that it has done its job of increasing the value of state assets. However at the local level, the mass of smaller SOEs are still struggling to break even or continuously loss-making (Mattlin, 2007). The bulk of SOE profits are made in a small number of large SOEs, most which are of course central SASAC enterprises[36] As mentioned above, most of the central enterprises are in monopolistic or semi-monopolistic sectors, such as the oil and petrochemical, energy, telecommunication and metal industries. Therefore, operating in a fast-expanding economy, and shielded from competition, large state enterprises do not only have SASAC to thank for their recent success.

Potential problems

While it is recognized in China that ownership and regulatory functions need to be separated (Mako & Zhang 2004, p. 4), in the case of SASAC such seperation does not seem to have been implemented. It can be said that the SASAC combines both ownership and regulatory functions. While it struggles to assume ownership authority, it simultaneously carries out regulatory and other miscellaneous roles at behest of the central government and Communist Party. This state of affairs gives the SASAC a powerful and intrusive role which can be detrimental to the management of SOEs. In fact some of the old problems in SOE governance remained:

- Management *short-termism* may be encouraged by unnecessary reshuffling of enterprise management (see Figure 3-9 for the case of telecommunication sector);
- Letting local government meddle in the management of successful companies can take managers' time and focus off *stakeholder inclusion*, and force them to care more about *guanxi* with officials, (see chapter 6, case study of Longertek);

[36] According to the NBS statistics, in 2005, the entire SOE sector had a net profit of 644.7 billion RMB, whilst according to the SASAC statistics, 627.7 billion RMB came from central enterprises, equivalent to 97%.

- Retained discretion by the Party Committee over appointment of key management personnel, combined with highly quantitative performance measurement criteria, may result in pursuit of short-term financial gain at any costs and failed 'interest alignment' between the principal and the agent.

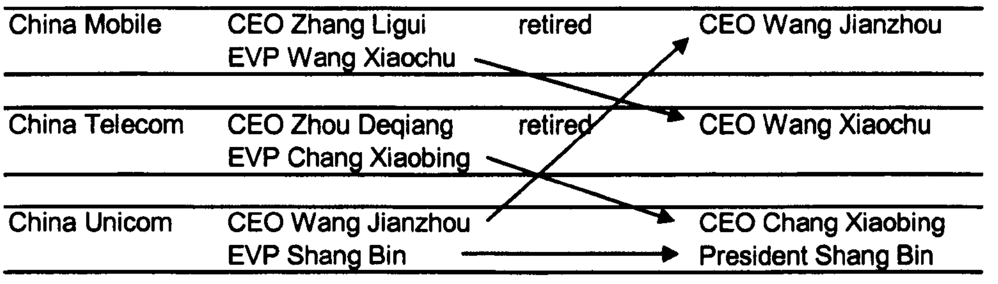


Figure 3-9 Reshuffle of senior managers in China's three major telecom firms, 2005
Source: (Naughton, 2006)

3.3.2 Corporate governance of private enterprises

The organisational forms of private enterprises (*Siying qiye*) can take many forms: sole proprietorships, partnerships, limited liability companies, and shareholding cooperatives. There are different requirements for registered capital and numbers of shareholder associated with these forms of private ownership. Since the early 1990s limited liability companies have been the fastest growing form of private enterprises (Qian, 2002).

According to a survey of the governance structures of private companies by Guo (2000), private companies showed the typical characteristics of family-dominated enterprises. The governance structure pattern in private enterprises is characterised as the *'blood-relative based distribution and balance of power among family members'* (Chen & Huang, 2001,p. 12). Fei (2004) points out that, though a growing number of large private companies have been set up as limited-liability companies and have introduced the standard formal corporate governance system, the sources of the board of directors, operators and managers have the characteristics of close family-orientation (Fei, 2004, p.78). According to the third national POE census in 1998, more than half of the spouses of the married proprietors of private companies were engaged in managerial work in the proprietors' companies. On the other hand, individual entrepreneurs still played a dominant role in making decisions despite the formally installed governance structure. The Asian Development Bank (ADB, 2003) concludes that the owners of private firms still maintains a firm hand in the business. Their survey (see Table 3-9) shows that private firms are currently still run by the shareholders (owners) themselves.

Some scholars argue that such alternative, informal governance mechanisms have been remarkably effective in the private sector (Allen *et al*, 2005). It is understandable from the Agency Theory viewpoint: the shareholders are much likely to be fully incentivised, enthusiastic managers themselves, excepted cases where non-family majority shareholders exploited minority family member shareholders. However, the informal governance structure may generate other governance issues, as Morck and Yeung (2003) points out. In China's situation, for the majority of POEs which are still under the control of first generation entrepreneurs, there is not much evidence of corporate governance (Huang, 2008). Many of these POEs are managed in an authoritarian tradition – entrepreneurs still perceive the business as his own property even when shares are sold to non-family members.

Other problems related to corporate governance in POEs need to be understood in the context of the political system. For example, the long-standing inferior status and lack of security for POEs means that entrepreneurs are prone to short-termism. Many prefer quick realisation of profit rather than reinvestment or long-term development. The difficulty in accessing and securing external finance, on the other hand, leads to risk-aversion – entrepreneurs are often reluctant to spend money on high-opportunity technological activities where there are high demand for capital and high level of uncertainty. Although not owned and run by the state, it is necessary for entrepreneurs to spend time and (often money) to cultivate and maintain a good relationship with the authorities, which means that they will have less to spare for activities for technological development. Moreover, POEs are often under pressure of the local governments to take in unwanted employees (Cooke, 2002).

Table 3-9 Internal Governance Structure of China's Private Enterprises

Highest decision-making body	(%)
Shareholders meeting	13.2
Board of directors	33.1
President of the company or the chairman of the board	36.0
Major shareholders	14.3
Other	3.5
Major decision maker	
Major shareholders	86.9
Minor shareholders	2.7
Professional managers with no share	6.8
Other	3.5

Source: Asian Development Bank (2003); Fei (2004)

3.3.2 Financial system as a source of funding

In China, debt finance is the primary method of corporate external funding. In 2003, the total loans of financial institutions reached RMB15, 931.5 billion, accounting for 130.1% of GDP[37], while stock market capitalization reached only 36.38% of GDP despite impressive growth since 1994 (see Figure 3-10). The bond market is essentially only accessible by the central government to raise funds, and is so far off by corporations (Chen, 2005).

Access to finance in general is highly unequal between SOEs and POEs. Unlike SOEs which receive policy-oriented loans from state-banks and stock exchange, private firms find it difficult to gain access to capital or to obtain loans from state-owned banks. The situation did not improve even after the government set up a network of credit guarantee agencies in the late 90s (Fung *et al*, 2007).

There are several explanations why the financing situation of POEs in general has not benefited from the establishment of the stock market. First of all, China has, until very recently very stringent listing requirements and quota system, which in practice

[37] Data for loans by enterprises is not available at the national level, however according to NBS's statistics, corporate loans account for around 50% of all loans in economically developed coastal regions (NBS annual statistics, Jiangsu and Zhejiang provinces, 2006).

prevented private firms from fund raising via stock market. This also applies to cash-thirsty high-tech start-ups.

Due to the high technology opportunity (see Chatper 2), high-tech enterprises often require high investment, especially in the early stage. This can be achieved through venture capital or other private equity arrangements, especially in Anglophone countries. Although international venture and private equity funds have recently started to grow in China (*Financial Times*, 19/02/2008), fast-growing Chinese VC industry has not been able to provide much help (Fung *et al*, 2007),). Below each of the three main channels of financing are reviewed, e.g. Banking, Stock market, and Venture capital.

The banking system

China's financial system is dominated by large state-owned banks, and their business has mainly involved giving cheap loans to large SOEs (Wang & Bi, 2006; OECD, 2008). On the other hand, POEs are strongly discriminated against and almost do not stand a chance applying for bank loans.

The banks' intention to favour SOEs can first be attributed to the current legal framework, which remains contradictory with regard to the state-owned banks' independence from the state. According to Article 6 of the current Commercial Banking Law, *'commercial banks are ... protected from bureaucrati influence'* However, Article 34 contradicts the above, stating that banks are required to support to the PRC's 'industrial policies'. Moreover, '*... the traditionally close ties between government and bank officials at the local level have created a culture that has given local government officials substantial influence over bank lending decisions*' (OECD, 2005, p.140-141).

On the other hand, state banks show particular aversion to small and medium firms (SMEs), particularly private enterprise. SMEs on the whole contribute over 60 % of GDP, yet they only receive 16 % of total loans granted by China's financial institutions (*Stock Exchange Daily*, 19/01/2006). Further down the food chain are the private firms, mostly also SMEs. In 2001 under 1% of all loans granted by the national banking system has reached SMEs (Tsai, 2002). Some researchers argue that most state banks lack the administrative and technical expertise required for processing individual loan requests (Yang, 2005). That inexperience notwithstanding, the banking system remains institutionally biased toward state lending.

Many commercial shareholding banks and city or regional banks have recently appeared in the financial system. However, even these banks appear to be averstive towards the private sector: the new banks respond to *guanxi* like everybody else (Tylecote *et al*, 2010). This may be rational enough for these more commercially sensitive banks: private firms are more vulnerable to bureaucratic actions or inactions beyond their control; and if in trouble for any reason will not be bailed out by the state. They hence bear higher risks. So most of the new banks tend to favour large POEs with positive credit and those with collateral (Langlois, 2001)

In order to resolve the problem, the Central Government in the late 1990s, set up a network of more than 200 guarantee agencies across the country, which were supposed to help channel a total of US$ 4.8 billion in bank loans for the SMEs, including POEs (Pei, 2002). Although well intended, the same obstacles were faced with the credit guarantee system as had been faced by banks dealing with POEs and SMEs. First most POEs did not even qualify for the service due to the tough criteria set by SETC: in fact only less than 1 per cent of SMEs qualified (US Embassy in China, 2002). In addition, ironically, these guarantee agencies continued to favour large enterprises (Fung *et al*, 2007). Moreover, interest rate ceilings means that commercial banks would not be able to structure commercially viable loans for private borrowers. The result has been that formal credit channels are nearly closed to private businesses.

The stock market as source of funding

Originally, almost all listed companies are former SOEs. This was because that the original purpose of setting up stock market was to help SOEs solve their funding problems associated with the restructuring process. In fact this has not worked out (see below). On the other hand, stock market is rarely utilised by the private firms as a funding channel.

As another primary actor in the Chinese financial system, the mainland Chinese stock market has grown rapidly since its establishment in 1992. According to the annual report by the Shanghai (SSE) and Shenzhen Stock Exchange (SZSE), from 1992 to 2004 the number of listed companies went from 53 to 1377. By mid 2007 the combined market capitalization has reached US$2.2 trillion, accounting for 76.8 % of GDP[38].

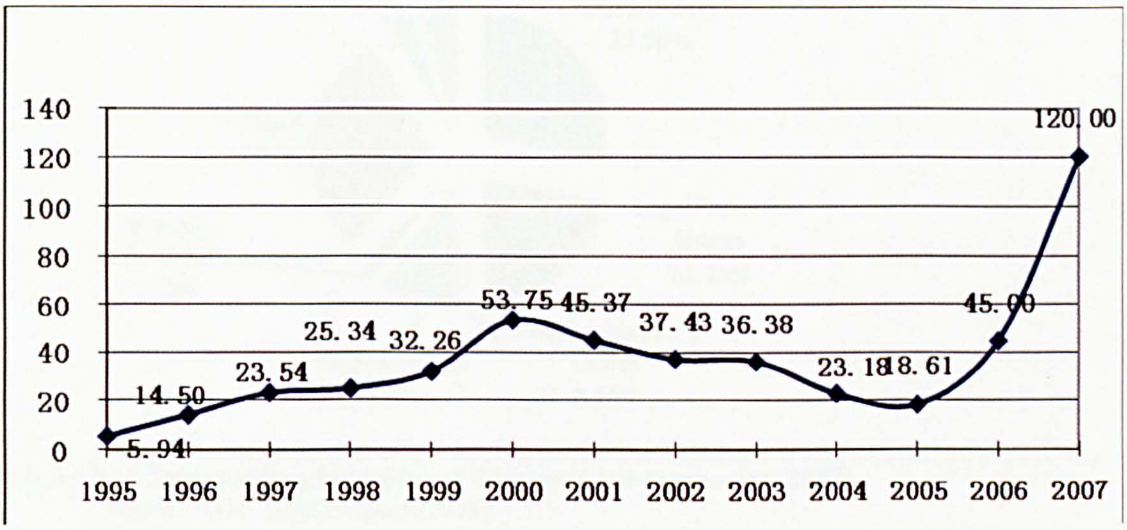


Figure 3-10 Total market capitalization of SSE and SZSE as percentage of GDP (%) 1995-2005
Note: As of end of calendar year
Source: SSE (2005), *China Daily* (08/01/ 2008)

China's stock market has a *split share structure* (*guquan fenzhi*). The shares controlled by the state may be owned directly by the governments at different levels, which may each own a substation number of shares of the same company (Zhang, 2007). These shares are termed 'state-owned shares' (*Guoyou gu*). They may be directly registered under the governmental departments, or may be held by companies specially created to hold and administer state shares. Furthermore, non-shareholding SOEs or not-for-profit organisations (such as universities) can hold shares too, so can their subsidiaries. These shares are termed 'state-owned legal person shares' (*Guoyou faren gu*). In addition to the distinction between tradable and non-tradable shares, all tradable shares of Chinese companies are divided into 3 categories. 'A' shares are the most common category:

[38] After Feb 2008 the Chinese stock market was affected by the global financial crises and experienced drastic devaluation. The total market capitalization had dropped by over 60 % by end of 2008 (Stock Daily, 01/01/2009): <http://*stock.jrj.com.cn/2009/01/0109303219097.shtml*>.

those domestically traded in RMB in SSE or SZE. 'B' shares are those traded in China although in foreign currency. 'H' shares are the shares of Chinese companies traded outside of China (including HongKong).

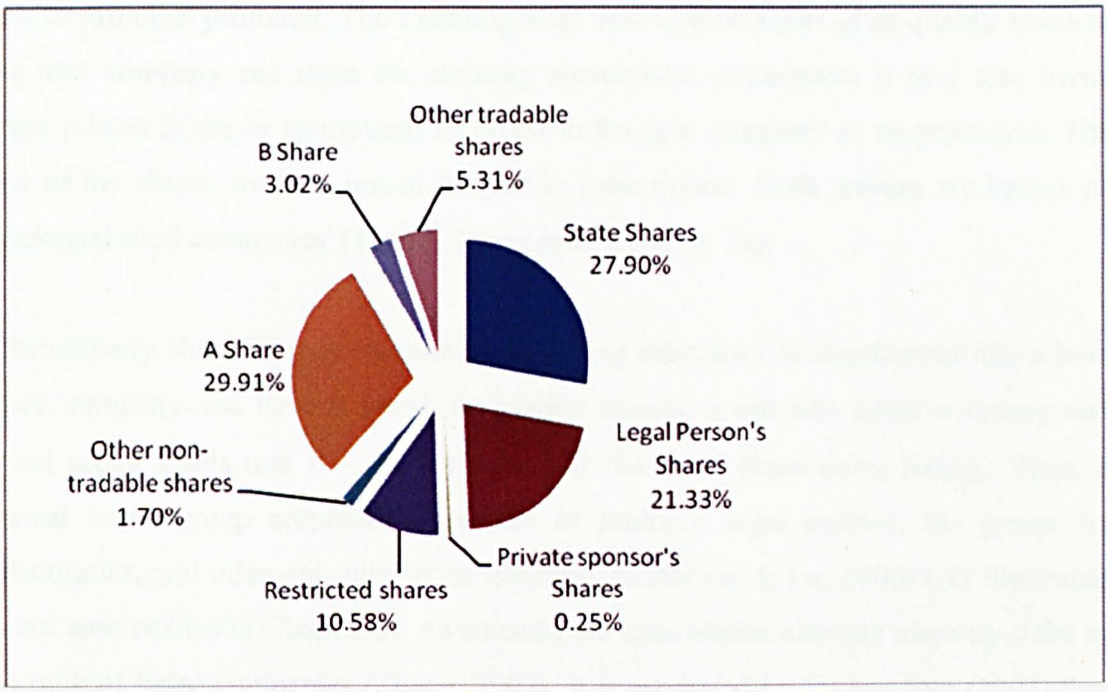


Figure 3-11 Shareholding Structure of Chinese listed companies (2007)
Source: CSRC annual report (2008)

Before September 2005, both state-owned shares and state-owned legal person shares were not allowed to be traded on the open market, and the non-tradable shares accounted for around 2/3 of the total shares issued (Xu and Wang, 1999; Tylecote and Cai, 2004). This model is changing, now all non-tradable shares are being converted into tradable shares (Mattlie, 2007), and according to CSRC, this process to be accomplished in late 2010 (CSRC website). While it is likely that the state is selling a part of its massive shareholdings, it is by no means certain that these newly converted tradable shares are to be sold. As of January 2009, 68.15 % of shares listed on SSE were still not circulated (according to SSE, data of the same period not available for SZSE).

Originally, almost all listed companies are former SOEs. This was because that the original purpose of setting up stock market was to help SOEs solve their funding problems associated with the restructuring process (although it has hardly worked out). The common practice of listing is for an SOE to set up a new company and acts as the sole or principal promoter. The founding SOE then channels part of its quality assets to the new company and stays the majority shareholder. Sometimes it may also invite other related SOEs or institutions to invest in the new company as co-promoters. The rest of the shares are then issued for public subscription. Such entities are known as 'packaged shell companies' (Tenev, Zhang *et al*, 2002, p. 75).

Alternatively, the SOE may transform an existing subsidiary is transformed into a joint stock company and have it listed, or quickly acquire a out-side listed company and inject group assets into it – the last is called '*houmen*' (back-door) listing.. Thus, a typical listed group corporation consists of multiple legal entities, the group, its subsidiaries, and often subsidiaries of subsidiaries (Meyer & Lu, 2006) (As illustrated in our case studies in Chapter 6). As a result, the state retains ultimate majority stake in the bulk of listed companies (Zhang, 2007). It is estimated by Lu and Sun (2003) that the state controlled around two-thirds of the total shares of listed companies. This figure is expected to have significantly dropped now, as in recent years the state has received or completely given up its shares in companies in financial distress flowing floating (Zhang, 2007).

According to the stipulation of the law, state companies or institutions or their subsidiaries are the legal shareholders of listed companies and exercise residual rights on these shares, but governments have some arbitrary influence over the ownership rights (Zhang, 2007; Socialismtoday.org: http://www.socialismtoday.org/122/hybrid.html). For example, appointment of top managers by the SOE controlling shareholders often needs to be approved by the state or even the Party (Liu & Sun, 2003; Firth *et al*, 2006).

On the other hand, the stock market is rarely utilised the private firms as a funding channel. Since stock financing for SOEs clearly benefited the government by reducing its fiscal burden, SOE listing was enthusiastically supported, partly by deliberately preventing non-SOEs from getting listed (Cao & Shi, 2000). Not until 1999 when the

Stock Exchange Law was revised did Chinese private firms enjoy equal treatment with SOEs when applying for listing. However, the stringent capital registration and profitability requirements mean that it is still impossible for most POEs to make their way into the stock exchange market. According to the new Stock Exchange Law, any firms to be listed must have at least RMB 50 million registered capital, and must have at least 1,000 shareholders with shareholding of 1,000 or more, and must pay out dividends within three years of initial public offering (Wu, 2003). Therefore, it is a commone practice for private firm wanting to be listed in the stock market to 'borrow a shell' – buy an already listed enterprise. This pragmatic approach not only incurs high cost but is also subject to hefty regulations (Bruton *et al*, 2003). As of end of 2001, out of 119 listed POEs in the 1175 listed firms in China, 65 were 'shell borrowers' (Wu, 2003)

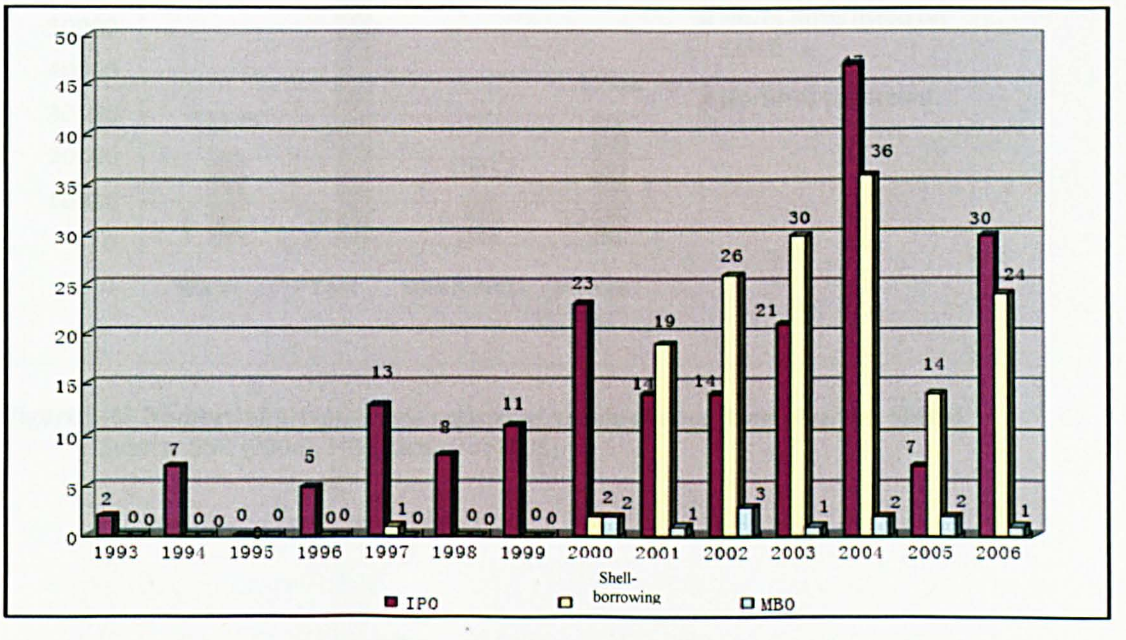


Figure 3-12 Number and method of listed private-holding firms. 1993-2006
Source: SSE (2008)

The Small and Medium Enterprise Board launched in June 2004 is supposed to help SMEs and POEs raise funds, however since it is a component of the main board; firms wanting to be listed on SMEB still have to reach same stringent list requirements. For example, CSRC requires that all firms to achieve a rate of return of 10% on net assets before they can be given permission to issue shares (Xiao *et al.*, 2004), and by stock exchange rules firms may be de-listed if they persistently report negative earnings (Buck *et al*, 2008).

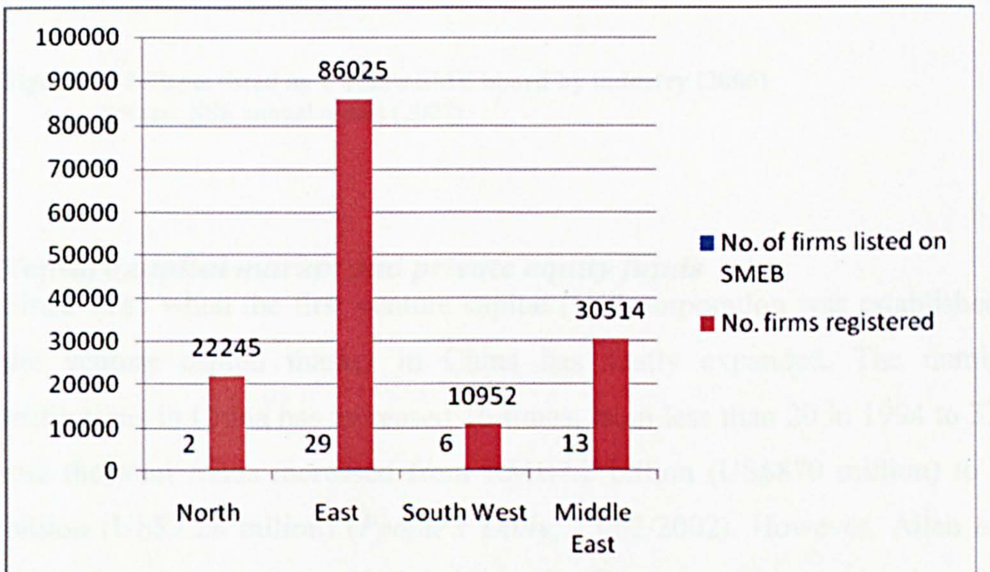


Figure 3-13 Number of private firms registered vs. number of firms listed on SMEB
Source: SSE (2006), NBS database (2006)

On the other hand, some private and family firms are reluctant to get listed, owing to the fear of ownership and controlling power dilution associated with listing. Nor are they willing to follow the rules of regular information disclosure or shareholders' meetings. One extreme example is Wenzhou, the city with the highest number and development speed of POEs. None of Wenzhou's over 130,000 POEs is listed, and most of them chose not to (*Wall Street Journal*, 30/03/2005).

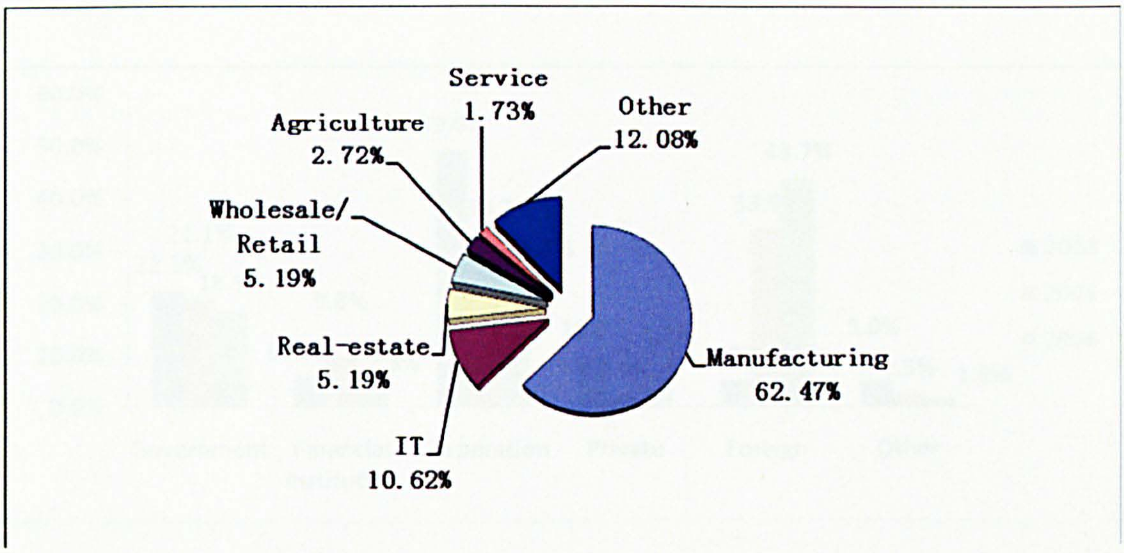


Figure 3-14 Firms listed on China's SME board by industry (2006)
Source: SSE annual report (2007)

Venture capital market and private equity funds

Since 1985 when the first venture capital (VC) corporation was established in China, the venture capital market in China has vastly expanded. The number of VC institutions in China has increased 16 times, from less than 20 in 1994 to 336 in 2006, and the total funds increased from RMB7.2 billion (US$870 million) to RMB 58.3 billion (US$7.28 billion) (*People's Daily*, 15/02/2002). However, Allen *et al* (2006) show that the venture capital industry in China is still underdeveloped and has a limited role in supporting the growth of young firms.

Until very recently, venture capital in China was still a state-controlled business. Up till the end of 2003, government or state-controled corporations still control more than 80% of VC funds in China, and only less than 15 % were provided by foreign and private investors (Fung *et al*, 2007). Since 2004, due to the relaxed policy constraint following China's WTO entry, foreign VC institutions started to invest in Chinese domestic businesses, either through offsetting-up a new VC company or by investing directly in an existing Chinese firm. Consequently, the landscape of VC in China significant changed. As shown inFigure 3-14 Figure 3-15, in 2006 around 40.57 % of available VC funds were from foreign investors. As for actual VC funds invested in 2006, 76.1 % came from investors with foreign background, whereas domestic funds only accounted for 23.9 % (Fung *et al*, 2007).

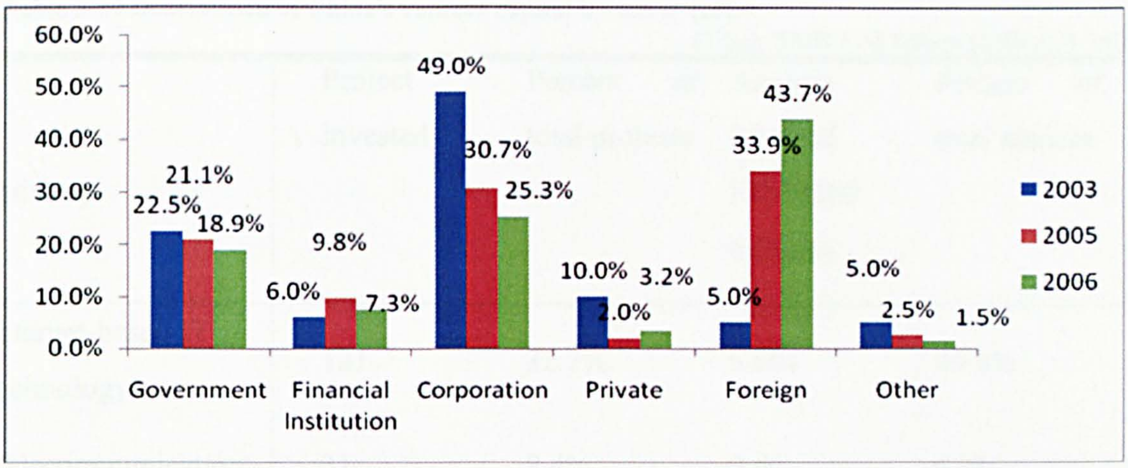


Figure 3-15 Sources of Venture Capital Funding in China, 2003-2006

Source: Composed based on annual report of Venture Capital in China (2006), China Venture Capital Research Institute

Venture capital investment in China features distinctive sectoral, development stage and geographic concentration. Most VC chose to invest in high-technology projects. As Table 3-10 shows, in 2006 the most invested VC projects were in 'internet-based IT' sector, accounting for nearly 1/3 of all; other popular VC destinations included 'traditional manufacturing' and 'energy/environment' projects. These three sectors together accounted for 64.05 % and 70.62 % of total projects and amount invested. In contrast, 69.94 % of the RMB 4.46 bn (US$ 557 million) invested by foreign funds all went to internet-based IT sector (Annual report of Venture Capital in China, 2006) – foreign venture capital investment has a higher sectoral concentration rate.

Table 3-10 Distribution of China's venture capital by sector (2006)

(Total: RMB 5.58 billion [US$ 6.98 bn])

Industry	Project invested	Percent of total projects	Amount invested (RMB100 million)	Percent of total amount
Internet-based IT technology	121	32.7%	63.01	43.9%
Telecommunication	31	8.4%	9.04	6.3%
Traditional manufacturing	60	16.2%	20.57	14.3%
Integrated circuit	31	8.4%	7.89	5.5%
Biotechnology	16	4.3%	8.76	6.19%
Energy/Environ-ment	56	15.2%	17.84	12.4%
Pharmaceutical	22	6%	1.72	1.2%
Financial service	8	2.2%	6.03	4.2%
Other	26	7.01%	8.78	6.11%
Total	371	100%	55.76	100%

Source: Author's calculation based on annual report of Venture Capital in China (2006), China Venture Capital Research Institute

Geographically, venture capital investment in China has concentrated mostly in the developed coastal regions. The Bohai Area (round Beijing), Yangtze Delta and Guangdong province took 85.28 % of total investment projects and 93.28 % of investment amount in 2006 (Yu *et al*, 2007).

While more and more funds tend to shift to the later stages of firm development, less than 10 % of venture capital investment projects were in the seed or start up phase (see Figure 3-16). In 2006, 55.92 % of total venture capital investment went to projects in their expansion or mature stages. This trend indicates that risk aversion of VC investors has in fact become stronger, and is likely to impede the development of cash-thirsty high-tech young firms. A number of factors deter venture funds from injecting into start-up POEs. Any firm seeking VC must show at least three years of financial accounts – and accounts in China are unreliable anyway. To evaluate a firm, a venture investor needs to know what sort of *guanxi* is possessed by the firm and by its managers as individuals, and how much they can capitalise that: as we have shown, these *guanxi* constitute valuable assets in Chinese context (Bruton *et al*, 2003).

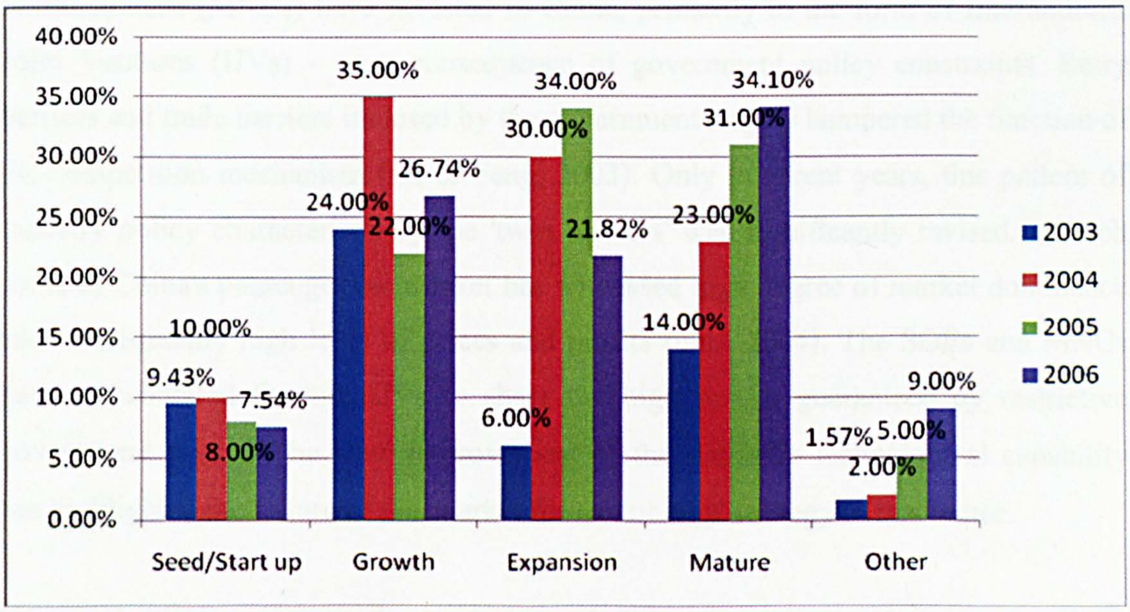


Figure 3-16 Distribution of China's venture capital by development stage

Source: Annual report of Venture Capital in China (2006), China Venture Capital Research Institute

3.4 The Chinese Automotive Industry: the industrial context[39]

Globally, the automotive industry remains one of the most important industries in the modern economy and contributes a prominent share of total GDP and employment. China regards automotive as one of its pillar sectors and has given it high strategic importance to develop. Quantitatively, it ranked fourth in the largest automotive manufacturing countries in 2003 and progressed to third in 2008. Nevertheless, China's passenger car industry is still in an early stage. The Chinese government seems to have pursued a 'third road' of industrial development in which Inward Foreign Direct Investment (FDI) was invited to reshape the industry during the reform period. During a relatively short period of time, the national market developed rapidly against a background of the fastest growing economy in the world. Most leading car-producing multinationals (MNCs) have invested in China, primarily in the form of International Joint Ventures (IJVs) – as a consequence of government policy constraints. Entry barriers and trade barriers imposed by the government largely hampered the function of the competition mechanism (Lu & Feng, 2003). Only in recent years, this pattern of industry policy characterised by the 'twin barriers' was significantly revised. In such context, China's passenger car market has witnessed high degree of market dominance and consequently high level of prices and profits (until 2004). The SOEs and MNCs have collaborated through IJVs to share the high profits guaranteed by restrictive government policy. The slow improvement of the domestic technological capability has highlighted the failure of the 'market for technology' strategy in this sector.

During the last ten years the landscape of China's automotive industry has been transformed, with the gradual introduction of increasing competition from abroad, and the sudden introduction of increased domestic competition from relatively small new entrants such as Chery and Geely. In subsection 3.4.1 we first examine the evolution of China's automotive industry in general and passenger car industry in particular, and

[39] Unless otherwise stated, much of the information relevant to the development of the Chinese auto industry (including passenger car sector) is from the China Association of Automotive Manufacturer (CAAM) website (www.caam.org.cn). This is because information of this type is fact-based and official statistics are relatively reliable. Other sources used in this section include Liang (2004) '*New Competition – foreign direct investment and industrial development in China*' which is a Ph.D thesis of Rotterdam School of Management, Erasmus University Rotterdam; Lu, F., & Feng, K. (2004) *Fazhan woguo zizhu zhishichanquan qichegongye de zhengce xuanze (In Chinese: The Policy Choice in Developing China's Proprietary Car Industry)*. Beijing: Beijing University Press.

some main characteristics of the industry context. In 3.4.2, industry policy is discussed alongside evidence of the bad effects of 'featherbedding' and the classic mal-governance of state-owned firms. Subsection 3.4.3 summarises the current development of China's passenger car industry.

3.4.1 Industrial evolution

The Chinese government has always attached great importance to building a strong automotive industry since the foundation of the People's Republic of China. In 1956 with help from the former Soviet Union, First Auto Works (FAW) was set up in Changchun. In the mid- 1960s China began to build its second auto factory with its own effort, the Dongfeng Motor Corporation (DMC). In 1960, the total output of motor vehicles exceeded 20 thousand and increased to 222,000 in 1980, the products principally medium-sized trucks (CAAM website).

In the pre-reform era of mid 1970s, China's automotive industry experienced stagnant development in a planned economy. In 1979, there were 130 assemblers making 186,000 motor vehicles, most assemblers had production of fewer than 1,000 vehicles. In 1980, over 75 % of the motor vehicle production was commercial vehicles, mostly medium-sized trucks, while the share of passenger cars was under 2 %. Product diversification, therefore, became a major aim in the government-led restructuring (Liang, 2004). Since the mid-1980s, the Chinese government started to shift its strategic focus from heavy- and light-duty trucks to passenger cars, resulting in a production boom of the passenger car industry, which is the main concern of this section.

The reform period since the late 1970s witnessed an all-round growth of China's automotive industry, particularly in the passenger car sector. For a long period of time, entry restriction and high tariffs imposed by the central government prevented both domestic and international competition. The situation gradually changed after the WTO access, as new international rules were increasingly complied with and government policies adjusted accordingly (for details of policy adjustment see the next subsection). Moreover, as a nation of rapid economic growth and a large population with almost zero penetration of private cars, the demand for passenger cars is explosive.

Consequently, a new phase of industrial development began since 2001, and the growth of automotive production accelerated with the structure dramatically shifting towards passenger car manufacturing. In 1990, the total production of passenger cars in China was merely 42.2 thousand. In 2006, China produced 2.33 million motor vehicles, including 703.5 thousand passenger cars. In 2002 the two numbers increased respectively to 7.28 and 3.87 million (see Figure 3-17). The percentage of passenger cars in total automotive production increased to 53 %.

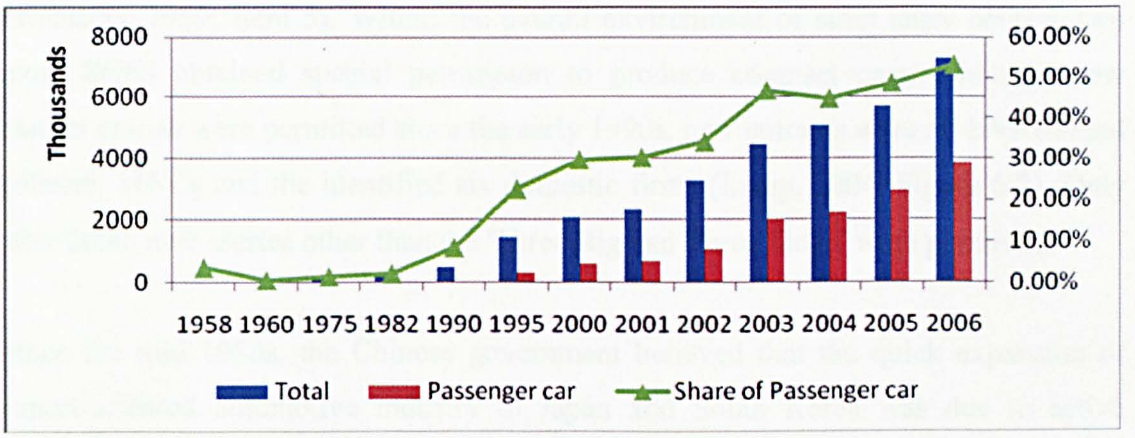


Figure 3-17 China's automotive production, 1958-2006[40]

Source: China Automotive Industry Yearbook 2007, China Association of Automotive Manufacturers, Beijing.

3.4.2 Industrial policy

As an industry that had heavy legacies of state planning and central to the government's development strategy, China's automotive industry has been largely led by government policy and intervention. Two of the most influential policies that have hampered the development of China's automotive industry have been 'entry restriction' and 'market for technology'.

Based on the argument that the Chinese automotive industry was in a highly fragmented structure, entry restriction was implemented continuously by the government agencies responsible for the regulation of this industry (Liang, 2004). In 1986 the Automotive Industry was officially listed as one of China's 'Pillar Industry' for explicit support. In 1988, the government sanctioned three major car assemblers, FAW,

[40] This figure is also published in Tylecote, Cai and Liu (2010).

DMC and SAIC, plus three smaller ones in Beijing, Tianjin, and Guangzhou. This was known as the 'Three Big and Three Small' Strategy[41]. The effort to limit new entries was confirmed by the later-formulated first industrial policy for the automotive industry in 1994. From 1989, one year after the establishment of the 'Three Big and Three Small' strategy, motor vehicle made by non-sanctioned firms has been included in the list of products that need to be strictly controlled (*Quanguo qi che, min yong gai zhuang che he mo tuo che sheng chan qi ye ji chan pin mu lu guan li zan xing guiding* (Provisional Regulation for the Administration of Automotive Vehicle Production and Producer), 1989: Item 5). Within the overall environment of strict entry control, two more SOEs obtained special permission to produce compact cars. Although new market entries were permitted since the early 1990s, new entrants were all IJVs formed between MNCs and the identified six domestic firms (Liang, 2004, Figure 6-2). Only after 2000, new entries other than the 'Three Big and Three Small' were permitted.

Since the mid 1980s, the Chinese government believed that the quick expansion of export-oriented automotive industry in Japan and South Korea was due to active government interventions (Aoki *et al*, 1996). As a result, China's first formal industrial policy was issued to the auto industry. The policy was formulated in 1994 and modified in 2004. In February 1994, the formal State Planning Committee released the 'Automotive Industry Industrial Policy'. As a long-term plan for industrial development, the automotive industrial policy highlighted the Chinese government's determination to building a strong national automotive industry. In 2004, this policy was replaced by 'Automotive Industry Development Policy' released by National Development and Reform Commission (NDRC).

The 1994 industrial policy reinforced the strategy of stringent entry control, and like many other government policies it not only established objectives but also dictated specific means. 1) It named the State Administration of Machinery Industry (SAMI), a small bureau under the State Economic and Trade Commission (SETC) to implement entry control through a system of product catalogue management (Automotive Industry Industrial Policy, 1994, Chapter 2). 2) The policy also provided detailed administrative

[41] In a meeting held by the State Council in August 1987, FAW, DMC and SAIC has been identified as the three car production bases. In 1988, the State Council declared the 'Three Big and Three Small' Strategy in 'Notification on the Strict Control of Passenger Car Production Locations'. In a later national meeting on automotive industry held in Shanghai, 1991, the strategy was re-stressed (www.caam.org.cn).

screening at the product level, deterring the firm decision on the development of new products (Automotive Industry Industrial Policy, 1994: Chapter 3, item 10). 3) Moreover, according to Item 13 in the policy, firms reaching certain production capacity, which could only possibly be large SOEs, were given an array of fiscal and financial privileges, including tax refund, prioritised stock market floating, cheap bank loans, priority to access foreign funding allocation and policy-related zero-interest loans. 4) In addition, a product license system was established, serving as an effective administrative measure of entry restriction. As a result, in order to avoid 'inefficient competition', private firms and small SOEs were practically not allowed to enter the Chinese automotive market in the whole of the 1990s (Liang, 2004).

The 1994 industrial policy also encouraged foreign investment in the automotive industry. It was hoped that through establishing 50-50 shareholding international joint ventures, the domestic firms would gain access to the most up-to-date technology from their MNC partners. Such strategy was clearly reflected in the policy wording. In the first sentence about the industry's technology policy, the document reads: 'the government encourages and supports automotive enterprises ...to build product development capability through assimilating and absorbing foreign technology... the foreign technology to be introduced needs to reach the current international standard'. Nothing was mentioned about self-reliant learning and development.

Such strategy posed striking contrast to that of South Korea in the 1970s (Kim, 1997). In 1973 the Korean government released its 'Long-Term Development Plan for the Automotive Industry', in which it requested Korean firms to design and develop their own cars. The Chinese policy on the other hand, only set 'product content localisation' as the industry's development objective in the 1990s. The logic was linear and over-simplified – that by achieving parts and components localisation, the industry would automatically achieve self-reliant R&D (see Figure 3-18). However content localisation involves a different set of technological activities than product development, and therefore requires (and consequently develops) different capabilities. Automotive vehicle product development is R&D intensive, which requires the capability of system integration (Teece *et al*, 1997) – bringing together the component subsystems/technologies into one and ensuring that the subsystems function together as a system. Parts and components manufacturing on the other hand is based on production, and mainly involves the capability to manufacture against specifications and requirements. Therefore it does not automatically generate indigenous R&D capability. The unsatisfying performance of the protected SOEs proved such an approach wrong (see the next subsection for more details).

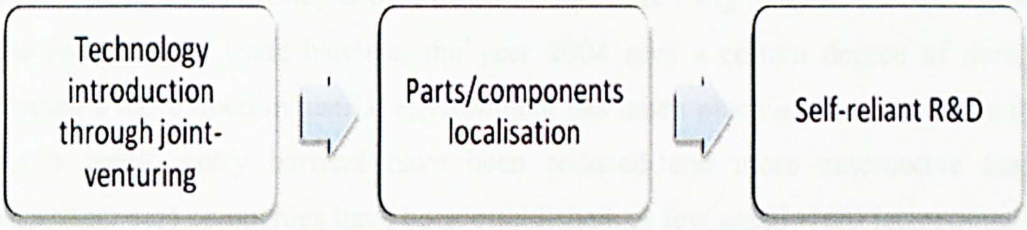


Figure 3-18 Hypothetical trajectory of technological development in China's automotive industry-policy before 2004

Source: Own composition

In May 2004, the NDRC released the 'Automotive Industry Development Policy', the newest version of industrial policy, with the new situation after China's WTO entry in consideration. The new industrial policy has eliminated the provisions related to FDI in the previous version that did not comply with the WTO obligations. The local content requirements have been eliminated, but the restrictions on foreign equity and on the number of IJVs participated by one foreign firm have remained. Surprisingly, despite of heated policy debate and open objection by industry experts, the new policy further increases barriers to entry. Although the administrative screening has been simplified, a series of criteria for investment projects of motor vehicle production have been prescribed. The threshold investment level for new automotive projects has been increased to from RMB 500 million to RMB 2 billion (average inflation rate during the 10 years has been -0.3 %), and a R&D centre with investment of over RMB 500 million must be established. This threshold imposed a restriction to relatively small-sized projects, especially those with private capital investment. By forbidding the transfer of production license, the new industrial policy also blocks new entry through mergers of small incumbents. Again private and small state firms have been officially blocked by the new industrial policy as a consequence. Although the industrial policy alleged to aim at the 'creation of a fair-competitive and integrated market environment', it did not treat different firms equally – as 'large-scale automotive group', firms with over 15 % market share can implement their own development strategy with the permission of the NDRC. Although no firms were specified, the SOEs with over 15 % market share in 2004 were only FAW, SAIC and DMC – the Big Three (www.caam.org.cn).

3.4.3 Current development in the passenger car industry

Following a heated policy debate triggered by Lu & Feng's report (2004), coupled with the reduction of trade barriers, the year 2004 sees a certain degree of deregulation toward a more open industrial environment has taken place in the automotive industry. As a result, entry barriers have been reduced and more automotive (especially passenger car) companies have been established. A few small-sized latecomers, such as Geely, Chery and BYD walked sideways and managed to get the license to produce cars. Most of them demonstrated determination to carry out own R&D and have out-performed the protected SOEs (for detailed example, see case study of Chery in Chapter 6). As the production capacity of the industry increased rapidly, with latecomers speeding up their presence, competition has been intensified.

Although industrial analysts agree that China still lag far behind leading nations in innovation capability, production capabilities have expereienced remarkable and rapid growth. Fuelled by the rapid expansion of domestic demand, in two decades China has grown from a nation with almost zero automotive production to the third largest auto producer globally (Noble, 2006). According to Goldman Sachs, between 2005 and 2025 the Chinese automotive market will boom another 10 times, from 19 million units in 199 million, and overtake the US market (Wilson, Puroshothaman, & Fiotakis, 2004, p.23). Meanwhile, in sharp contrast to their almost negligible presence in 2000, domestic brands are now making speeded appearances and taking over the low-end market (see Table 3-11 and

Figure 3-19). In early 2009, China's domestic brands for the first time take up more than a quarter of China's passenger car market (*Xinhua*, 24/03/2009: http://news.xinhuanet.com/auto/2009-03/24/content_11060476.htm). In the February 2009 top 10 ranking, 4 out of 10 brands were domestic, again an unprecedented rise. Latecomers such as Geely, Chery and BYD have been the fastest growing Chinese car firms.

Table 3-11 Market share and concentration ratio in China's passenger car industry, selected years[42]

Year	1986	1990	2000	2004	2006
Domestic brands (%)	--	--	4.1	10.5	25.7
IJV brands (%)	83	69	83	77	71
Concentration ratio (C3) (%)	99	71	65	48	46

Note: Calculated according to the production data (units of passenger car produced)
Source: CAAM

The recent success of Geely and Chery in China's passenger car industry demonstrates that domestic brands can establish their competitiveness in a market that has already been dominated by international brands. Table 3-11 shows how 'domestic brands' – made by domestically-owned firms outside joint ventures – have held their position in the domestic market in spite of the increased openness to foreign competition (from wholly-owned subsidiaries as well as imports) following WTO entry in 2001. Chery is the first Chinese domestic passenger car brand to have sold 300,000 units in a year. In 2006 one of its models ranked first in the best-seller list on the Chinese market; and Chery's domestic market share growth also surpassed all of its competitors – foreign or domestic. Exports of these domestic brands have also begun to climb rapidly. Chery has become the biggest car exporter with headquarters in China. According to the statistics of International Organization of Motor Vehicle Manufacturers, in 2006, Chery has become the world's fastest growing car manufacturer at the rate of 65.62% (http://oica.net/wp-content/uploads/2007/07/chery.pdf).

[42] This table is also published in Tylecote, Cai and Liu (2010).

Table 3-12 Production and market shares of Chery and Geely, 1999-2007 selected years[43]

Firm	1999		2001		2003		2005		2006	
	Production (Units)	MS (%)	Production (Units)	MS (%)	Production (Units)	MS (%)	Production (Units)	MS (%)	Production (Units)	MS (%)
Chery	/	/	30,070	4.2	101,141	5.0	207,300	5.9	308,000	6.7%
Geely	3,750	0.7	23,808	3.3	85,000	4.2	150,000	5.3	238,080	4.6%

Source: Chery and Geely websites: www.Chery.cn; www.Geely.com.

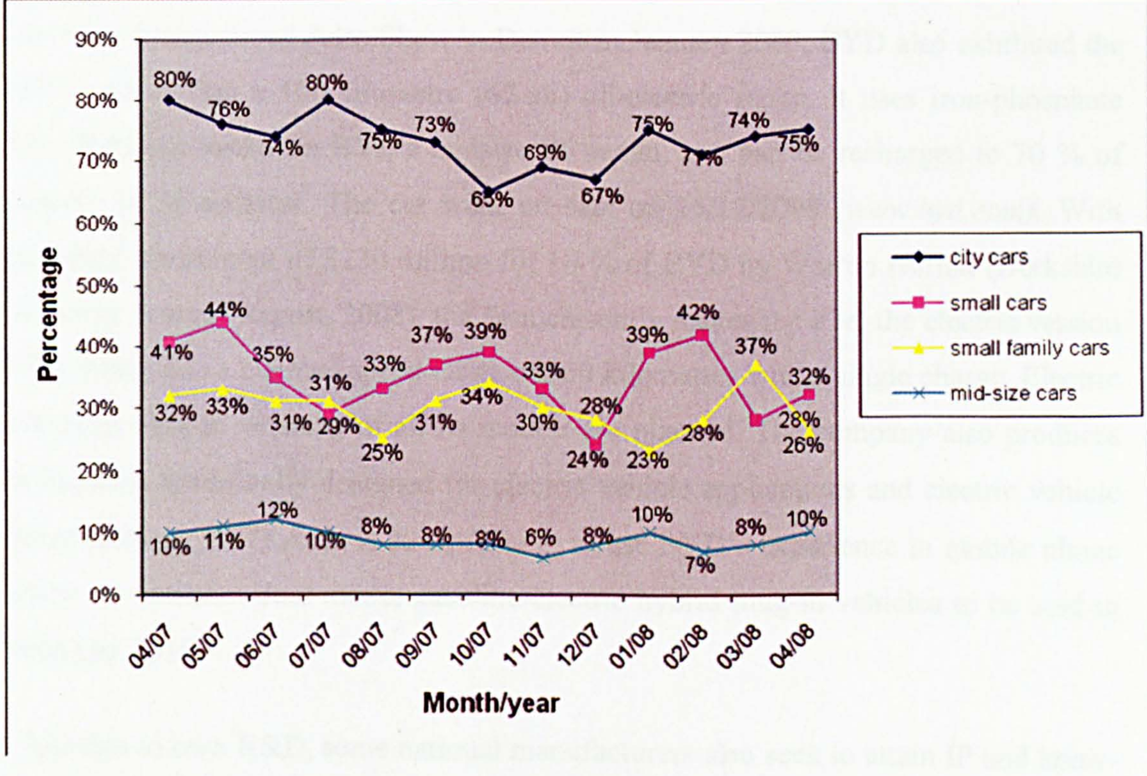


Figure 3-19 Market shares of domestic brands in passenger car segments, 2007-2008[44]
Source: Beijing Lange Steel Information Research Centre.
URL: http://www.lgmi.com/shanghailg/info/detailnewsb.asp?infono=514634 (accessed in June 2008)

[43] This table is also published in Tylecote, Cai and Liu (2010).
[44] This table is also published in Tylecote, Cai and Liu (2010).

Some national programmes and young firms are showing strong ambition to compete in cutting-edge innovations, such as the development of hybrid cars, electric cars and hydrogen fuel cells. For example, BYD Auto (*Biyadi qiche*) as a young auto firm established in 2003 has been leading the race of electric car development. In 2008 its parent, BYD, made '65% of the world's nickel-cadmium batteries and 30% of the world's lithium-ion mobile phone batteries' (BYD official website: *www.byd.com).*

The firm was established as BYD bought the bankrupted state-owned auto maker Qinchuan in west China and hence acquired tightly controlled license to produce automobiles in China. In first half of 2007, the company's F3 model was selling over 10,000 units per month. In addition to F3, the company has unveiled the new models F3R, F6, F8 and F1. BYD announced introduction of a production plug-in hybrid electric vehicle (PHEV) sedan in China in the second half of 2008. At the North American International Auto Show in Detroit in January 2009, BYD also exhibited the PHEV, which has a 100-kilometre (62 mi) all-electric range. It uses iron-phosphate based batteries based on BYD's midsize F6 sedan, and can be recharged to 70 % of capacity in 10 minutes. The car went on sale on 15/12/2008 (*www.byd.com).* With confirmed investment of $230 million for 10 % of BYD by Warren Buffett (Berkshire Hathaway Annual Report, 2008), the firm currently makes the F3e, the electric version of F3, which has a claimed speed range of 350 kilometres with a single charge. Electric as well as plug-in versions of all its models are planned. The company also produces car batteries specifically designed for electric vehicle applications and electric vehicle charge stations. BYD Auto is also planning to use BYD's experience in mobile phone battery to construct dual-mode, gasoline-electric hybrid plug-in vehicles to be sold in Europe by 2010.

In addition to own R&D, some national manufacturers also seek to attain IP and know-how through global mergers and acquisitions (M&A). For example, China's largest auto parts manufacturer Wanxiang has performed extensive M&A and Greenfield activities in 30 companies in eight countries, including United States, England, and Germany (Altenburg *et a*l, 2008). As for BYD, through acquisition and reconfiguration of BAIC's mould divisions, it has now become one of the largest Chinese auto mould producers and the only Chinese car assembler with passenger car complete-mould-set production capacity. In 2008 it also started to enter the international market by supplying moulds for Land Rover's new models (*Moju zhizao* [in Chinese, Mould manufacturing], 11/2008). The largest auto maker SAIC also acquired a majority stake in Korean Ssangyong (Liu & Tylecote, 2009) as part of its intention to build Chinese cars with its own brand. However it remains to be seen whether such capital operatioins really boosts indigenous capabilities.

3.5 The Chinese Electronics Industry: the industrial context

The electronics industry in China has developed remarkably during the reform era, especially since the early 1990s. The total sales and profits increased from RMB 49.2 billion and 5.7 billion in 1989 to RMB 2,996.9 billion and 188.9 billion in 2005, and the total export jumped from US$ 2.8 billion to US$ 268.2 billion during the same period. In 2003, China surpassed Japan by almost 20 % to become the second largest producer of electronics products (MII). It has also become the single largest manufacturing industry in China in terms of both output and export.

China's imports and exports of electronics and information products reached US$885.4 billion in 2008, up 10 % from the 2007 (*Shanghai Daily*, 19/02/2009). Exports rose 13.6 % to US$521.8 billion, which accounted for more than a third of China's total export. Imports expanded 5.4 % to US$ 363.7 billion, or 32.1 % of the country's total import. More than 75 % of the industry's exports in 2008 were telecommunications products, computers and home audio and video products. According to the National Development and Reform Commission (NDRC), China's production of mobile handset, colour TV, monitor and central office switches in 2006 accounted respectively for 35, 40, 55 and 30 % of the world's total. In 2006, 40 % of colour TVs, 50 % of mobile handsets and PCs, and 60 % of monitors produced in China was exported (NDRC website: www.ndrc.gov.cn).

It is a broad consensus that FDI played a central role in shaping China's electronics industry (Ma, Nguyen, & Xu, 2006). The largest exporters remain foreign, but several Chinese electronics firms have rapid grown to become global players in under 20 years, and the most famous examples include Huawei Technologies, Lenovo, and the Haier Group (see Altenburg *et al*, 2008 for a snapshot of these firms)

Chinese electronics multinationals are serious about the competition, each dedicating substantial resources to innovation. Huawei, for example, claims to have almost 30,000 employees in this field and to invest more than US$1 billion in R&D (Altenburg *et al*, 2008). Like in other export-oriented industries, Chinese electronics firms initially depended heavily on insertion in global value chains for technological catch-up: through low-cost OEM according to the specifications of foreign customers, these Chinese subcontractors quickly learned how to carry out mass production. Furthermore, the explosive boom of domestic markets for PCs and consumer electronics also brought enormous economies of scale. Chinese leading firms quick accumulated experience in both the home and export market. For example, Chinese personal computer brands in 2004 had roughly two thirds of the domestic market (Zhou, 2005, p. 1121).

However, the apparent prosperity in the Chinese electronics industry does not withstand closer inspection. It is undeniable that apart from a small number of enterprise mentioned above, the Chinese electronics industry as a whole still mainly operate on the low value-added manufacturing, packaging and assembly end of the global value chain. In value terms, more than 80 % of the exports were only processed or assembled in China with materials supplied by overseas clients, according to MII (*Shanghai Daily*, 19/02/2009). From 1995 to 2001, foreign invested firms increased their value added share in Chinese industry by an annual rate of 18% on average. In the electronics industry, foreign invested firms account for at least 65% of total value added (Hu & Jefferson, 2009).

In the next three subsectors, we examine three areas where China's manufacturing strength lies: consumer electronics and telecommunication equipment.

3.5.1 Consumer electronics (non-white goods)

The consumer electronics industry was the first segment within the Chinese electronics industry to grow up. According to international standard definition (ITU website), this segment includes two broad ranges of consumer electronics categories: white goods and brown goods. White goods include refrigerators, air conditioners, washing machines, and other household appliances, which is not included in our observation. Brown goods include home audio and video products such as television, DVD players, MP3 players, digital still cameras, personal digital assistants (PDAs) and home stereo systems, as well as portable audio products.

The development of the consumer electronics industry in China features temporary success after foreign technology introduction in the 90s, and fierce price war afterwards (Woetzel, 2003, Gao *et al*, 2007). Starting from the early 1980s, MNCs have gradually moved the production of consumer electronics products from South-East Asian economies to lower cost countries, such as China. Due to China's protectionism industrial policy back then, these MNCs were not allowed to invest directly; hence some international joint ventures (IJVs) were established, such as Panda and Skyworth. They have been among the largest firms in this sector. On the other hand, the development of IJVs has been accompanied by the rapid growth of domestic firms, both SOEs and non SOEs. Home-grown firms such as Changhong (TV), Chunlan (Air Conditioner) were initially actively involved in technological learning and catch-up, and their effort brought them overwhelming success in the late 80s and the whole of 1990s. Unfortunately, after absorbing and assimilating technology introduced from foreign MNCs, these Chinese firms did not manage to gradually develop indigenous products and upgrade their technological capabilities. Therefore, most domestic Chinese firms continue to be located downstream of the global value chain (Gao, 2005).

In the meantime, following the homogenisation and commoditisation of these consumer electronics products, competition for Chinese firms was increasingly based on price. One may argue that in the name of defending the home-owned industry, price wars did help domestic firms fend off their foreign competitors temporarily. But the rising market share of some of the Chinese firms was at the cost of their domestic peers or even themselves (Liang, 2004). For example, Changhong TV sets have been sold by their weights — RMB 30 per kilogram. (*Zhongguo jingji shibao [China Economic Times]*, 12/06/2002). In 2001, the average profit level for Chinese TV manufacturers further reduced from 2.26% in 1999 to 2.05%, and caused an industry-side loss of nearly 3 billion Yuan (*Hong Kong Mail*, April 26th 2002, p. 2.).

3.5.2 Telecommunications equipment

Telecommunications equipment is an industry which is exceptional within the broader area of 'electronics/ICT' in at least two ways. The first is its success – to be precise, the success of mainland Chinese firms - in international competition. See Figure 3-20, Table 3-13 and Figure 3-21. The second is its independent approach to technological development[45] (Gao, 2003; Cai and Tylecote, 2005; 2008).

The rise of Huawei, the largest Chinese telecoms equipment manufacturer, has been remarkable. In less than 10 years, Huawei has set up 20 branches and 100 offices outside China, selling to over 100 countries and regions with over 1 billion customers. It has 12 foreign-based research centres and 28 regional training centres. In 2007, over 72% of its sales revenue was generated from the overseas market. In December 2005, Huawei, together with three other multinationals: Ciena, Lucent and Siemens, became supplier of British Telecom's $17.4 billion 21st Century Network (21CN), which '*... has been one of the largest single procurement programmes ever undertaken in the communications industry worldwide*'(BT Group, 9/12/05, http://www.btplc.com/21CN/WhatisBTsaying/Keymilestones/Keymilestones.htm).

ZTE, the second-largest telecoms equipment manufacturer, is following the same trajectory, approximately two years behind. From 2004 to 2006, the company entered partnerships with the top 50 global GSM/WCDMA systems equipment operators, as

[45] It can be, and has been, argued that it was this 'forced' independent development which made Chinese telecoms more successful than (for example) television manufacture (Gao *et al.*, 2007). However what happened in the telecommunications sector is that the only people (and organisations) who get to 'first base' by the end of the 1990s, were the ones which were capable of understanding a certain type of innovation strategy which requires a certain type of corporate governance (Cai & Tylecote, 2005).

well as six of the top ten WCDMA telecom vendors in terms of terminals. In 2006, it secured 10 WCDMA deployment contracts in Western Europe, South America and Asia Pacific. In 2007 its total revenue was $4.6bn, of which 57.8% was generated from overseas markets, and its sales growth in Europe and North America was 155%. (ZTE website:http://wwwen.zte.com.cn/main/News%20Events/Whats%20New/2008040260 720.shtml). *'It is believed that the recent merger and acquisition deals between Ericsson and Marconi, Alcatel and Lucent, and Nokia and Siemens were at least partly designed to 'fight off competition from Huawei and ZTE'.'* (Li, 2007 p.2). We are not aware of any other part of the ICT industries in which the leading players are (or seem to be) afraid of their Chinese rivals.

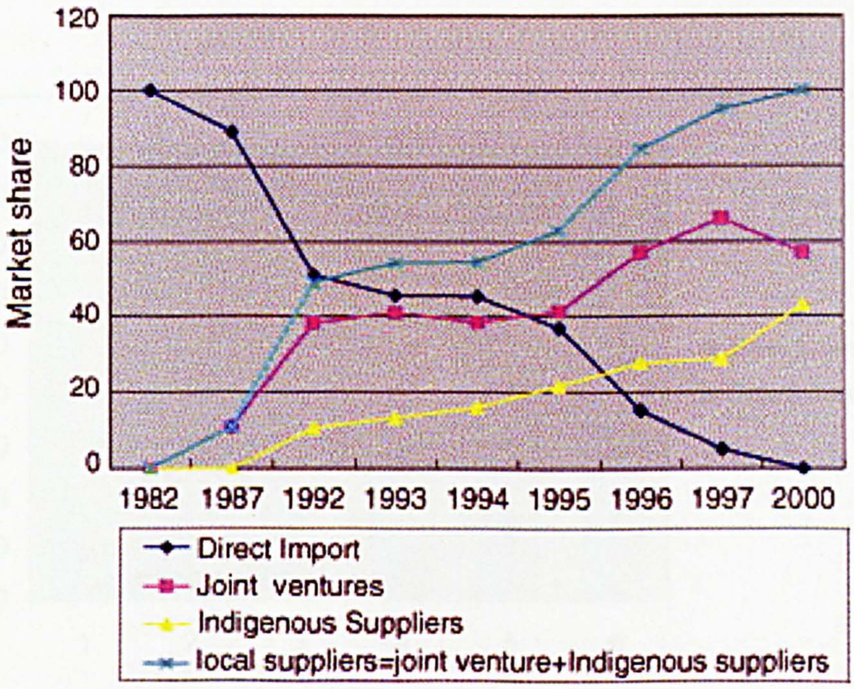


Figure 3-20: Local products vs. imported products in the telecom switch market in China (1982–2000)[46]
Source: (Mu & Lee, 2005)

[46] This table is also published in Tylecote, Cai and Liu (2010).

Table 3-13 Stored Programme Control Exchange (SPC) annual market share by three groups in China (1982 -2000)[47]

	1982	1987	1992	1997	2000
Direct import (%)	100	89	54	5	0
Joint venture (%)	0	11	36	63	57
Domestic supplies (%)	0	0	10	32	43

Source: (Tan, 2002)

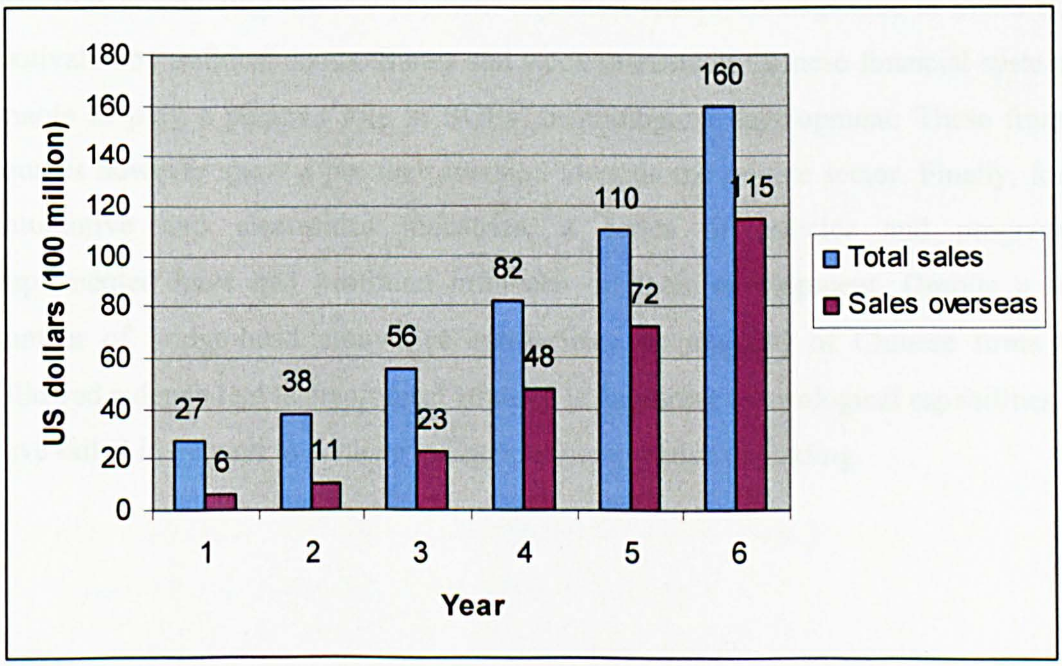


Figure 3-21 Value of sales contract of Huawei: 2002-2007 (100 million US dollars)[48]
Source: Huawei website: http://www.huawei.com/about/AboutIndex.do (Accessed 08, June 2008)

[47] This table is also published in Tylecote, Cai and Liu (2010).
[48] This table is also published in Tylecote, Cai and Liu (2010).

3.5.3 The Chinese electronics industry- conclusion

To sum up, China's electronics industry has developed rapidly, but it still is structurally poor. Apart from a small fraction of bridge-head firms such as Huawei and ZTE in the telecom equipment sector, China may have achieved economies of scale through mass production and export of electronic products, however most firm do not enjoy higher added value as they need to pay to use the core technologies.

3.6 Summary

The decision initially made to reform China's SOEs was not to privatise the large and medium SOEs, but to transform them into 'modern enterprise corporations' with as much state shareholding as possible. This strategy has been modified, but not abandoned. Chinese corporate governance in SOEs is far from aligning managers' interests with those of shareholders. Apart from financial reward (perhaps this is less effective, considering the low payment and short tenure) management in SOEs is also motivated by political status. Banks and stock markets in Chinese financial system are unable to play a positive role in SOEs' technological development. These financial sources however show a peculiar aversion towards the private sector. Finally, for the automotive and electronics industries, a series of policies and programmes implemented have had profound influence on their development. Despite a small number of bridge-head innovative companies, the majority of Chinese firms have followed a dependent technological strategy in acquiring technological capabilities, and have failed in general to achieve indigenous competence upgrading.

Chapter 4 Theoretical Frameworks Used in This Study

This chapter describes the theoretical frameworks used in this study. Section 4.1 discusses a conceptual framework developed to measure technological capability of firms in newly industrialising economies. Measurement of capabilities in NIE firms should serve a predictive function; it is important to assess the firm's *potential* to enhance the dynamism of their technological capability. Therefore the concept of 'dynamic technological capability' is incorporated in the framework. Our definition is a synthesis of those of Teece *et al* and Winter's - the ability or the capability to generate change, to enhance future competitiveness in response to the competitive environment (see also Chapter 2, section 2.1.1). Therefore, rather than assessing firms' static capability – '*the ability at a given point in time to make a sophisticated product with advanced processes*' (Cai & Tylecote, 2008, p. 1794), we aim to measure the firms' ability to achieve continuous, far-reaching improvements in product and processes (independently). Based on critical review of previous attempts to measure technological capability in the literature (see Chapter 2, Section 2.1.2), a framework is proposed in Section 4.1 to capture the 'dynamism' of firms' technological capabilities. Moreover, it is argued that the firms' technological performance should also be measured to gain a complementary insight into their capability, namely, innovation performance, sales performance and product performance.

After the reality of China's corporate governance and finance system are reviewed in Chapter 3 Section 3.3, Section 4.2 adapts the theory of CGFS and technological capability development to the Chinese context. Section 4.3 describes the five general propositions to be investigated in the empirical research to follow.

4.1 Framework for measuring technological capability in this thesis

A combination of capability measurement and performance measurement is used in the empirical research.

4.1.1 Technological capability

The framework of technological capability in this study is composed of two dimensions. The first dimension is the *conceptualization* dimension, which defines four types of technological capability: Manufacturing, R&D, Internal and External Organisational:

- ***Manufacturing capability*** measures a firm's ability to convert R&D results into products in accordance with design request, which caters for market needs, and cost effectively (Yam et al, 2004).
- ***R&D capability*** measures a firm's ability to incorporate customer/market desired functions into product design/development process, to carry out necessary process/product improvement and innovation, and to respond to market and manufacturing feedbacks about design and manufacturing.
- ***Internal Organisational Capability*** measures a firm's ability to cultivate organizational culture, to secure organizational mechanism, and to adopt good practices to facilitate progressive, far-reaching technological improvement.
- ***External Organisational Capability*** measures a firm's capability to interact with other companies. More specifically, its capability to construct a specialized network with its suppliers upstream of its operation; and with its customers and buyers downstream.

There are 'elements' of capability within each type. For example, one of the elements of Manufacturing Capability is 'Manufacturing Cost Control'; another element of Internal Organisational Capability is 'Co-ordination and control of the major functions within the company'. These are fundamental building blocks of technological capabilities, as captured in Table 4-1.

The second dimension is the *operationalisation* dimension of the conceptual framework. It is concerned about the extent or strength of a firm's given element of capability: measured by *degrees*, which goes from degree 1 (below the average of the region) to degree 6 (advanced by world standard). Bear in mind that a firm could conceivably have high score in one or other element in Manufacturing Capability; and very low score in some element of R&D Capability. It would thus mean, to that extent, that the firm has high manufacturing capability, and low R&D capability – common in China (Cai & Tylecote, 2008). The converse (degree 6 in some element of R&D Capability, degree 1 in one of Manufacturing) is also perfectly possible for a firm which has long-standing research background but is new to manufacturing (examples can be found in public research institute spin-offs). Thus it might be skillful in reverse engineering, but poor in manufacturing. The framework is further elaborated below.

Table 4-1 The dimensions and levels of firms' technological capabilities

Types / Elements / Degree	***Manufacturing***	***R&D***	***Organisational***	
			Internal	***External***
Degree of capability ↓ **Below the average of the nation** **Average in the country** **Above average but not advanced in the country** **Advanced in the country** **Approaching world standards** **Advanced in the world**	• Overall level and capacity of machinery and equipment • Ensuring smooth functioning of equipments and routine production • Complying with the request of R&D • Manufacturing cost control • Total quality control • Making improvement to the manufacturing system • Utilising manufacturing process to contribute to the innovation process	• Overall R&D capacity • Communication within the R&D department • Process improvement • Process innovation • Incorporating desired functions in product design/development process • Quality and speed when responding to feedback from manufacturing about design and engineering • Incorporating market and customer needs/feeback in the improvement and innovation process	• Flexibility in adjusting organisational structure according to the need for technological developments • The culture and mechanism to encourage and reward inventiveness and creativity • Co-ordination and control of the major functions within the company • Initiative of sub-units within company strategy	• Access external knowledge (science, technology, techniques, know-how, tacit knowledge) • Performance of purchasing and procurement force • Relationship management with major customers • Knowledge and skills for collecting market intelligence • New markets development • Establishing and maintaining distribution channels • Provision of customer services

Source: own construction with some elements drawn from Yam *et al* (2004) and Cai & Tylecote (2008)

Conceptualisation Dimensioin: Types and elements

Types. In this study, as mentioned in Chapter 2, the typology of technological capability follows the basic notion of classification of Lall's, i.e. according to function. An array of empirical research regarding measurement of technological capability, have also been critically reviewed (see Chapter 2, section 2.1.2) and synthesized to form the framework. Particularly, instead of categorising technological capability by Product and Production as Lall did, we make a distinction between Manufacturing and R&D capabilities. This is done with China's empirical reality in mind - that pronounced separation between Manufacturing and R&D functions is commonplace, especially in firms with a tradition/history of state-ownership (which is partly a legacy of the planned economy; see Chapter 3, section 3.2.3). Therefore it is meaningful to measure firms' Manufacturing and R&D capabilities separately, as a firm strong in manufacturing might well be relatively weak in R&D, and vice versa.

The concept of Internal and External Organisational Capabilities is adapted from Arnold & Thuraus's work (see Figure 2-1), especially their typology of Internal and External capabilities, and the concept of organisational capabilities (OCED, 1992, see also Chapter 2, section 2.1.2). As mentioned above, it measures the firms' capability to coordinate and orchestrate internal and external efforts both on operational and strategic levels. Moreover, it emphasises the intangible aspect as well as the organisational characteristic of technological capabilities. As mentioned in Chapter 2, Section 2.1.2, we take into consideration of the mediating effect of linkage activities on capability development – that firms' linkage (networking) activities are partly influential to their development of other types of capabilities. It is hence sensible to leave out firm's specific linkage activities as elements of their organisational capability, as this may cause multi-collinearity issues in the quantitative study stage. Therefore when devising the elements for Organisational Capabilities, we focus on evaluation of the firm's capability to handle relationships on the strategic level, i.e. structural flexibility for innovation, cultural aspects, etc.

Elements used for capability evaluation have also been adapted and synthesized from previous empirical frameworks. Particularly, we incorporate the concept of routine-based evaluation. As argued in Chapter 2, Section 2.1.1 (Dynamic Capabilities), routines are good indicators of capability, and the efficiency of a certain routine reflects the degree of this type of capability being achieved (see below for an example in a routine in Manufacturing Capability). In this study we therefore include those routines which are both good reflection of firms' capabilities, and are relevant to the industrial sector.

Operationalisation Dimension: Degrees

In the second phase of empirical study (the questionnaire survey), in order to assess the sophistication of types of capability achieved by firms, all elements under all capabilities (Manufacturing capability, R&D capability, Internal and External Organisational capability) are ranked from Degree 1 to 6 (degree 1 – below average in the country; degree 2 – average in the country; degree 4 – advanced in the country, degree 6 – advanced in the world)[49]. It was assumed that firms have fully developed that element of capability when they reached 'Degree 5' The reason for using 'Degree 5' as the threshold is that 'Degree 5' means those capabilities are approaching the worlds' leading level. In empirical studies, an effective means to gather such information would be through subjective comparison with peers in the same sector (see Chapter 5 Methodology for details about collection of data in this study).

By using Degrees to evaluate capability elements/routines (see top of this page), it enabled us to apply the evaluation framework to a wide range of firms with varied dynamism of capabilities - since the selection of routines/elements used in the survey can indicate different Degrees of capability in different firms. For example, for the capability '...to comply with the request of R&D', an element/routine of Manufacturing Capabilities, Firm A may only have the basic ability to make to specification, hence is at Degree 2 or below (average in the nation). In Firm B, such routine may involve creation of new production systems or change of the current ones, and is therefore at Degree 5 or above. It hence can be said that Firm B has acquired dynamic capability in this element and Firm A has only acquired static capability.

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[49] Using a 6-scale Likert points instead of 5-scale has been proven to be effective in forestalling respondent's default choice of scale 3 (Jacoby & Matell, (1971) 'Are three-point likert scale good enough? *Journal of Marketing Research*, 8(4): 495-500 http://www.jstor.org/stable/3150242). Cai & Tylecote has also adapted similar scale points in their survey in the Chinese telecommunications industry (2008)

Reflections on the capability measures and further implications for this study

As with many other attempts to capture technological capabilities in the empirical work, the list of elements given in Table 4-1 should be regarded as an indication rather than definition. Its purpose was to *'...allow respondents to identify with reasonable precision the degree and types of capabilities they were rating in their firms'* (Cai & Tylecote, 2008, p.1798), and the case study and pilot survey (see Chapter 5, Section 5.3, 5.4 and Chapter 6) reassured that they felt they could do this.

Another crucial element of this framework is that it also facilitates differentiation of visibility among types of capabilities (see Chapter 2, section 2.3.3): the extent to which the type of capabilities respond to low-visibility technological activities and availability of finance. R&D capability and both internal and external Organisational Capabilities are assumed to gain more from low visibility activities than high-visibility ones (see Chapter 2, Section 3). Any such differential effect is likely to be less with manufacturing capability. For example, the 'overall levels and capacity of machinery and equipment' can be achieved via the purchase equipment and licenses – expensive but highly visible (as argued in Chapter 2 Section 3). The same would not apply to R&D capabilities, such as the capability of 'Incorporating desired functions in product design/development process'[50]. There, relatively low-visibility efforts would be needed and investment expected. Moreover, manufacturing capability should be most sensitive to the availability of finance, organisational capabilities least.

4.1.3 Performance measurement

As discussed in Chapter 2, Section 2.1.2, we also measure the firms' technological performance to gain a more complementary insight into their capability. We decide not to rely entirely on financial performance measurements since Chinese firms are normally very reluctant to reveal such sensitive data (Yam *et al*, 2004). Therefore three performance indicators – proposed by Chiesa *et al.*(1996) and successfully

[50] We are aware that some of the activities could be outsourced, however even in such a case the firm's overall ability to coordinate and orchestrate internal and external efforts towards innovation still reflects its overall technological capability, and is also incorporated in the Organisational Capability category of this framework.

experimented by Yam *et al* (2004) – were adapted in this study, namely, innovation performance, sales performance and product performance.

• Innovation performance is measured as '*the number of commercialized new products expressed as a percentage of all products in the company over the last 3 years*' (Yam *et al*, 2004, p.1127). It is generally accepted that the absolute number of innovations is not a good indicator for innovation performance (OECD, 1997) as the numbers varies significantly across sectors. On the other thand, innovation rate shows the relative innovative strength and therefore is a better indicator. Moreover, how effective and how efficient new product development takes place often reflects a firm's competitiveness (Lawless & Fisher, 1990; Yam *et al*, 2004).

• Sales performance is defined as 3-year average rate of average annual sales growth. It is a good indicator of a firm's market advantage. It also shows whether the innovation has been commercially successful (Yam *et al*, 2004).

• Product performance also helps to demonstrate a firm's innovation impact on the market. Chiesa *et al.*(1996) used a portfolio of elements to evaluate product performance, such as 'average concept-to-launch time', 'programming product series', 'quality leve'l, 'cost',,'technology characteristics', and 'price/function advantage' (p. 121). Most dynamic technological capabilities are behind the market success of products (Fu, 1998; Wu, 2001). In our study, eight different product related dimensions are measured through subjective evaluations by top executives on a Likert-type scale (see Chapter 5, Section 5.4).

4.2 Corporate governance/finance and technological capability development in China

As shown in Chapter 2, Section 2.3.3, the theory of the effects of corporate governance and finance on technological capability, although originated from empirical research of developed countries, can be adapted to NIEs. Following a thorough review of the general technological strategy and the CGFS of Chinese firms in Chapter 3, this section further adapts these frameworks to describe the reality of China.

As in any newly industrialising economy, domestic Chinese firms normally face the choice between:

- Dependent technological strategy, which often involves buying state-of-the-art, complete-sets of technology and equipment from abroad - a typical *high-visibility* technological activity (see shown in Chapter 3, Section 3.1.3);
- Independent, or 'imitative' technology strategy (see also Chapter 3, Section 3.1.3), by a deliberate and careful combination of sourcing (from abroad and domestically) and self-reliant efforts. It is relatively cheaper, and crucially, *less visible* than the first option, but will often benefit the firm's long-term technological capability development[51].

Historical review of corporate governance in Chinese SOEs shows that (Chapter 3, Section 3.3.1), traditionally, SOE top managers progress in their career path as officials. They are often chosen by officials, not necessarily for their entrpreneurship but political merit, and are allocated to them with a view to rotate. The time horizon in the job is thus short, and whilst in it there is need to quickly impress senior officials – who are takeo regular rotations, and not likely to take a long-term interest in the firm (Cai & Tylecote, 2005).

[51] Very well-funded firms connected to research institutes may have a third, very expensive option of complete self-reliance.

There are modifications of this situation alongside the move towards a more marketised economy. Especially, according to Cai & Tylecote (2005), the most significant modification happens when (fully or partial) sales of state stake take place. Although in many SOEs key appointment are still made 'administratively' (see also Chapter 3, Section 3.3.1), i.e. directly by the state; some are now selected by the shareholders (state or not), while the remaining adapt a middle route of recommendation or approval by the state. Since how they started may largely determine how they progress, the distinction in management selection method must will influence managers' behaviour and their decision-making. On the other hand, the size of the state shareholding is likely to affect the firm in other ways. It is not hard to imagine that in the Chinese context, firms with higher state presence would be better looked after by state finance providers, such as state-owned banks. Cai & Tylecote argue that firms might be pursuing other financial sources when the share of state falls below 50 % (2005; 2008). Therefore it may be useful to draw a line between firms with 50% or more state share (Majority SOEs), and those with fewer percentage of state shares (Minority SOEs).

Privately-owned firms (POEs) in China have a very different situation. As discussed in Chapter 3, Sections 3.1.1 and 3.3.2, being young (since 1980) and predominantly family-owned, they have shareholders who has every intention to be full-engaged, and with deep knowledge about their own firms. So information asymmetry does note often pose a dominant issue for these firms. However they are often financially handicapped, with discriminated access to finance and possibly other resources (Cai & Tylecote, 2005). As mentioned in Chapter 3, although private sector has become much less discriminated, they still clearly experience unequally treatment.

4.3 Propositions for empirical research

Based on the initial review of theoretical literature and China's context, four propositions are thus developed; each of them are operationalised for in-depth investigation in the empirical phase of this study, which are presented in the next four chapters.

Proposition 1. For Chinese Auto and Electronics companies, different types of ownership (e.g. MASOE, MISOE and POE) entail different patterns of corporate governance and level of access to finance;

Proposition 2. Firms with a certain pattern of corporate governance (e.g. intelligent engagement and inclusion) will excel (other things equal) in capability types which are sensitive to low-visibility activities.

Proposition 3. Firms with better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities.

Of these 3 propositions, the 2nd and 3rd have higher weight, as they help answer the key research question, i.e. what are the influential elements of corporate governance and finance on a firm's technological capability; and how these elements take effect (see Chapter 1, Research Questions).

Chapter 5 Research Methodology

This chapter introduces research methodologies which have been used in this study. Section 5.1 reviews the philosophical perspective underlying this research. Section 5.2 describes the two main research methods used in this study: multiple-case studies and questionnaire survey. Section 5.3 introduces the techniques used for conducting interviews and case studies. Section 5.4 describes how questionnaire surveys were designed and circulated, including information about population, sample size, administration of the pilot surveys and the final stage of large scale circulation. Section 5.5 summarises this chapter.

5.1 Philosophical perspective

All research (qualitative or quantitative) is based on some underlying assumption about the validity of research and appropriateness of methods (De Vaus, 2002). There have long been debates been two of the mainstream views of how research should be carried out in social sciences. They are social constructionism and positivism.

The main thrust of *positivism* argues that reality is an external existence, and can only be accessed through objective measures (Easterby-Smith *et al.*, 2002).

Two fundamental assumptions lie beneath this statement and other propositions of positivists: 1) Ontologically, reality exists as a piece of external, objective 'hard truth', and is not influenced by human perception or interpretation. 2) Epistemologically, knowledge can only be acquired through observations of the external reality, whilst the observations themselves must take an equally external and objective form. Consequently, positivists generally associate scientific research with the conventional physics type of approach, where they tend to believe truth can only be accessible through lab-condition experimenting, or in the case of social sciences, hypothesizing of fundamental laws.

It has been strongly believed that positivism offers the best approach to studying and understanding human and social behaviour, and for a long time dominated the literature. However, a new and contrasting paradigm has come into being, and philosophers of science start to argue that 'reality' is not only external, but socially constructed and are given meaning by people (e.g. Khun, 1960). The idea was further developed by many authors in social science authors and comes into being as the term *social constructionism*. It is concerned with the manners which we share experiences with others to make sense of the world, especially through the use of language.

Social constructionism, on the other hand regards reality as socially constructed, rather than what positivists believed to be objectively determined (Easterby-Smith *et a.l*, 2002) In the ontology of social constructionists, not only inanimate objects, but also humans are embraced in observable events. It therefore argues that the human interpretation of the phenomena and events should constitute the focus of research. *'The task of the social scientist should not be to gather facts and measure how often certain patterns occur, but to appreciate the different constructions and meanings that people place upon their experience*' (Easterby-Smith *et al.*, 2002, p.30). One should therefore try to 'make sense' of people's different experiences through attempts to understand and explain them, and the explanation, according to social constructionists, does not lie in external causes and fundamental laws.

Positivism and Social Constructionism are each associated with certain data collection techniques, namely, quantitative methods and qualitative methods. There is a noted tendency in social science to deliberately dichotomise these two methodologies, and the attitudes towards methodological matters seemed to have somehow polarised among certain scholars. It is believed by many people that these two philosophical paradigms are incompatible with each other; however recently there have been many pragmatic researchers drawing from both traditions by deliberately combining methods.. Easterby-Smith *et al* (2002) defines this mixture as the relativistic approach.

The relativist position assumes that some reality does exist independently of the observer; however, this part of reality is not readily accessible through physics-type of experiments, in which key factors are measured to test hypotheses (Westacott, 2005). On the other hand, relativism acknowledges the roles that human participants, both the subject of research and the researchers themselves, are playing in shaping the characteristics of 'truth' in its own circumstances. In other words, the 'truth' cannot simply be determined through observations extracted from the circumstances, nor does it merely depend on people's interpretations or predictions. Following this approach, with its more open-ended, exploratory nature, qualitative methods are particularly useful in the beginning of a study. Quantitative methods, on the other hand, can be adopted to verify the reliability of the theory by testing the hypothesis.

Table 5-1 Comparison of positivism, relativism and social constructionism in management research

Ontology	*Representationalism*	*Relativism*	*Nominalism*
Truth	requires verification of prediction	is determined through consensus between different viewpoints	depends on who establishes it.
Facts	are concrete, but cannot be accessed directly	depend on viewpoint of observer.	are all human creations
Epistemology Elements of methodologies	***Positivism***	***Relativism***	***Social constructionism***
Aims	Discovery	Exposure	Invention
Starting points	Hypothesis	Propositions	Meanings
Designs	Experiment	Triangulation	Reflexivity
Techniques	Measurement	Survey	Conversation
Analysis/interpretation	Verification/ falsification	Probability	Sense-making
Outcomes	Causality	Correlation	Understand

Source: Easterby-Smith, Thorpe, and Jackson (2008, p. 62-63, Tables 4.4 - 4.5,).

The relativistic approach is appropriate for this research. The ultimate goal of this study is theory verification in relation to the effect of corporate governance and finance on technological capability development in Chinese firms, however the theory to be verified is insufficiently researched in the past and requires further development. In this case a mixture of qualitative and quantitative methods is effective. As illustrated in Figure 5-1, both positivist and relativist approaches were utilised. In the early stage qualitative method has been used to: 1) gain enriched insights into the issues (i.e. how does corporate governance and finance influence technological capability development in a developing country); 2) answer the 'why' questions relating to the observed phenomenon (the failure of most Chinese firms and the success of a few of them and why there are not more); and 3) further develop the proposition and generate hypotheses (the specific effects of corporate governance and finance on technological capability development). At the later stage, positivist methods (data collection through questionnaire survey and parametric data analysis) have been used to evaluate the sampled firms' technological capabilities and to test the hypothesis. A detailed introduction to the specific methods and techniques employed will be provided in the next section.

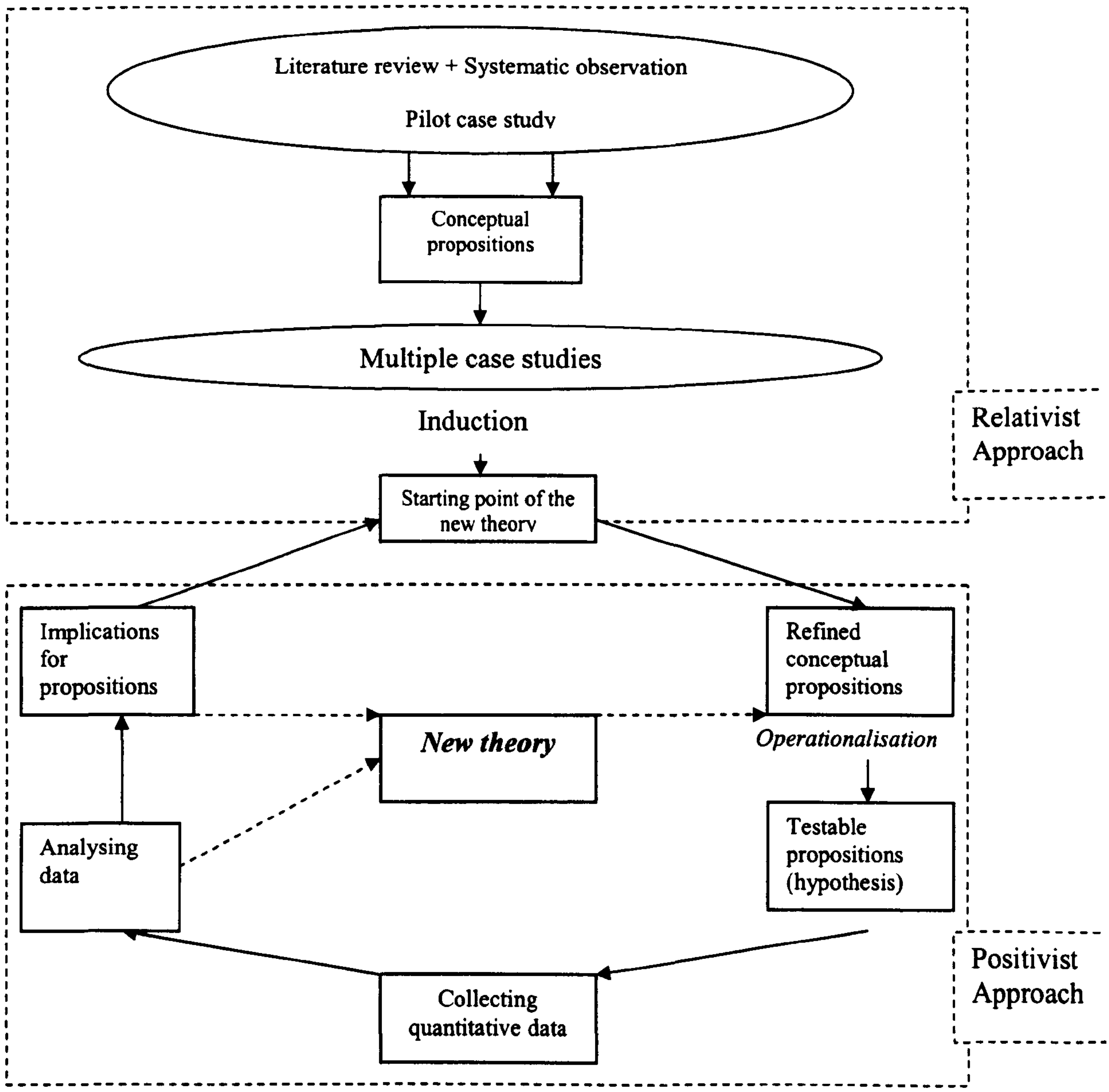


Figure 5-1. Research methodologies of this study
Source: Self-construction and partial adaptation from De Vaus , 2002. p16.

5.2 Research methods in this project

Main research methods used in this research are the case studies (including face-to-face interviews and documentary data collection) and questionnaire surveys.

Case study. It is widely believed that case study is a useful method of research into relatively new areas, especially those connected with social and organisational development (Dyer & Wilkins, 1991; Yin, 1994). Gill and Johnson (1997) summarised several advantages of case study: 1) it is an effective method to investigate a new topic, since case study research does not rely on previous literature or empirical evidence; 2) the case study can encompass a wide range of data, including documents, interviews and observations, therefore it can provide a deepened insights into the research objective; 3) the case study is also a preferred method of inquiring into those theories that are concerned with the organisational planning, culture, institutional reform, technological development, for its holistic, in-depth investigation. As our aims in this project are to explore, explain and establish a relatively new theory (Yin, 2002; Flyvbjerg, 2006), we therefore used multiple case-studies in the first stage to facilitate in-depth, longitudinal examination of individual instances to gain a sharpened understanding of the subject matter; then to decide what might become important to look at more extensively later; and then to shape hypotheses for testing in the next stage.

Questionnaire survey. The advantages of a questionnaire survey have several aspects: 1) it provides a widely reachable population and produces quantified and generalised information (which is necessary for hypothesis testing in this study); 2) it enables systematic analysis of results by using statistical methods; 3) it allows researchers to test hypotheses through both open ended and closed ended questions, and through multiple item scales and /or multiple questions; 4) it is well suited to make classifications and comparisons in different categories (e.g. the comparison of different levels of technological capabilities according to ownership types and management selection methods in this study) (De Vaus, 2002). There are also disadvantages with a survey method. De Vaus (2002,8-9) expressed a concern that the questionnaire survey is too restricted, because it relies on highly structured questionnaires.

The following part of this chapter explains how case studies and questionnaire survey have been conducted, and introduces the sample size and the administration procedure.

5.3 Case studies and semi structured interviews

A balanced portfolio of 5 firms from varied backgrounds was selected for case study. 3 of them were from the auto industry (2 selected for paired pilot study) and 2 from electronics industry. 4 firms were majority state-owned enterprises (MASOEs) at the time of case study, and 1 private-owned (POE). Their geographical locations ranged from the most developed coastal area to underdeveloped inland provinces (see Figure 5-2), and firms' ages also varied. This 'self-selection' sampling technique is recommended for exploratory research (Saunders *et al.*, 2000,171), and therefore would contribute to the understanding of how corporate governance and finance worked its way (in different settings) in shaping the firms' technological strategy and behaviour.

Figure 5-2 Map of China and geographic locations of case study firms

Pilot case studies of two state-owned firms – Shanghai Auto Industry Corporation (SAIC), and Chery – were conducted in the auto industry. These two cases were studied mainly from published sources, which in their cases are abundant. Analysis was made both *longitudinally* (how changes take place within the organisation over time) and *laterally* (how behaviour differ between the two). Specifically, the evolution of both companies' technological capabilities was monitored; their different approaches to capabilities building were compared and analysed in relation to their finance and governance mechanisms. During the pilot case study three goals were fulfilled: to gain practical experience in using the analytical framework; to help formulate interview questions for formal case studies at a later stage; and to make necessary modifications to the framework of research.

Semi-structured interview questions were formulated through analysis of findings from the pilot study and through brain-storming with the supervisor and academics with similar research experiences in China. Following on initial findings from pilot study, formal case study was undertaken in three more Chinese firms (one from auto industry and two from electronics industry). In June 2006, 8 face-to-face semi-structured interviews was conducted in Guizhou Tyre Co., Ltd (the auto firm), starting from company CEO, party secretary, to technology director, line manager and then to shop-floor workers. In June 2008 two follow-up interviews were conducted on the phone to collect updates about the firm's most recent development. From May 2006 to March 2007, 16 in-depth semi-structured interviews were carried out in a similar manner in the two electronics firms (see Table 5-2). Such 'top-down' interview technique helped to generate holistic maps of the cases in limited time period and more importantly, to triangulate key issues of interest (Tylecote & Conesa, 1999). In the interviews adjusted sets of questions were put to each informant according to her operational role. See Figure 5-3 for the detailed research process during case study stage.

Before each interview, background information was collected and studied, such as historical development, evolution of shareholding structure (if the company studied is publicly listed), product technology, and general industry and market information. The sources of information ranged from books, journals, public reports, newspaper (mainly electronic version), and internet. Through the pre-interview study, the interviewer developed a brief understanding of the case and can be more precise when formulating technology / process-specific questions. Moreover, with an enhanced understanding of the general technology in the product sector, the interviewer is able to comprehend and perceive the firm's level of technology advancedness more confidently.

Table 5-2: Number and type of interviews conducted in case studies

Company name / Number of person interviewed / Position	GTC	SouthElectro	Longertek
CEO	1 +1 (resigned)	1 + 1(retired)	1
Senior managers in charge of technology or finance	2 + 1 (retired)	2	2
Operation managers	1	1	1
Line managers	2	1	3
Shop floor operatives and maintenance workers	1	1	2
Number of interviews in each firm	**10**	**7**	**9**
Grand total of interviews	**26**		

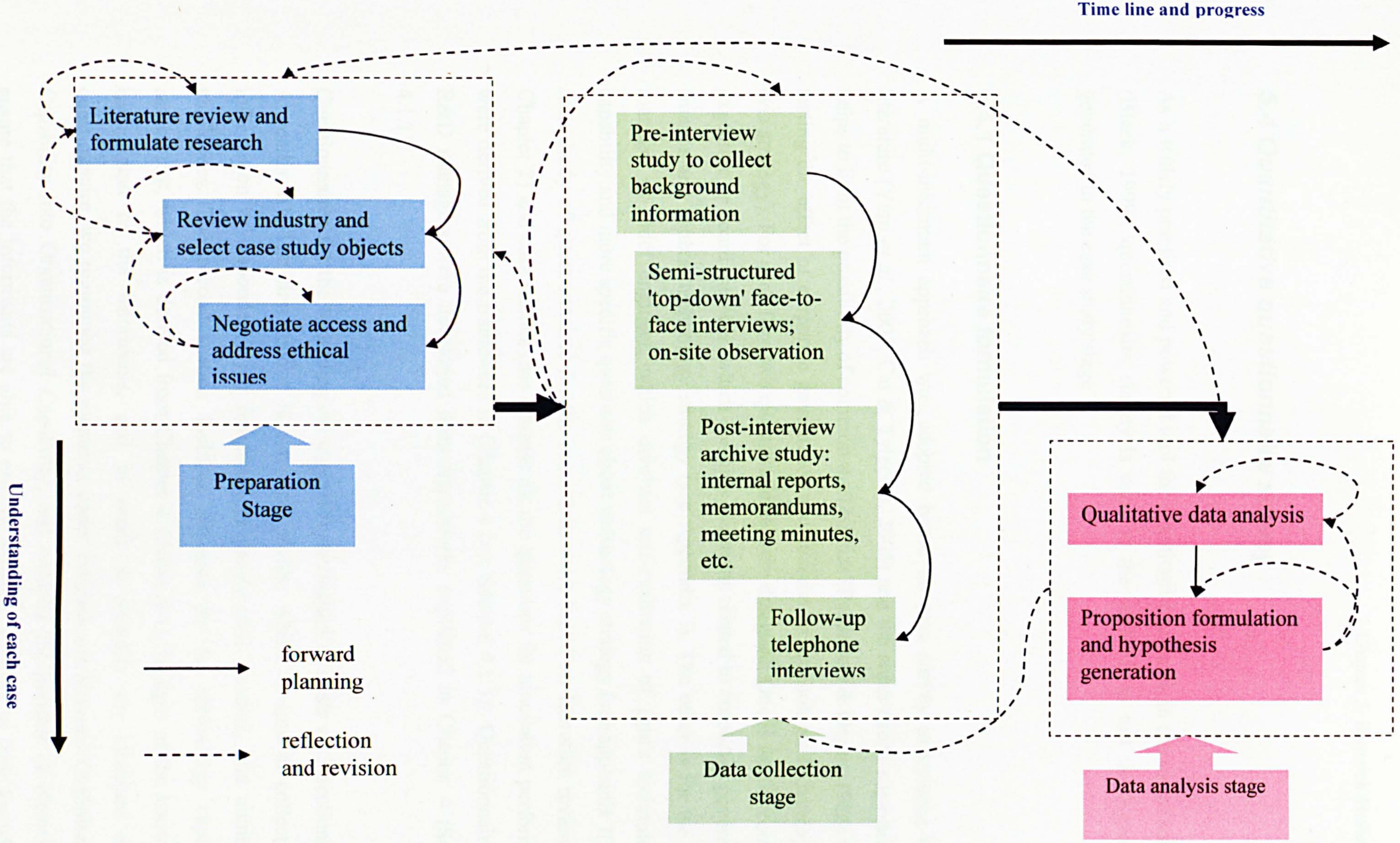
Interviews were carried out in Chinese and recorded by hand-written notes during the interview. Tape recording has been reported to be very difficult in the Chinese culture (Cooke, 2002). Initially, interviewees were asked if they would accept tape recording; however all but one refused, and this person was very reluctant to express opinions openly when the recorder was on. When the interviewer put the recorder away, he finally started to talk in a much more relaxed manner. Therefore the idea of tape recording the interviews had to be dropped. After each interview, notes were reviewed and reorganised within 24 hours to enable the interviewer to recall details more readily. In addition to the interview notes, the interviewer also obtained documents from interviewees to enrich the data collected. These documents include the organisations internal reports (long-term and short-term development agenda and minutes of meetings), organisational structure, peer-comparison of market performance and R&D project planning, etc. All interview reports were presented to the supervisor so that feedback could be obtained for further improvement and as guidance for supplementary interviews. Effort was also made to ask the chief interviewees or their authorised representatives to review the reports (in English). The purpose is to minimise misunderstanding and to ensure that all information collected in the case studies has been at the informants' consent.

Face-to-face interviews were also followed by site visits, where the researcher gained observational insights into the firm's organisational and daily routines, as they are often reflections of its capability dynamism (Zollo & Winter, 1999; Winter, 2003). In addition, after the interviews, the interviewees were invited to introduce some of his or her colleagues who have previously worked in the firm. Follow-up interviews were then made with these former employees (if possible) for their opinion on the key issues. Such anecdotal approach reported in past accounting and management research (Lukka & Kasanen, 1995; Hillebrand *et al.*, 2001) has worked well in this project to cross-check answers provided by the incumbent staff[52], and to clarify some findings from the case study.

Interview data was carefully studied and analysed, together with supplementary literature review. In Chapter 5 the key findings from pilot and formal case studies will be described and discussed with reference to the literature and theoretical framework.

Once the analyses of the case studies were completed, the process of hypothesis generation, questionnaire formulation, design and circulation was undertaken. The objective of questionnaire survey was to find out the levels of technological capabilities which had been attained by sampled firms and the effects of those key factors identified on firm's technological capability development.

[52] Such method proved useful especially when the firm has a hierarchical structure and the current staffs were reluctant to reveal their opinion about the corporate governance and general management.



Firgure 5-3. Detailed research process at case study stage
Source: Self-composition based on Saunders, Lewis and Thornhill, 2000. Figure 1.2, p 5.

5.4 Quantitative questionnaire survey

As a widely practised and powerful tool for quantitative research in the social sciences (Black, 1999), questionnaire survey is used in the research to test the hypothesis generated in the case study stage.

5.4.1 Questionnaire formulation

A multi-informant approach was adopted based on past survey experience in the literature (Yam *et al.*, 2004; Cai & Tylecote, 2006) and the supervisor's suggestion. It helps to limit the possibility of common method bias (Podsakoff & Organ, 1986) whilst testing the effect of corporate governance and finance on technological development (via strategy). For each firm two questionnaires were designed. One is for the company executive or board member, which contains questions related to corporate governance, finance and general technology strategy (see Appendix I). The other is for the R&D manager or chief engineer, which involves self-evaluation of firm's technological capability and more specific questions about technology strategy (see appendix II). The main body of questionnaires for the executives were based on literature review (see Chapter 2) and case studies (see Chapter 6); the questions for innovation performance were derived from the framework in Chapter 4 (see Section 4.1.3). Questionnaires for R&D managers were developed from frameworks explained in Chapter 4 (Section 4.1.1).

Questionnaires for the technological capability evaluation consists of 3 sections (see Appendix II). The first section is company profile, which is used to collect such information as respondent's job function, company's main product, and number of employees. The second section includes elements for the technology capability assessment, which is derived from Chapter 4 (Table 4-1). In light of the knowledge background of the informants, and in order to simplify the structure of the questionnaire, we regrouped the elements under Internal and External Organisational Capability into Organisational Capability, and reduced the number of elements to ensure that the informants are able to provide accurate answers to their knowledge.

Moreover, since it is not feasible to collect objective data about technological capabilities of a large number of firms, and subjective measurements have been widely adopted in organizational research (Powell & Micallef, 1997; Rouse & Daellenbach, 1999; Guan & Ma, 2003), we asked the R&D managers to provide their opinion about the firms' technological capabilities. For manufacturing, R&D, and organisational capabilities, all elements were measured on a six-point Likert-scale, where the scales were labelled as 1 = less than average in the nation; 2 = average in the nation to 6 = advanced in the world (detailed explanations can be found in Chapter 4, Section 4.1). The questions on innovative performance were not included in this questionnaire, instead, we ask the CEOs to answer them in the other questionnaire. There are two reasons for such arrangement. First it could reduce the common source bias and single-informant bias by gathering information from two groups of informants. Moreover, the company CEOs are expected to have a more reliable overview on the firm's general performance than the R&D managers; therefore they are in a better position to answer performance related questions. The third section collects information about firm's technology strategy and behaviour. The questions include internal and external links that have been forged and their impacts on the firms' technological development; the types of technologies that have been transferred; and the firms' reliance on certain technological activity for technological development over the last five years.

The questionnaire for corporate governance and finance consists of four sections (see Appendix I). The first is company profile and the firm's general and innovative performance. Performance questions include: 1) the average annual sales growth rate over the last 3 years; 2) the ratio of the sales revenue generated by innovative products to that of the total revenue; and 3) evaluation of the competitiveness of products in general. In the last question, company executives were asked to compare their main products with the competitors' in eight dimensions: Average concept-to-launch time; Quality level; Cost advantage; Price/function ratio; Product manufacturing process; Product technology features; Market need and growth potential; Market competitiveness. The second section of this questionnaire collects information about corporate governance issues, such as ownership structure, selection, evaluation and penalties of top managers, internal power concentration, and shareholder engagement that are proxied by evaluation of (financial) reporting. The third section is about access to finance and project approval. Questions asked relate to sources of finance for firms' business expansion. The last section asks questions about firm's general technology strategy, such as the strategy for technology acquisition, proportion of expenditure on technology-related activities with varied visibility, and factors that inhibit firms' technological development.

Review of the supervisor's experience in collecting data in China (Cai and Tylecote, 2005) aided the design of the questionnaires. For example, after discussion of their past survey experience in China, every anchor of the items on a Likert scale was individually labelled. Moreover, explanatory texts were kept to a minimum to provide a neat appearance and encourage response. Many versions of the questionnaires were produced based on several meetings with the supervisor and a number of peer researchers and industry experts in late 2006 and early 2007.

Finally, the issue of common response bias were taken into consideration. The question of self-reporting arose with any attempt to collect and analyse data through surveys. Several measures were used to address this. For instance, for different sets of items that are related to each variables, we used different scales of response (5-, 6- and 7-point Likert Scale). In the pilot questionnaire items that pertained to shareholder engagement measures were also reversed to verify attention paid by respondents. The data validity is also verified by comparing the firms' financial and market performance with archival industry data (see Chapter 7, Section 7.1).

Questionnaires were first constructed in English and translated into Chinese for circulation. The language translation of final version of the survey was verified by a bilingual Chinese research professor in a similar area. After the translation had been proofread as accurate and modifications have been made according to the supervisor's and peer researchers' suggestion, the questionnaires (Chinese version) were taken to China for pilot survey.

5.4.2 Pilot questionnaire survey

Table 5-3 Respondent firms of pilot survey

Ownership	Majority SOE		Minority SOE	Private
No. of firm	4		3	3
Sub-sector	Telecom	Consumer electronics	TV & related products	Electronic equipments
No. of firm	2	3	1	4
Firm location	Guizhou (inland)	Guangdong (coastal)	Sichuan (inland)	Qingdao (coastal)
No. of firm	4	2	1	3
Firm size	Large size full-time staff >1000		Medium size 500<staff<999	Small size staff <499
No. of firm	1		2	7

The pilot questionnaire survey was first conducted in 3 electronic companies which have participated in the case studies, and then in 7 other companies with which the first 3 had business connections – a sampling method called 'snow-balling'(Easterby-Smith *et al.*, 2008,218). All questionnaires at this stage were filled out in a face-to-face manner with the researcher. Notes were carefully taken according to the respondents' reaction – such as when they had a prolonged pause on a particular question and why. Questions regarding ease of understanding were asked during and at the end of each survey. All respondents were also invited to provide suggestions, such as the design of questionnaire layout and question wording, to encourage future response. Moreover, two questions which measure virtually the same issue were put in two different parts of the pilot questionnaires as diagnostic questions to check if the respondents understand the intended meaning of the questions and if they were paying enough attention to answering them.

5.4.3 Final stage of the large-scale questionnaire survey

5.4.3.1 Questionnaire circulation

Table 5-4 Questionnaire survey for electronics industry: distribution of sample firms (total = 527)

Ownership		Majority SOE			Minority SOE				Private firms	
No. of firm		200			200				127	
Sub-sector	01	02	03	04	05	06	07	08	09	10
No. of firm	88	75	57	55	55	53	46	45	40	13
Firm location			Coastal region					Inland region		
No. of firm			315					212		
Firm size		Large size full-time staff >1000			Medium size 500<staff<999				Small size staff <499	
No. of firm		115			79				333	

Following the pilot study, a large-scale questionnaire survey was conducted between March to August 2007. The target population of this research comprises 11655 domestic firms in the Chinese electronics industry. The name and contact address of the firms were acquired through the database published in the Yearbook of Chinese Electronics Industry 2006. We systematically sampled 527 firms according to the following criteria: a) ownership type, we targeted firms of three ownership types: majority SOE, minority SOE, and private firms. (b) industrial sub-sectors based on China's National Bureau of Statistics' codes: telecommunication (coded 01), consumer electronics (coded 02), TV& broadcasting equipments (03), computers and related products (04), electronic equipments (05), integrated circuits & semi-conductors (06), sealed vacuum electronic devices (07), electronic parts and components (08), electronic material (09), and photo-electronic sectors (10); (b) 7 locations divided into two regions: coastal region and inland region. Table 5-4 provides detailed distribution of the sampled firms.

For each firm two letters were posted with return envelopes included: one to the CEO and one to the R&D department c/o R&D manager. Since the objective of this research is not only to evaluate technological capability attained by Chinese electronics firms, but also factors in the corporate governance and financial system (CGFS) which influence firms' capability building; we needed to collect both questionnaires from each firm to ascertain the correlation between CGFS factors and capability development. Therefore only if both types of questionnaires had been filled and returned, were they regarded as a pair of valid responses. In order to tell whether the respondent belonged to the same company, questionnaires were marked with numbers for identification. For example, number 001 was marked for both questionnaires sent out for company A, and number 002 was marked for company B.

During the period of circulation, postal reminders were mailed every two weeks to encourage response. Moreover, various useful contacts were facilitated which included former interviewees, friends and relatives who had had contacts with those targeted sample firms. Personal connections turned out to be very effective to large-scale, state-owned firms (not private firms). Also, respondents were offered three alternatives to fill out the questionnaire – either by post, or by email, or by filling out the on-line version of questionnaire at www.surveymonkey.com. If postal mail was chosen, a return envelope with pre-paid postage was provided and the respondent was asked to mail his questionnaire to a local address in China. Every four weeks the collected questionnaires were sent back to England. If email or on-line questionnaire was chosen, the electronic questionnaire version or the web link to the on-line version will be provided via emails. Appropriate coding was also used to differentiate respondents from different firms.

For the final stage of the questionnaire survey, a total of 1054 (527 pairs) questionnaires were mailed. 207 firms participated in this survey. Among them 124 had completed both types of questionnaires (one for corporate governance and finance and one for technological capabilities and strategies) and 35 completed by email and 26 participated the online survey, the rest 22 firms had completed either type of questionnaires. It generated a response rate of 35.1% (185/527). 392 questionnaires had been returned, of which 202 were for corporate governance and finance and 190 for capabilities and strategies. The total number of qualifying sets of response is 195 including those respondents from pilot survey. If firms are grouped by type of ownership (among 195 firms), 89 are MASOEs, 68 are MISOEs, and 38 are POEs. 21 firms have been listed on the stock market of which 18 contain more or less state share. If grouped by size, there are 72 (37%) large firms with more than 1000 full-time employees, 27 (13.9%) medium firms with 500-999 employees, and 96 (49.2%) small firms with less than 499 employees. (See Table 5-5).

Table 5-5 Respondent firms of full questionnaire survey (N = 537; n = 195, general response rate = 36.31%)

Ownership	Majority SOE			Minority SOE				Private firms		
No. of firm	89 (43.6%)[53]			68 (33.5%)				38 (29.2%)		
Sub-sector	01	02	03	04	05	06	07	08	09	10
No. of firm	38 (42.2%)	24 (30.7%)	17 (29.3%)	33 (60.0%)	21 (35.6%)	16 (30.2%)	17 (37.0%)	18 (40.0%)	6 (15.0%)	5 (38.5%)

Firm location	Coastal region	Inland region
No. of firm	112 (35.0%)	83 (38.2%)

Firm size	Large size full-time staff >1000	Medium size 500<staff<999	Small size staff <499
No. of firm	72 (62.1%)	27 (33.3%)	96 (28.2%)

[53] The percentage in bracket is the response rate within each category, for example, the sample for majority SOE contained 204 firms (4 in pilot and 200 in full circulation), 89 firms returned both types of questionnaires, generating a response rate of 42.6%.

5.4.3.2 Questionnaire administration and data analysis

During the questionnaire survey, data was administered and put into SPSS 15, every month. All of the returned questionnaires were printed out, coded and put into archive for later reference. A unique number was assigned to each pair of responses so that in the later stage of data analysis, any anomalies observed could be easily verified by checking the original document. Respondents were required to leave their email addresses and telephone numbers; therefore if one questionnaire was found to have more than 3 missing answers, the respondent would be asked on the phone or by email to answer these specific questions. 11 out of 17 such questionnaires were corrected in this way. As for the remaining 6, reasonable discretion was taken to either treat them as missing data (if analysis would not be significantly affected) or to discard the entire questionnaire. Finally only one questionnaire was discarded.

In order to clearly interpret how this study evaluates the firms' technological capabilities, we take Manufacturing Capability as an example, as shown in Table 5-6. Survey data were sorted by types of capabilities – Manufacturing Capability, R&D capability, and Organisational Capability (Table 5-6 only shows Manufacturing Capability). Under each type of capability there are 4 to 8 elements which cover various aspects of the capability. In order to assess the level of technological capability, each of the elements were evaluated by Degree from 1 to 6 (see horizontal Degrees in Table 5-6).

Analyses in this study measure percentage of those firms who have reached each degree of each element of capability. The average of degrees were then calculated and rounded to represent the overall level that the firms have reached in such type of capability. Cronbach's α (Cronbach, 1951) was calculated to checked the elements' internal consistency (further interpretation in Chapter 7, section 7.2).

According to the research framework, detailed descriptive analysis was conducted which covered four aspects: 1) Firms' sales performance, innovation rates, and product competitiveness; 2) details about firms' development of technological capabilities; 3) Their technological endeavour, such as investment behaviour, technological development strategies and activities; 4) Firms' corporate governance and finance (see

Chapter 7). With reference to relevant theory and statistics, analytical description of such data is necessary, as it renders enhanced insights into the aforementioned subject matters, which were insufficiently researched. Moreover, through descriptive analysis the results of hypothesis testing at a later stage can be better validated and understood (see Chapter 8).

Table 5-6 Manufacturing Capability

Manufacturing Capability						
Elements of capability	Level 1: less than average in the nation	Level 2: average in the nation	Level 3: less than advanced in the nation	Level 4: advanced in the nation	Level 5: less than advanced in the world	Level 6: advanced in the world
Equipment						
Production routine						
Ability of the manufacturing department to comply with the request of R&D						
Total quality control						
Manufacturing cost control						
Ability to make improvement in the manufacturing system						
Level of contribution made by manufacturing department to the innovation processes						

In addition, analysis were conducted of comparisons between different ownerships and management selection methods to find out which type is the most vigorous to develop high level of technological capability. Techniques used in these comparisons include both the descriptive and statistical methods. The descriptive method uses percentages to compare differences between different categories of firms, which have reached certain level of capability. However it is of equal importance to show statistically how robust these differences are. ANOVA was used to evaluate whether the ranks for different ownerships and management selection methods differ significantly (Hypotheses 1, 2, 6 and 7). Here ANOVA test as a parametric test is more desirable than non-parametric tests, as the former is more rigorous in detecting differences between groups – lower probability of a Type- II error[54]; on the other hand, it is better than multiple T-tests in that the latter has relatively higher probability of Type-I errors, i.e. ascribing significance to chance differences (Black, 1999). Careful checks of the data was carried out beforehand to insure that the data meets the stringent requirements for ANOVA tests: 1) the scales of 1 to 6 for measuring technological capabilities are ordinal scores with very similar variances; 2) observation of the distributions of capability scores were confirmed to be normal; 3) the smallest sub-group (Private Owned Enterprise) has a sample of 38 firms, which is higher than the threshold of 30.

In order to test Hypotheses 3 to 5, hierarchical multiple regressions were conducted. Definition of the variables used in the tests and the regression models are explained in Chapter 8, section 8.1; the results of the testing are reported in Chapter 8, section 8.2.

5.5 Summary

An essentially positivist approach is used in this study to evaluate firms' technological capabilities. A relativist approach is used to identify the key factors in corporate governance and finance which influence firms' technological development and how. Two main research techniques used in this study are case studies (with its techniques of interviews and archival data collection) and questionnaire surveys. Five case studies have been conducted in the electronics and auto industries to develop seven hypotheses, and paired questionnaire surveys have been undertaken in the electronics industry to test the hypotheses.

[54] A type –II error is also known as a β error, or a 'false negative': the error of failing to reject a null hypothesis when the alternative hypothesis is the true state of nature (Greene, W. (2007) *Econometric Analysis* (6 ed.). Upper Saddle River: Prentice Hall.) In other words, this is the error of 'failing to observe a difference when in truth there is one' (Wikipedia).

Chapter 6 Findings from Case Study and Hypotheses Generated[55]

This chapter presents findings from the qualitative stage of the empirical study. Two pilot case studies were first undertaken in the Chinese auto industry: Shanghai Auto Industry Corporation (SAIC) and Chery. SAIC is a long-established 'favoured' enterprise controlled on rather traditional lines. Chery is a small under-funded latecomer that has received exceptional 'engagement' from its controlling local and provincial government. The two firms were studied mainly from published sources, which in their cases were abundant. Later, three more firms were studied on the basis of semi-structured interviews with senior and middle managers, line supervisors and shop-floor workers between June 2006 and May 2008. One of the case study firms is from the auto sector: Guizhou Tyre Co. Ltd (MASOE), and the other two from electronics industry: Longertek (POE), and South Electro (MASOE). GTC is a long-established state firm, relatively poorly financed, and located in one of the least-developed areas of China. From a very weak position, it managed to revive in less than 20 years and became the biggest heavy-duty tyre exporter in China. We found that in GTC's long march to endogenous innovation, it was the low-visibility strategies (unbundling, in progressive manner) that contributed more to its dynamic capability building. Similarly, Longertek as a private firm excels in its niche market with excellent shareholder (owner) engagement as well as expertise. Low-visibility strategies which required hard work, long-term investment, staff cooperation were evidently implemented enthusiastically and confidently. In contrast, Electro wanted a quick-fix by joint-venturing (high-visibility strategy) and failed, lacking not only appropriate corporate governance and finance, but also the portfolio of capabilities. It failed again when trying to catch up.

In Section 6.1 we describe key findings from the pilot studies. The distinctive patterns of technological capability development through '*bundling*' (a typical type of high-visibility strategy) and '*unbundling*' (a typical type of low-visibility strategy) emerged,

[55] The three case studies in the auto industry – SAIC, Chery and GTC, have been adapted from Liu & Tylecote (2009). Particularly, the majority of 6.1.3 and the last part of 6.2.3 (Potential problems and further insights) was written by Tylecote.

and then inspired the formal case studies. Sections 6.2 to 6.4 present key findings from each of the three interview-based case studies. In particular, the three aspects of the theoretical framework were investigated and analysed: 1) company profile and general performance (including ownership structure, technological performance and product competitiveness); 2) technological strategy and behaviour; 3) corporate governance (including shareholder engagement, stakeholder inclusion, etc). Section 6.5 discusses the findings from case studies with reference to the literature reviewed in Chapters 2 and 4, and generates seven hypotheses for quantitative testing at a later stage. Section 6.7 summarises the chapter.

6.1 Pilot Case studies – SAIC and Chery

6.1.1 SAIC (Shanghai Automotive Industry Corporation)

Profile and general performance

Shanghai Automotive Industry Corporation (Group) is China's biggest auto manufacturer both in terms of capacity and market share (http://www.saicgroup.com). Together with First Auto Works (FAW) and Dongfeng Motor Corporation (DMC), it is also well-known as one of the state-favoured 'Big Three' auto manufacturers in China. In 2007, the firm sold 2.26 million vehicles including 1.13 million passenger cars, and achieved sales revenue of 22.6 billion USD, boasting to be one of the few Chinese 'Fortune 500s'. The history of SAIC can be traced back to 1940s. In December 1955 Shanghai Car Plant was communised and renamed as 'Shanghai Internal Combustion and Components Company' and was conglomerated and renamed again in 1996 as 'Shanghai Automotive Industry Corporation (Group)'.

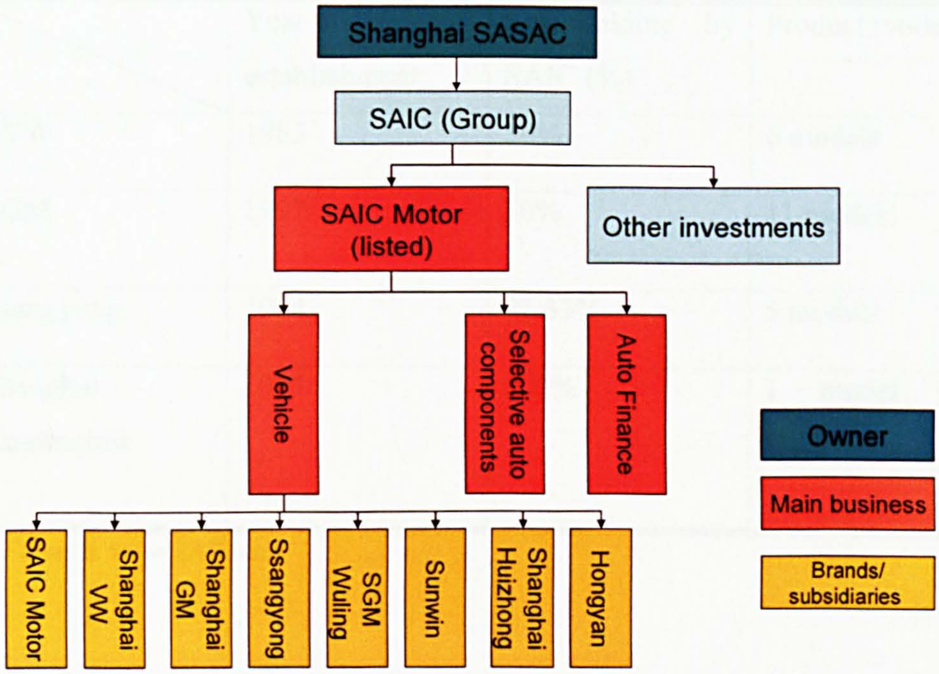


Figure 6-1 SAIC's organisational structure
Source: www.SAIC.cn

SAIC's ownership entirely belongs to Shanghai State-owned Assets Supervision and Administration Commission (the regional division of SASAC). Its main body is SAIC Motor Co., Ltd, which is listed on Shanghai Stock Exchange (89% of its shares were owned by SAIC as of March 2008), which makes it a MASOE. SAIC has 8 vehicle subsidiaries, 4 of which assemble passenger cars (see Table 6-1). In 2004 SAIC produced 11 models of passenger cars, and apart from Saibao[56], all other 10 products are sold under the brand names of its foreign partners. In 2008 the firm was making 23 models of cars, however, only one of them has intellectual property that was entirely owned by SAIC – Roewe (sounds like 'glory and power' in Chinese), an improved modification of Rover 75.

[56] Saibao was a car model built in SAIC's own manufacturing base in Yizheng, Jiangsu province; it was a modified model based on GM's Opel platform. It was introduced in 2002 and only sold around 5000 in three years. SAIC later decided to withdraw it from the market in 2005 due to sagging profit.

Table 6-1 SAIC's 4 passenger car subsidiaries

	Year of establishment	Shareholding by SAIC (%)	Product models
SVW	1985	50%	6 models
SGM	1997	50%	11 models
Ssangyong	2004	51.33%	5 models
Shanghai Automobile	1955	100%	1 model (full IPR)

Source: www.SAIC.cn

Table 6-2 shows that from 2003 to 2007, SAIC's revenue improved by 62.4% and export rose by 159%. However, the firm's income in 2007 was mainly from its long-term investment in the two joint-ventures and from stock-market speculation (data collected from SAIC's public account). On the other hand, its solely-owned operations, including the Roewe project, were highly likely to be loss-making (Tong, 2008).

Table 6-2 SAIC's general performance 2003-2007

		2007	2006	2005	2004	2003
Gross product value (million RMB[57])		1,411,537	1,178,668	866,344	1,049,819	1,578,320
Sales revenue (million RMB)		1,580,126	1,303,603	1,075,825	1,000,630	972,936
Export revenue (million USD)		905.41	892.41	865.23	699.47	349.17
Labour productivity (RMB/Year)		400,408	401,285	302,708	464,800	609,546
Full-time employee		79,394	70,374	68,726	68,720	64,343
Total Vehicles sold (1,000 units)		1,691	1,344	1,058	983	797
	Passenger cars (1,000 units)	1,137.37	915.23	742.95	610.64	612.22
	Business vehicles (1,000 units)	553.14	428.84	315.68	236.89	184.81

Source: SAIC's published annual report, various years. Available from http:// www.CNLIST.com

Since 1978 SAIC has had 4 different chief executives, and their service terms were 4, 8, 4 and 12 years respectively (the 4th and longest-serving CEO Mr Hu Maoyuan, resigned in early 2009 due to large losses from overseas acquisition of Rover UK and Ssangyong South Korea, but still remained Chair of the Board of Directors. (China Value, 07/03/2009). Three out of the four were transferred from senior positions in Shanghai government and two remained officials after leaving SAIC[58]. Hu Maoyuan, who was appointed in 1999, represents an exception. His career started in one of the SAIC's factories and he has been in the management since 1986 (http://www.saicgroup.com).

[57] 1 USD ≈ 7 RMB

[58] The other one retired afterwards, yet he still is 'senior consultant' both in SAIC and in Shanghai Auto Industry Development Committee.

SAIC has always been well looked after by government officials at both central and local levels. For example, since 1985 SAIC was given the privilege to retain 1,250 USD of the profit from each car sold by its joint venture. By 2002 this reservoir had reached more than $50 million. However, at the same time SAIC's R&D expenditure was less than 1% of its sales (Jin, 2004).

Approaches to Technological Capabilities Development

The first half of SAIC's technological development history (1978 – 2002) resembles that of most other Chinese car companies, that is, *seeking technological spill-overs from international joint-venturing.* SAIC used to have its own brand and product development capability back in the 1950s. After Russian technical support withdrew from China, 'Phoenix' was built in Shanghai Auto Assembly Plant, the predecessor of SAIC. 'Phoenix' later was renamed 'Shanghai' and expanded into 4 different models and reached a capacity of 5,000 in 1975[59].

Since 1978, SAIC followed the government's urge to seek co-operation with foreign companies. In 1985 it started a joint venture with Volkswagen, in which VW provided comprehensive package of product and production technologies, as well as capital investment. Before installing the production line, SAIC's capacity was examined by some Chinese industrial experts and was classified as 'too outdated to use'. In a company memorandum it read: 'the design capability was weak, the processing quality was low, and there were not enough testing equipments; the staff were only used to repairing and fixing tasks, and knew nothing about standardised streamline operation. If we were to rely on ourselves for equipment improvement, it would take too long and cost just about the same as importing...*therefore, it is highly recommended that we import the technology as well as the key equipments... it requires some investment, but it pays off very quickly, and is economically feasible* (italics are ours)' (Jiefang Ribao [*Liberation Daily*], 2004). It can be seen that the motive for SAIC to choose a packaged deal (technology, equipments, training, and components/subsystems, *bundled* together) was to achieve quick pay-off whilst avoiding investing time and effort in independent learning.

[59] There were only 70,000 cars built in China from 1958 to 1991, and in 1982 total production was 5,101.

In 1991 SAIC decided to cease production of its own brand 'Shanghai' and devoted 90% of its retained profit from 'Shanghai' to the SVW Santana project. The initial form of production in SVW was CKD (complete knocked-down) assembly with components and parts shipped from Germany - according to the contract, without VW's discretion SAIC cannot make adjustment to the original design ('not even a screw', Lu & Feng, 2004). Although VW and SAIC shared equal investments in SVW, the later was not happy to see disproportional profit distribution, especially after paying extra for imported parts. Significant effort was hence made to develop parts and components production capacity. In 1991 Santana became the first foreign-branded car to be exempted from import licensing, symbolizing fully localised production. However, after satisfactory profit margin – also thanks to the monopolistic policy – was secured[60], little was achieved regarding independent product development. With only one major design modification, Santana dominated SAIC's assembly lines as well as Chinese roads until 2002, whilst production in Germany already stopped in 1993. Apart from its two joint-venture cash cows, SAIC barely had car production in other divisions. In 1999, it purchased a loss-making plant in Yizheng city, Jiangsu province. Three years later Saibao was launched as SAIC's first own-branded car since 1958. This model was developed on GM's Opel platform. However, Saibao did not appeal to the market and was short-lived; its total sale in 2003 and 2004 was 4,298, less than 10% of Chery's best-seller QQ in 2004 alone. In 2005 its production came to an end (*Daily Economic Review*, 15 Dec.2005).

From 2003, SAIC started to resort to *offshore acquisition*. The logic underneath was clear: blessed with cash but weak in R&D capability and bargaining power, SAIC hoped to acquire technological competence by acquiring new organisations. The first big target was Ssangyong, the loss-making South Korean company. In 2004 SAIC bought 48.92% of Ssanyong's shares and became its controlling shareholder. In 2005, after giving up bidding on bankrupt Rover, SAIC paid £67 million on the technology details and rights to all of Rover's engines and its 75, 25 series. It was hoped that the injection of fresh blood could enhance SAIC's weak technology basis, however, as Rover's equipments and human resources were bought by Nanjing Automobile (Group) Corporation (NAC), another well-connected SOE, SAIC encountered difficulties in

[60] 7 of the 153 companies under SAIC make 85% profit and 5 of them are foreign partnerships (Financial Times, 21 April 2004, p.31).

mastering its newly purchased technologies. *'...we now have four potential sources of technology, 1) Rover; 2) Ssangyong; 3) Ricardo in the UK (we pay them for engine design and technological consultancy); 4) our own joint ventures, Shanghai VW and Shanghai GM. Apparently we are doing a lot better...However we have a long way to go in understanding and integrating Rover and Ssangyong's organisation and technologies, plus we are still dependent on our partners in the two joint ventures for turnkey technologies...'* said a senior member of management (*First Economic Daily*, 03, Aug. 2005).

With government encouragement and support, in 2007 SAIC successfully merged with its long-standing rival NAC. Most of NAC's operations were taken over by SAIC, and in return the mother company of NAC, Yuejin Motor, received around 5% of SAIC's shares. In doing so SAIC acquired the MG series sports car technology platform (Forbes, 2007)

The effect of SAIC's serial mergers and acquisitions on its long-term success is yet to be seen. However acquisition of organisations with desirable technology provides a plausible alternative (considered as a 'short-cut' by rich SAIC) to capability development. On the other hand, several challenges remain as to how to assimilate newly acquired technology as well as to integrate new organisations. These issues are particularly profound when acquiring foreign firms with distinctive cultural differences – in year 2006 and 2008, strikes in Ssangyong have already cost SAIC billions (Jinghua Ribao [*Jinghua Daily*], 25/09/2006; *China Value*, 07/03/2009), which has directly caused the CEO Hu Maoyuan's resignation. Even in the domestic environment, the MG project division in NAC has also expressed disappointment over the merger and threatened to resist the takeover through 'non-cooperation' (Li, 2007).

6.1.2 Chery Automobile Co., Ltd

Profile and general performance

Chery Automobile Co., Ltd. came into being in 1997, with an initial capital of RMB 1.752 billion channelled from five local state-owned investment companies[61] (Chery website, accessed in 2008). Plant construction commenced on March 1997 in Wuhu, a medium sized city in the landlocked province of Anhui. The first car was produced on December 18, 1999. This represents a mile stone in Chinese car manufacturing history because it was the first car produced by a purely Chinese owned and managed company (Chery website: http://www.cheryglobal.com/about_chery.jsp). Though small in size, short in history and simple in structure, Chery has caught the nation by surprise - it developed its first 2 models of cars in just 8 months, less than 2 years after its establishment; it is the first Chinese car makers to export branded cars and the first to build cars overseas with own IPR[62]. Shortly after the launch of 4 new models in 2006 and China's first full-IP passenger car engine, it became the biggest car exporter based in China, with highest sales growth in 2006 and the first Chinese domestic passenger car brand to have sold 300,000 units in a year in 2007. In the same year one of its models became the best seller on Chinese market; meanwhile Chery's domestic market share growth also surpassed all of its competitors – foreign or domestic. According to the statistics of International Organization of Motor Vehicle Manufacturers, in 2006, Chery has become the world's fastest growing car manufacturer at the rate of 65.62% (http://oica.net/wp-content/uploads/2007/07/chery.pdf).

The foundation of Chery was however dramatic. The relatively remote city of Wuhu was a latecomer to the fast-growing market economy. In desperate search of growth potential, the local officials were fascinated by the lucrative business of auto parts production. Despite the strict entry control by the central government, they decided to build their own car company. In 1998, local officials bypassed the regulations and recruited Yin Tongyao, a rising star in one of the VW joint ventures as a well trained engineer (Hessler, 2005). Yin became vice-president of Chery and has been in effective

[61] According to Lu and Feng (2004), this figure was an exaggeration to meet the scale threshold set up by the National Committee of Development and Reform.
[62] In 2003 Chery signed a contract with Iran to build a plant there, assembling CKDs with Chery's brand name.

charge since then – a total of 12 years by 2009. Chery received whole-hearted support by Anhui and Wuhu government. National regulations forbade new entries, so the officials named the enterprise 'automotive components' company. When Chery built its first car, VW was furious due to the apparent imitation, so was the central government (Hessler, 2005). Yet when authority has become decentralized during the reform erea in China, an ancient tactic prevailed – *Xianzhan Houzou* (act first, and then ask for forgiveness) (Hessler, 2005). After more than a year's negotiation between Wuhu and the central government, finally a compromise was made: by giving out 20% of its shares, Chery became affiliated to SAIC. In so doing it obtained the necessary licenses to manufacture cars and to establish a sales network. However, SAIC in this deal pictured its role as lenient rather than strategic, it made clear in the memorandum that SAIC's relation with Chery does not involve investment, management, debt, or dividend. SAIC realised its mistake afterwards; however, their marriage stopped shortly after Chery won favour with high state officials, leaving settlement of the 20% share a rumour (Jin, 2004).

Approaches to Technological Capabilities Development

Chery's strategy can be summarised as *technological unbundling – acquiring the capability to produce each component and sub-system, and system, separately, and indeed at the extreme involves separate acquisition of each element (machinery from one supplier, training from another, blueprints from a third).*

A glimpse of Chery's initial attempts to build its own engines and cars can be found in Hessler (2005), where modest, yet extensive unbundling was evident: '...first manufacturing equipment from an *outdated* Ford engine factory in England and moved... to Wuhu (italics are ours)'.... 'manufacturing blueprints ...from a *struggling* Ford subsidiary in Spain'... – all were inexpensive alternatives to flashy new imports, and obviously the Chery people were not shy of sourcing what suited them from across the world.,. The first Chery-made engine was built in secret in May of 1999, followed by the first Chery-made car merely seven months later. It used parts from suppliers supposed to be exclusive to VW (Hessler, 2005). 2000 cars named 'Fengyun' were made that year. Since Chery did not have the license to produce or sell assembled cars, Wuhu government persuaded its local taxi company to swallow the batch. In late 2000, Chery got hold of its first research team – a group of around 20 engineers who had formerly worked for Dongfeng Automobile Co., Ltd, another officially protected MASOE just like SAIC. This team of elite engineers and designers were laid idle by their previous employer, and the rumoured intention by Dongfeng to close its technical centre after joint-venture with Citroën finally triggered their collective resignation. 8 months after joining Chery, the team launched two new models, 'Son of the Orient' and 'QQ'. The former looked exactly like Volvo's 'S80', and 'QQ' immediately reminded people of Chevrolet's 'Spark'. In fact, Chery's own team was only capable of design, or imitation, of the bodies. The chassis were made by Tower (USA) and the majority of mouldings were provided by a Taiwanese company. In addition to engine production on its own Ford assembly line mentioned above, Chery also sought external supplies due to insufficient capacity. As for smaller parts like accessories, electronic devices and engine accessories, prototypes were provided by Chery to domestic parts suppliers for batch production (Hessler, 2005). By breaking down product technology to the most detailed elements possible, and by only paying for things that Chery could not do by itself, cost was brought down. QQ was 1/3 cheaper than its Chevrolet counterpart and so was Son of the Orient. Both types became big hits in the Chinese market and ranked top-sellers.

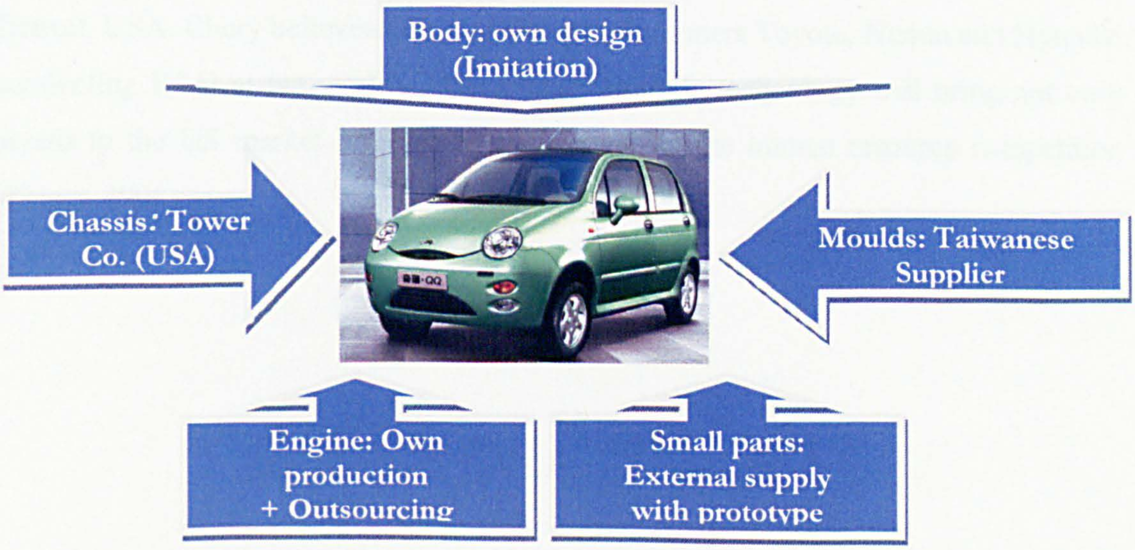


Figure 6-2 Illustration of Chery's initial unbundling behaviour: the making of QQ
Source: Own construction according to Lu & Feng (2004) and Hessler, 2005

After winning the first buckle of gold, Chery started investing heavily in R&D and technological training. It is spending 10%-15% of its revenue on R&D (Chery website March 06), and from 2000 to 2005 its research and technical team expanded 40 times into 11 departments with over 800 members. On the other hand, Chery also worked closely with foreign companies to cultivate its technological capabilities. However it adopted a much different strategy in cross-border collaboration than most of its domestic peers. Rather than going to multinational competitors (car manufacturers) for turn-key plants or offering them OEM (own equipment manufacturing), Chery chose to work with up-stream players who had aligned interest in its own success and were therefore much more motivated to transfer their technology and skills than did those car makers. For example, in its cooperation with AVL (the world's 4^{th} engine designer in Austria), it took over the responsibility of initiating ideas and setting up standards, while AVL specialised in design and coaching/mentoring of Chery's engineers. 'The baseline of our cooperation is that, we can ask any question regarding the technical details of their design, and that we can send our staff to observe and finally to participate.' (Wang, 2002: 29). More than 100 Chery engineers went to AVL to receive training, some other 900 were sent to other countries over the past decade. The strategy of learning by training and doing enabled Chery to develop the first China-made engine with its own IP. Compared to pure imitation and reverse engineering in the previous phase, its new models, Tiggo, A5, F and M series featured more in-house design and development. In 2006 Chery set up a branch research centre near the Ford HQ in Detroit, USA. Chery believes that, just like its forerunners Toyota, Nissan and Hyundai, conducting R&D at the world's Mecca of automobile technology will bring not only access to the US market but also a crucial edge in the human resource competition (Zhang, 2006).

6.1.3 Discussion of pilot case studies[63]

SAIC's technological development (the first half) and that of Chery are manifestations of two contrasting approaches, i.e. *bundling* and *unbundling*. In SAIC's joint-venturing with VW and GM, *components*, *key parts* and *sub-systems* (brakes, engines, etc) were provided either by the foreign companies or by their designated (and also foreign) suppliers; while many of the process and product technologies were covered by patents or other forms of IP protection, *licenses* were granted. In order to guarantee adoption and implementation of newly introduced technologies, *blueprints* for production methods were provided, along with *training*. Whenever there was a problem, there was always *on-site technical support* from the technology provider. All of the above forms a typical full technology *bundle*. (In the initial stage of the VW-SAIC deal, the bundling activity even took a more extreme manner – a 'turnkey' plant, in which VW took responsibility even for putting the equipment together on site.

The advantage of bundling from the technology seller's point of view is clear: the seller keeps control. The main advantage from the buyer's point of view is speed and simplicity: there is one bundle, one deal, one provider who (presumably) knows how everything fits together and can quickly make sure it all works, as long as local conditions do not get in the way. It can easily be seen that the speed and simplicity of a bundle are of particular value for the typical Chinese SOE top manager. As shown in Table 6-3, SAIC's CEOs, at least the first three, were functioning in a setting that featured governance with typical Chinese characteristics: 1) All of the first three CEOS were parachuted into the organisation, knowing little about the company, or even the industry, they therefore had very limited *industrial expertise* to understand what would be most beneficial for the firm's long-term technological competence. 2) With limited time in position (maximum 8 years) and *short-termist performance pressure*, these managers needed to deliver quickly – and bundled deals in this case did provide quick-fix: the 'disengaged' monitoring officials were shown and pleased with quick results, in terms of technology: new products, new equipment, and new processes. The new products showed quick results too in terms of market share. The bundle also delivered quick profits: the main up-front payment was for equipment, and that would be shown

[63] This part is written by Tylecote, which is published as Liu & Tylecote (2009)

in the accounts as an asset, not as a current cost to be subtracted from profits. Of course, large amounts of money would have been needed – which has normally meant borrowed from banks – and interest paid on that. However, SAIC as a large SOE owned and favoured by central government, have long been able to borrow very cheaply indeed.

Table 6-3 SAIC's CEOs – origin, time in position, and performance targets– 1981-2008

Name	Occupation before CEO of SAIC	Time in position (Years)	Main Performance Targets
Jiang Tao	Deputy Director, Shanghai City Committee of Economic Planning	1981-1987 (6 years)	Joint-venturing with VW; production of Santana model
Lu Ji'an	Deputy Director, Shanghai City Economic Committee, (27-year experience in the textile industry)	1987-1995 (8 years)	100% localisation of Santana model
Chen Xianglin	Director of Shanghai City Committee of Economic Planning; Deputy Secretary-General of Shanghai Government/Shanghai Party Committee	1993-1997 (4 years)	Joint-venturing with GM; 2 more localised VW models
Hu Maoyuan	Trainee staff in SAIC since age 17; workshop director, division manager, assistant general manager	1997- 2009 (12 years)	China's largest/strongest car manufacturer; capable of producing own-brand cars and competing in the global market

Source: SAIC's annual report 1997-2005; Shanghai City Chronicles, available online: www.shtong.gov.cn/node2/

What was gained in terms of technological capability, then? By the end of its first stage of bundling, SAIC had achieved full localisation of imported car models and leading production capacity (mostly static manufacturing capabilities), however, due to lack of dynamic R&D and organisational capabilities, it still had to rely heavily on foreign partners for model improvement or diversification. The foreign partners still retained control over key technologies: *'we were rejected by VW when we offered to buy its Santana platform after more than 20 years' co-operation',* said a senior manager from SVW[64].

On the other hand, as an untypical SOE Chery opted for an untypical, independent *unbundling* approach. Unbundling can also be practised at different levels, depending on the technology basis of the unbundler. In Chery's case the initial unbundling was not done in glamorous fashion; it involved scrubbing and fixing of second-hand equipments: bargain-hunting out-dated product blue-prints, and even infringing copy-rights of car models, etc. However Chery did gain from the process of decomposition. Its staff and technical team had to work out how all the parts and elements, both in physical and engineering terms, fitted together. In other words they had to master systems integration (Prencipe *et al*, 2003). Such process requires learning endeavour and if managed intelligently, will improve not only manufacturing and design capability, but also organisational and strategic capabilities. Just as confirmed by CEO Mr Yin Tongyao:

> *'Maybe the outsiders would consider what we had initially done (copying the design and technology of established car models) as trivial, however when we first started, even copying had appeared so difficult and impossible to manage...yet we worked our hands to the bone and did it, and went beyond the initial imitation...'*[65]

Chery pressed on after having acquired the basic capabilities to assemble a copied car. It is apparent that Chery's unbundling at the later stage was planned and executed at the organisational and strategic level, and had much higher in-house technological content: It designed its new production lines and had them supplied through auctions; more key parts were made by itself, others by domestic suppliers working to its specification;

[64] First Economic Daily, 03, Aug. 2005
[65] Interview with China Central TV. July 2005

farther-reaching in-house R&D was initiated with extensive training by collaborators of its choice, most of which industry leaders such as AVL; it orchestrates resources both domestically and internationally to develop not only new cars but also engines. What was learned through the process of unbundling has given them the strategic ability to develop new models with ever more in-house and local input.

How can we explain this in terms of its governance? Certainly not in terms of superior expertise among monitoring officials. What did the local Party hierarchies of Wuhu and Anhui know about the motor industry? Engagement, then? Undoubtedly Chery got a great deal of attention from the highest officials in Wuhu and Anhui. Lacking expertise, however, it is hard to believe that, however closely they engaged, they would have been able to judge the quality of Yin Tongyao's strategy. What they did was simply to take some trouble to pick the right man, highly experienced in the industry, and then to back him while he built them a successful motor firm from scratch. For this they gave him time (we do not know how much) and money – but certainly not much of the latter. As Hu Maoyuan of SAIC is alleged to have said when criticised for not following Chery's road, they did it that way because they had to: unbundling was a great deal cheaper. (It is plausibly rumoured that the teachers of the whole province of Anhui had to wait several months for pay at one point, when Chery got one of its largest cash infusions: Anhui is dirt poor compared to Shanghai.) Chery's market position followed from its shortage of resources: they started at the bottom end of the market, where their low prices were most appreciated and their low initial quality most forgiven. Yin Tongyao, not having to watch his back, could watch his front: he could concentrate on building strong relationships with employees and suppliers. In sharp contrast with large-scale SOEs, staff expertise and inputs were treasured and their potential explored during the process of learning. Chery again wins higher marks for *employee inclusion*. Chery may also have gained from its complete insignificance in its early years.

We argued that two factors, *engagement* and *inclusion* in corporate governance, affect a firm's strategy and behaviour in technological capability building. The findings of our pilot case studies fit precisely into this expectation: SAIC has had a problematic governance structure, government parachuted its officials into the company who did not necessarily have industrial expertise, and they were moved away not long after.

Managers came to their posts with assigned tasks, either to increase capacity or to enhance profit; anyway, both are quantitative, highly visible and easy to measure. Remember that they did not have much time nor did they have sufficient knowledge, hence it was sensible for them to choose bundled technologies which come from multinational partners – these are easy to understand, readily available, and fast in effect. Now threatened by competitors such as Chery, and having a CEO who came up from within the organisation and who has the potential to stay, SAIC started to try to fight its way out. Its advantage is that it need not worry much about its budget; therefore it is able to buy not only technologies but also organisations that own the technologies. It is too soon to say whether it will succeed, but at least this offers an alternative to its previous practices. On the other hand, Chery benefited from better practice. The CEO is highly experienced in the auto industry, and his aspiration level comes from higher autonomy and longer service term, which determines his strategy of technological unbundling. Such a process is more novel and low in visibility but proved rewarding and sustainable. Moreover, in sharp contrast with large-scale SOEs, staff expertise and inputs were treasured and their potential explored during the process of learning. Chery again wins higher marks for *employee inclusion*. All these contribute to its fast growth in capabilities.

Chery's current success also has implications for SAIC. As a large enterprise with strength in finance and the capacity to produce against high standards, SAIC can experiment with unbundling and can do so from an advanced starting point.

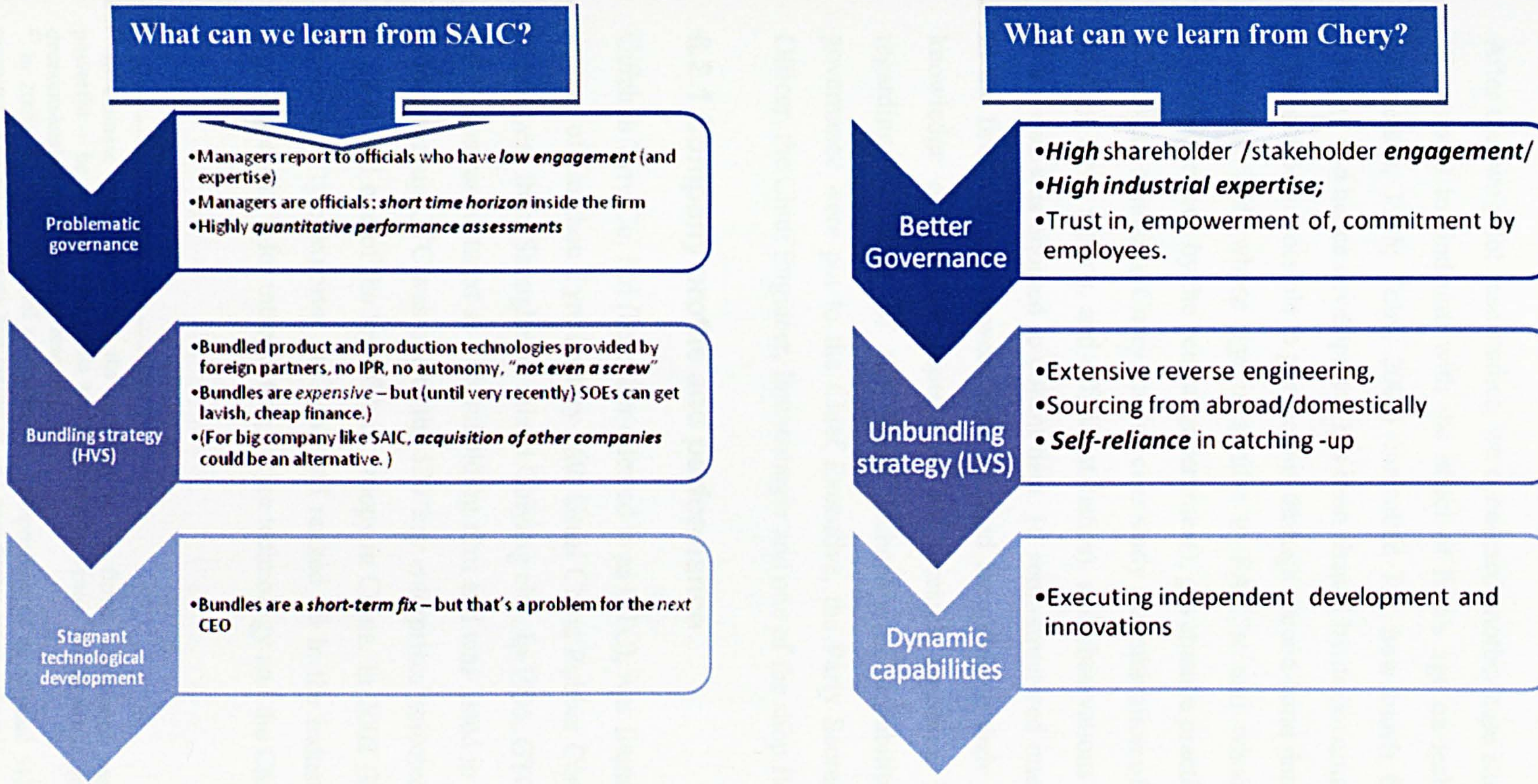


Figure 6-3 Corporate governance and technological development – lessons from SAIC and Chery cases

6.2 Guizhou Tyre: a long march to endogenous innovation

After the two pilot case studies, we conducted another case study in the auto industry. We wanted to find out, with the effect of firm's age on technological development (Audretsch, 1995; Toby, 2000) controlled for, how much the firm's technological strategy and hence development has been shaped by its governance. In the pilot studies it has not been possible to pursue this through second-hand data. We selected Guizhou Tyre Co., Ltd, whose age is similar to SAIC's; and whose political status (less favoured/noticed by the central government), governance practice, and location (inland China) are similar to Chery. In this case study a combination of archive search (journal articles, news reports, and official statistics), site observations and top-down in-depth interviews was adopted to collect data. 10 semi-structured interviews were conducted in the firm and interviewees were selected according to their job responsibilities and knowledge of different aspects of the research question. Longitudinal questions regarding evolution of the firm's technological capabilities and its corporate governance were put to the Chief Executive, the Party Secretary[66]/ Chief Operating Officer, the Chief Engineer, line manager and one of the shop floor operatives.

6.2.1 Company profile and performance

Guizhou Tyre Co. Ltd (hereafter referred to as GTC), was founded in 1965 through the merger of Guizhou Tyre Factory with Great China Rubber Company, which relocated in that year from Shanghai to inland Guiyang city. In 1995, GTC's main business 'GTC Tyre' was restructured as a shareholding firm and was listed in 1997 in Shenzhen. The holding group GTC was one of the 520 'key enterprises' selected by the State Council[67] in 1992 and one of the top 10 tyre groups in China. In 2002 GTC became the biggest heavy-duty tyre exporter in China and ranked 38 in the industry worldwide in 2004. (See Appendix V for introduction to tyre technology and the Chinese tyre industry.)

[66] In Chinese state enterprises the secretary of the firm's communist party committee still remains powerful – he or she often holds key positions in senior management and is officially the ultimate decision-maker of key human resource.

[67] In 2000, the State Council readjusted the composition of its original 512 'Key State Enterprises' by merging 113 into 14 groups and taking in 107 new firms; many are well-performing private companies and high-tech enterprises. The list thus extends to 520, around 200 of which are listed companies or parents of listed firms. (www.sasac.gov.cn, 2000). The National Team (Nolan, 2002) is a subset of the list.

GTC's main products included bias-ply tyre, radial-ply tyre, steel-belted radial tyre, heavy duty tyre, agricultural tyre, tubeless tyre and air spring. 25% of its product was exported at the time of case study in 2006. At the end of 2005 it had 6,532 employees, 349 of which were R&D staff. Its shareholding structure before May 2006 has been: state shares: 51%, tradable shares 49%. (After May 2006 it became: state shares: 27.2%, tradable shares: 72.8 %.) Therefore GTC has been a MASOE during the period studied in this thesis. The recent state share reduction was operated through bonus issues to original holders as a gift (10:3.6)[68]. The state shares officially belong to Guiyang State Asset Management Co., Ltd, which is the provincial branch of SASAC; just as SAIC is owned by the Shanghai branch of SASAC.

Table 6-4 GTC – contrasting performance between 1985 and 2005

1985	2004	2005
Below its 1965-designed capacity: 300,000 units per year.	38th in the world in tyre output; heavy duty specialist; largest tyre exporter in China; 25% of output exported	Radial tyre output reaches 1.5 million per annum; total sales income up 31% on 04, exports up 39%. Most profitable listed tyre company in China

Source: GTC internal document

[68] This is perhaps a neat expression of the fact that private property in a formal sense in China is less important than a clear recognition by the relevant people in power that one has the right to the yields from a particular asset

Table 6-5: **GTC's recent market performance**

	Jan. – Nov. 2005	**Increase from same period in 2004**
Gross Output Value	RMB 2.47 bn ($298 million)	22.46%
Total Production (Units)	3,374,243	5.26%
Total Sale (Units)	3,041,613	11.75%
Total Gross Revenue	RMB 2.78 bn ($335 million)	31.41%
Net Export	USD 64.83 million	39.45%

Source: GTC internal statistics.

Like most state-run enterprises in west China, in the 60s and 70s GTC almost had no technological input. In 1985, Mr Ma Shichun, an engineer who had worked in the tyre industry for over 20 years became executive of this firm. GTC at that time was lagging behind most of its domestic competitors. One example is that its designed capacity in 1965 was 300,000 per year; while GTC's output never reached that amount even 20 years later. The new management asked the National Ministry of Chemical Engineering – the then supervising authority for expert consultation. The latter commissioned Guilin Institute of Rubber Industry to draft GTC a 'Ten-Year Development Plan' for GTC, stating that it should 'acquire and assimilate advanced foreign equipment and technology, adjust product structure, improve quality and realise economies of scale'. In the next decade GTC's major technological activity mainly revolved around this plan. A total of 220 million RMB (mainly from government subsidy) was infused to fund technology-related activities, such as the expansion of heavy-duty tyre workshop; weight-reduction of nylon tyres and the purchase of a 1.05 million-capacity small-tyre manufacturing line and the following up process innovations.

In less than 8 years GTC accomplished its first 10-year objective, and sales increased by 20%-30% annually. It also became the first and largest heavy-duty tyre producer in China. Seeing the higher profit margin of radial tyres, a second '10-year plan' was initiated by itself this time, aiming at developing radial tyres capabilities while maintaining its advantageous position in the traditional bias tyre and heavy-duty tyre market. From 1996 to 2000 1.05 bn RMB was channelled from retained profit, government bonds, and bank loans (at subsidised interest rate) to acquire the capability to produce radial tyres. The initial product details were bought from Michelin, and since then GTC has been making continuous improvement and innovation on the basis. By the end of 2005 GTC's steel-belt radial tyre capacity had reached 1.5 million (the national capacity is 11 million), ranking 8th in China and the only one of the top 10 that was located in an inland areas. The products were among the first in China to be certificated with international standards, and were granted the official 'Famous Brand Product' title (*mingpai chanpin*) in 2004. It has become the only major tyre manufacturer in inland China (the others firms are all located in developed coastal regions like Shandong and Shanghai), and GTC Tyre became the most profitable listed tyre company.

6.2.2 Technological capability development

The history of GTC since 1985 has been an older case of unbundling, and according to its CEO Mr Ma, 'Sensitivity to cost has been the driving force behind our self-reliant development.'

Relatively poorly financed, and located in the least-developed hinterlands of China, GTC had little to offer to foreign multinationals in exchange for bundled technology and equipments. Therefore they had to seek effective alternatives to catch up. '*We always use domestic machines if there is one available, because they are so much cheaper*' (said the CEO). The 1998 radial project is a case of unbundling in point. When buying production equipments, instead of importing the complete set of machinery from the production technology vender Michelin, GTC commissioned its technical team to work out the most appropriate combination of equipments that meets their need, and then organised 4 international auctions to get the key machines. *In fact none of them were bought from Michelin.* For complementary equipments they searched for cheap substitutes in China. After careful bargain-hunting, comparison of quality and after-sale service among over 30 domestic suppliers, they finally chose a private Tianjin company (such type of lower-end unbundling has also been found in the Chery case, see previous section). It later proved that these equipments were well adapted in production, and compared to the quote by Michelin, it was cheaper by USD

3.41 million (key machinery) and RMB 4.43 million (complementary equipments) respectively. GTC also cut cost through rigorous process innovation. According to the purchasing plan drafted by Michelin, GTC needed to buy 7 forming machines for the new project, which would cost over RMB 38.5 million. After studying the process of radial tyre production in both Michelin and Dunlop, GTC technical staff found out that they wouldn't need to invest that much in equipments if they could shorten the sulfuration time. Sulfuration process improvement was accomplished in 5 months' time. This enabled GTC to cut the purchase of sulfuration equipments by 6 units, forming machines by 3 units, and in turn reduced the demand for radial parting moulds, which saved the group a total of RMB 29.46 million.

Other measures of low-visibility technological acquisition were master-minded by GTC, with cost in mind of course. A retired tyre expert from Dunlop Australia (cheaper than usual consultants, but had much more time available and higher commitment, plus less need for GTC to bargain for technological details) was invited to work in the radial division as managing director until 2003. Asking a foreign manager to be fully responsible for a key division is a very rare case in Chinese SOEs, especially when no joint-venturing is involved. GTC was rewarded by implementing such an innovative strategy. By fully empowering this foreign manager it maximised his commitment; and his technological and managerial expertise were well observed and learned. GTC sent one of its deputy executives to shadow the foreign expert and took over after his departure. In the interview the CEO commented that the radial division had highly autonomous management style, largely inherited from the Australian manager[69].

Just like Chery, GTC also spent generously on staff training. Around ¼ of employees from its two R&D departments (the steel-belt radial project has its own R&D team) are funded by the firm for part-time degree courses, either at Qingdao University of Technology (MSc in Macromolecular material) or at Guizhou University of Industry (MSc in Mechatronics). Regulations were enforced to insure that money was well-spent – only when the staff passed all modules and received the degree would they be

[69] All medium level managers are university graduates and the division manager has HR rights to hire and fire people right under him. Wage rates are generally higher than same posts in other divisions and give more weight to workload rather than years of service.

reimbursed their fees. Training of managerial staff was also well planned. According to the Human Resources manager Ms Wei, tailored short courses were provided to middle and senior managers on weekends, organised in the form of seminars followed by group discussions. The area of training ranged from management psychology, strategic management, production safety, corporate culture, personalised leadership to logistic management. Tutors were from top main land universities, renowned industry experts from overseas, and professors from Taiwan. '*Flow of information and ideas from outside of the organisation expanded the managers' vision, which is crucial for a firm located in a land-locked province*' (Ms Wei, May 2008). Moreover, during the courses, case-related group discussion among staff from different corporate functions enhanced mutual understanding and according to the HR manager has speeded up internal communication and decision-making.

R&D expenditure in 2005 was RMB 140 million, thus 4.6% of its total turnover (Michelin in the same period spent 4.2 %, according to GTC's internal document). '*All the money that we got from GTC Tyre's IPO (Initial Public Offering) was invested in technology activities*,' said the Party Secretary, Mr Qian (September 2006). To further enhance its endogenous basic research, in 2003 GTC set up a post-doctoral station and hired two post-docs from Sichuan University to conduct research in the area of macromolecule materials. Each of these researchers were assigned three GTC technical staff, who provided on-site assistance and support and meanwhile to learn by working closely with them (Mr Wang, Principal Engineer/ Deputy Chief Executive, September 2006).

GTC's attention to routine operations was also believed to have contributed to its dynamic capability building (Mr Qian). According to site observations in the heavy-duty tyre and bias tyre divisions[70], the level of routine operation was high; for example, the rubber-kneading workshop was kept very tidy, which '*was hard for such type of process*' (Mr Qian, September 2006). Shop-floor workers mentioned during the conversations with the author that their working conditions have been constantly improved with ongoing process fine-tuning, carried out by engineers from the R&D department and themselves.

[70] A visit to GTC's radial tyre plants was rejected due to secrecy concerns.

6.2.3 Corporate Governance

Quality of shareholder engagement

Although officially supervised by Guiyang State Asset Management Co., Ltd which is an independent entity, GTC still perceives itself as a state firm closely associated with the local government (Mr Qian, Party Secretary). It can be seen how much support *as well as* autonomy (a type of intelligent *engagement* in the case of lack of *industrial expertise*) given by the local authority has helped GTC:

'...The leaders are very busy and are in charge of thousands of firms, making tyres is a very complicated thing, we cannot expect them to understand what we are doing, and all we can expect is autonomy and support...' (Mr Ma Shichun, CEO)

'We were very lucky to be favoured as number one by the Guiyang government; it makes our life a lot easier. We received financial supports such as interest subsidy on bank loans in our radial project in the 1990s. Even now when subsidy is no longer allowed, we can still get our projects approved by the bank much more easily than other local companies since we have the local government as our guarantor... there have been occasions where the senior officials stepped in to sort our problems out... Because we are doing quite well now, especially in a remote province like Guizhou, the central government starts to notice us and has listed us in the mid-long-term Agenda of the National Technology Development, which will provide us tax benefit. This has a crucial meaning because in the period of fierce competition it not only gives us the financial edge but also political support.' (Mr Qian, Party Secretary)

The Party Secretary of Guizhou province and Guiyang city and the Mayor often come to GTC, sometimes spending a whole day working on the site. '*...the Mayor once said if our output reaches RMB 5 bn in 2007 he will give us this and that. We don't know if he really means it, and we doubt if he could do so because of the financial constraint that Guizhou faces as a whole, but at least we know that he cares about the whole thing and would be pleased if he could ...*' (Mr Ma, CEO, September 2006.)

Management continuity and* de facto *shareholding

All senior managers have worked in GTC for at least 10 years and many of them have been on their posts for more than 10 years. '*We think it is very important that we have a relatively stable management team. I give you an example, there is another firm, for some reasons their senior managers were changed almost every 6 months, and now the firm is just about to go bankrupt, surely there are many other reasons to this, but the management disruption was definitely not a positive factor...*' said Mr Qian, who started his career at GTC in 1965 and became Party Secretary in 1997.

CEO Mr MA Shichun, aged 68 in 2006, has been working in the tyre industry for over 38 years and remained chief executive until early 2008. His 48-years-old successor Mr Chen was also a long-standing insider who started from the firm's shop floor and has had extensive experiences in various posts.

Although there was no sign of significant shareholdings by the management team, the CEO and other senior managers received discreet remunerations from the local government. At the end of 2004, due to outstanding product and market performance, Ma and his team was rewarded RMB 1 million each by the city government (Mr Qian, Party Secretary; September 2006). This amount was 100 times the average staff pay and 3 times the bonus paid to the company for winning the 'National Famous Brand' title. So long as they realised this would happen, Ma and Co had every incentive (and time) to aim and play long-term, as their personal wealth was tied to the firm's prosperity - Guizhou province, Guiyang city and Mr Ma and his team in effect have been co-owners of GTC.

The role of CEO and inclusion

CEO Mr Ma was widely respected and regarded as the core of this enterprise. His name was mentioned by almost all interviewees with admiration: '*If our enterprise were to be described as a machine, then Mr Ma (the CEO) is the crucial axis that makes the machine start and work properly*', said Wang Hai, Principal Engineer/ Deputy Chief Executive.

Mr Ma was thought to be able to make important, correct strategic decisions at the correct time. For example, lorries in China are normally seriously overloaded, and ordinary tyres are not durable enough. Ma asked research staff to modify the formula of the heavy-duty tyres and sold them to the replacement market. Sales increased dramatically and the profit was later injected into their new radial tyre project, which partially solved the fund-shortage problem. It was proved that such strategy secured GTC's market competence. He is also a diligent entrepreneur, shop-floor operatives are very familiar with him coming into the workshop and consulting them on strategic decisions (Mr Gou, operative, September 2006).

Mr Wang also believed that sufficient autonomy was given to the technical staff:

> *'We are encouraged to carry out experiments and trials, and don't need to worry about any fine or punishment if we do not succeed in the first place...'*

As a state-owned company in Guizhou, GTC has relatively high wage rates. Salary consists of two parts: basic pay and performance pay. Shop floor operatives are paid according to their job type/workload, requirement for skills and job hazard. Maintenance workers are paid slightly more than others. However, skilled workers still tend to leave, and Mr Wang admitted that continuous loss of skilled maintenance workers has had an impact on the firm.

> *'...working in a tyre-making factory is a tough job, but we are not too worried about shop-floor workers, they are more or less attached to their jobs due to technical reasons (although we have a job-rotation scheme) and it is not too difficult to recruit young peasants from the countryside. It is maintenance workers that we are more concerned about at the moment. It's a much more skilled job and it takes longer to train qualified staff. The nature of their roles means that they must be very dedicated; there is hardly any time to sit down and chill out in a day. For the same work they could find much higher-paid jobs in other factories, either in Guiyang or in other big cities.'*

Examination of remuneration policy by the author also revealed that GTC had various awards for outstanding technical performances. The award committee was mainly composed of senior engineers and experts from research institutes and universities, while GTC's senior management is not involved in the selection process, which was very rare for a Chinese SOE, according to Ms Wei, HR manager (May, 2008). Firm-level 'model workers' were rewarded very generously as well. The firm's bonus was five times higher than the amount paid by the provincial trade union (Ms Wei, 2008).

Apart from staff inclusion schemes, GTC was also seeking to incorporate external input from external stakeholders. It had close, friendly collaborations with local research institutes and universities, and ongoing R&D projects with China Science Academy and Qingdao University of Technology. According to the contracts, GTC owns all of the IPRs of new developments (Mr Wang, Principal Engineer/ Deputy Chief Executive).

Potential problems and further insights[71]

There are three key problems that GTC was still grappling with: the surplus of manual workers and lower-level administrative staff that it was not allowed to fire because of the poor employment situation in Guizhou (Mr Qian, Party Secretary, September 2006). Its rather poor brand reputation largely due to being a domestic firm in an unfashionable location; and its lack of basic R&D capacity which would allow it to tackle challenges like making full use of glass fibre (Mr Wang Hai, Principal Engineer).

GTC's modest success since 1985 strongly confirms our view of Chery and SAIC. While limited in financial resources, due to its weak initial technological and market position, the poverty of its province, and its need to 'carry' surplus employees, GTC is an impressive example of endogenous growth based on sound corporate governance. The endogenous growth is clearly built on thorough and intelligent unbundling, as illustrated by the radial tyre project, including the use of the retired Australian. The key to the sound corporate governance was that the relevant officials picked the right man – an experienced tyre engineer and manager – and backed him. He was still in charge 20 years later and with no end of his tenure in sight – a dramatic difference from the traditional SOE rotation of officials doing a stint as an industrial manager. Clearly Mr Ma's time horizon was very long: he had every opportunity and motivation to aim for

[71] This part is written by Tylecote, which is published as Liu & Tylecote (2009)

real technological capability development and he did so. How expert and engaged the monitoring officials have been over the years it is hard to tell, and the evidence suggests, not very, but in this context it hardly matters: Mr Ma was very expert and very engaged and in effect, though not in any formal sense, he was a major shareholder of the firm: he could have every confidence that he would be handsomely rewarded if it succeeded, and he was.

Under Mr Ma, there has been a great deal of inclusion, formally and informally. The Party organization within the firm (one of the *laosanhui*, old three organizations that controlled the firm) seems to continue to function and to do so in harmony with Mr Ma. (Not only can a good Party secretary – who in this case doubled as Chief Operating Officer - help to make relationships run smoothly within the firm, he can do the same for important relationships outside the firm.) There is a stable management team. Shop-floor workers are made to feel included partly by Mr Ma's practice of Management by Walking About, partly by the care taken to reward valuable contributors. (The loss of skilled maintenance workers is however a point on the other side.) The cooperation with outside research organizations is another aspect of stakeholder inclusion, and its close cooperation with various domestic universities and the national academy of science is clear evidence. On the other hand, although there is no formal collaboration with other firms, according to Mr Qian, informal information flow (Macdonald, 1992) from peer research staff in competitor firms has always been active and largely contributed to the growth of GTC's technological capabilities (for more detail and direct quote, see the next section).

6.3 *Longertek*

After case studies of three firms with similar ownership types (MASOEs), we understood that governance practise can strongly affect a firm's technological strategy and capability. It would be meaningful, on the other hand, to find out how such mechanism works in a different ownership structure. Therefore our second interview-based case study was conducted in a privately owned company. Also, we chose our target firm from the electronics industry to settle how much such experience is replicable in another industrial context.

6.3.1 Company profile and general performance

Longertek Technology (Group) Co. Ltd (hereafter referred to as Longertek) is a private enterprise established in 2000 in the coastal city of Qingdao, Shandong province. As of April 2006, Longertek Group's total assets were RMB 84.83 million, and had 285 full-time employees (60 university graduates and 55 technical staff). It had two subsidiaries, Qingdao Longertek Co., Ltd (*TLL*) and Laiwu SANHE Technology Co., Ltd (*SANHE*). TLL specialises in the R&D and production of Intelligent Power Control Modules (IPM), Universal Intelligent Power Modules (UIPM) and Permanent Magnet Variable Refrigeration (PMRV) related products; and SANHE mainly makes energy-efficient variable-frequency multiple-split system refrigerators and air-conditioners used on locomotives and passenger trains.

Longertek has been awarded 16 national patents and 2 of its products have been named 'National Key New Products'. According to 'Electronic & Information Technology Promotion Plan year 2008', it was the only Chinese firm to have independently developed, patented and commercialised Permanent Magnet Variable Refrigeration (PMRV) technology. Combining its PMRV and UIPM technologies, Longertek's energy-efficient products were at least 1/3 cheaper than ordinary PMRV controllers and much more user-friendly. Moreover, the unique re-programmable feature means it can not only be used on air conditioners but also on any other electric and electronic appliances and devices (Mr Li Jingmao, CEO. September 2006).

Longertek's market performance has also been impressive. It supplied IPM-embedded controllers to most major Chinese air-conditioner producers, and hence dominated 60%-70% of the domestic market at the time of case study in 2006. It was also selling to international brands including Siemens, LG and companies in the US and Italy (Longertek internal document, accessed in September 2006). In 2004 by introducing new technology and cutting unit price by 150% - 200%, SANHE became the only firm outside of the Chinese railway system to supply air-conditioners to locomotives and passenger trains[72] (Ms Zhan Meiyan, PA to CEO/PR manager, September 2006). It also dominates 80%-90% of the air-conditioner market in other transportation sectors. Table 6-6 summarises its sales performance between 2004 and 2006:

Table 6-6 Longertek's sales performance: 2004-April 2006

Year	Total Sale (Thousand RMB)	Gross Profit (Thousand RMB)	Net Asset (Thousand RMB as end of period)
2004	41，929	2，741	15，943
2005	54，417	3，682	21，575
1st Quarter 2006	19，666	1，235	22，810

Source: Longertek's Internal Document (May, 2006)

6.3.2 Approach to technological development

'*Offence is the best form of defence – competition through innovation is what we have always been doing*' (Mr Hu Wensheng, Principal Engineer/Director of R&D).

Longertek's technological development has followed three stages: 1) Reverse engineering; 2) Extensive unbundling and other low-visibility in-house development accompanied by external support and collaboration; 3) independent design/development and high R&D spending.

- Stage 1 - Initial acquisition of product technology through intensive reverse engineering.

[72] Procurement of air-conditioners in the railway system is highly controlled and rationed by the corresponding ministry; in the past only three companies were short-listed as suppliers. They are: Shijiazhuang Guoxiang Transportation Equipments Co., Ltd (Taiwan Invested and Controlled); Shanghai Hakenuke Refrigeration Co., Ltd (Foreign-invested) and State-Controlled Guangzhou Refrigerator Co., Ltd (http://www.chinarail.cn, accessed in May 2006).

Longertek's technology base can be traced back to the early 1990s. Mr Li Jingmao, CEO and owner-founder of Longertek gained his experience in air-conditioning through reverse engineering of Japanese technology:

> *'I was a free-lance engineer before setting up this company, and what I did basically was imitation...of Japanese technology, and I then sold the copied prototypes to Chinese air-conditioner makers at lower prices than if they were to buy such technology from Japan. But that for me was by no means easy. In 1994 I bought a 2-unit split air-conditioner from Japan. When I first saw the inside I gasped: it was so complicated and sophisticated, and so state-of-the-art! But I managed to disassemble it and understand the technology behind it, and finally made something even better than the original. 12 years on, we are now producing our own branded 16-unit machines.'* (Mr Li Jingmao, CEO, May 2006)

- Stage 2 - Although not overtly recognised within the company, *unbundling as well as other low-visibility strategies* have been practised over time, and the level and complexity has experienced significant progress:

Phase 1. In the early stage of the company's development, due to lack of capital and experience in production operations, and since the production of an air-conditioner controller only involves generic manufacturing process which can be managed by any electronic company (information provided by Mr Li [CEO] and later confirmed by Ms Wang Ying [Production Manager]), Longertek outsourced production to its local partners between 2000 and 2003. In doing so it concentrated its limited resource on the areas where it has competitive advantage - concept development and product design. We identify such activity as one of the two orthogonal dimensions of unbundling as discussed in the Chery case, which are: tangible/physical component and intangible/process unbundling. (See Section 6.1.2)

Phase 2. *Withdrawal of outsourced production and fostering of manufacturing capabilities through tangible unbundling.* Since 2003, after securing a leading position in the R&D of controllers for air-conditioners and refrigerators, Longertek started to expand its speciality to manufacturing, and set up two factories. The approach to developing manufacturing capability has been low in visibility:

- Using local supplies of manufacturing equipments instead of expensive complete-set imports when possible. (Information provided by Ms Wang Ying [Production Manager] and confirmed by author's site observation at SANHE's Jimo factory, May 2006)
- In view of its modest budget, second-hand or stock-clearance machines were bought when technical staff and CEO safeguarded good value for money. The R&D staff then worked closely with production and maintenance workers to make fine-tunings and changes to the machines to meet the production requirements. (Information provided by both CEO and Head of R&D on different occasions, May 2006)
- As to parts and materials, Longertek purchased from domestic or local suppliers if possible. For parts and components that are crucial to the performance of products, supply was sought from the world's best makers to ensure quality (Information provided by Mr Zhang Gulin, line-manager at Jimo factory).

- Stage 3. Independent design/development and high spending on R&D and other technological activities.

➢ *Expansion of in-house R&D and informal technical consultation*. From 2000 to 2008, Longertek's R&D team has grown from 1 person (CEO) to over 70. The CEO Mr Li was widely regarded in the company as the driving force of innovation and was well informed of product and technology details; however with the steady growth of the R&D team, his role in the firm has gradually changed to a more strategic one. Most of the R&D staff had previously worked in the technical departments of China's two biggest air-conditioner companies (both in the same city of Qingdao), and were head-hunted by Longertek for their expertise. Their experience in, and personal connection with these two strong clients/competitors proved to be precious assets to Longertek:

> '*...It is quite commonplace that, when there was a technical issue that one of our member of staff was not very sure about, they would ring up their previous colleagues from their old jobs to check...I sometimes do that too, as I also came from one of the big firms...but of course this is conducted very tactfully, and under the radar of their bosses...*' (Mr Hu Wensheng, Director of R&D, May 2006).

As discussed in the previous case, informal information exchange among previous university classmates and colleagues has also been noticed in GTC (see the end of previous section):

> *'Many of our R&D members, especially younger ones, have university classmates who work in the same (tyre) industry. Probably because they are working for firms in different regions, the sense of competition is much weaker; rather, they seem to share a lot of empathy amongst each other. I know some of my team members often consult their classmates for technical problems, especially those in SOEs - who feel much less loyal towards their employers than those in POEs...'* (Mr Qian, Party Secretary, GTC, June 2006).

Such pattern of peer consultation and informal information exchange are bound to have benefited collective learning and development of technological capabilities in these two companies.

➢ *High spending on R&D and technology-related activities.* According to the company's management accounting reports, between 2003 and 2007 Longertek's investment in technology-related activities has exceeded 20% of its turnover. Besides formal R&D investment, a fair share of the expenditure has been on low-visibility technological activities. For example, Longertek pays executive-level salaries to three retired Chinese engineers and university professors in the tyre industry for formal staff training and technical consultancy. Through the CEO's personal network, two Japanese experts from Panasonic and Sanyo were also invited regularly to provide training and trouble-shooting. They were also financially rewarded for bringing market information and business opportunities.

6.3.3 Corporate governance and finance

As a private company, Longertek is controlled by its sole shareholder and founder, the CEO. There was thus no owner outside the firm; and the owner inside the firm was guaranteed to be fully engaged, and a well trained and informed expert in the industry. In the Chinese context however, absence of state shareholders does not necessarily mean that the state has no share in control. We were informed that there is no excessive intervention from outside Longertek: '*we are subject to lots of authorities...but it only involves quite ordinary stuff: paying taxes/fees, renewing registration, handling routine checks. We are left to mind our own business...*' commented CEO Mr. Li. However, he also admitted that '*...in China, it is essential for an enterprise to build and maintain a good relationship with local authorities.*' Li learned his lesson the hard way. According to Li's old colleague from his free-lance job Mr Gu, as the first Chinese company to develop (air-conditioner) controllers, in the 90s Longertek's technology level was not very far behind its Japanese counterparts. However, not understanding the crucial importance of winning government support, it was never funded either under government projects or by banks, thus missing the opportunity of catching up. Nowadays Li spends 80%-90% of his working life cultivating all sorts of relationships, a significant proportion of which were spent on dining, drinking and entertaining with local government officials. It was believed to be beneficial for the firm, according to Mr Li,

> '*...the government controls a lot of key resources – favourable taxation, industrial policy and the use of land – we need to have good guanxi to access them; on the other hand, we also need government officials themselves – they could use their resources and personal networks to help us with the sales of products.*'

Longertek's belated friendly gesture with the authorities finally took effect – it started to receive the treatment it had long desired, but on the other hand, seeing the firm's promising prospects some supervising bodies are getting over-excited.

> '*At times we are given unrealistic performance targets and so on...actually they (the authorities) don't quite understand what we are doing and what our situation is like. In other words they just want to use us to showcase their political merits, which gives us unnecessary pressure.*' (Li)

Employee Inclusion

The advantage of owner-management is that close committed relationships can be developed between those who control the firm and those who work for it – employee inclusion - starting of course at the top. At Longertek the CEO is not the only one who is enthusiastic about his job – the R&D manager, company vice president and manufacturing manager works long hours both at the Qingdao HQ office and on the production sites. In 2 separate interviews, 2 members of senior management commented that '*...I don't simply Dagong (make a living) here, at Longertek I am building my career*'. One of the 2 interviewees was 29-year-old Production Manager Ms Wang Ying, who was put in charge of the main factory 60 km from her home in Qingdao. In order to ensure smooth routine production, and to set an example for the young workers, she lived with workers in the factory's dormitory:

> *'We moved to this new site this May (2006). I remember it was raining heavily on that day and the road outside of the factory became so muddy that our lorries got stuck. The young workers didn't know what to do. I dashed into the rain and picked up a box...they all followed suit...those days I slept in the office, and since there was no hot water I even couldn't wash my feet...'.*

Highly motivated young managers – such as Ms Wang – did excellently in eliciting their team members' enthusiasm and contribution by demonstrating their own. Shop-floor operatives were encouraged and rewarded for constructive suggestions and contributions. During the author's site observation in Jun 2006, one of the front-line operatives mentioned that after solving a technical problem, he was commended on the company's newsletter and financially rewarded. In addition, the company has implemented formal policies to reward committed managers and technical staff:

1) The company selects top-performing staff (mainly from technical employee and managers) every year and pays for the interest on their house mortgage;
2) The company pays all or part of the university tuition fees for outstanding staff's children;
3) If any member of staff takes on part-time education that leads to degree or certificate qualifications, the fees can be reimbursed by the company.
4) An employee shareholding scheme was being drafted at the time of interviews in 2006.

Finance

As a private company Longertek had to constantly battle for financing. Due to the past discriminatory rules against small private firms, Li never managed to get a loan from the banks.

> *'... what we had at that time was nothing but ideas, patents and intellectual property rights, and we needed money badly to commercialise them, but the banks wouldn't accept intangible assets as collaterals... therefore we could not get even a penny'. The reason for choosing to float in the US rather than on the domestic market is similar. According to the current policy in China private firms have to go through a time consuming and painful process to get listed. 'It means life and death to us that our project be launched in a certain time frame, and I am afraid that by the time we finally got listed in China the dinner would be cold already'.* (Mr Li Jingmao, CEO)

6.3.4 Summary

Longertek was a bridgehead of technology and market in its area; showing endogenous capabilities of executing independent development and innovations. The firm has had extensive reverse engineering, coupled with various combinations of sourcing from abroad, sourcing domestically, and different degrees of self-reliance in its early days of catch-up. All its behaviour was indeed associated with the strategy of *unbundling,* although the interviewees never used the exact term. Meanwhile, Longertek had a governance that featured high shareholder engagement; strong industrial expertise of corporate decision-makers; trust in, empowerment of, commitment by, lower-level managers and shop-floor workers. The interviewees agreed that these factors contributed to the process of organisational learning and capability building.

6.4 South Electro

6.4.1 Company profile and performance

South Electro is one of the four affiliates of South (Group) S&T Co., Ltd, which was among China's first batch of shareholding companies (all of its shares were state-owned in various forms). South Group was established in 1965 as one of the 'National Defence Electronics Industry Bases' in inland China. Along with 6 other companies in Guizhou province, South Group had enjoyed the privileged status of National Key Enterprise[73]. In 1991 it became one of the first 57 'National Experimental Large-scale Enterprises/Groups'[74]. As of end of May 2006, 50.3% of South Electro's shares were tradable and the rest 49.7% were non-tradable state shares. However around half of the tradable shares were owned by state shareholders – it was thus a 'MASOE'.

At the time of field work in May 2006, South Electro had 570 full-time staff (large-sized by NBS' standard), 170 of whom were in management and administration positions. The number of full-time-equivalent employees at South Electro was only half compared to that of its best in the early 90s. The firm was suffering from severe losses and struggling to survive.

South Electro as one of the four subsidiaries of South Group specialises in the manufacturing of cathode-ray tubes (CRTs) for colour televisions and other generic electronic circuit boards. Its CRT production started in the late 80s when TV production and demand for CRTs started soaring in China. South Electro started off by manufacturing CRTs and television remote-controls against specification for a Japanese company which supplied the technology and equipments. A few years later, the collaboration ended but South Electro managed to understand the technology and continued its own production. By the end of 1992 its products ranged from 17" B/W to 25" colour CRTs. Annual sales reached over 1 million units with over 30% gross profit. From 1997 on, however, when the competition among Chinese TV set firms became a cut-throat price war, 70% of decrease in profit margin was passed on to parts and

[73] GTC, on the other hand, as an SOE in the same province, was never given such status.
[74] The purpose was to deepen internal reforms, improve the level of management, enhance competence of the firms and hence to set good examples for other enterprises, in 1998 another 63 large-scale companies were selected to join the list.

components suppliers (Kang, 2003). As one of the major suppliers to most domestic TV brands, South Electro was then forced to cut its price by 40% compared to the mid 90s. From 2000 on, major breakthrough in TV display technology started to prevail, such as rear projection, LCD and plasma. South Electro was still only capable of producing traditional small-sized CRTs for a fast-shrinking market. Moreover, with market perspectives for CRT TVs on the decline, many TV set firms ceased regular orders and demanded 'just-in-time' supply, which again increased pressure on South Electro's inventory control and cash-flow. From 2001 on, due to lack of investment, its research and development team was cut by more than half compared to mid 1990s, '*...the company's R&D has almost ground to a halt...*' (Mr Hou Song, retired Chief Engineer, May 2006). In 2002 when the senior management found the firm was too indebted to guarantee regular wage payment, they resigned collectively.

6.4.2 Technological Development Strategy

South Electro's failure in developing technological capability can be attributed to the following reasons:

1) Inconsistent product development strategy, due to decision-makers' lack of industrial expertise and firm-wise understanding.

The strategic decision makers of the company, i.e. CEO and Party Secretary did not understand the firm's core competence and hence were not able to cultivate it. The management at South Electro was content with profit generated from its CRT division and never aimed at new projects that were compatible with the firm's traditional strength and long-term development. According to Mr Yang, Director of R&D (who refused to reveal his full name), South Electro made a strategic mistake in the mid 90s by entering into a product niche market where South Electro did not have any advantageous resources to compete. In 1993 China started mass production of wireless telecommunication devices, such as pagers and mobile phones. Seeing this as an opportunity to revive the company from failing in the TV components market, the CEO decided to chase the fashion by starting to produce chip resistors for mobile phones. Knowing nothing about the sector and production, it invited Samsung, the industrial leader to set up a joint venture – a quick-fix measure of technology transfer that is too familiar to disengaged Chinese SOE managers. However, the Korean guests were not impressed by South Electro's overall performance, especially its problematic managerial practice (see explanation in section 6.4.3) and 500 retired employees[75]. After the failed attempt to gain technological expertise through joint-venturing, the firm opted for the highest-visibility form of 'bundling' – complete sets of equipments were bought in batches – with interest-free loans taken from state-owned banks.

2) The absence of technological and organisational learning.

'*The firm has always relied entirely on disassembling prototype products and then mass-producing it. Such strategy worked and paid off in the early years of the reform (from 1979 to 1989), but there was no growth from there, nowadays in the market economy, if you don't try hard to at least follow the tide, you are doomed to fail...*' (Mr HOU Song, retired Chief Engineer, May 2006)

Due to its poor endeavour in technological learning, the lack of knowledge stock within its human resources has also caused the company's failure to adapt to the industrial transformation:

> '*...from 1995, due to lack of special funding by the government, the previous CEO decided to stop providing the technical staffs with on-the-job training and reduce the subsidy for their qualification programmes, such as Dianda [distance undergraduate courses]. Many highly qualified and experienced R&D personnel started to leave for more lucrative jobs in the coastal regions and the technology team shrank from over 100 people to around 30. South Electro was not capable of carrying out any serious research and development independently. In the early 2000s, new TV display technology started to emerge in China and we knew we must do something to catch up; however, the gap between CRT and other types of display technology is too big to be understood by us.*' (Mr Chen Song, CEO, June 2006)

3) Lack of investment in R&D and technological activities

Sagging profits and the urgent need to meet all sorts of immediate payments meant that South Electro hardly had any R&D expenditure since the mid 1990s. Mr Xie Mingfang, line manager of circuit board workshop mentioned in the interview that sometimes, even project proposals which could lead to significant process improvement and cost

[75] In the mid 1990s Chinese firms were fully responsible for wage payment of retired employees.

reduction would be rejected: he once proposed to invest 7,000 RMB (1,000USD) to improve the lighting system which could lead to significant manufacturing cost reduction.

> '*Last year I put in an application for some money to improve the lighting system in the workshop. My proposal stated that the investment would pay off in only 2 to 3 months. They (senior managers) told me to wait for my proposal to be discussed at the group level – for heaven's sake all I asked for was 7,000 yuan (less than 1,000 USD)! ...I was never given an answer since.*' (Mr Xie Mingfang, Line Manager, June 2006)

4) High priority for dependent technology strategy and high-visibility activities

It became clear during the interviews with the CEO of South Electro that, when considering introducing a new technology, the senior managers' instinct was to buy from world-leading multinationals:

> *"When we realised that we need to update our technology (from CRT to LCD and Plasma [added by author]), we tried to seek technology imports from Japan. Unfortunately, as a monopolist in the industry NEC holds its technical details so tightly that it is impossible for South Electro to do so. Then we thought about buying machines from them, so that at least they can provide some production training. However by that time we were already in deep debt and couldn't afford to do so either."* (Mr Chen Song, CEO, June 2006)

As mentioned before, South Electro also bought state-of-the-art machineries for its production of chip resistors. During the site visit, the factory line manager was eager to show the flashy chip-placement machines they imported from Mitsubishi, and referred them as signs of the firm's technical strength. However, these machines are '*highly automatic and don't require specific training to operate, and Mitsubishi provides 24/7 on-call technical support*' (Mr Jiang, Deputy Director). In other words, South Electro did not have the opportunity to learn by operating or maintaining the machinery independently, and its production capability remained static and completely dependent on those foreign machinery vendors.

6.4.3 Corporate Governance and Finance

Corporate Governance

South Electro retained many legacies of a typical Chinese MASOE. For example, despite stipulation of the Company Law, after South Electro's senior managers collectively resigned in 2002, all replacement members were assigned by South Group, rather than being nominated by the board and elected at the shareholders' meeting (Mr Qian, Deputy Director, June 2002).

South Group as the biggest shareholder had overriding power and control over South Electro [76], and their intervention was perceived to have been '*over-simplified, inconsiderate and often detrimental*' (Mr Jiang, Deputy Director, August 2007). South Electro's performance was measured by the Group against uniform criteria with financial performance as a priority. Not truly appreciating the difficult situation South Electro was in, the Group demanded an unrealistic target of 10%-15% annual asset value increase. According to South Electro's CEO Mr Chen Song: '*there is no way we can manage that given the current situation, but the report determines how much funding we can get from the Group next year, therefore we must meet these targets. So...you know, if there is a will, there is a way.*' (It was later indicated by R&D director that South Electro could meet these targets through fraudulence of financial accounts).

Irregular inspections were conducted by the Group management; however, it only involved financial reporting to the Group chief finance director and the chief accountant (which had already been 'tailored' to meet their expectations). Sometimes the Group executive in charge of production also comes to the workshops to inspect, but he normally did not stay for more than 30 minutes. Afterwards, expensive 'souvenirs' and dinner at luxurious hotels were always arranged by South Electro as part of the routine (Mr Jiang, Deputy Director, June 2006).

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[76] South Group on the other hand, had its ownership exercised by SASAC at the provincial level (just like SAIC and GTC).

All of the interviewees were very reluctant to give specific comment on the top managers' involvement in innovation-related activities. Meanwhile, CEO Mr Chen felt that he had better things to worry than technological improvement:

> *'...Oh, I simply don't have the energy and time to go over all the details of daily operations - relationship management with external officials for our company is definitely of higher priority – otherwise we would have no money to pay and keep the workers, without workers how can we be innovative?'* (CEO Mr Chen Song, August 2007).

It can be seen that with the corporate governance typical in a major SOE, South Electro's senior managers were not motivated to look after their company. Rather, the highly quantified appraisal enforced by the main shareholder had forced managers to go out of their ways to fabricate immediate financial gains. Also, the time spent to keep government officials happy meant that the CEO would not have the chance to learn about the firm's technological strengths and weakness. Nor was he aware of, or concerned about the long-term price to be paid by the company by totally relying on foreign technology.

By the same token, it became clear during the fieldwork that little was done in the firm to harness stakeholders' input in the technological development. There was no well-defined and implemented scheme to promote healthy management-employee relationship in the firm. Also, relationship between lower-ranking managers and senior managers was highly hierarchical. The CEO of South Electro, Mr Chen, refused to comment on the situation. However, Mr Xie and Mr Wu, two of the production line managers, expressed their discontent:

> *'Our managers ... are very stubborn and closed-minded. They don't seem to be bothered about what their staffs think. Many of the younger senior managers also deliberately keep distance from the lower-level employees to preserve their image of authority. I can say there is always an air of tension between upstairs and downstairs* (meaning between the managers and workers, author).' (Mr Xie Mingfang, June 2006)

> *'Many of my colleagues actually have a lot of ideas to improve their jobs and to improve the workshop's performance. However they often choose to keep it to themselves – what's the point? There have been occasions that, whenever things go wrong, a witch-hunting then*

begins and it's always workers and junior supervisors who get the blame'. (Mr Wu Can, June 2006)

On the other hand, like many other old-fashioned SOEs, South Electric had an apprenticeship system to train new workers, where tacit experience was passed on through life-long apprenticeship. It was particularly evident in South Electro's maintenance work force that such close mentoring and coaching relationship had cultivated a highly skilful and innovative team. In the team each new worker was allocated to a *Shifu* (master worker). Whenever a problem occurs, (e.g. a minor technical hiccup) the master worker would gather all of his apprentices around to brain-storm a solution. Everyone was encouraged to build on or challenge other people's ideas. According to the Chief of R&D (Mr Yang), most maintenance workers had great understanding of the machines/equipments, and shared a pool of knowledge and experience among them. In the past they had made many important contributions to the production department's innovation. For example, Mr Sun, director of the maintenance team, found out that on three key equipments the boring bar and boring sheath does not match. This situation was reported to the CEO and a budget worked out. A set of matching bar/sheath costs at least 30,000 RMB. Sun suggested that the cost could only be around 5,000 Yuan for each machine if right changes can be made on site. At the time of site observation his team was experimenting on one of the equipments.

Site observations showed that front-line operatives were mainly middle-aged skilled workers. '*They are well trained, responsible and loyal to the company, we are very grateful to them*' (Mr Xie, Production Line manager and Mr Yang, Chief of R&D, 2006). However, with more and more of them retiring or leaving, young workers were recruited and could hardly match their old peers in experience and work ethic. Managers described them as '*irresponsible, lazy cry babies*' (Mr Xie). In order to discipline the new workers, harsh measures were initiated. For example, the main gate was kept locked and guarded to prevent workers from leaving earlier than they should.

Finance

As a MASOE with long-standing connection with the state, South Eletro used to enjoy a privileged financial status. As mentioned in the previous section, up till the mid 1990 it could easily secure cheap or interest free loans from State-owned banks to purchase expensive foreign-made machinery. However, since South Electro started to show signs of loss-making, it gradually fell out of favour by the banks and governmental funding authorities. The situation continued to deteriorate especially after state-owned banks were required to tighten up their lending and carry out credibility scrutiny in the late 1990s.

> '*...we used to be the 'star' company in the group – we were outstanding in all aspects – technology, sales, profit, staff income, and tax contribution...and all banks were eager to lend to us - because they know we didn't really need money, and even if we couldn't repay the group could always bail us out...sadly it's all history now. Our financial situation started to dip when the government stopped providing direct finance in the late 1990s...and then the banks started to ask difficult questions. You know, nowadays without a good project in the horizon we can't bid for government money, even when South Group agreed to be our guarantor.*' (In a separate interview, the R&D director commented that the firm was not able to bid for any large-scale projects due to lack of technological competence)

Direct financial support from the government has been rare and limited since the mid 1990s. The latest infusion dated back to 2004 when South Electro received 150,000 RMB (20,000 USD) from the Provincial Committee of Economy and Trade for its Enterprise Resource Planning (ERP) project and another few *wan* (10,000 RMB) for its product improvement project.

6.4.4 Summary

To sum up, South Electro struggled to survive due to lack of capability to keep up with the demand of product upgrade and development dictated by the market. Its corporate governance conformed to that of old-fashioned MASOEs, which largely caused its failure. Top managers were appointed on basis of relationships with their superiors but not merit. They were pushed by the state shareholder to pursue immediate financial performance and cared more about *guanxi* with officials than what was best for the company. Although starting off well-equipped and favourably-financed, South Electro failed to preserve the momentum and adopted a highly dependent, high-visibility technological strategy. Meanwhile, little did its employees feel valued for their effort and ideas for technical improvement and innovation - the only exception was with the maintenance team, however the positive experience was based on tradition and was not disseminated outside of the department.

6.5 Discussion, hypotheses generation and further insights

In Chapter 4, Section 4.2 we developed 3 propositions: 1) In Chinese firms, different types of ownership (e.g. MASOE, MISOE and POE) entail different patterns of corporate governance and level of access to finance; 2) Firms with intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities. 3) Firms with better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities.

After initial findings of each of the case studies are analysed in the previous four sections, it is important to develop an integrated overview of all five cases. This will be used to identify patterns which can be related back to the three propositions, and to generate testable hypotheses for stage two of the empirical research.

A synthesized summary of the five cases are presented in Table 6-7. In order to show how these cases illustrate the theoretical framework, three types of factors were selected, namely capability factors (Manufacturing, R&D and Organisational), visibility of technological activities; and corporate governance and finance factors (CEO's time-horizon/autonomy, quality of shareholder engagement, inclusion, pressure for shareholder value, and ease of access to finance). When ascending scores from low/short to high/long (with matching colour labels from green to red) were assigned to the above factors, some interesting patterns start to emerge[77]. Below each of the propositions will be discussed with reference to patterns in the table, and 8 corresponding hypotheses will be generated.

[77] Scoring of the firms' capabilities and CGFS factors was based on author's own assessment during the case studies, and was individually verified by each firm's respondents to the questionnaires survey conducted at a later stage. The survey results are reported in Chapter 7 and 8.

Table 6-7 Case study summary – the impact of corporate governance and finance on capability development

	Owner-ship	Selection method	Area	Size	Age	MAN-CAP	RND-CAP	ORG-CAP	Visibility of Tech. Activity	Engmt. quality	Stake holder Inclusion	Access to finance
SAIC	MASOE	Official-appointed	Developed	Large	Old	High	Mid	Mid-low	High	Low	Mid-low	High
Chery	MASOE	Shareholder-select	Developing	Medium	Young	Mid	Mid-high	Mid-high	Low	High	Mid-high	Mid
GTC	MASOE	Shareholder-select	Developing	Large	Old	Mid-high	Mid-high	Mid	Low	High	Mid-high	Mid
Longertek	POE	Shareholder-select	Developed	Small	Young	Mid-low	High	Mid-high	Low	High	High	Low
South Electro	MASOE	Official-appointed	Developing	Medium	Old	Mid-low	Low	Low	High	Low	Low	High then Low

Abbreviations: MAN-CAP: Manufacturing capability;
RND-CAP: R&D Capability;
ORG-CAP: Organisational Capability;

Reference:

Capability and Product Competitiveness	Corporate governance and Finance

Low score	Medium-low score	Medium score	Medium-high score	High score

Based on the case studies, only 1 out of 5 firms has scored 'High' in Manufacturing Capability, another 1 scored 'High' in R&D Capability, and none has 'High' scores in Organisational Capability (for definition and elements of these capabilities, see Chapter 4, Section 1). Although the sample size is too small to produce a generalisable conclusion, the finding enables us to tentatively infer that the situation of Chinese firms in terms of dynamic capability development is not optimistic.

6.5.1 Proposition 1 and Hypothesis 1 &2: Ownership and CGFS

It was proposed in P1 that different types of ownership entail different patterns of corporate governance and finance. This was mainly based on our literature review of past research in the Chinese context (see Chapter 4, Section 4.2). Moreover, Cai, Tylecote *et al* (2005; 2008) argue that MISOEs (Minority State-Owned Enterprises) in China enjoy better corporate governance than MASOEs (Majority State-Owned Enterprises), and easier access to finance than POEs (Private-Owned Enterprises), and therefore outperform the other two in capability development. Our case studies partially supported such argument, as a MASOE South Electro exhibited worrying signs of poor corporate governance and quickly diminishing access to favourable financial support. Moreover, all of its 3 types of capabilities scored the lowest of the 5 firms: Medium-Low for Manufacturing and Low for both R&D and Organisational. On the other hand, Chery and GTC as 2 of the 4 MASOEs appeared have healthier CG and have become successful. Arguably, they could have done even better had they had the amount of cash enjoyed by the big favoured SAIC, but this was mainly due to their geographical disadvantage - with their hands tied, the official of local authorities simply could not have done more.

The finding hence begs two questions: is ownership a good indicator of governance? Is there a better indicator of CG for capability development?

Cai and Tylecote pointed answers in the direction of *selection method for top management*. They suggest that for Chinese SOEs, it is a better predictor of their technological capability than is ownership type (2008). Specifically, they found that in the telecommunication sector, firms with senior managers selected by the shareholders out-perform firms with managers appointed by authorities.

To what extent does selection method influence CG for capability development then? As the case study shows, for the four MASOEs, since SASAC was the main shareholder as well as governing authority (for explanations see Chapter 3, Section 3.3.1), it requires a closer examination to understand whether the CEOs were selected by the shareholders according to the law, or appointed as officials. We did so by looking at the selection and appraisal procedure:

Yin Tongyao from Chery had been head-hunted by the local authorities for his industrial expertise, and stayed in effective control from the beginning in 1997; Ma Shichun had served GTC for 25 years. Although none of the supervisory authorities of Chery and GTC displayed superior expertise, they compensated for this by giving the real experts - the CEOs - full autonomy to pursue their goals. They both had every opportunity and motivation to aim for real technological capability development, and they did so. In sharp contrast, SAIC displayed the typical form of CEO rotation in Chinese SOEs: firm executives were hand-picked by Shanghai government, with a short-term target to deliver. Once failed, they were either forced to resign (Hu Maoyuan), or moved to another company (two former CEOs). South Electro obviously had a mechanism of authority-appointed senior managers, which is typical of old-fashioned MASOEs (see Section 6.4). It then explains why senior managers in SAIC and South Electro could not think long - why would they risk their careers to undertake long-term capability building, when the authorities were breathing down their necks for immediate profitability?

It is therefore reasonable to infer that, for the two firms with better CG, their management selection method resembled what is defined as 'shareholder-selection' - selection based on expertise and competence. As for SAIC and South Electro, the management selection conformed to 'appointed by the authority'. Two Hypotheses are then developed:

H1a: In China, different types of ownership lead to different corporate governance for the purpose of capability development. H1b: In China, in getting access to financial resources, different types of ownership lead to different treatment.

H2: In China, different selection methods for top management in SOEs lead to different corporate governance for the purpose of capability development. (There is no H2b because theoretically, there is no reason why selection method should affect finance).

6.5.2 Proposition 2 and Hypothesis 3, 4 &5: engagement, visibility and technological capability development

In Chapter 2, the existing Western-developed theory was adapted for the Newly Industrialised Economies, that four corporate governance factors - 1) Quality of shareholder engagement 2) Stakeholder Inclusion 3) Pressure for shareholder value and 4) Management autonomy - are each influential to four aspects of technological learning and capability development: 1) Visibility of technological activity; 2) Stakeholder spill-over; 3) Need for configuration and 4) Technological opportunity. After the situation of Chinese firms was reviewed in Chapter 3, the framework was further refined in Chapter 4. Specifically, since most unsuccessful technological learning in Chinese firms has been in the form of highly dependent, high-visibility activities, we proposed that firms with higher quality of shareholder engagement will excel (other things being equal) in capability types which are sensitive to low-visibility activities. Proposition 2 thus has the highest weight in all of the three propositions, that if it holds, then any degree of improvement in engagement quality should have a significant and positive impact on capability development in Chinese firms.

It is obvious that the case studies confirmed our prediction: in Table 6-7, the two firms (SAIC and South Electro) with 'Low' scores of engagement quality had implemented technological strategy/activities that were high-visibility. Consequently, they scored 'Mid-low' and 'Low' respectively in the type of capability (Organisational Capability) that are most sensitive to low-visibility activities. The other three firms had higher quality of engagement, and all had low-visibility technological capabilities, and therefore exhibited higher dynamism in their capabilities, especially in Organisational Capability. Three more hypotheses are thus developed:

H3: there will be a positive relationship between the quality of shareholder engagement and the firm's technological capability.

H4: Poor engagement leads to strategy prioritising high-visibility activities; intelligent engagement leads to strategy prioritising low-visibility activities.

H5: Strategy prioritising high-visibility activities leads to lower dynamic capabilities than strategy prioritising low-visibility activities, does.

6.5.3 Proposition 3 and Hypothesis 6 and 7: Corporate governance, finance and technological capability

Proposition 3 predicted that firms with better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities. This is again proved to be true for the case studies. As demonstrated in Table 6-7, SAIC enjoyed very high access to finance, and scored the highest in Manufacturing Capability in all 5 firms. (According to the framework set out in Chapter 4, Manufacturing Capability is most sensitively to high-visibility activities, compared to the other two capability types). On the other hand, the two firms with low access to finance both had medium to low dynamism of manufacturing capability, whilst Chery and GTC were favoured by the local governments, but had medium financial advantage due to the finical constraint intrinsic to their location, and each scored 'Medium' and 'Medium-high' in Manufacturing capability. Therefore, if combining Proposition 1 with 3, and if the previous six hypotheses all hold, two further hypotheses can be developed:

H6: Ownership form affects technological capability; more specifically, (H6a) ownership forms giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities. It would also be expected (H6b) that ownership forms giving better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities.

H7: Technological capability in SOEs is affected by selection method for top management. (H7a) Selection methods giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities. (There is no H7b because there is no reason why selection method should affect finance.)

Hypotheses 6 and 7 can be seen to address the overall aim of this research, that is, to identify the most influential factors of corporate governance and finance for technological capability development in Chinese firms.

6.5.4 Further Insights: Unbundling, inclusion and technological capability

In addition to the above 7 hypotheses developed for testing in the questionnaire survey, there are also a number of further insights from the case studies. Below each of them will be discussed to explore opportunities for future research.

Unbundling and dynamic capability

In the case studies most successful firms have shared a pattern of behaviour which can be termed as *technological unbundling*. As the word indicates, it refers to firms' endeavour to acquire the capability to produce each component and sub-system, and system, separately, and indeed at the extreme involves separate acquisition of each element. Three key characteristics of unbundling have been identified:

1) As a commonplace example of low-visibility activity, unbundling may take either or both of two orthogonal forms: *tangible/component unbundling*, such as acquisition of machinery from one supplier and parts from another (Chery with SEAT, and GTC with the Tianjin machinery supplier), and *intangible/process unbundling*, such as training from a third party; or joint R&D (Chery with AVL). In terms of their effects on dynamic capability development, tangible/component unbundling directly benefited the case study firms' development of dynamic manufacturing and R&D capabilities; whilst intangible/process unbundling required higher-level coordination of intra- and inters-organisational activities and strategic planning, and hence pushed the firm to improve

dynamism of its organisational capability. Although limited sample size is not sufficient to test how the two forms of unbundling compare with each other, more can be revealed with further study focused on such issue.

2) Firms in our case studies were mostly 'forced' to unbundle to tackle financial constraints; however unbundling should not be considered exclusive to poor, small firms. Just as other technological learning endeavour to enhance dynamic capabilities, unbundling requires not only the intensity of effort, but also existing capability and knowledge base to be able to learn (see discussion of the literature in Chapter 2). Therefore firms with higher degree of static capabilities and better financial stance could be in a better position to unbundle, and benefit even more from it. Likewise these firms could execute unbundling at a much more advanced starting point - just as SAIC did. The key to success - as argued in this thesis - is a sound corporate governance mechanism to see the process through.

3) The applicability of unbundling and its benefit on capability development is dependent on the sectors and the characteristics of technology. Clearly for firms in the auto and electronics industries, unbundling provides them a unique opportunity of learning by doing, and to understand systems integration. These two industries involve assembly of components, to subsystems, to systems, then to final products. For those that don't (chemical, plasma, etc), there is less scope for unbundling and less need for systems integration. But the intangible unbundling is still relevant.

Inclusion, guanxi and dynamic capability

In the case study we confirm that although it is not a sufficient condition, stakeholder inclusion is positively associated with dynamic capability - again shown in Table 6-7. We also found that for firms with high quality of engagement, such as GTC and Longertek, their quality of inclusion was equally higher, and the same pattern applies to South Electro and SAIC where there was poor engagement, hence inclusion and engagement tend to go together.

Two more findings from the case study enrich the existing theory. Specifically, 1) intelligent inclusion benefits not only technological activities, but also flow of information for innovation; 2) in the Chinese context, the convention of *guanxi*, which often involves relationship between the government officials and the firm, may be necessary for a firm's survival and sales growth in the short run, but in the long term could be destructive to firms' other inclusion activities.

Our cases have shown that close and constructive relationship with stakeholders - such as suppliers with Chery and GTC, skilled workers and technical staff with GTC and Longertek, and 'lead' industrial customers with Longertek, are vital. Whilst some of these relationships are based on transaction of commodities or collaboration of activities, many focus on facilitation of information flow. Take Longertek as an example: while accepting that their tougher resource constraints did inhibit formal training, information scanning and formal R&D, most product development was achieved through constant and open communication - not only within the firm, but with external sources. Longertek's technological competitiveness depends on key employees, including the owner/manager, bringing together the knowledge they have gained by experience, and making the routines developed within the firm explicit: thereby they are able to share knowledge, combine it, and create new knowledge. Unfortunately, the CEO's time must be spent elsewhere - much more than he would like to - to cultivate and expand his *guanxi wang* with officials. On the other hand, South Electro's case was a different side of the story: its CEO's enthusiasm in *guanxi* building reveals his incompetence and ill-willed motivation, which is largely attributive to the selection method of official appointment (see 6.5.1).

6.6 Summary

In this chapter, findings from five in-depth case studies were described and analysed. After integrated discussion was made based on the theoretical framework, seven corresponding hypotheses were developed for testing through questionnaire survey in a later stage:

H1a: In China, different types of ownership lead to different corporate governance for the purpose of capability development. H1b: In China, in getting access to financial resources, different types of ownership lead to different treatment.

H2: In China, different selection methods for top management in SOEs lead to different corporate governance for the purpose of capability development.

H3: there will be a positive relationship between the quality of shareholder engagement and the firm's technological capability.

H4: Poor engagement leads to strategy prioritising high-visibility activities; intelligent engagement leads to strategy prioritising low-visibility activities.

H5: Strategy prioritising high-visibility activities leads to lower dynamic capabilities than strategy prioritising low-visibility activities, does.

H6: Ownership form affects technological capability; more specifically, (H6a) ownership forms giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities. It would also be expected (H6b) that ownership forms giving better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities.

H7: Technological capability in SOEs is affected by selection method for top management. (H7a) Selection methods giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities.

Moreover, further insights from these cases which were not included in the hypotheses have been identified and discussed.

Chapter 7 Findings from Questionnaire Survey (1): Testing of Hypotheses 1 - 2

This chapter is dedicated to descriptive findings of quantitative surveys which evaluated the technological capabilities and corporate governance /finance of Chinese electronics firms. Section 7.1 draws a general picture of the data collected from the survey, such as firm size, age, location and sub-sectors. It also gives an overview of the variables used in the survey. Section 7.2 gives a general assessment of firms' technological capabilities and their technological endeavour. Section 7.3 evaluates the firms' corporate governance and finance. Section 7.4 summarises the chapter.

7.1 Data profile and variables

7.1 .1 Data description – general profile

The target population of this research comprised 11655 domestic firms in the Chinese electronics industry. From March to September 2007, paired questionnaires were circulated among 527 firms through post and email (for details about the circulation see Chapter 5, Section 5.4). 195 sets of valid responses generated a response rate of 36.3%, which is reasonably high for a multi-questionnaire survey. In the questionnaire survey, 89 firms (45.6%) were MASOEs, 68(34.9%) were MISOEs and the remaining 38 (19.5%) were POEs. About 76% of the respondents to questionnaires had worked in the surveyed firm for a minimum of 5 years. This indicates that most informants had sufficient firm-specific knowledge to answer these questions. The average age of the firms was 25.64 years. (SD=15.24 years). The youngest firm was established in 2005 and the oldest in 1959. 72 firms (37 %) had more than 1000 full-time-equivalent employees, which is large-scale according to the criteria of State Statistic Bureau (http://www.stats.gov.cn/tjsj/ndsj/2007/indexce.htm, last accessed June 2008), 22 (13.9%) had between 500 to 999 staff, and 96 (49.2 %) had less than 499 staff, which is small-scale. Among the 195 firms, 72 firms (36.9%) were located in developed coastal region, and 53 (27.2%) in less-developed western regions. The three sub-sectors with most respondents were: telecommunications (38, 19.5%), computers and related products (33, 16.0%), and consumer electronics (24, 12.3%).

Table 7-1 gives detailed information about the distribution of sample firms by region and by sub-sector.

At the time of survey, 63.6% of the firms (124) had sales growth rates between 3 – 20% over the past three years, with only 2.6% firms suffering from sales reduction. These percentages were comparable to the industrial figures reported in the Yearbook of China Information Industry 2006 (pp.94-98). In order to gain further insights into the validity of the data set, especially its industrial characteristics, comparisons were undertaken with industry statistics. For instance, we correlated the SOE sector's general sales growth with that of the SOEs in our survey (POE data at the macro level was not available) and observed a low but significant Pearson ratio of 0.12 ($P<0.01$). This again confirmed that our data was representative of the population.

Sales increase however did not necessarily reveal how competitive the firms were. As discussed in Chapter 5, innovation rates were collected in the survey to measure firms' innovation strength – proxied by the average percentage of revenue from newly introduced products to total revenue in the company over the last 3 years (Yam *et al.*, 2004). More than a quarter of the firms had less than 9% of sales generated from new products in a 3-year period, and the top quartile was between 30-49%. This performance compared poorly to developed countries such as Sweden, Austria, Canada, Denmark, Switzerland, Ireland, Netherlands and Germany with innovation rates above 60%. It is also unsatisfactory compared to another BRIC[78] country – Brazil – with 31% in 2000 (Cassiolato, 2001). Bearing in mind that newly introduced products were not always innovative products (the latter was often a fraction of the former), the actual strength of innovation in the surveyed firms would even be arguably lower. This finding supported our prediction that despite the superficially satisfying sales data, most electronics firms were faced with lack of sustainable growth propellers.

[78] A term referred to the combination of Brazil, Russia, India, and China.

Table 7-1 Sample distribution by region and industrial sub-sector

Location	Sample	Percent	Sub-sector	Sample	Percent
Beijing	40	20.5	Telecommunication	38	19.5
Guangdong	62	31.8	Consumer electronics	24	12.3
Sichuan	30	15.4	TV& broadcasting equipments	17	8.7
Guizhou	48	24.6	Computers and related products	33	16.9
Shandong	9	4.6	Electronic equipments	21	10.8
Zhejiang	1	0.5	Integrated circuits & semi-conductors	16	8.2
Shaanxi	5	2.6	Sealed vacuum electronic devices	17	8.7
			Electronic parts and components	18	9.2
			Electronic material	6	3.1
			Photo-electronics	5	2.6
Total	195	100%	Total	195	100%

7.1.2 Measuring variables

In order for analysis and hypotheses testing to be conducted through use of the survey data, a series of variables were devised when the questionnaires were designed. According to their definitions and the theoretical framework, these variables can be categorised into four types: 1) dependent; 2) independent; 3) intermediate and 4) control variables.

1) Dependent variables -Technological capability

Past research on innovation management (see Chapter 2 and 4 for discussions of the relevant literature and theoretical framework) and initial findings from the case studies inspired the content of *technological capability* measurement. Considering the feasibility of data collection method and the target respondents' job responsibility and knowledge about the firm (firm chief executives and R&D managers), the four types of capabilities set out in Chapter 4 were condensed into three in the questionnaire survey, where Organisational capability covered both Internal and External Organisational Capabilities (see below). A brief description of the three types of capabilities is given below, and a list of elements for each capability is presented in Table 7-2:

- ***Manufacturing capability*** (***MANCAP***) refers to a firm's ability to convert R&D results into products in accordance with design request, which caters for market needs, and cost effectively (Yam et al, 2004).
- ***R&D capability*** (***R&DCAP***) refers to a firm's ability to integrate customer/market desired functions into product design/development process, to carry out necessary process/product improvement and innovation, and to respond to market and manufacturing feedbacks about design and manufacturing.
- ***Organisational capability (ORGCAP)*** refers to a firm's ability manage both internal and external relations, to secure organizational mechanism, to cultivate distinctive and strong organizational culture, and to adopt good management practices to facilitate technological change.

R&D capability and organisational capability are assumed to gain more from low-visibility strategies than high-visibility ones (see explanation in Chapter 4, Section 4.1, and case-based illustration in Chapter 6, Table 6-7). Any such differential effect is likely to be less with manufacturing capability, since successive improvements in static manufacturing capability could be bought with *bundled* foreign technology (see the cases of SAIC and South Electro in Chapter 6). Moreover, manufacturing capability should be most sensitive to the availability of finance, organisational capability least.

2) Independent variables: Corporate Governance factors

According to the hypotheses generated from the case studies (see Chapter 6, Section 6.5), three corporate governance factors were included in the quantitative study as independent variables: i) Ownership Type; ii) Management Selection Method; and iii) Quality of Shareholder Engagement.

i) Ownership Type. Firms' ownership was categorised according to the theoretical framework: Majority State-Owned [State share $\geq 50\%$] (***MASOE***); Minority State-Owned [0 %< state share<50%] (***MISOE***); and Private-Owned (***POE***).

ii) Management Selection Method. Selection methods of management mainly take through broad forms: *selected by administrative authorities **(ADMINS)**, recommended or approved by administrative authorities **(REC/APPS)*** and *selected by firms' shareholders **(SHARHS)** (Cai & Tylecote, 2008).*

iii) Quality of Shareholder Engagement. The findings from the case studies showed that, shareholder assessment criteria are good proxies of the level and extent of their *engagement.* Based on the case studies and SASAC's portfolio of performance measurement in large-scale SOEs (see Chapter 3, Section 3.3.1), four of the most representative criteria are selected to measure quality of shareholder engagement in the survey. *Profit rate **(MEAS_PFT)*** and *sales revenue **(MEAS_SALES)*** are two of the indicators most commonly used by Chinese authorities to evaluate firms' financial and overall performance. Although containing some overview of firm's past financial and market position, they do not show how these profits and sales have been generated (by selling more new, innovative products, or by simply cutting down R&D to reduce cost?), nor do they say anything about the firms' potential to sustain profits and sales. Hence over-reliance on these figures can be seen as a sign of lack of engagement or inappropriate engagement. *Market share **(MEAS_MKT)*** is a slightly better indicator, as it reflects the firm's product competitiveness in the market and indirectly informs the firm's longer-term competence. Shareholders caring more for market shares can therefore be regarded to have higher level of engagement. Finally, the *innovation rate (sales revenue from products introduced in last 3 years/total revenue)* ***(MEAS_INNO)*** is a new adoption from the western world at the turn of the century, among the four it requires the highest expertise to prepare and understand, moreover, it best indicates the firms' current technological capabilities – the capability to develop new products, and the capability to profit from innovation. Close attention to, and emphasis on improving this ratio can mean high level of engagement by the shareholders to enhance firms' technological capability. In the questionnaire, firm executives were asked to rate the weight of the above shareholder assessment criteria on a 5-point Likert Scale (there was no cross-criterion ranking).

3) Intermediate variables – Technological Strategy/Activity

As mentioned in the previous Chapter and in the literature review (Chapter 2, Section 2.3), technological activity/strategy can be influenced by a firm's corporate governance and finance, and meanwhile is liable to determine its technological capability development and performance. Therefore, they could be referred to as *intermediate variables* - the ones which mediate the effects of corporate governance and finance on technological capability development. In the survey three types of intermediate variables were included as inspired by the literature and the case studies, namely: 1. *Technological strategic priority;* 2. *Technology-related financial input*; 3. *Non-financial technological endeavour.*

1. *Technological strategic priority variable.* Firm executives were asked to report their preference between choosing the most advanced technology, given sufficient funds (high visibility strategy [**HVS**]), and choosing the most appropriate technology according to the firm's current situation (low-visibility strategy [**LVS**]).

2. *Technology-related financial input* – In light of the complexity of relationships among different investment activities, the focus is on two types of technology-related investments which are most relevant to the research questions (average of last three years):

- Investment in tangible asset as percentage of total revenue [**INV_TAN**];
- Investment in technology absorption as percentage of total revenue [**INV_ABSB**].

High intensity of investment in tangible asset can be associated with high-visibility strategy, which according to the hypothesis indicates poor engagement; whereas high level of investment in technology absorption can be read as outcome of low-visibility strategy – deriving from intelligent engagement.

3. *Non-financial technological endeavour* – 7-point Likert scales were used to measure firm's technology-related activities in the past five years.
   - Reliance on foreign technology supply (***FRGN***)
   - Reliance on reverse engineering (***REVS***)
   - Reliance on staff training (***TRNG***)
   - Reliance on networking activities both internally and externally (8-item average, Cronbach's α=0.868, for item description see Table 7-2) (***NTWK***)

As observed, a high score for **FRGN** indicated **HVS**, whereas high scores for **REVS**, **TRNG**, and **NTWK** indicated **LVS**.

4) Control variables

In the regression analysis, firms' *R&D investment* was treated as a control variable (**INV_RD**), measured by the proportion of investment in R&D to total sales revenue over the last 3 years. There are two explanations, first, the positive effect of R&D intensity on technological capability development has been thoroughly studied and widely proved (Cohen & Levinthal, 1989; Deeds, 2001), hence it is not pertinent to re-test the hypothesis. Moreover, since R&D activities are relatively easy to quantify and fairly high-visibility, it does not effectively reflect the strength of shareholder engagement.

Firm age and size were also control variables. Studies in the past have shown that older firms may have cumulated experience that facilitates technological development; yet they may also encounter difficulties in keeping in line with developments in the external world (Hanson, 1992; Audretsch, 1995; Toby, 2000), therefore, *Firm Age* (**AGE**) is controlled for. Likewise, larger firms may have more resources but lack the necessary organisational flexibility; hence *Firm Size* (**SIZE**) was controlled for by including the total number of full-time employees of the firm. *Geographic location* has been confirmed as an important factor for a firm's development, particularly in the Chinese context (Demurger *et al.*, 2002), two regional dummies are created for the three *geographic locations* in which the data was collected (**RIG_DUM**). In addition, dummy variables for 9 of the 10 industrial *Sub-sectoral Categories* are included (**SECT_DUM**).

Definitions of the variables and the questions designed to gather relevant data have been summarised in Table 7-2 below:

Table 7-2 Variables measured in the questionnaire survey (labels of variables in bold italics)

Variables and labels	Definition and Measurement	Informant	Variables and labels	Measurement	Informant
Control Variables					
Age ***AGE***	In what year was your firm established?	CEOQ*	Size ***SIZE***	About how many full time employees does your firm have?	CEOQ
Region (6 Region dummies) ***REG_DUM***	What province is your firm based (main body)	CEOQ	Sector (9 sector dummies) ***SECT_DUM***	What sub-sector does your firm belong to? (select from 10 sub-sectors according to CSB criteria)	CEOQ
Dependent Variables					
Technological Capabilities	Multiple-item response scales, ranging from 1 ='below the average of the nation' to 6= 'advanced in the world'				R&DQ**
Manufacturing capabilities [***MANCAP***]	7 types of manufacturing capabilities measured, average used in regressions, Cronbach's α=0.93				
MANCAP1	⇒ Overall capability of equipment		***MANCAP2***	⇒ Ability to ensure smooth functioning of equipments and routine production	
MANCAP3	⇒ Ability to comply with the generic request of R&D		***MANCAP4***	⇒ Manufacturing cost control	
MANCAP5	⇒ Total quality control		***MANCAP6***	⇒ Ability to make improvement in the manufacturing system	
MANCAP7	⇒ Level of contribution to the innovation process				
R&D Capabilities [***R&DCAP***]:	6 types of R&D capabilities measured, average used in regressions, Cronbach's α=0.94				
R&DCAP1	⇒ The overall R&D capability		***R&DCAP2***	⇒ The ability to carry out process improvement	
R&DCAP3	⇒ The ability to carry out process innovation		***R&DCAP4***	⇒ The ability to carry out new product development	

R&DCAP5	⇒ Quality and speed when responding to feedback from manufacturing about design and engineering		***R&DCAP6***	⇒ Ability to incorporate market and customer feedback in the improvement/innovation process	
Organisational Capabilities [***ORGCAP***]:	4 types of organisational capabilities measured, average used in regression, Cronbach's α=0.93				
ORGCAP1	⇒ Flexibility in adjusting organisational structure according to the need for technological developments		***ORGCAP2***	⇒ The culture and mechanism to encourage and reward inventiveness and creativity	
ORGCAP3	⇒ Co-ordination and control of the major functions within the company		***ORGCAP4***	⇒ Initiative of sub-units within company strategy	
Independent variables					
Ownership variables: ***MASOE*** ***MISOE*** ***POE***	What is your ownership type (100% state-owned, state-shareholding, collective, or private)? What is the nature of your first and second shareholders (if shareholding); what are their shareholding percentages? (Final categories by own-calculations to insure accuracy)	CEOQ	Management selection variables: ***ADMINS*** ***REC/APPS*** ***SHARHS***	How is the senior management selected in the firm: ⇒ Appointed by authorities ⇒ Selected by the firm but approved or recommended by authorities ⇒ Selected by shareholders	CEOQ
Shareholder Engagement variables: ***MEAS_PFT*** ***MEAS_SALES*** ***MEAS_MKT*** ***MEAS_INNO***	Rank on a 5-point scale each of the strategic priorities of firm's major shareholders: 1= least important, 5= most important: ⇒ The firm's profit rate ⇒ The firm's sales growth ⇒ The firm's market share ⇒ The proportion of revenue from recently introduced products	CEOQ			

Intermediate dependent variables					
Strategic Priority variable: ***ADV_TECH*** ***MATCH_TECH***	Is your strategic priority to : ⇒ Choose the most advanced technology, given sufficient funds ⇒ Choose the most appropriate technology according to the firm's current situation	CEOQ	10. Technology-related finance investment variables: ***INV_TAN*** ***INT_ABSB***	On average, in the past three years: ⇒ Investment in tangible assets/revenue ⇒ Investment in technology absorption /revenue	R&DQ
Non-Financial technological endeavour: ***FRGN*** ***REVS*** ***TRNG***	Self-reported sources of technological development in the past five years. 5-point Likert scale to measure level of reliance on various activities: ⇒ Foreign technology supply ⇒ Reverse engineering ⇒ Staff training	R&DQ	***NTWK***	8 types of networking activities, internal and external; average used in regressions, Cronbach's α=0.868	R&DQ

7.2 Firms' technological capabilities and technology activities

7.2.1 Sampled firms' technological capabilities

This section describes degrees of technological capabilities developed by all sampled firms. By using the framework introduced in Chapter 4, it explains briefly why these firms have (or have not) developed these capabilities. Before proceeding, it is worth repeating briefly that technological capabilities (Manufacturing Capability, R&D Capability, and Organisational Capability) are evaluated by elements. A scale of 'Degrees' from 1 to 6 was used to assess the level of a firm's achievement in each element. Sample firms would select Degree 4 if they believed that their capability in question was 'advanced in the nation', or Degree 6 if it was 'advanced in the world'. Given that respondents may lead themselves to believe that higher degree was more 'desirable', which is commonplace in self-reports (Podsakoff & Organ, 1986), and there may hence be a upward shift in the distribution of response. Only those reached 'Degree 5' or higher are regarded as fully dynamic in the element of capability. Fortunately such bias is not going to jeopardise the interpretation of correlations involving the scales.

There are respectively 7, 6 and 4 elements for the 3 types of technological capabilities measured in the questionnaire survey. Cronbach's α (Cronbach, 1951) was calculated to checked the elements' internal consistency and the values are 0.74, 0.73 and 0.73, which are all above the 0.70 cut-off value of being acceptable (Reynaldo & Santos, 1999).

Findings for the general assessment are presented below. Table 7-3 to Table 7-5 provides detailed assessment of all capability elements.

Manufacturing Capability

Table 7-3 Manufacturing capability of Chinese electronics manufacturing firms - the survey result

Elements of capability	1	2 Average in the nation	3	4 Advanced in the nation	5	6 Advanced in the world
Equipment*	9 (4.6%)	63 (32.3%)	64 (32.8%)	15 (7.7%)	20 (10.3%)	23 (11.8%)
Routine	8 (4.1%)	62 (31.8%)	54 (27.7%)	40 (20.5%)	20 (10.3%)	10 (5.1%)
Capability to comply with R&D	2 (1.0%)	59 (30.3%)	51 (26.2%)	53 (27.2%)	17 (8.7%)	11 (5.6%)
Total quality control	5 (2.6%)	62 (31.8%)	61 (31.3%)	37 (19.0%)	14 (7.2%)	15 (7.7%)
Manufacturing cost control	10 (5.1%)	67 (34.4%)	44 (22.6%)	48 (24.6%)	24 (12.3%)	1 (0.5%)
Process improvement	7 (3.6%)	74 (37.9%)	30 (15.4%)	64 (32.8%)	11 (5.6%)	9 (4.6%)
Contribution to innovation	16 (8.2%)	92 (47.2%)	33 (16.9%)	39 (20.0%)	7 (3.6%)	8 (4.1%)

Note: * The first row is the number of firms. The figure in the second row is the percentage of firms claimed over the total sampled firms (195 firms). For example, 9 firms have evaluated their Equipments at 'degree 1' and they make up 4.6% of the total firms sampled.

There are 7 elements measured in the manufacturing capability. The element that has been best developed was *the capability to maintain routine operation* - 15.4% of the firms have ranked themselves 'degree 5' or '6', of which 5.1% believe their routine operation was advanced in the world. The next best was the firms' *equipments*. 22.1% firms had ranked their equipment to be approaching or at world standard. The poorest assessment was with *manufacturing department's ability to contribute to innovation*, only 7.7% of the firms think they have developed this capability to degree 5 or 6. The findings indicate that Chinese electronics firms have developed some manufacturing capabilities, but these were mainly static capabilities which were more sensitive to high-visibility input. For example, the element of *equipments* in manufacturing capability may be relatively easily enhanced by acquiring *bundles*. Just as discussed in Chapter 4 and 6, the idea of depending on purchasing bundles particularly appeals to short-termist managers – the reasons included quick turnover from new products and (accounting) profits to please the disengaged shareholders. However, after bundles were acquired, the buyers' activities were likely to be limited to utilization and maintenance of the bundled technology, which explained why firms scored highest in their *capability to maintain routine operations*. In the long run, although the firms may have extended their production capacity or learned to operate the established production systems efficiently, they may still have limited capabilities to carry out planning, product design, and evaluation of alternative design and plans, which was represented as *the ability to contribute to innovation* in the questionnaire. The data supported such argument - nearly 70% of the 43 firms which scored 5 or above in *equipments* have scored 3 or less in their *capability to contribute to the process of innovation*. It is evident that possession of sophisticated equipments does not automatically generate dynamic manufacturing capability.

R&D Capability

Table 7-4 R&D capability of Chinese electronics manufacturing firms - the survey result

Elements of capability	1	2 Average in the nation	3	4 Advanced in the nation	5	6 Advanced in the world
R&D in General	8 (4.1%)	55 (28.2%)	57 (29.2%)	48 (24.6%)	12 (6.2%)	15 (7.7%)
Process improvement	16 (8.2%)	53 (27.2%)	61 (31.3%)	44 (22.6)	18 (9.2%)	3 (1.5%)
Process innovation	24 (12.3%)	77 (39.5%)	40 (20.5%)	39 (20.0%)	12 (6.2%)	3 (1.5%)
New product development	7 (3.6%)	52 (26.7%)	37 (19.0%)	71 (36.4%)	16 (8.2%)	12 (6.2%)
Response to feedback from manufacturing dept.	13 (6.7%)	61 (31.3%)	60 (30.8%)	44 (22.6%)	14 (7.2%)	3 (1.5%)
Response to market feedback	10 (5.1%)	62 (31.8%)	42 (21.5%)	63 (32.3%)	9 (4.6%)	9 (4.6%)

On average, 10.7% of the sampled firms have fully developed dynamic R&D capability (degree 5 or 6): 10.7% and 7.7% scored degree 5 and 6 respectively in *'process improvement'* and *'process innovation'*; 14.4% of the firms scored degree 5 or 6 for *'new product development'*. Although 13.9% firms believed that they have fully developed dynamic capability in *'R&D in general'*, their capabilities to *'respond to feedback from manufacturing department'* and *'respond to market feedback'* were two of the weakest elements: only 9.7% and 9.2% have scored degree 5 or more respectively. Such weakness clearly reflected the lack of coordination among the three key functions of the firms. It is argued that well integrated and networked functional departments within a firm could contribute more to technological success (Gupta *et al.*, 1986; De Meyer & Van Hooland, 1990). Unfortunately this kind of behaviour, which again is low in visibility, has not been widely observed in Chinese firms. On the other hand, the poor scores in *'process innovation'* can be seen as an outcome of over-reliance on high-visibility activities, such as bundled equipment acquisition – the more and the better that is bought externally, the less there is left for internal effort to make improvements on, hence the less likely is such capability cultivated through learning by doing.

Organisational Capability

Table 7-5 Organisational capability of Chinese electronics manufacturing firms

Elements of capability	1	2 Average in the nation	3	4 Advanced in the nation	5	6 Advanced in the world
Organisational flexibility for technological development	26 (13.3%)	60 (30.8%)	57 (29.2%)	31 (15.9%)	12 (6.2%)	9 (4.6%)
Atmosphere and mechanism to encourage innovation	20 (10.3%)	72 (36.9%)	51 (26.2%)	40 (20.5%)	12 (6.2%)	3 (1.5%)
Coordination and control among major functions	17 (8.7%)	85 (43.6%)	53 (27.2%)	28 (14.4%)	9 (4.6%)	3 (1.5%)
Initiatives of sub-units within strategy	26 (13.3%)	81 (41.5%)	47 (24.1%)	29 (14.9%)	9 (4.6%)	3 (1.5%)

More than 50% the firms believed that their capability to *'coordinate and control major functions'* was average or below average in the nation (degree 2 or 1), and the situation of *'sub-units initiatives within strategy'* was similar (54.8%). Only 10.8% of all firms acquired the dynamic level of degree 5 or 6 for *'organisational flexibility for technological development'*, and only 7.7% thought their firms to have fully developed the *'atmosphere and mechanism to encourage innovation'*. It has been argued that, organisational capability is the one to benefit least from high-visibility strategy/activity, and also the one to benefit the most from low-visibility strategy/activity (Chapter 4, Section 4.1). Assessment of the sample firms' technology activities below will reinforce the argument.

7.2.2 Technological activities

Following the framework set out in Chapter 4, we now look at the sample firms' technological strategy. In particular, three types of strategies are examined: 1) general strategy; 2) investment strategy/behaviour; and 3) technology-related activity.

General technological strategy

When acquiring new technology from outside, 58.7% of firms choose to buy *'most advanced technology (if funded)'* as opposed to *'appropriate technology compatible to their existing technology'*. Equally, over 57.2% of firms consider *'purchasing discrete package of technology (such as equipment)'* to be their first choice when upgrading their existing technology; and only 4.6% firms prioritised *'training'*.

Technological Investment

Table 7-6 Investment in technology-related activities in Chinese electronics firms

	Investment intensity (as percentage of revenue) over the last 3 years					
	<1%	1%-3%	3.1%-5%	5.1%-7%	7.1%-9%	>9%
Investment on tangible technology such as equipments	12.3%[79]	26.2%	26.7%	7.2%	7.7%	20.0%
Investment in intangible technology such as patent and licences	36.9%	32.9%	13.3%	6.7%	9.2%	1.5%
Investment in technological absorption*	16.4%	39.5%	10.4%	16.9%	5.6%	5.1%
Investment in R&D	29.5%	16.4%	23.6%	10.8%	13.8%	5.9%

*Note: Technological absorption expenditure is the money spent on activities in assimilating newly acquired technology, which include various training (on the job training, course based training etc.), inviting experts or engineers from outside for problem solving, trials, experiments and so on.

Table 7-6 summarise the firms' investment in technology-related activities. Before looking into the findings, the official statistics can put the survey data into perspective. According to National Bureau of Statistics, the R&D intensity of medium-large scale enterprises in general (most of which SOEs) was 0.71% in 2000 and 0.77% in 2006, which has not been a significant improvement. Moreover, in 2000 the intensity of foreign technology introduction (such as patents and licenses, measured as *investment in intangible technology/revenue* in our survey) was 13 times higher than that of technology absorption (same sort of data for 2006 was not available). As shown in Table 7-6, the investment behaviour of electronics firms are not exceptional - R&D intensity is higher than investment in intangible technology and absorption – this is understandable as high volume of R&D input is inevitable for most electronics firms operating in medium-high technology sectors– nearly 1/3 of them have invested less than 1% of their revenue on '*R&D*' over the last three years, and another 1/3 clustered

[79] The figure is the percentage of firms claimed over the total sampled firms (195 firms). For example, 24 firms have reported to invest less than 1% of their revenue in purchasing tangible technology, and they make up 12.3% of the total firms sampled.

at the other end (invest more than 5%) of the spectrum. Several patterns identified in the official data are equally distinctive in the survey. Generally, firms are inclined to pay more for ***high-visibility*** activities than for the opaque ones. More than 1/5 of firms spend at least 9% of their revenue on purchasing technology externally, and most of the money was spent on *'buying tangible assets such as equipments'*. On the other hand, more than half (55.9%) of the firms have very limited budget for *'technology absorption'* (<3% of revenue). Finally, investment in intangible technology is clearly not favoured by the firms. Why?

The answer lies in how investment and return are measured and appreciated in the current system. In 2004 SASAC introduced a portfolio of accounting ratios (see Table 3-8 in Chapter 3) to evaluate senior managers' performance in SOEs. In the portfolio 'net return to asset' accounted for 14%; and 'technological input' as a modification indictor only accounted for 3.5% of the overall score. When their remuneration and career are directly connected to ratios, managers no doubt strive to make the ratios look good, and the most straight forward way is increasing profit and cutting costs – expenditure on licences/ patents (intangible technology) and training/experiments (technology absorption) should be economised as it reflects accounting costs; while money spent on equipments is transformed into assets, it would then contribute to 'ratio of firm asset value added', which accounts for 7% of the assessment portfolio.

Technological activity

Table 7-7 Degree of reliance on various technological activity and the impact on technological capability development

Degree of reliance / Type of activity	None or very little reliance (Degrees 1 and 2)	Moderate reliance (Degrees 3 to 5)	Very heavy reliance or indispensable (Degrees 6 and 7)
Receiving foreign technology supply	20[80] 10.3%	95 48.7%	24 12.3%
Reverse engineering	24 12.3%	108 55.3%	63 31.5%
Own R&D	37 19.5%	99 50.8%	58 29.8%
Training	89 45.7%	88 45.2%	17 8.8%

Four types of technological activity commonly practised in Chinese firms were investigated here: 1) reliance on foreign technology supply; 2) reverse engineering; 3) own R&D; 4) training. The *visibility* of acquiring foreign technology, as discussed in the previous chapters, is much higher than that of reverse engineering and own R&D, and training has the lowest visibility - having no direct and immediate pay back in the short term, and is recorded as a current accounting cost; therefore the demand of *engagement* and *expertise* ascends: foreign technology acquisition the lowest and training the highest. Meanwhile, purchase of technology from foreign firms normally involves *bundled* deals, in which little input is required from other stakeholders, such as employees or related firms, who also gain little from it - there is no obvious need for *stakeholder inclusion*. By the same token, training has to be organised and managed in the sense that trainees' (employees') needs and suggestions are considered. In other words, they are the subject of such activity and ought to be included, and will gain directly from the activity. Less inclusion can be linked with reverse engineering and own R&D.

[80] The number in the first row is the number of firms claimed, and the second row is the percentage of the total sample (195).

Table 7-7 reports the firms' reliance on different activities for technological development over the past 5 years (from 2002 to 2007). Nearly half of the firms have relied moderately (degrees 3 to 5) on all four kinds of activities. 12.3% and 19.5% of firms did not or hardly rely on (degrees 1 and 2) *'reverse engineering'* or *'own R&D'*, and 45.7% on *'training'* – yet all of the three activities are important vehicles for technological learning in NIEs (Kim, 1997; Lall, 2000). On the other hand, less than 1/3 of firms have relied heavily on reverse engineering or own R&D for developing their technological capability and only 8.8% have utilised training for technological development (degree 6 and 7). Whilst 10% of all firms hardly bought any foreign technologies, another 1/8 have depended heavily (degrees 6 or 7) on foreign technology supply as a crucial source of technical upgrading.

Table 7-8 Engagement in reverse engineering, own R&D and training by firms relying heavily on foreign technology supply

Degree of reliance / Type of activity	None or very little reliance (Degrees 1 and 2)	Moderate reliance (Degrees 3 to 5)	Very heavy reliance or indispensable (Degrees 6 and 7)
Receiving foreign technology supply	---	---	24[81] 100%
Reverse engineering	5 20.3%	16 66.7%	3 12.5%
Own R&D	9 37.5%	15 62.5%	0
Training	20 83.3%	4 16.7%	0

It is obvious that although explicit technological activities such as reverse engineering and own R&D have been fairly widely practised in the firms, the more tacit elements, e.g. staff training, have been largely over-looked. Many firms preferred the much more straightforward way of acquiring bundled technology from foreign multinationals.

[81] The total number of firms relying heavily on foreign technology supply is 24.

However, technological knowledge and capability cannot be wholly embodied in the bundle of equipment or instructions, patents, designs or blueprints. We have argued in the previous chapters that successful development of capabilities requires not just transactions but also local learning; and learning can be a prolonged, sometimes opaque process. We therefore suspect that those firms which have relied more on foreign technology supply would have undertaken less of opaque (low-visibility) and time-consuming activities. A cross-tabulation is sufficient for the initial insight: as shown in Table 7-8, for the 24 firms regarding foreign technology as very important or essential for their technological development (Degree 6 and 7), the proportion of firms actively engaging in other activities is much lower than the whole sample. In fact except for 3 firms (12.5%) which have also relied on reverse engineering, none of the firms have considered own R&D and training as indispensible paths to technological capability development. One-Way ANOVA tests have been carried out to verify our argument and the results are presented in Table 7-9. Again, except for reverse engineering ($p \approx .10$), the values of the F tests for the other two activities are highly significant ($p<.05$), indicating negative associations between bundled foreign technology acquisition and the more self-reliant approaches.

Table 7-9 Comparison of reliance on other technological activities with level of reliance on foreign technology supply: One-Way ANOVA test

		Sum of Squares	df	Mean Square	F	Sig.
Reverse Engineering	Between Groups	27.870	7	3.981	1.734	.103
	Within Groups	429.279	187	2.296		
	Total	457.149	194			
Own R&D	Between Groups	81.050	7	11.579	4.572	.000
	Within Groups	473.534	187	2.532		
	Total	554.585	194			
Training	Between Groups	54.346	7	7.764	3.146	.004
	Within Groups	461.470	187	2.468		
	Total	515.815	194			

We also evaluate firms' endeavour to *network* to understand what internal and external links have been harnessed by the firms, and how that impacted their technological capability development (see Table 7-10). The extent of network utilisation is assessed in 5 levels, from '1: no links' to '5: links centred on knowledge flows to innovate'. (See Section 7.1.2 and Table 7-2 for details of variable and question design).

Successful product innovation is vital to many firms, and an effective design requires that market possibilities for a product are linked with technological possibilities, e.g., Who are the users? What will they use the product for? What do the requirements mean technically? Therefore collaboration among the technical, marketing, and manufacturing departments is very important to a new product's success (Dougherty, 1992). For internal networks, around 10% of the firms claim that the linkages between their internal departments were almost non-existent or only centred on day-to-day operations. 56.4% of the firms believed that the communication of manufacturing and R&D department encouraged minor technological changes (level 3), and significantly fewer firms (36.9%) felt the same about the linkage between R&D and marketing departments. On the other hand, 26.7% of the firms gave credit to the network between R&D and marketing for the major technological changes (level 4), and 23.1% for the development of their innovative capabilities (level 5), both outnumbering the linkage between manufacturing and R&D departments. This means that whilst it is harder to cultivate close collaboration between marketing and the technical (R&D and manufacturing) departments, once its importance is realised and fully utilised by the firm, it could make an even more significant contribution to innovation than intra-technical team collaboration.

For external domestic (and local) networks, around 1/3 of the firms did not deal with domestic suppliers of key parts and components at all (level 1); another 24.6% felt such dealings were pure business transactions and did not involve new skills (knowledge) transfer (level 2); The firms' relationships with domestic equipments suppliers and customers were equally underutilised for technological capability development – 16.4% and 21.5% of firms ranked themselves level 1 and 2 for linkage with domestic equipment suppliers, and 24.1% of the firms believed their relationship with domestic customers were purely transactional and did not enhance pre-existing capabilities (Level 2).

As for networks with foreign firms, around 20% of the surveyed firms did not have connections with foreign firms at all (Level 1). Among the other firms the majority claimed that their networking with the foreign suppliers (of equipments or parts/components) encouraged little or minor technological changes (Level 3); 8% of them believed that they have benefited from such relationships by involving substantial knowledge flow to build up innovative capabilities (Level 5).

Table 7-10 Internal and external linkages of Chinese electronics firms and their impacts on technological capability development

Type of network / Extent of utilisation	Internal		External (domestic)			External (foreign)		
	Manufacturing department with R&D department	R&D with marketing department	Domestic suppliers of Equipments	Domestic suppliers of Key parts & components	Domestic buyers	Foreign suppliers of Equipments	Foreign suppliers of Key parts & components	Foreign buyers
Level 1: **No links**	2[82] 1.0%	5 2.6%	32 16.4%	65 33.1%	6 3.1%	38 19.5%	35 17.9%	56 28.7%
Level 2: Links centred on **market transaction** or day-to-day work. It doesn't involve new skills or knowledge transfer which will enhance pre-existing technological capability;	27 13.8%	21 10.8%	42 21.5%	48 24.6%	47 24.1%	55 28.2%	43 22.2%	34 17.4%
Level 3: Links centred on knowledge flow to improve existing technology. It involves substantial information flow which encourages **minor technological changes**	110 56.4%	72 36.9%	69 35.4%	83 42.6%	78 40.0%	54 27.7%	54 27.7%	72 36.9%
Level 4: Links centred on knowledge flow to improve existing technology. It involves substantial information flow which encourages **major technological changes**	31 15.9%	52 26.7%	35 17.9%	41 21.0%	57 29.2%	31 15.9%	37 19.0%	29 14.9%
Level 5: Links centred on knowledge flows to innovate. It involves substantial flow to build up **innovative capabilities**.	25 12.8%	45 23.1%	16 8.4%	17 8.7%	7 3.6%	17 8.9%	14 7.2%	4 2.1%

[82] The figures are the number of percentage of firms claimed over the total sampled firms (195 firms). For example, 2 firms have reported no linkage between their manufacturing and R&D departments, and they make up 1% of the total firms sampled.

7.3 Sample firms' corporate governance and finance, and hypotheses 1 and 2

7.3.1 Corporate governance

According to the framework and the current situation in China, four aspects of corporate governance that are potentially influential to firms' technological capability development are evaluated in the survey. Namely, they are 1) ownership type; 2) management selection method; 3) performance measurement criteria; and 4) measures of penalty to managers.

Ownership

The classification of ownership types is based on the theoretical framework (see chapter 4). In the questionnaire survey, 89 firms (45.6% of 195) are MASOEs, 34.9% are MISOEs and the remaining 19.5% are POEs.

Management Selection

In the 195 surveyed firms, 30.3% have their managers appointed by the administrative authorities *(ADMINS)*, 27.2% say they select their own managers but the candidates are either recommended or approved by the authorities *(REC/APPS)*, the rest 42.6% firms have shareholder selected managers (***SHARHS)***. There is a clear-cut although imperfect correlation between management selection methods and ownership types (Table 7-11): 59.6% of MASOEs are administrative-selected, 37.1% are authority-recommended/approved, and only 3.4% are shareholder-selected. For MISOEs, the percentages are: 8.8%, 27.9% and 63.3% respectively. None of the POEs have administratively selected managers, 1 (2.6%) of them have managers who were recommended or approved by the authorities, and the rest 97.4% have shareholder-selected managers.

Quality of engagement

Managers in 152 firms (77.8% of 195) rank claim that profit rate is a very important, if not only, criterion for their performance evaluation. 37.9% and 36.4% of the firms believed their shareholders care equally about sales growth and market share; only 22.5% of the firms are evaluated according to their innovation rates. 43.1% of the firms' innovation rates are barely considered by their shareholders (degree 1 and 2 on scales of 5). Pursing sales revenues and net profit leads managers to focus on those Static Capabilities. The quickest way to increase sales revenue and profit in the short run is to make as little change to the design as possible and get as quickly as possible to market.

The effect of ownership and management selection method on the quality of engagement is summarised in Table 7-11. 85.2% of MASOEs are evaluated primarily with profit rate, a slightly smaller proportion of POEs claim the same (81.6%); and less so with MISOEs, with 66.2%. Meanwhile for SOEs with shareholder selected managers, only 45.7% of which use profit rate as one of the more important evaluation criteria. As for the two longer-term and lower-visibility criteria (Market share and Innovation rate), much fewer firms believe they are specially evaluated according to their 'Market Share' (50.6% of MASOEs, 27.2% of MISOEs, and 21.0% of POEs). POEs lead the ownership types in using innovation rate as the key performance indicator (38.2% compared with 11.2% of MISOEs and 11.2% of MASOEs). Their owners, often also CEOs who are fully engaged, have every incentive to improve processes and develop new products as fast as possible, since this is the way to profit and wealth. However the tougher constraint on finance means they have to constantly worry about their immediate profitability - hence a high propensity for profit-focused evaluation (see top of the page). 21.1% of shareholder-selection SOEs emphasize innovation rate in evaluation. Clearly shareholder-selection firms tend to have the highest level of engagement of all SOEs.

From the above analysis one can see that the type of ownership shapes the quality of engagement in a firm, but the practise of management selection displays a stronger signal of influence. Chi-Square tests are conducted to compare these corporate governance variables among ownership types and management selection methods, as shown in Table 7-12. Statistically, the difference of corporate governance among management selection methods are all more significant than ditto among ownership types, especially with Innovative Rate, which is the lowest-visibility and longest-term variable. These findings are consistent with Hypotheses 1a and 2:

In China, different types of ownership lead to different corporate governance for capability development (H1a). Meanwhile, the effect of selection method is a good indicator of corporate governance in SOEs (H2). Specifically, compared to authority appointed or approved SOEs, those with shareholder-selected managers have much higher quality of shareholder engagement. The effect of ownership and management selection method on firms' technological activity and capability will be further discussed in Chapter 8.

Table 7-11 Ownership and management selection method, and their effects on corporate governance

	Ownership types (N=195)			Management Selection Method* (N=157)		
	MASOE	MISOE	POE	ADMINS	REC/APPS	SHARHS
Selection of management						
Selected by the administrative authorities	59.6%	8.8%	0			
Recommended or approved by administrative authorities	37.1%	27.9%	2.6%			
Selected by the shareholders	3.4%	63.3%	97.4%			
Shareholder engagement proxied by assessment criteria**						
Profit rate	85.2%	66.2%	81.6%	84.7%	51.9%	45.7%
Sales revenue	76.4%	40.9%	55.3%	25.4%	44.2%	44.2%
Market share	50.6%	27.2%	21.0%	8.5%	17.3%	26.1%
Sales revenue from products introduced in last 3 years/ total sales revenue	11.2%	17.9%	38.2%	5.1%	5.8%	21.1%

*. **(ADMINS)**: Selected by administrative authorities, **(REC/APPS)**: recommended or approved by administrative authorities, **(SHARHS)**: selected by firms' shareholders.

**. Assessment criteria: percentage presented are those of: 4 'important' and 5 'very important' for each criterion.

Table 7-12 The comparisons of corporate governance among types of ownership and management selection methods by Chi-square test
Test Statistics (a, b)

	Profit rate	Sales revenue	Market share	Innov. rate
Chi-Square (a)	37.505	26.994	21.702	7.278
df	16	16	12	16
Sig.	0.002	0.001	0.005	0.507
Chi-Square (b)	40.942	72.896	32.805	68.579
df	8	8	8	8
Sig.	0.000	0.000	0.001	0.000

a. Grouping variable: Ownership type, N=195
b. Grouping variable: Management selection method N=157

7.3.2 Finance

Ownership and access to finance

In the questionnaire company CEOs were asked to list the sources of finance for business expansion over the past three years[83], the most popular source of funding is from state-owned banks (chosen by 90 firms, 46.2%). In sharp contrast, only 32 (16.4%) firms use non-state-owned banks. 76 firms claimed to use own savings (38.9%), and 5.6% all firms said they access funding from the venture capital market. It is a good reflection of the lack of dynamism in the Chinese VC market (Chapter 3, Section 3.3.2), and is also due to lack of awareness (and confidence) among the firms.

Stock market is chosen by a small proportion of firms - 17.9%. Again, this is consistent with our observation in Chapter 3 (Section 3.3.2), that stringent entry requirements for Chinese stock market are responsible for the lack of equity funding by most firms. On the other hand, following the loosening of restrictions on foreign direct investment after WTO entrance in 2001, many multinationals have adopted a much more aggressive strategy in China - rather than partial investment in established domestic firms as in the 1990s, foreign firms are setting up their own full-funded subsidiaries or branches. This explains the relatively small number of foreign investments received by the surveyed firms over the last 3 years (21 and 13.3%).

[83] Since the survey mainly targets established firms, it does not ask for sources of finance for start-up business.

Cross tabulation and Chi-Square tests are conducted between the three ownership types and their use of financial sources (Table 7-13). The poor access to finance suffered by most POEs becomes very obvious: 60.5% of them have to rely on own savings for funding. Only 5.3% of the private firms have used the sources of state-owned banks, compared with 60.7% of MASOEs and 13.4% of MISOEs which have used it. A very small number of private firms have sought foreign investors (7.5%) and some have turned to the venture capital market (23.1%). None of them have received direct government or subsidy, and only 1 private firm, out of 39, has used the stock market for financing. In comparison, loans from state-owned banks dominate MASOEs' primary financing choice - 60.7%. None of them used the venture capital market, and 13.4% have had government funding. On the other hand, MISOEs have a more diversified finance portfolio - 43.3% chose to use own saving, 13.4% and 11.9% approached state-owned and non-state-owned banks, around a quarter are listed on the stock market and a similar number of them received foreign investment. It is worth noticing that MISOEs do not seem to share a same level of financial privilege as MASOEs, a situation once observed in 2003 (Cai, 2003). Nevertheless, the fact that MISOEs are utilising a more balanced portfolio of funding channels than the other two ownership types can indicate higher financing capacity and stronger competence in strategic investment.

Results from the Pearson Chi-Square test show a statistically significant difference in access to finance between the three ownership types [z=79.099, $p = .000$ which is less than 0.05]. These findings therefore are consistent with Hypothesis 1b:

H1b: In China, in getting access to financial resources, different types of ownership lead to different treatment.

Table 7-13 The comparison of financial sources used by different types of ownership (N=195)

Finance for business expansion *				
Ownership types / Financial sources used	MASOEs	MISOEs	POEs	All ownership
Firm's own savings	27.0%	43.3%	60.5%	38.9%
State-owned banks	60.7%	13.4%	5.3%	46.2%
Non-state-owned banks	2.2%	11.9%	31.6%	16.4%
Stock market	16.7%	25.4%	2.6%	17.9%
Venture capital market	0	2.9%	23.1%	5.6%
Foreign investment	6.7%	24.4%	7.5%	13.3%
Government subsidies	13.4%	6.0%	0	3.6%

* Sum of these percentages could be greater than 100%, as some firms would have access to more than one sources of funding.

Guanxi and access to finance

During the generation of hypotheses we argue that there is no reason why selection method should affect finance, although comparisons of financial resources used by SOEs with different management selection methods say otherwise. Particularly, as shown in Table 7-14, SOEs with shareholder-selected managers rely mostly on stock market (57.8%), they are also the only group of three that has actually used venture capital market for financing (23.3%). Roughly 1/3 of these shareholder-selection firms still reply on own savings for business expansion, however in general this type of firms appear to have a much diversified portfolio of finance. In contrast, 10.2% of administrative-selection SOEs still enjoy government subsidies; 64.4% of them rely on state-owned banks; and none of them use either non-state-owned banks or venture capital market. As for SOEs with authority-recommended managers, almost half of them borrow from state-owned banks, and only 3.4% borrow from non-state-owned banks. Why has this happened?

Table 7-14 The comparison of SOE's financial resources used by different types of management selection methods (N = 157)

Finance for business expansion *			
Selection methods** / Financial sources used	ADMINS	REC/APPS	SHARHS
Firm's own savings	16.9%	46.2%	37.8%
State-owned banks	64.4%	46.2%	6.7%
Non-state-owned banks	0	3.4%	17.8%
Venture capital market	0	1.4 %	23.3%
Foreign investment	16.7%	14.4%	17.5%
Stock market	5.1%	5.8%	57.8%
Government subsidies	10.2%	1.9%	0

* Sum of these percentages could be greater than 100%, as some firms would have access to more than one sources of funding.
** (**ADMINS**): Selected by administrative authorities, (**REC/APPS**): recommended or approved by administrative authorities (**SHARHS**): selected by firms' shareholders.

The explanation of financing variance among management selection methods lies in the managers' relationship with government officials and authorities. Review of the reality in China (Chapter 3, section 3.3.1) and the case studies in Chapter 6 (especially those of South Electro and SAIC) have already shown that the conventional corporate governance in Chinese SOEs features a heightened importance of the managers' *Guanxi* with government officials. Managers count heavily on officials for promotion, marketing resources, policy favours, insider intelligence, and most importantly, financial help. Particularly, in addition to government subsidies, the local governments still exert decisive power over lending decisions made by state-owned banks (Zhang, 2007). It is therefore easy to understand why firms with administratively-selected managers have best access to the above two sources (followed closely by authority-recommended ones) - these managers could well have been officials themselves, or at least have already established a good rapport with them. On the other hand, shareholder-selected managers are probably not chosen for their political merit, but for their competence to run a business. They are therefore not necessarily favoured by officials. The combination of their entrepreneurship and the lack of political privilege hence pushed them to look elsewhere, which explain why these firms have a much more market-led and diversified financing landscape.

7.4 Summary

This chapter describes the primary findings from the questionnaire survey in Chinese electronics industry.

The general evaluation of firms' technological capabilities shows that all sampled firms have developed better Static than Dynamic Capabilities. Firms are more likely to invest in tangibly advanced technology, which extends the process of technology absorption. Problems in corporate governance cause managers' poor engagement, which we argue inhibits firms' Dynamic Capability development, particularly in R&D and Organisational Capabilities.

The comparison among different kinds of ownership reveals that different ownership type entails different ease of access to finance. Particularly, private firms are disadvantaged in terms of access to finance. Moreover, although theoretically there is no reason why management selection method should affect finance, the survey result shows that SOEs' relationship with officials and authorities does influence their finance. This is because the latter still have great influence over key financial resources, such as government subsidy and loans from state-owned banks.

Chapter 8 Findings from Questionnaire Survey (2): Testing of Hypotheses 3 - 7

After general evaluation of the sample firms' technological capability and their CGFS in Chapter 7, this chapter presents the results of regressions used to test Hypotheses 3-5, and the tests of hypothesis 6 and 7.

All Hypotheses are supported. Section 8.1 reviews the correlation matrix and explains the regression models. In Section 8.2, the regressions results are found to be consistent with Hypotheses 3, 4, and 5, that corporate governance factors, especially quality of engagement, are positively associated with technological capability, and part of the correlation is achieved via its impact on technology strategy/activity. Section 8.3 goes on to present and discuss the results of ANOVA tests for Hypotheses 6 and 7. It compares the firms' capabilities among different types of ownership, and among different methods of management selection. The conclusion also supports these two Hypotheses, that ownership type affects technological capability, and there is an even stronger impact on technological capability from management selection methods. Section 8.4 summarises this chapter.

8.1 Correlation matrix and regression models

This chapter tests 5 more hypotheses generated in Chapter 6, which are based on the theoretical framework and findings from the previous stage of case study:

Hypothesis 3: There will be a positive relationship between the quality of shareholder engagement and the firm's technological capability.

Hypothesis 4: Poor engagement leads to strategy prioritising high-visibility activities; intelligent engagement leads to strategy prioritising low-visibility activities.

Hypothesis 5: Strategy prioritising high-visibility activities leads to lower dynamic capabilities than strategy prioritising low-visibility activities, does.

Hypothesis 6: Ownership form affects technological capability; more specifically, (H6a) ownership forms giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities. It would also be expected (H6b) that ownership forms giving better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities.

Hypothesis 7: Selection method for top management in SOEs affects technological capability. (H7a) Selection methods giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities[84].

H3, 4 and 5 are tested through multiple regressions, and since H6 and H7 involve crosstabulation between categorical and ordinal data, ANOVA tests are used.

In order to facilitate the hypothesis testing, the elements of each capability are summed and averages are taken (for definitions of these elements see Table 7-2, for summary of firms reaching each degree, see Table 7-3, Table 7-4, and Table 7-5). The average values are used to represent levels of corresponding capability type in the regressions. Before developing the final regression models for testing H3, H4 and H5, correlation matrix is created for all ordinal and scale variables and then examined for significant relations. The correlation matrix in Table 8-1 computes correlation coefficients which represent the linear relationship between two variables, and the significance level for each correlation provides primary information about the reliability of the correlation. Since the sample size of our study is more than 100, normal distributions of the residual values of the dependent variables can be assumed. Therefore it is safe to make inferences based on the significance values in the matrix (Greene, 2007). While interpreting the correlation matrix, scatterplots are also employed to help detect any potential outliers which may have a significant influence on the slope of the regression line and therefore on the value of the correlation coefficient.

[84] In the previous chapter we found that firms' finance does differentiate among selection method, therefore there should be an H7b, that that selection methods giving better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities. However since this finding only emerged after the questionnaires were designed and circulated, there are no devisable variables to facilitate testing of the hypothesis. Future research could consider including that issue.

The correlation with the greatest magnitude between the variables was .533 (.614), which is lower than the threshold of .80 that indicates a serious multicollinearity problem (Kennedy, 1979; O'Connor *et al*, 2006). However, in reality the relationship among competing strategies and activities is mixed A solution for the resulting intrinsic multicollinearity is needed.

Split-model multiple regressions are developed for testing hypotheses 3 to 5 and to tackle the issue of multicollinearity[85]. There are two parallel models; Model 1 consists of independent variables representing poor engagement and high-visibility strategy/activity, which are common in typical state-owned Chinese enterprises. It is predicted that this model contributes to a very limited extent, but positively, to a firm's manufacturing capability, and negatively to its R&D and organizational capabilities. Model 2 contains independent variables that are proxies for intelligent engagement and low-visibility strategy/activity. As explained in the next paragraph, such an arrangement is theoretically feasible as well as reasonable according to the correlations. Model 2 is predicted to serve better than Model 1 in explaining success of all three types of capabilities (H3).

The matrix shows positive and significant correlations between the *intelligent engagement* variable (MEAS_MKT, MEAS_INNO) and all LVS variables. The lowest coefficient is between MEAS_INNO and TRNG, $\alpha = .139, p = .002$, and the highest is between MEAS_INNO and NTWK, $\alpha = .388, p = .000$. These engagement variables, however, are not related to HVS variables (passive reliance on foreign tech. transfer and investment in tangible assets). On the other hand, poor engagement variables' (MEAS_PFT and MEAS_SALES) correlations with all HVS variables are positive and significant, but with lower strength; and their correlations with LVS turned out to be all negative and mostly significant. These primary findings support our predictions that LVS tends to be associated with intelligent engagement; and poor engagement leads to less LVS – if not leading to doing less of all. They also strengthen the validity of the split-model approach in the regression that combines poor engagement variable with HVS and ditto with intelligent variables and LVS.

[85] Alternative econometric analysis (e.g. LOGIT regressions and structural equation modelling) were conducted to verify the robustness of the regression model, and the results were all significant.

Table 8-1 Correlations of variables

	Variables	Mean	S.D.	Age	Size	INV_ R&D	MAN CAP	R&D CAP	ORG CAP	MEAS PFT	MEAS SALES	MEAS MKT	MEAS INNO	INV TAN	INT ABSB	FRGN	REVS	TRNG
Control Variables	1. Age	25.64	15.24															
	2. Size	2.81	1.30	.340** .000														
	3. INV_R&D	3.48	2.03	-.277** .000	-.066 .358													
Capability Variables	4. MANCAP	3.12	1.07	.188** .009	.122 .091	.223** .002												
	5. R&DCAP	2.93	1.01	.163* .023	.118 .099	.250** .000	.567** .000											
	6. ORGCAP	2.72	1.06	-.268** .000	-.093 .197	.277** .000	.541** .000	.614** .000										
Engagement Variables	7. MEAS_PFT	4.20	0.94	.303** .000	.106 .141	-.076 .295	-.315** .000	-.331** .000	-.438** .000									
	8. MEAS_ SALES	2.78	1.40	.322** .000	-.043 .557	-.059 .416	-.181* .012	-.241** .001	-.223** .002	.250** .000								
	9. MEAS_ MKT	3.01	1.22	.281** .000	.007 .927	.101 .169	.104 .157	.122 .097	.180* .014	.268** .000	.368** .000							
	10. MEAS_ INNO	2.68	1.10	-.250** .000	-.003 .969	.038 .595	.421** .000	.533** .000	.408** .000	-.388** .000	-.325** 000	-.147* .045						
Strategy/ Activity variables	11. INV_TAN	3.32	1.69	-.231** .001	.061 .395	.336** .000	.156* .030	.029 .683	.107 .135	.130* .002	-.003 .971	-.300** .000	-.051 .476					
	12. INV_ ABSB	2.71	1.36	-.412** .000	-.155* .031	.610** .000	.334** .000	.284** .000	.316** .000	-.155* .031	-.262** .000	-.163** .000	.257** .000	-.259** .000				
	13.FRGN	3.18	1.58	-.014 .848	.086 .234	-.129 .071	.127* .005	-.085 .238	-.098 .175	.194* .003	.021 .076	.028 .707	.000 .996	.166* .020	.073 .309			
	14.REVS	4.64	1.54	-.150* .038	-.028 .698	.179* .012	.395** .000	.477** .000	.438** .000	-.224** .002	-.232** .001	.212** .004	.298** .000	.003 .965	.076 .292	-.232** .001		
	15.TRNG	3.03	1.63	-.119 .100	.017 .809	.247* .001	.356** .000	.381** .000	.327** .000	-.006 .932	-.063 .386	.268* .005	.139** .002	-.075 .299	.069 .335	-.281** .000	.204** .004	
	16. NTWK	2.95	0.77	-.359** .000	.238** .001	.282** .000	.437** .000	.508** .000	.501** .000	-.177* .013	-.291** .000	.335** .000	.388** .000	.254** .000	.187** .009	-.005 .994	.215** .000	.170* .018

Hierarchical multiple regressions are also used to test the mediating effect of strategy on capability development (H4 and 5). Three equations were developed for each type of technological capability, each with all control variables as the base. The first is a regression between capability and the engagement variables; the second a regression between capability and the strategy variables; the third a hierarchical regression in which the engagement variables were put in first, then the strategy variables. If strategy mediates between engagement and capability, then any significant relationships identified between engagement and capability in the first equation will drop to insignificance in the third equation:

Model 1:

$$CAP = A_0 + A_1 MEAS\_PFT + A_2 MEAS\_SALES + \varepsilon \qquad (1.1)$$

$$CAP = A_0 + A_1 ADV\_TECH + A_2 INV\_TAN + A_3 FRGN + \varepsilon \qquad (1.2)$$

$$\begin{aligned} CAP &= A_0 + A_1 MEAS\_PFT + A_2 MEAS\_SALES \\ &+ A_c ADV\_TECH + A_4 INV\_TAN + A_5 FRGN + \varepsilon \end{aligned} \qquad (1.3)$$

Model 2:

$$CAP = B_0 + B_1 MEAS\_MKT + B_2 MEAS\_INNO + \varepsilon \qquad (2.1)$$

$$\begin{aligned} CAP &= B_0 + B_1 MATCH\_TECH + B_2 INV\_ABSB \\ &+ B_3 REVS + B_4 TRNG + B_5 NTWK + \varepsilon \end{aligned} \qquad (2.2)$$

$$\begin{aligned} CAP &= B_0 + B_1 MEAS\_MKT + B_2 MEAS\_INNO + B_3 MATCH\_TECH \\ &+ B_4 INV\_ABSB + B_5 REVS + B_6 TRNG + B_7 NTWK + \varepsilon \end{aligned} \qquad (2.3)$$

Where:

(1.1) and (2.2) are regressions between capability and the engagement variables; (1.2) and (2.2) regress capability and the strategy variables; (1.3) and (2.3) are integrated regressions between engagement, strategy/behaviour and capabilities.

8.2 Testing of Hypotheses 3- 5

As discussed in the previous section, hierarchical split-model regressions are used to test Hypotheses 3, 4 and 5. The detailed results are provided in Table 8-2 to Table 8-4.

By comparing all the hierarchical equations, it is found that the relationship between *Capability* and *Engagement* variables became slightly weaker once strategy variables were entered into the regression. This can be taken as evidence that the impact of engagement is not an entirely direct one. In other words, engagement influences capability partly through the effect on strategy preference, while strategy has a direct impact upon capability. This is again confirmed in all equations (3) of Model 2, where the incremental contribution of strategy variables to total R^2 increased significantly.

It is also noticed that in equations (3), the relationship between *engagement* and *capability* has not been completely shadowed out by *strategy* variables. Especially for MEAS_PFT in Model 1 and MEAS_INNO in Model 2 – even when the variance in capability accounted for by strategy was factored out, MEAS_PFT still relates to all three capabilities negatively and strongly ($\beta = -.294, -.293$ and -.300 respectively, all p values <.01). The same applies to MEAS_INNO in Model 2, which contributes to capabilities significantly positively. This indicates that both short-sighted (profit-oriented) and long-sighted (innovation-driven) engagement would have independent impact on capability development, although the effects work in opposite directions. This is consistent with Hypothesis 4: Intelligent engagement is positively related to higher dynamism in capability.

Hypothesis 5 is supported through comparing the explanatory power of Model 1 and Model 2. In Model 1, poor engagement predicts high-visibility strategy/activities, which hardly explains the development of dynamic capabilities (as shown in). The best prediction is for manufacturing capability, where $R^2 = .290$. On the other hand, Model 2 exhibited much stronger explanatory power for dynamic capability: R^2 is highest for R&D capability (0.547) as opposed to 0.228 in Model 1, indicating a strong causal link between low-visibility strategy and the successful development of dynamic capability.

Other interesting features in the regression are noted: the positive contribution to capability dynamism by networking activities within and outside the firm (NTWK) is particularly strong. In sharp contrast, FRGN (passive reliance on foreign technology transfer) contributes little to a firm's manufacturing capability, and hinders one's R&D and organisational capabilities development. This was once mentioned by one of the interviewees in our case study *'...originally the government hand-picked the best performing SOEs to set up joint ventures, hoping that advanced technology and management style can be brought in by these multinational partners, but 10 years on, many of those former stars have found themselves actually trapped in the deal – little gained and little transferred, the lesson was learned the hard way...'*[86]. The obvious explanation is that whilst necessary machinery and product blueprints were brought in to facilitate operation, many of the Chinese firms either voluntarily or were encouraged to gave up their own technological endeavour – the rumoured closure of one of Dongfeng Auto's own R&D divisions after joint-venturing with Citroën is an example in point. The limited introduction of static capability by foreign partners is easily understood and preferred by a disengaged shareholder and appeals to his agents. However, without active learning, which requires intelligent engagement coupled with clever strategies, such superficial advantage will not be sustained.

[86] Interview with R&D director of South Electro, May 2007.

Table 8-2 Hierarchical regressions of Model 1 and Model 2 with Manufacturing Capability

MODEL 1				**MODEL 2**			
Regression Equation	**1.1**	**1.2**	**1.3**	**Regression Equation**	**2.1**	**2.2**	**2.3**
Control Variables				*Control Variables*			
INV_R&D	.176*	.196*	.189**	**INV_R&D**	.227*	.223*	.127*
Other control variables	Included	Included	Included	Other control variables	Included	Included	Included
Engagement variables				*Engagement variables*			
MEAS_PFT	-.304**		-.294**	**MEAS_MKT**	.107*		.095
MEAS_SALE	-.096		-.083	**MEAS_INNO**	.294**		.205**
Strategy variables							
ADV_TECH		.059	.065	**MATCH_TECH**		.213*	.217**
INV_TAN		.076	.085	**INV_ABSB**		.274*	.337**
FRGN		.002	.005	**REVS**		.204**	.210**
				TRNG		.257**	.268**
				NTWK		.196**	.259**
R^2	.197	.129	.290	R^2	.264	.421	.457
Adjusted R^2	.175	.101	.254	Adjusted R^2	.243	.396	.433
Standard error	.988	1.01	.901	Standard error	.948	.833	.816

Table 8-3 Hierarchical regressions of Model 1 and Model 2 with R&D Capability

MODEL 1				**MODEL 2**			
Regression Equation	**1.1**	**1.2**	**1.3**	**Regression Equation**	**2.1**	**2.2**	**2.3**
Control Variables				*Control Variables*			
INV_R&D	.267**	.249**	.248**	**INV_R&D**	.273**	.167*	.112*
Other control variables	Included	Included	Included	Other control variables	Included	Included	Included
Engagement variables				*Engagement variables*			
MEAS_ PFT	-.385**		-.293**	**MEAS_ MKT**	.101*		.085
MEAS_ SALE	-.153*		-.146*	**MEAS_ INNO**	.339**		.320**
Strategy variables				*Strategy variables*			
ADV_ TECH		.008	.061	**MATCH_ TECH**		.197**	.214**
INV_TAN		.019	.059	**INV_ABSB**		.206*	.220**
FRGN		-.046	-.074	**REVS**		.226**	.261**
				TRNG		.180*	.230**
				NTWK		.185*	.267**
R^2	.221	.142	.265	R^2	.377	.490	.567
Adjusted R^2	.200	.114	.228	Adjusted R^2	.360	.467	.547
Standard error	.945	.990	.899	Standard error	.853	.769	.712

Table 8-4 Hierarchical regressions of Model 1 and Model 2 with Organisational Capability

MODEL 1				**MODEL 2**			
Regression Equation	**1.1**	**1.2**	**1.3**	**Regression Equation**	**2.1**	**2.2**	**2.3**
Control Variables				*Control Variables*			
INV_R&D	.273**	.247**	.172**	INV_R&D	.274**	.114	.025
Other control variables	Included	Included	Included	Other control variables	Included	Included	Included
Engagement variables				*Engagement variables*			
MEAS_PFT	-.348**		-.300**	MEAS_MKT	.174*		.129
MEAS_SALE	-.150*		-.145*	MEAS_INNO	.249**		.191**
Strategy variables				*Strategy variables*			
ADV_TECH		.065	.073	MATCH_TECH		.174**	.183**
INV_TAN		.044	.058	INV_ABSB		.150*	.176**
FRGN		-.083	-.100	REVS		.114*	.187**
				TRNG		.113*	.157**
				NTWK		.258**	.358**
R^2	.205	.147	.225	R^2	.262	.459	.543
Adjusted R^2	.145	.119	.191	Adjusted R^2	.241	.435	.523
Standard error	1.077	1.10	1.047	Standard error	.911	.800	.778

8.3 Testing of Hypotheses 6 & 7

Hypothesis 6 and 7 involve working with non-parametric data (ownership types and management selection methods), hence we used descriptive tables and ANOVA as well as Welch & Brown-Forsythe tests to check the robustness of the findings.

If H6a and H7a are true, then we should expect the ownership form and management selection form giving more intelligent engagement will excel in capability types which are sensitive to low-visibility activities. Table 7-11 has shown that MISOE and SHARHS have the highest scores of their own category in intelligent engagement (MEAS_INNO). On the other hand, as clearly presented in Table 8-5 to Table 8-7, MISOEs and SHARHS do outperform in R&D and organisational capabilities which are more sensitive to low-visibility activities than does manufacturing capability. ANOVA tests are used to verify the findings. In case of variances of the capability variables not being equal across groups, Welch & Brown-Forsythe tests are used as alternatives to the usual F test. Table 8-8 and Table 8-9 list the ANOVA tables. All F tests are significant $(p < .05)$, and the equivalent $p-$values from Welch & Brown-Forsythe tests are also well below the .05 level. It supports the hypothesis that capabilities differ among ownership types and management selection methods. The same applies to H6b, where MISOEs (well-governed and well-financed) outperform MASOEs (well-financed), which narrowly lead POEs (well-governed) on manufacturing capability. This form of capability is most sensitive to finance and benefits most among all capabilities from high-visibility strategy – that is why MASOEs lead POEs. The ANOVA tests again demonstrated the significance of such difference.

Table 8-5 Comparison of Manufacturing Capability among ownership types and management selection methods

Manufacturing Capability						
Elements of capability	Type of ownership	Degree 4	Degree 5 or 6	Degree 4	Degree 5 or 6	MGT selection
Equipment	MASOEs	10.1%	14.6%	13.6%	15.3%	ADMINS
	MISOEs	4.5%	38.8%	1.9%	20.8%	REC/APPS
	POEs	7.9%	10.5%	7.3%	20.4%	SHARHS
Production routine	MASOEs	13.5%	10.1%	20.3%	16.8%	ADMINS
	MISOEs	30.9%	26.8%	24.5%	15.1%	REC/APPS
	POEs	13.2%	7.9%	18.3%	20.0%	SHARHS
Ability of the manufacturing department to comply with the request of R&D	MASOEs	21.6%	9.1%	24.1%	6.9%	ADMINS
	MISOEs	40.3%	25.3%	34.0%	12.2%	REC/APPS
	POEs	18.4%	7.9%	25.6%	20.7%	SHARHS
Total quality control	MASOEs	6.7%	12.4%	15.3%	8.5%	ADMINS
	MISOEs	40.3%	22.4%	17.0%	18.9%	REC/APPS
	POEs	10.5%	7.9%	23.2%	17.1%	SHARHS
Manufacturing cost control	MASOEs	13.5%	8.9%	16.9%	6.8%	ADMINS
	MISOEs	34.3%	17.9%	18.9%	5.7%	REC/APPS
	POEs	34.2%	13.2%	34.1%	22.0%	SHARHS
Ability to make improvement in the manufacturing system	MASOEs	29.2%	9.0%	28.8%	3.4%	ADMINS
	MISOEs	45.6%	12.7%	49.1%	5.7%	REC/APPS
	POEs	18.4%	7.9%	25.3%	7.2%	SHARHS
Level of contribution made by manufacturing department to the innovation processes	MASOEs	13.5%	3.4%	23.7%	0	ADMINS
	MISOEs	29.4%	13.2%	17.0%	7.5%	REC/APPS
	POEs	18.4%	7.9%	19.3%	13.2%	SHARHS

- **Ownership types: N = 195; MASOE: n= 89 (45.6%), MISOE: n =68 (34.9%), POE: n =38 (19.5%)**
- **Management selection: N=157; ADMINS: n = 59 (37.6%), REC/APPS: n= 52 (33.1%), SHARHS: n=46 (29.3%)**

Table 8-6 Comparison of R&D Capability among ownership types and management selection methods

R&D Capability						
Elements of capability	Type of ownership	Degree 4	Degree 5 or 6	Degree 4	Degree 5 or 6	Selection of management
The overall R&D capability	MASOEs	18.0%	11.3%	23.7%	6.8%	ADMINS
	MISOEs	41.2%	20.6%	24.5%	17.0%	REC/APPS
	POEs	10.5%	7.9%	25.3%	14.9%	SHARHS
The ability to carry out process improvement	MASOEs	13.5%	3.4%	20.3%	0	ADMINS
	MISOEs	33.8%	23.5%	26.4%	1.9%	REC/APPS
	POEs	23.7%	5.3%	21.7%	24.1%	SHARHS
The ability to carry out process innovation	MASOEs	10.1%	3.4%	16.9%	0	ADMINS
	MISOEs	38.2%	13.2%	17.3%	1.9%	REC/APPS
	POEs	10.5%	7.9%	34.8%	23.9%	SHARHS
The ability to carry out new product development	MASOEs	34.8%	10.1%	10.2%	0	ADMINS
	MISOEs	33.8%	23.5%	5.8%	1.9%	REC/APPS
	POEs	44.7%	7.9%	8.7%	23.9%	SHARHS
Quality and speed of response to feedback from manufacturing about design and engineering	MASOEs	13.5%	3.4%	13.6%	6.8%	ADMINS
	MISOEs	32.4%	19.1%	25.0%	1.9%	REC/APPS
	POEs	26.3%	2.6%	28.3%	17.4%	SHARHS
Ability to incorporate market and customer feedback in improvement/innovation	MASOEs	19.1%	6.8%	28.8%	0	ADMINS
	MISOEs	51.5%	13.2%	28.8%	7.7%	REC/APPS
	POEs	28.9%	7.9%	43.5%	23.9%	SHARHS

- **Ownership types: N = 195; MASOE: n= 89 (45.6%), MISOE: n =68 (34.9%), POE: n =38 (19.5%)**
- **Management selection: N=157; ADMINS: n = 59 (37.6%), REC/APPS: n= 52 (33.1%), SHARHS: n=46 (29.3%)**

Table 8-7 Comparison of Organisational Capability among ownership types and management selection methods

Organisational Capability						
Elements of capability	Type of ownership	Degree 4	Degree 5 or 6	Degree 4	Degree 5 or 6	Selection of management
Organisational flexibility to meet the need for technological development	MASOEs	11.1%	6.5%	5.1%	0	ADMINS
	MISOEs	22.0%	22.0%	23.1%	7.7%	REC/APPS
	POEs	18.9%	8.1%	17.4%	30.4%	SHARHS
The culture and mechanism to encourage and reward inventiveness and creativity	MASOEs	10.1%	3.4%	0	0	ADMINS
	MISOEs	20.6%	22.0%	46.2%	7.7%	REC/APPS
	POEs	22.1%	7.9%	26.1%	10.8%	SHARHS
Co-ordination and control of the major functions within the company	MASOEs	6.7%	0	10.2%	0	ADMINS
	MISOEs	22.1%	10.1%	7.7%	11.6%	REC/APPS
	POEs	18.4%	7.9%	23.9%	6.5%	SHARHS
Initiative of sub-units within company strategy	MASOEs	3.4%	6.7%	0	0	ADMINS
	MISOEs	17.6%	8.8%	11.5%	13.4%	REC/APPS
	POEs	36.8%	0	19.6%	10.8%	SHARHS

- **Ownership types: N = 195; MASOE: n= 89 (45.6%), MISOE: n =68 (34.9%), POE: n =38 (19.5%)**
- **Management selection: N=157; ADMINS: n = 59 (37.6%), REC/APPS: n= 52 (33.1%), SHARHS: n=46 (29.3%)**

Table 8-8 ANOVA tests – comparing means of manufacturing capability between ownership types and management selection methods

	Ownership	df	Mean Square	F	Sig.	MGT selection	df	Mean Square	F	Sig.
Equipment	Between Groups	2	28.856	16.514	.000	Between Groups	2	14.849	8.230	.000
	Within Groups	191	1.747			Within Groups	153	1.804		
	Total	193				Total	155			
Production routine	Between Groups	2	20.198	14.934	.000	Between Groups	2	14.163	10.037	.000
	Within Groups	191	1.352			Within Groups	153	1.411		
	Total	193				Total	155			
Capability to comply with R&D requests	Between Groups	2	23.373	19.877	.000	Between Groups	2	17.724	13.935	.000
	Within Groups	190	1.176			Within Groups	152	1.272		
	Total	192				Total	154			
Total Quality Control	Between Groups	2	20.444	14.923	.000	Between Groups	2	11.357	7.538	.001
	Within Groups	191	1.370			Within Groups	153	1.507		
	Total	193				Total	155			
Manufacturing cost control	Between Groups	2	16.307	13.742	.000	Between Groups	2	18.801	17.909	.000
	Within Groups	191	1.187			Within Groups	153	1.050		
	Total	193				Total	155			
Process improvement	Between Groups	2	15.171	11.314	.000	Between Groups	2	11.135	8.639	.000
	Within Groups	192	1.341			Within Groups	154	1.289		
	Total	194				Total	156			
Contribution to innovation	Between Groups	2	11.169	8.206	.000	Between Groups	2	5.703	4.246	.016
	Within Groups	192	1.361			Within Groups	154	1.343		
	Total	194				Total	156			

Table 8-9 ANOVA tests – comparing means of R&D and organisational capabilities between ownership types and management selection methods

	Ownership	df	Mean Square	F	Sig.	MGT selection	df	Mean Square	F	Sig.
R&D Capability - overall capability	Between Groups	192	18.432	13.093	.000	Between Groups	12.377	12.377	9.183	.000
	Within Groups	2	1.408			Within Groups	1.348	1.348		
	Total	192				Total				
R&D Capability - process improvement	Between Groups	194	24.848	22.694	.000	Between Groups	21.821	21.821	20.209	.000
	Within Groups	2	1.095			Within Groups	1.080	1.080		
	Total	192				Total				
R&D Capability - process innovation	Between Groups	194	26.976	23.689	.000	Between Groups	25.214	25.214	22.890	.000
	Within Groups	2	1.139			Within Groups	1.102	1.102		
	Total	192				Total				
R&D Capability - product innovation	Between Groups	194	12.189	8.626	.000	Between Groups	15.792	15.792	11.130	.000
	Within Groups	2	1.413			Within Groups	1.419	1.419		
	Total	192				Total				
R&D Capability - quality and speed responding to feedback	Between Groups	194	15.899	14.675	.000	Between Groups	12.732	12.732	11.235	.000
	Within Groups	2	1.083			Within Groups	1.133	1.133		
	Total	192				Total				
R&D Capability - ability to incorporate market/customer feedback	Between Groups	194	17.864	14.126	.000	Between Groups	18.094	18.094	13.833	.000
	Within Groups	2	1.265			Within Groups	1.308	1.308		
	Total	192				Total				
Organisational Capability - flexibility	Between Groups	194	20.934	14.483	.000	Between Groups	28.655	28.655	22.081	.000
	Within Groups	2	1.445			Within Groups	1.298	1.298		
	Total	192				Total				
Organisational Capability - culture and mechanism	Between Groups	194	11.481	9.945	.000	Between Groups	21.988	21.988	23.786	.000
	Within Groups	2	1.154			Within Groups	.924	.924		
	Total	192				Total				
Organisational Capability - coordination and control	Between Groups	194	4.412	3.955	.021	Between Groups	15.579	15.579	16.598	.000
	Within Groups	2	1.115			Within Groups	.939	.939		
	Total	192				Total				
Organisational Capability - initiative of subunits within strategy	Between Groups	194	10.032	8.503	.000	Between Groups	16.341	16.341	15.230	.000
	Within Groups	2	1.180			Within Groups	1.073	1.073		
	Total	192				Total				

8.4 Summary

In this chapter five more hypotheses are tested and supported. Through split-model hierarchical regressions, a positive relationship between the quality of shareholder engagement and the firms' technological capability is established. Moreover, the relationship is partially mediated by the visibility level of technology strategy/activity. In other words, poor engagement leads to strategy prioritising high-visibility activities, which leads to lower dynamic capabilities.

Based on the above findings, ANOVA tests show that ownership type affects technological capability. Minority-state-owned-firms, which combine the advantages of both state-owned firms (good access to finance) and privately owned firms (good corporate governance), can and did do better in dynamic capability development. On the other hand, the degrees of dynamic capabilities developed in firms differ even more significantly among different management selection methods. Compared to administrative-selected or approved managers, shareholder-selected managers are much better incentivised to prioritise low-visibility strategy/activity, which as H4 and H5 show, will lead to higher dynamic capabilities. It is suggested that a much more diversified financing portfolio by shareholder-selection SOEs also contributes to higher dynamism of capability building.

Chapter 9 Conclusion

This chapter summarises the major findings, contributions and limitations of this study. Section 9.1 discusses the findings related to the four research questions set out in Chapter 1. Following theoretical frameworks developed from literature review and past research, empirical work in the Chinese auto and electronics industry has generated answers to these research questions: 1) What is the situation of technological capabilities developed in the firms in Chinese Auto and Electronics Industry? 2) How has the development process of technological capabilities been? 3) What is the situation of corporate governance and finance in the firms in Chinese Auto and Electronics Industry? 4) How can the capabilities developed be explained from the finance/corporate governance point of view? Section 9.2 concludes this chapter with contributions and limitations of this study.

9.1 Main findings

This thesis sets out with the following aims:

> (From the perspective of corporate governance and finance), explain why have the majority of the Chinese firms failed to develop technological capability such that would enhance their competitiveness; explain how have the minority succeeded and why there are not more of them; and identify influential elements of corporate governance and finance on a firm's technological capability; and how these elements take effect. It is hoped that findings and new theories developed from the Chinese context will shed light on dynamic capability development in NIEs in general.

In order to achieve this aim, four research questions are developed to be answered in this thesis. Through empirical research composed of both qualitative (case studies) and quantitative (questionnaire survey) stages, all four research questions are answered:

1) What is the situation of technological capabilities developed in the firms in China, especially medium-high/high technology industries?

In this research, a paired questionnaire survey in 195 Chinese electronics firms was conducted in 2007 using a capability evaluation framework inspired by previous research. The aggregated result shows that in general, Chinese electronics firms have developed better Static than Dynamic capabilities. In particular, firms have achieved higher dynamism in capability type (Manufacturing) that is more sensitive to strategy that prioritises high-visibility activities, and much lower dynamism in Organisational Capability, which is more sensitive to low-visibility technological activities.

2) How has the development process of technological capabilities been?

This question is answered through five in-depth case studies in both auto and electronics industry carried out between 2006 and 2008. It has found that firms' strategies which prioritise low-visibility activities lead to higher dynamic capabilities than strategies prioritising high-visibility activities, does. In addition, firms with better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities. Three hypotheses are developed for testing in the quantitative stage of empirical research:

H3: there will be a positive relationship between the quality of shareholder engagement and the firm's technological capability.

H4: Poor engagement leads to strategy prioritising high-visibility activities; intelligent engagement leads to strategy prioritising low-visibility activities.

H5: Strategy prioritising high-visibility activities leads to lower dynamic capabilities than strategy prioritising low-visibility activities, does.

Split-model hierarchical regressions using data from the questionnaire survey support these findings.

3) What is the situation of corporate governance and finance in the firms in Chinese Auto and Electronics Industry?

Again, rich qualitative data collected from the case studies has been analysed to answer this question. In the five case study firms, different corporate governance and finance are observed in different ownership types. MASOEs, especially those with administration- selected managers have enjoyed privileged access to finance, including state subsidy and cheap loans from state-owned banks (South Electro and SAIC up till

2001). However they tend to have deeply flawed corporate governance. Government parachuted its officials into the company who did not necessarily have industrial expertise, and they were moved away not long after. Managers came to their posts with assigned tasks, either to increase capacity or to enhance profit; anyway, both are quantitative, highly visible and easy to measure.

Moreover, based on observations of the other two MASOEs (GTC and Chery), we argue that MASOE can too have better corporate governance – provided the shareholders/governing officials are prepared to make it happen. They may not be industrial experts themselves, yet they compensate with high quality engagement. Failing that, they take some trouble to pick the right person, highly experienced in the industry, and then gave him time, and possibly other key resources (including financial ones) to think and act long-term. In other words, these are the SOEs with managers selected for their entrepreneurship, not their *guanxi* with the officials. And whatever the formal ownership position, in practice the management team are treated as though they are co-owners, and behave as though they were. Thus in effect in these (exceptional) SOEs there are highly engaged owners. On the other hand, POEs have fully engaged owners/managers; however they struggle to access necessary finance to support their business and technological development. Two corresponding hypotheses are developed:

H1a: In China, different types of ownership lead to different corporate governance for the purpose of capability development. H1b: In China, in getting access to financial resources, different types of ownership lead to different treatment.
H2: In China, different selection methods for top management in SOEs lead to different corporate governance for the purpose of capability development.

Hypotheses testing in the quantitative research supported above findings. Particularly, MISOEs enjoy a combined advantage of better corporate governance than MASOE, and better finance than POE [87]. Moreover, different selection methods for top management in SOEs lead to different corporate governance for the purpose of capability development. Specifically, compared with SOEs with administration-

[87] Unfortunately case studies of MISOEs were not undertaken in this research, and the corresponding hypothesis is partly inspired by previous research (Cai & Tylecote, 2008).

selected or approved managers, SOEs with shareholder-selected managers display significantly higher quality of shareholder engagement and more diversified portfolio of finance.

4) How can the capabilities developed by the firms be explained from the perspective of corporate governance and finance?

This question is answered by both case studies and questionnaire survey. As shown in the case studies, the lack of dynamism in firms' capability development is largely due to their situation of corporate governance and finance. Particularly, POEs normally have highly engaged shareholders/owners and well included employees, which enable them to choose technology strategy that prioritises low-visibility activities, which in turn lead to higher dynamic capability. However, their poor access to financial resources inevitably constrains their scope of static capabilities, which are necessary for more radical innovations. On the other end of spectrum are MASOEs. As mentioned above, their managers are often administratively-selected for their political merits, or their *guanxi* with the officials. Poorly motivated and evaluated by short-term quantitative performance criteria, it is not hard to see why the majority of them choose highly dependent strategy that prioritises high-visibility activities, often in the form of bundled technology. Consequently, they develop better Static than Dynamic capabilities. Although no case study was undertaken in any MISOEs, one would expect that by combining the advantage of better finance (than POEs) and better corporate governance (than MASOEs), they should outperform technologically in all ownership types. These findings are again consistent with hypotheses tested in the quantitative study:

H6: Ownership form affects technological capability; more specifically, (H6a) ownership forms giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities. It would also be expected (H6b) that ownership forms giving better access to finance will excel (other things equal) in capability types which are sensitive to high-visibility activities.

H7: Technological capability in SOEs is affected by selection method for top management. (H7a) Selection methods giving more intelligent engagement will excel (other things equal) in capability types which are sensitive to low-visibility activities.

9.2 contributions, policy implications and limitations of this study

9.2.1: Contributions and policy implications

The contributions of this study are significant in several respects:

1) This study provided a thorough account of how firms with different corporate governance and finance (CGFS) in the Chinese auto and electronics firms develop their technological capabilities. Through multiple case studies, this study explained why the majority of Chinese firms failed to acquire dynamic capabilities, and why the minority of them succeeded. It finds that firms which succeeded have adopted an independent technological strategy, where a lot of low-visibility learning activities took place. On the other hand, trust and mutual loyalty from lower-level employees, local suppliers, and lead customers made it possible to draw inputs from them during the process of technological learning. It therefore indicates that in order for Chinese firms to successfully develop sustainable competitiveness, a more independent approach to technological capability development needs to be implemented. Specifically, in order for the independent, low-visibility learning strategy to work, it is highly important for shareholders (especially the state shareholders) to have a great interest in, and develop an understanding of the industry in general, and the firm they own in particular. They also need to align their interests with the management, possible through formal (in the case of POEs and MISOEs) or *de facto* (in the case of MASOEs) co-ownership, or through trust and decent autonomy; they also need to encourage their managers to think long-term.

2) This study gives a thorough evaluation of firms' technological capabilities in the Chinese electronics industry. For firms, they could learn from this study where their efforts have been mostly put in so far, and where they should have endeavoured instead.

For policy makers, they could learn from the empirical results of how high-tech firms develop and generate their capabilities under the current mechanism of corporate governance and finance system. Based on findings from the case studies as well as questionnaire survey, strong evidence has been established on the effects of corporate governance on firm's technology development. This is has crucially important policy implications for China's SOE reforms as well as the reform of the corporate governance and finance system. China's SOE reform so far has been focusing on the privatisation of small and medium SOEs. Those which remain (mainly large SOEs, especially central enterprises under SASAC) are being controlled in an even more conventional fashion. Clearly the trend is to increasing measure firm performance with Wester-style financial accounting measures (Tylecote *et al*, 2010). In particular, the SASAC website in 2006 revealed the governing bodies' enthusiasm in using Economic Value-Added – which, broadly speaking is a fair measure of a firm's profitability. Clearly, the challenge for SASAC is to realize the potential (or inevitable) conflict between long-term goals and the availability of any immediate measure of profitability. It is particularly problematic with the new emphasis on circulation of outside top managers (see Figure 3-9). Both of these developments can be highly effective in bringing about short-term efficiency and return. However argued in the thesis, if a CEO is under pressure to impressive in a relatively short time, and if the impression will mainly be measured financially, low visibility investments in technological capability will be discouraged.

On the other hand, it is found in the thesis that for most POEs and some small SOEs, the lack of access to necessary finance has unduly impeded their technological development. Although there have been some formal steps taken by the policy makers to address this problem – such as the foundation of a dedicated Start-Up Board in the Shenzhen Stock Exchange in summer 2009 (*China Daily*, 02/09/2009) – it remains to be seen to what extent will these measures actually benefit the development of POEs and less favoured SOEs.

3) As for theoretical contributions, this thesis contributes to the literature on technological capability by creating a better understanding of firm-level technological capability in the Chinese Electronics Sector. It also provides a new framework for measuring firm-level technological capabilities in similar sectors in either China or other NIEs. More importantly, this study has modified, enriched and tested Tylecote's framework (see Chapter 2) in the Chinese context. Therefore it will provide guidance for confident and skilled applications of such theories to other NIE contexts.

9.2.1 Limitations and Reflection

This study has a number of limitations. Its quality could have been further improved if a parallel survey had been conducted in the auto industry. However due to the fact that study of technology development in any Chinese high-tech (or medium-high-tech) industry has become increasingly sensitive to foreign-based scholars[88], attempts to access the Chinese auto industry at a larger scale has thus not been successful.

As for generalisation of findings, some caution needs to be taken when generalising findings to some other high-/medium-high-tech industries. As discussed in the literature review (Chapter 2) and in the discussion of case studies (Chapter 6), low-visibility technological activities in general, and *unbundling* in particular, are more applicable to sectors where product assembly and systems integration are central. It would therefore be slightly harder to generalise (in high-tech) from electronics to pharmaceutical industry, and (in medium-high-tech) from cars to chemicals -since for those with non-assembled products, there is less scope for unbundling and less need for systems integration.

This study looks at only one country. Further insights could be gained by conducting comparative studies between countries/regions, for example, South Korea and Taiwan. South Korea caught up with the technology frontiers 10 to 20 years ago, with highly supportive industrial policies and firms' indigenous efforts focussed on incremental improvement in process and product technologies. Taiwan is a thriving economy based on strong family business, especially in the electronics industry. It would be highly relevant and important to carry out similar studies on CGFS and technological capability development in these two economies to shed more light on the current theoretical framework.

In the empirical study, there may also be some problems that are intrinsically associated with questionnaire-based data collection. For example, all multiple regressions were performed with the assumptions that differences between each degree

[88] During an interview in one of the auto firms, the author was shown the official notice issued by the Ministry of Commerce on protection of national business and technology secrecy. The document specified that any information provided to foreign-based institutes or scholars has to be carefully scrutinised and signed off by supervisory authorities.

of capabilities were equal, which in reality is deemed impossible to guarantee. In addition, although further analysis was conducted with the survey population to verify representativeness of the data set, it has main drawn on second-hand data (NBS statistics, see Chapter 7.1.1). Alternatively, a follow-up study of the non-respondents would be an optimum approach.

One further limitation of this study is that, apart from the engagement dimension of corporate governance, it has not fully explored – through hypotheses testing – the effects of the other three CGFS dimensions on the capability development of firms: 1) need for competence-destruction/ reconfiguration and pressure for shareholder value; 2) technology opportunity and expert risk capital and management autonomy; 3) spill-overs and stakeholder inclusion. Some attempts have been made on one aspect of stakeholder inclusion, i.e. the positive effect of networking activities on capability building. However more studies need to be done, to find out more about: 1) How much pressure do shareholders in Chinese firms exert for shareholder value and is it possible to measure it? 2) How do inter-firm relationships (both with domestic firms and international firms) impact on strategy and capability development? And is it possible to measure it?

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Appendix I. Sample questionnaire 1: Questions for CEOs about Corporate Governance

Questionnaire for Corporate Governance and Technology Strategies

To be filled out by company managing director or board member

By answering this questionnaire, you give consent to the researcher to collect, integrate, and analysis the information they provide, and to disseminate the findings in an aggregate manner

All data and information will be used for research purposes only and
no specific names or details will be revealed to a third party
without the informants' knowledge and consent

Section One: The Company

1.
Please indicate how many years you have been working in the company:

☐ Less than 1 year ☐ 1 – 3 years (including 3 years)

☐ 3 – 5 years (including 5 years) ☐ 5 – 10 years (including 10 years)

☐ More than 10 years

2.
Your position within the company:

Yes ☐ No☐ Board-level management

Yes ☐ No☐ General management

Yes ☐ No☐ Production Management

Yes ☐ No☐ R&D/ Technical Management

Yes ☐ No☐ Sales & Marketing Management

Yes ☐ No☐ Others (please specify) ________________

3.
Approximately in what year was this company established? ________________.

4.
Approximately how many employees are in your company?

☐ <99 ☐ 100 – 499 ☐ 500 – 999

☐ 1000 - 4999 ☐ > 5000

5.
Which sub-sector is your company in?

□ Telecommunication	□ Consumer electronics
□ TV& broadcasting equipments	□ Computers and related products
□ Electronic equipments	□ Integrated circuits & semi-conductors
□ Electronic parts and components	□ Sealed vacuum electronic devices
□ Electronic material	□ Photo-electronics

Section Two: Corporate Governance

6 .
What is the current type of ownership of your company?

☐ Private firm

☐ Collective firm

☐ 100% State-owned firm

☐ Share-holding firm (including state-shareholding, domestic joint venture and foreign joint venture)

☐ Foreign firm, from which country/economy? ________________

7. (***Please answer this set of questions if your firm IS share-holding company***)

7.1 What is the nature of your first shareholder?

☐ SASAC central office

☐ Local government, SASAC local office, or state asset administration company

☐ State-owned firm or state-shareholding firm

☐ Individual or private firm

☐ Foreign-owned firm or foreign multinational company

7.2 What is the percentage of shareholding by the first shareholder?

☐ 1%-29% ☐ 30%-49% ☐ 50%-69% ☐ 70%-99% ☐ 100%

7.3 What is the nature of your second shareholder?

☐ Local government, SASAC local office, or state asset administration company

☐ State-owned firm or state-shareholding firm

☐ Individual or private firm

☐ Foreign-owned firm or foreign multinational company

(end of question 7)

8.

How are your top managers selected? (please choose one as appropriate)

☐ By administrative authorities

☐ By shareholders

☐ By firm but candidates are recommended by administrative authorities or the final potential candidate need to be approved by administrative authorities

☐ Others (please specify)

9.

How many people hold the positions of: 1) Chair of board; 2) CEO/ Chief Operating manager; 4) Party secretary (cross this out if not applicable)?

☐ 1 ☐ 2 ☐ 3

10.

How much pressure does your company feel from the performance evaluation conducted by the administrative authority?

	Little pressure		Medium pressure		High pressure
Level of pressure from evaluations by administrative authority	☐	☐	☐	☐	☐

(if your answer to this question is 'Medium' or above, please go to question 11, otherwise please go to question 12)

11.
<u>(Only answer this if your answer to question 10 is MEDIUM or above, otherwise please go to question 11)</u>
Please order from 1 to 5 the weight of the following indicators that are used in the authority's evaluation (1 – the lightest, 5 – the heaviest weight)

	1	2	3	4	5
Gross profit rate	☐	☐	☐	☐	☐
Taxation	☐	☐	☐	☐	☐
Sales revenue	☐	☐	☐	☐	☐
Employment	☐	☐	☐	☐	☐
Firm's technology development	☐	☐	☐	☐	☐
Patents received/applied for	☐	☐	☐	☐	☐
Sales revenue of innovative product (within the last 3 years)	☐	☐	☐	☐	☐
Market share	☐	☐	☐	☐	☐
Other, please specify: ____________	☐	☐	☐	☐	☐

12.

<u>Only answer this if you believe that the pressure from the authority's evaluation is BELOW MEDIUM</u>

In your major shareholders' evaluation of the firm's performance, order the degree of the following factors from 1 to 5 when (1- the lowest degree, 5- the highest):

	1	2	3	4	5
Gross profit rate	☐	☐	☐	☐	☐
Sales revenue	☐	☐	☐	☐	☐
Firm's technology development	☐	☐	☐	☐	☐
Sales revenue of innovative product (within the last 3 years)	☐	☐	☐	☐	☐
Market share	☐	☐	☐	☐	☐
Other, please specify: ____________	☐	☐	☐	☐	☐

Section Three: Finance and Success in Project Application

13.

What have been the MAIN channels for your business expansion finance?

☐ Firm's own savings

☐ State-owned banks

☐ Non state-owned banks

☐ Stock market

☐ Rural cooperative foundations; financial centres/capital rotating credit associations; mutual association

☐ Joint venture

☐ Government subsidies

☐ Others (pls specify)

14.
Do you feel any difficulty when applying for official approvals for new projects?

☐ Yes ☐ No

15.
If your answer to question 14 is 'Yes', then which of the following factors would help you to obtain the approval (choose all that apply)?

☐ State Ownership

☐ Relationship with government authorities

☐ Firm's commercial performance

☐ Others (please specify)

Section Four: Technological Strategy

16.
When considering acquiring new technology from outside, what is the strategy most likely to be chosen?

□ Choose the most advanced technology given sufficient capital

□ Choose appropriate technology which is compatible to firm's existing technology

□ Others (please specify): ______________________________

17.
What is the average proportion (in the last 3 years) of the following categories of technological expenditure to total revenue? (please tick as appropriate)

Tangible technology purchasing such as equipment	□<1%	□1% -3%	□3.1% -5%	□5.1% -7%	□7.1% -9%	□10% -19%	□20% -29%	□30% -39%
Intangible technology such as patent, licences	□<1%	□1% -3%	□3.1% -5%	□5.1% -7%	□7.1% -9%	□10% -19%	□20% -29%	□30% -39%
Process technology improvement	□<1%	□1% -3%	□3.1% -5%	□5.1% -7%	□7.1% -9%	□10% -19%	□20% -29%	□30% -39%
Technological absorption*	□<1%	□1% -3%	□3.1% -5%	□5.1% -7%	□7.1% -9%	□10% -19%	□20% -29%	□30% -39%
R&D	□<1%	□1% -3%	□3.1% -5%	□5.1% -7%	□7.1% -9%	□10% -19%	□20% -29%	□30% -39%

18.
How important are the following factors in hampering firm's technological development?

Factors hampering technological development	Unimportant			Neutral		Important	Crucial
Lack of appropriate finance	☐	☐	☐	☐	☐	☐	☐
Lack of skilled technical personnel	☐	☐	☐	☐	☐	☐	☐
Lack of skilled managerial personnel	☐	☐	☐	☐	☐	☐	☐
Lack of government support and assistance in initiating R&D activities and/or innovation projects	☐	☐	☐	☐	☐	☐	☐
Others (pls specify):	☐	☐	☐	☐	☐	☐	☐

*Note: Technological absorption expenditure is the money spent on activities in assimilating newly acquired technology, which include various training (on the job training, course based training etc.), inviting expert or engineers from outside for problem solving, trials, experiments and so on.

Thank you very much for taking the time to complete this survey!

If you want to expand on any of your answers to one, or more, of the questions please do add them here:

If you have any additional comments that you would like to add, or comments about the survey then please add them here:

If you would like to receive a copy of the report please add your name and company address here.

Name: ________________________________

Address: ______________________________________

____

Appendix II. Sample questionnaire 2: Questions for R&D Managers about Technological Capbaility

Questionnaire for evaluation of technological capabilities and strategies

(To be filled out by the R&D/Technical director)

By answering this questionnaire, you give consent to the researcher to collect, integrate, and analysis the information they provide, and to disseminate the findings in an aggregate manner

<u>All data and information will be used for research purposes only and no specific names or details will be revealed to a third party without the informants' knowledge and consent</u>

Section One: The Company

1.
Please indicate how many years you have been working in the company:

☐ Less than 1 year ☐ 1 – 3 years (including 3 years)

☐ 3 – 5 years (including 5 years) ☐ 5 – 10 years (including 10 years)

☐ More than 10 years

2.
Your chief position within the company:

Yes ☐ No☐ Board-level management

Yes ☐ No☐ General management

Yes ☐ No☐ Production Management

Yes ☐ No☐ R&D/ Technical Management

Yes ☐ No☐ Sales & Marketing Management

Yes ☐ No☐ R&D/ Technical project supervisor

Yes ☐ No☐ Others (please specify) _________________

3.
Approximately how many employees are in your company?

☐ <99 ☐ 100 – 499 ☐ 500 – 999

☐ 1000 - 4999 ☐ > 5000

Section Two: Technological Capabilities

5. Evaluating manufacturing capability

Please circle the most appropriate number to the right of each statement.

Manufacturing Capability						
Elements of manufacturing capabilities	1	2 (average in the country)	3	4 (advanced in the country)	5	6 (advanced in the world)
Ability to ensure smooth functioning of equipments and routine production	☐	☐	☐	☐	☐	☐
Ability of the manufacturing department to comply with the request of R&D	☐	☐	☐	☐	☐	☐
Level of total quality control	☐	☐	☐	☐	☐	☐
Manufacturing cost control	☐	☐	☐	☐	☐	☐
Overall technical capability of equipment	☐	☐	☐	☐	☐	☐
Ability to make continuous improvement in the manufacturing system	☐	☐	☐	☐	☐	☐
The level of contribution made by manufacturing department to the innovation processes	☐	☐	☐	☐	☐	☐

6. Evaluating R&D capability

Please circle the most appropriate number to the right of each statement.

Elements of R&D capabilities	R&D Capability 1	2 (average in the country)	3	4 (advanced in the country)	5	6 (advanced in the world)
The overall R&D capability	☐	☐	☐	☐	☐	☐
The ability to carry out process improvement	☐	☐	☐	☐	☐	☐
The ability to carry out process innovation	☐	☐	☐	☐	☐	☐
Ability to incorporate desired functions in product design/development process	☐	☐	☐	☐	☐	☐
Quality and speed when responding to feedback from manufacturing about design and engineering	☐	☐	☐	☐	☐	☐
Ability to incorporate market and customer feedback in the improvement/innovation process	☐	☐	☐	☐	☐	☐

7. Organising Capabilities

Please circle the most appropriate number to the right of each statement.

Organising Capabilities						
Elements of Organising capabilities	1	2 (average in the country)	3	4 (advanced in the country)	5	6 (advanced in the world)
Flexibility in adjusting organisational structure according to the need for technological developments	☐	☐	☐	☐	☐	☐
The culture and mechanism to encourage and reward inventiveness and creativity	☐	☐	☐	☐	☐	☐
Co-ordination and control of the major functions within the company	☐	☐	☐	☐	☐	☐
Initiative of sub-units within company strategy	☐	☐	☐	☐	☐	☐

Section Three: Technology Strategy

8.
What are the internal and external links which have been forged and what are their impacts on your firm's technological development?

		NL[1]	MT[2]	ET-1[3]	ET-2[3]	IL[4]
	Production department with R&D department	☐	☐	☐	☐	☐
	R&D department with marketing department	☐	☐	☐	☐	☐
Domestic suppliers of	Equipment	☐	☐	☐	☐	☐
	Key components and parts	☐	☐	☐	☐	☐
	Domestic buyers	☐	☐	☐	☐	☐
Foreign suppliers of	Equipment	☐	☐	☐	☐	☐
	key components and parts	☐	☐	☐	☐	☐
	Foreign buyers	☐	☐	☐	☐	☐

1. NL: No links;
2. MT: Links centred on market transaction or day-to-day work. It doesn't involve new skills or knowledge transfer which will enhance pre-existing technological capabilities;
3. ET 1&2: Links centred on knowledge flow to improve existing technology. It involves substantial information flow which encourages either minor technological changes (ET1) or major technological changes (ET2)
4. IL: Links centred on knowledge flows to innovate. It involves substantial flow to build up innovative capabilities.

9. In your company, in the past 5 years, how heavily have you relied on the below activities to change the situation of your technological capabilities (1-least heavy, 5-heavist)?

	1 Least heavy	2	3 Medium	4	5 Heaviest
Technology supply by foreign partner(s)	☐	☐	☐	☐	☐
Reverse engineering	☐	☐	☐	☐	☐
Collaboration with outside experts or universities / institutes	☐	☐	☐	☐	☐
Own R&D	☐	☐	☐	☐	☐
Recruitment of new staff	☐	☐	☐	☐	☐
Training of various kinds	☐	☐	☐	☐	☐
Other methods, please specify:	☐	☐	☐	☐	☐

Thank you very much for taking the time to complete this survey.
If you want to expand on any of your answers to one, or more, of the questions please do add them here:

If you have any additional comments that you would like to add, or comments about the survey then please add them here:

If you would like to receive a free copy of the report please add your name, email address and company address here.
Name:

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Address:

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Appendix III. China's current S&T Programmes

Programme	Initiating year	Objective	Programme characteristics
Key Technology R&D Program (Gong Guan Ji Hua)	1983	Concentrate resources on key and common technologies that direly needed by industrial upgrading and social sustainable development.	The program target set in 10th five-year plan from 2001 to 2005 is:1) By 2005 the general agriculture technology is increased to the level that lags behind international advanced level 5 years; 2)The technology and equipment level in several key industry sectors like ICT and manufacturing sector matches the level of developed countries in the mid of 1990s; 3) Develop the technology related to environment protection and sustainable development; 4) Support the enterprises to be the major technological innovators.
State Key Laboratories Program (Guo Jia Zhong Dian Shi Yan Shi Ji Hua)	1984	Support selected laboratories at public or private facilities.	This program is intended to promote the research and advanced training in the 159 laboratories (2002 data) belonging to universities and R&D institutions and establish a string of national engineering research centers.
Spark Program (*Xing Huo ji Hua)*	1986	Support technology transfer to rural area to promote the rural area development.	In 1990s the government appropriation for this program hardly surpassed 5%. The bank loan and enterprises own capital occupied the majority investment of the projects. In fact, the projects sponsored by this program attain the government credit for the bank loan application. In 2000, 16.8% of total investment of this program came from bank loans.
National Natural Science Foundation of China (NSFC) (*Guo Jia Zi Ran Ke Xue Ji Jin*)	1986	Support basic research through directly funding the projects.	From its establishment of 1986 to 2000, the NSFC has funded over 52,000 research projects of various categories by investing a total sum of RMB 6.6 billion. More than 60,000 scientists are supported by NSFC to conduct basic research. In 2004, the NSFC received over 40,000 funding applications.
High Technology R&D Program (863 Program) (*863 Ji Hua*)	1986	Enhance China's international competitiveness and improve China's overall capability of R&D in high technology.	The Program is concentrating on mid to long-term development in both civilian and military areas. This Program is co-managed by MOST and the Commission of S&T and Industry for National Defense. The Program covers 20 subject topics selected from eight priority areas: Biotechnology, Information, Automation, Energy, Advanced Materials, Marine, and Space and Laser. Recent years 863 program continuously increased the funding for R&D projects undertaken by enterprise.
National New Product Program (*Guo Jia Zhong Dian Xin Chan Pin Ji Hua*	1988	Compile the annual list of new and high technology product and fund those products selectively through the grants and interest subsidiary.	In 2002, 71.86% of the program's funding is by the means of grants and 28.14% is through interest subsidiary.
Torch Program (*Huo Ju Ji Hua*)	1988	Support high technology industry sector development through setting up science park and incubator, funding projects, and human resource training etc.	By the end of 2003, through Torch Program the governments have established the structure such as science park, incubator, software park, university science park etc. Inside these science parks and incubators, 28,504 high technology enterprises had been founded and created 3.49 million jobs. The program had funded 10,261 projects.
Key Basic Science R&D Program (973 Program) (*973 Ji Hua*)	1997	Support basic science research.	The 973 Program's specific tasks are to support the implementation of key basic research in important scientific areas related to agriculture, energy resources, information, resources & environment, and population & health; to provide a theoretical basis and scientific foundation for innovation; to foster human resource; and to establish a number of high level scientific research units.
The Innovation Fund for Small Technology Based Firms (IFSTBF) (*Ke Ji Xing Zhong Xiao Qi Ye Chuang Xin Ji Jin*)	1999	Support the establishment of Newly Technology Based Firms.	The financial support includes interest subsidiary, grants and capital investment. The fund connects to Key Technology R&D Program, 863 program and Torch Program to facilitate the technology transfer from the R&D projects funded by them.

Source: Huang, *et al* (2004)

Appendix IV. The formal corporate governance system of China

Legal component	Legal rights and responsibilities
The general shareholder meeting	The highest authority within the company • Determination of company strategy and operational business and investment plans • Appointment and dismissal of representatives of shareholders as members of the supervisory board, and their remuneration • Examination and approval of annual reports as well as the operating budget for the following year • Examination and approval of the firm's profit distribution and dividend policy and of plans for meeting any losses. • Approval on the decisions related to registered capital, on issuance of company bonds, and on matters relating to mergers, de-mergers, dissolution and liquidation • Shareholders present at the meetings are entitled to one vote for each share held. A two-third majority is required for the approval of issues on merger, de-merger and dissolution or on the amendments of the company charter
The board of directors	The decision-making body of China's shareholding companies. The size of the board ranges from 5 to 20 members • Calling and hosting the annual or special shareholder meeting and reporting to shareholders • Executing resolutions passed by shareholders • Preparing the company's operating and investment plans, dividend policies and debt and equity financing plans • Drafting any plans for mergers, de-mergers or dissolution of the company • Appointing, dismissing and deciding on the remuneration of the company's general manager.
The supervisory board	Comprise a minimum of three members, with a minimum of one-third of members representing the company's employees • Review and examine the company's finances • Supervise and oversee directors and managers to ensure non-violation of law, regulations and the company charter in the course of their duties • Require any director manager to correct any act that is harmful to the company • Propose an extraordinary shareholding's meeting, when necessary

Source: Translated by author from Company Law (2006)

Appendix V. Tyre technology and the Chinese tyre industry[89]

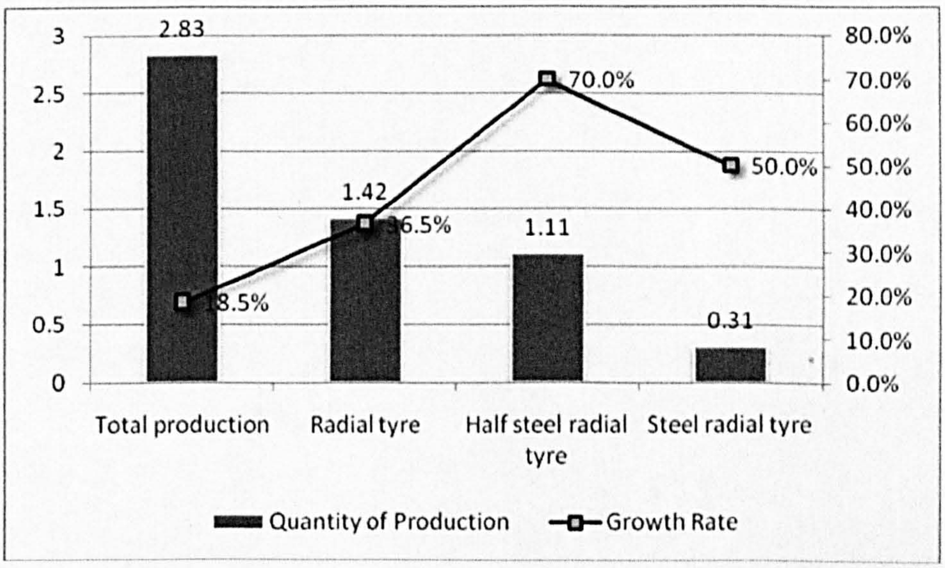
A radial tyre is a particular design of automotive tyre. Michelin developed the original design in 1964, and has now become the standard design for essentially all automotive tyres (http://dictionary.sensagent.com/radial+tire/en-en/).

Tyres are not fabricated just from rubber; within the rubber are a series of plies of cord that act as reinforcement. In the past, the fabric was built up on a flat steel drum, with the cords at an angle of about +60 and -60 degrees from the direction of travel, so they criss-crossed over each other. They were called cross ply or bias ply tires. By comparison, radial tires lay all of the cord plies at 90 degrees to the direction of travel (that is, across the tire from lip to lip). This design avoids having the plies rub against each other as the tire flexes, reducing the rolling friction of the tire. This allows vehicles with radial tyres to achieve better fuel economy than vehicles with bias-ply tyres. It also accounts for the slightly "low on air" (bulging) look that radial tire sidewalls have, especially when compared to bias-ply tyres.

Radial tyre has been widely produced and used as the main-stream product; the average radial rate of tyres used in car manufacturing has reached 90% worldwide, while in developed countries this figure is nearly 100%. In China research projects on radial tyre can be traced back to the mid 60s, however, mass production only started in 1996. Within 7 years of development, by 2003 total radial tyre production has reached 75 million units, of which 11 million were steel-belted (Guizhou Tyre Co., Ltd., as described in the case study Chapter 6, produced over 14 per cent of the national total in 2003). In the same year China's radial rate of car tyres reached 60%.

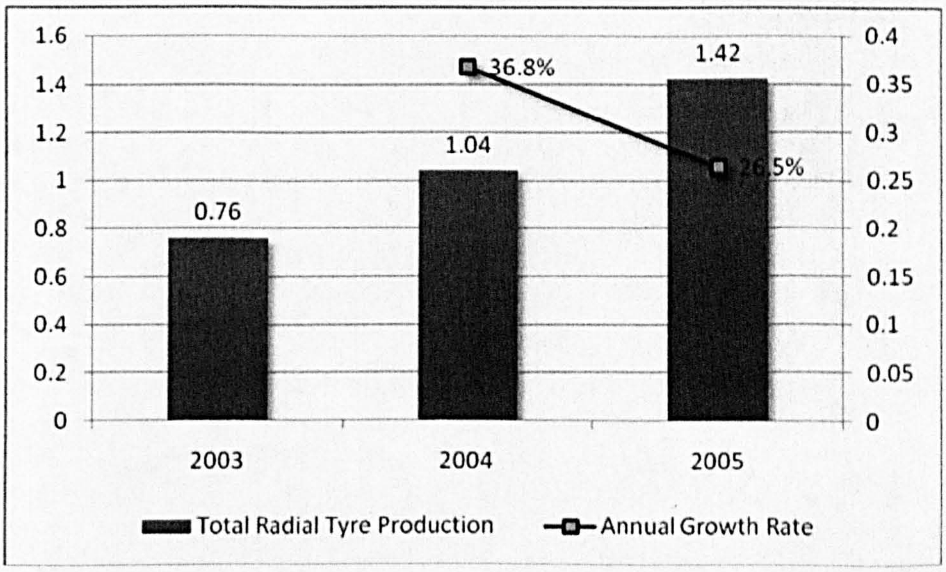
[89] This part has been published in Liu & Tylecote (2009).

Figure 0-1. Structure of Tyre Production in China in Year 2005 (100 million units)



Source: Data from Heading Century Consulting Co., Ltd (http://www.heading-century.com)

Figure 0-2. Production of Radial Tyres in China, Years 2003-2005 (100 million units)



Source: Data from Heading Century Consulting Co., Ltd (http://www.heading-century.com)