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Three Essays on the Study of China's Steel Industry and Industrialization

by

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Abstract

This thesis includes three essays that examine the history and relevant theories related to China's steel industry and industrialization to help understand China's drastically-changing social landscape and economic transitions from the late 1800s to recent decades. First, I use the primary sources to explore China's early industrialization efforts as presented by China's first commercial/industrial syndicate—the Hanyeping Coal/Iron/Steel Company from 1889-1908. This trial, pioneered by Confucian scholar-bureaucrat elites, largely failed because of China's institutional deficiency in establishing effective governance. Second, I present a theoretical expansion from the "big push" model. Developing a more general approach to find multiple-equilibrium entailing the "big push" opportunity, I illustrate that some forms of economic coordination, such as cartel or syndicate, can promote the aggregate efficiency under certain circumstances.

Last, I have an empirical study on the development of China's steel sector in its incremental reforms in recent years. Using the data of China's 60-70 major steel State-Owned-Enterprises, I note that in a transitional period of 1993-1999 those firms' performance was negatively correlated with political interference indexed by the regulatory criteria from China's earlier industrial design and positively correlated with the openness proxy of social-cultural environment indexed by the geographical location of mills. In general, the firms' performance was also positively correlated with capital construction investment but negatively correlated with the technical updating Investment, which may indicate some negative institutional factors in China's ongoing transitions.

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Introduction

After almost a whole century of struggle, China became the world's biggest steel producer in 1996. This arduous process was intertwined with radical social changes and can be traced to China's first industrial/commercial cartel—the Hanyeping Coal/Iron/Mining Company established in 1889. The fundamental reason of this early corporate failure deserve some specific analysis. Since its inaugural years, China's steel industry has been heavily influenced by institutional factors. I explore the historical facts mainly from the primary source of corporate archive compilation to have a thorough study on Hanyeping. My arguments can be used to buttress the general opinion suggested by North (2005): Economic performance largely relies on the kind and quality of institutions, while most economic changes are incremental, gradual, and constrained by the historical past.

China's governments dominated its steel sector in most stages and this situation has started to change recently. China's major steel enterprises were largely organized as industrial cartels or some forms of syndicates across sectors under omnipresent governmental intervention. The grouping characteristics may have helped China's steel industry to bypass some hurdles in the early developing stages from a relatively weak position compared to most industrialized countries. The second chapter attempts to explore relevant issues regarding the "big push" theory that was introduced by Rosenstein-Rodan (1943) and addressed in depth by Murphy, Shleifer, Vishny (1989). Based on their original model, I specifically apply the analytical approaches of game theory. Addressing the syndicating feature in China's steel industry, this chapter presents a theory expansion in a compatible but more general sense. The analysis will illustrate

that in certain circumstances a positive profit may not be so strictly demanded in all sub-sectors in an economy that aims at a reasonable opportunity of simultaneous industrialization. I illustrate that information asymmetry may lead to a mixed strategy and multiple-equilibriums, while the required equilibrium conditions for the bonding of fellowship, via any particular institutional mechanism, can also be more explored.

The third chapter focuses on the recent development of China's steel industry. Since reopening to the West in 1978, China has devoted most of its resources to economic growth. Negative effects of political interference in business operations were gradually adjusted in some controllable steps. Ideological argument started to fade away in China's economic development, while the steel sector pioneered most of its economic reforms. Economists can easily detect an incremental reform/deregulation in the market transition of China's steel sector in the last two and a half decades. As a significant sign of the deregulation trend, China's metallurgical ministry, which held a key position in the central government of Beijing for decades, was quietly disbanded in 2001 after a 3-year adjustment with the State Commission of Economics & Trade. The administrative role is partially afforded by the Chinese Iron & Steel Association (Metallurgical Enterprises Management Association) that loosely coordinates most major steel SOEs members and local & central government, while the major investors have shifted from the government to public multiple-investors. The chapter includes an empirical examination of the performance of China's major steel State-Owned-Enterprises (SOES), regarding the inherited institutional factors of those firms and the structural transition of the fixed investments. Due to the incrementalism in China's economic reforms after 1978, as typically represented in the series of transitions in its steel industry, some dichotomy or

paradox features would be expected to be observed at some particular transitional stages. And those institutional problems call for more continuous reforms in the future, as specifically supported by my empirical findings on the firm-specific performance of China's major steel state-owned enterprises in the transitional period of 1993-1999.

CHAPTER 1

A CASE STUDY OF CHINA'S EARLY INDUSTRIALIZATION AND CORPORATE HISTORY: HANYEPING IRON/COAL/MINING COMPANY (1889-1908)

1. Introduction

China's first modern iron/coal/mining cartel, the Hanyeping Company, was formed by the amalgamation of three enterprises, the Hanyang Iron Plant, founded at Hanyang, Hubei in 1889, the Daye Ore Mining Company founded in 1890 at Daye, Hubei, and the Pingxiang Coal Mining Company at Pingxiang on the border of Hunan and Jiangxi in 1892.[1] In 1908, the formal merging of these three enterprises created the biggest iron/steel facility in East Asia at that time.[2] An understanding of its failure can help us to interpret China's early industrialization and corporate history. In sum, Hanyeping's failure can be attributed to its failure in governance, resulting from a deficiency in its institutional structure, which can be broadly defined as the laws, conventions, cultures, social rules, and other regulative elements in the structural framework of social interaction. Moreover, China's deteriorating social-political status also helps to explain this corporate failure during China's early industrialization.

When exploring the case of Hanyeping, I note that China's early industrial experience is generally regarded as a failure, for which many explanations have been offered from various perspectives. Gary Hamilton (1985) critically examined three theory subsets—class theories, market theories, and Protestant ethic theories—that portrayed China in terms of a stereotyped backwardness or the reverse image of the West, and

suggested reasons for why China did not follow a similar course to that of Western countries. Arguing for a fundamental difference between Chinese and Western economic institutions, he explored China's merchant organizations to explain why capitalism was not more fully developed in China and how China's marketplace was defined in its traditional moral terms.

Historian Wellington Chan (1977) also generally argued that both historical and environmental forces shaped China's early enterprises in the late Qing period.[3] He concluded that China's economic considerations were often sacrificed to political interests due to a deficiency of constraints on institutions and incentives for industrial investment or entrepreneurship. Many recent studies have re-investigated this traditional line of argument in economic growth studies, stressing that institutions have a first-order effect on the performance of firms, industries, and economies. For instance, Stulz and Williamson (2003) argued that culture had an impact on finance through three influences or channels: value systems, institutions, and attitudes in resource allocations.[4] Similarly, Rosenberg and Birdzell (1987) suggested that the political pluralism and the flexibility of Western institutions could explain their unparalleled wealth, and those crucial institutional elements included diversity, in terms of the wide diffusion of the authority and resources needed for widespread experimentation, the relative absence of political and religious restrictions on experimentation, and the incentive mechanism providing ample rewards for success and experimentation.[5] More recently, Douglas North (2005) argued how different societies arrived at institutional infrastructures determining their economic trajectories and how economic change depends on "adaptive efficiency"—the effectiveness in creating institutions that are productive, stable, fair, and most of all,

flexible enough in response to political-economic feedback.[6] He further noted that path dependence—the way by which institutions and beliefs derived in the past influence present choices—plays a crucial role in societal change.[7] This case study will provide specific evidence to support all these views.

The failure of China's early industrialization can be credited to its social mismanagement. Ray Huang (1999) particularly attributed this problem to China's traditional "mathematically unmanageable" condition, in which social management is not efficiently applied through mathematical methodologies.[8] I doubt this projection proclaimed by Huang, although he must have grasped some specific problems of China under some facts as China did not initially have more mathematically unmanageable features than other countries, and the Chinese bureaucrats were skilled in maintaining detailed records. Even after a glance at the archive records regarding Hanyeping, the reader will be impressed by their detailed figures and dates. A more plausible explanation would be China's legally ungovernable status, which could have been caused by over-stressing the elites' morality and capability so that China's social issues became overly-dependent on the elite's personal efforts. A high level of trust within a small group of elites usually suggests a low level of trust in society at large, which can cause a serious impediment to economic development as the trust highly concentrated among the elite can lead to moral hazards and promote political rent-seeking behaviors that will seriously retard growth.[9] All of these negative features can be observed in Hanyeping.

Some researchers have provided more specific references regarding the subject of this study. In a study somewhat overlapping with this one, Tim Wright (1999) noted that the substantial development of China's coal sector from 1895 to 1937 was held back

largely by the vicissitudes and difficulties of the peasant economy of China.[10] Referring to one of this study's major event cities, Rowe portrayed the commerce and society in Hankou, which he believed reflected the highest stage of development of China's indigenous urbanism before this process was arguably deflected by a wholesale imitation of Western models.[11] Rather than interpreting China's modernization as a wholesale imitation of the West, I believe that China's transition more often presented compromised features incorporating both foreign ideas and traditional factors.

Goetzmann and Köll (2005) also argued that China's business institutions imitated the Western corporate institutions without fully establishing the essential structures and features of the corporate system based on the Western interpretation. They further noted that the top-down approach by the government to creating a robust corporate sector in China overlooked public capital markets as key disciplinary and motivational institutions for corporate executives. The specific case of Hanyeping also supports their conclusion that China's first corporate code did not sufficiently shift ownership and control from managers, previously empowered by government patronage, to shareholders, and that the code did not effectively stimulate the emergence of an active share market that would induce entrepreneurs and family-owned firms to exchange control for access to investment capital and the liquidity of an active exchange.[12]

Among all the relevant studies, Albert Feuerwerker (1958) in particular studied Sheng Xuanhuai's personal achievements. Generally regarded as China's most famous entrepreneur, Sheng built a commercial/industrial empire across the sectors of banking, shipping, textile weaving and the telegraph in China's early industrialization.[13] However, I find that little has been done to explore Hanyeping and China's modern iron and steel

industry co-founded by Sheng, so this study can contribute a more firm-specific study to the field. My study will concentrate on both economic and corporate perspectives reflected by the case of Hanyeping. This significant case provides a valuable opportunity to comprehend China's modern corporate evolution and industrial history, as North (1997) suggested that economic history should be studied to understand not only the economic past but also economic changes within an abstracted analytical framework.[14] As for the structure of this essay, I will first have a short introduction to the historical background of Hanyeping; and then I will explore its early development and lessons, before examining its deteriorating and backward condition in the late period. At the end I summarize this case study of China's corporate development history.

2. Historical Background of Hanyeping

China's first commercial corporation was the China Merchants Steam Navigation Company, established by issuing stocks to the public in 1872. This firm played a special role in buying, operating and overhauling merchant shipping for the Empire. Six years earlier, the Governor-General of Minzhe (Fujian and Zhejiang provinces), Zuo Zongtang (1812-1885), and the Imperial Commissioner, Shen Baozhen (1820-1879) co-founded the Fuzhou Shipbuilding Yard at Mawei, Fuzhou, Fujian in 1866. This yard, officially beginning China's modern (military) industry, was planned to build and overhaul warships, as a response to the ever-growing threat of Western encroachment on China. In a biographic study, David Pong (1994) used the career of Shen Baozhen to illustrate the political awakening of a small coterie of dynasty officials. Those Confucian elites, driven by a deep sense of crisis, dedicated themselves to restoring the vitality of the declining

Qing dynasty and to protecting it from further foreign inroads by adopting Western technology, especially military technology; and Shen's successes and failures could articulate the complex relationship between Confucianism and modernization.[15]

Along with the establishment of this shipyard, China's modernization was under way in earnest from 1860. According to the early studies, all machinery for the yard-factory and almost all raw materials including lumber and iron were purchased from abroad.[16] Machines had to be imported also, as China did not have access to the technologies that were available in Europe. Although Fujian in south China had a large lumber production, the local lumber quality was unsatisfactory for building warships, and it was more cost-efficient to import lumber from Southeast Asia. The problems with iron were due to the small quantity and the poor quality of domestic supply. Initially, the authorities planned to use iron from the surrounding regions, but the annual iron production in Fujian province was just 500 tons. Attention then shifted to the village mills of Hubei in central China, which had a larger output, but the lack of quality guarantees plus the high cost entailed in long-distance transportation undermined that effort.[17] When Hanyang Iron Plant started two decades later, all its machines were imported from Europe, as were raw materials like coke and firebricks for a long while.[18]

The starting conditions for China's steel industry were inauspicious. At that time in China, the economic problems actually appeared less imperative than the political crises facing the country. Defeated in the first Opium War in 1842, the Empire was forced to open to the West, which started China's century-long struggle. In treaty after treaty, China's administration largely relied on its military force to maintain its monarchy against foreign aggressiveness and domestic insurgency. Social conflicts were so severe

that rebellions broke out widely in the country. The largest was the *Taiping* Rebellion (1851-64), which expanded across half of China and almost toppled the Empire after tens of millions of people were killed.[19] Remarkably, after so many crises in the 19th century the last Empire of China did not collapse right away but managed to survive beyond the 19th century and on until 1911. The great efforts of China's elites to sustain their world and beliefs need to be acknowledged. Those reform-minded Confucian elites put most of their hopes into the *Yangwu* movement, a "self-strengthening" restoration, posing like a westernization act but without attempts to alternate the fundamental structure of existing systems. These *Yangwu* practices included the building-up of Westernized schools, opening international trade, establishing the army equipped with the western firearms and by the western ways, sending child students abroad to learn from foreigners, and financing the economy for mass production.[20]

China's *Yangwu* movement occurred almost simultaneously with the Japanese reforms during the *Meiji* period (1868-1912), which succeeded in leading Japan into the industrial age and an outward expansion path. Despite some setbacks, Japan's Westernization measures turned out to be largely feasible, but similar policies created different results in China. After the *Meiji* reform, the new government of Japan promoted swift industrialization while those family-owned businesses, in a need of capital vastly in excess of the families' own wealth, turned to public equity markets and organized new pyramidal firms, called *zaibatsu*, to float equity for new ventures.[21] China did not present a similar story in its industrialization. With huge resistance from inside, China failed this "self-strengthening" restoration largely because its compromised reforms did not aim to change the basic social structure based on China's traditional ideas, aimed at another

restoration of the dynastic order more than at an active and full adaptation to the West in the expansion. This ultimate "restoration" goal was frequently stated in the archive memorandums of Hanyeping.

Therefore, the establishment of Hanyeping was based on the Western corporate notion but was greatly compromised by China's reality. Although the inhibiting force was huge, China's emerging entrepreneurs, incrementally influenced by Western concepts, made great efforts to apply the corporate method for business expansion. Examining the early stages of the Western steamship business on the Yangtze River and along the China coast, Liu noted that the local businessmen of China were actively involved in the Western shipping ventures brought to the Chinese, not only in developing their commerce, but also in stimulating their own enterprises.[22] The China Merchants Steam Navigation Company founded in 1872 was one of those initiating efforts. Before then, in 1869 British businessmen opened the first foreign-owned security exchange company, called the *Changli* Company, in Shanghai.[23] In September 1882 local merchants established the first Chinese-owned security exchange company in Shanghai, named the *Pinghuai* Stock Company. Nevertheless, the issuing of stocks did not occur at China's first steel facility at first, although starting this capital-intensive industry by using the new capital market seemed feasible and sensible. China's emerging entrepreneurs might have been willing to issue stock but were greatly limited by the local investors' capabilities and lack of confidence in corporate firms, as suggested by the *Hubu* (Board of Revenue) report on the iron industry in 1897.[24] This situation can be significantly correlated to the sudden collapse of China's securities market in the 1880s.

In October 1884, a landslide market collapse in Shanghai broke out. This market crisis was largely influenced by the Sino-French War (1884-85). China's embryonic capital market was too fragile to endure such political shocks. Beijing abruptly surrendered after its Fujian fleet was destroyed in less than an hour by France in Mawei, Fujian. This war was between the student and tutor for the control of the South China Sea, because the fleet's personnel had been trained by the French while being equipped mainly by France and a few other European countries. The fleet's base, also the Navy's base in South China – the Fuzhou Shipbuilding Yard – was almost totally destroyed. Actually, before the battle started, the shipyard was nearly self-destroyed by the panicked Chinese authorities, as a unilateral gesture of self-constraint in the face of coercion by other foreign countries. This self-detonation did not occur because, ironically, the man sent out to ignite the explosion was accidentally killed by the French cannons.[25] According to the local press, all Chinese securities turned into waste paper as those initiators or managers vanished with everything in the political chaos. This crisis seriously crippled investor confidence at the start of China's industrialization. The recovery from this market collapse took a long time. After the panic, Chinese investors held doubts about corporate finance for years due to a lack of confidence in the capital market.[26] As Goetzmann and Köll (2005) argued, China's domestic security market, although started as early as the 1870s, was subject to a series of booms and busts that prevented it from being effective in tapping investor savings, right at the nascent stage of China's industrialization.[27]

Five years after the chaos of 1884, the Hanyang Iron Plant was officially initiated by Zhang Zhidong, the Governor-General of Huguang (Hunan and Hubei provinces).[28] As one of the highest imperial bureaucrats and a prestigious *Yangwu* leader, Zhang started

China's modern iron/steel industry during his tenure in Huguang from 1889 to 1907. However, the facility proposal was much earlier. As early as 1874, the Qing government announced a nation-wide investigation of mines. According to the memorandums in the archive, in this initiating project Sheng Xuanhuai served the central government as an official deputy/coordinator. He hired and assisted a British mining engineer to investigate China's mine resources in 1875.[29] During the investigation, Sheng's British technician located huge new reserves of high-quality iron-ore at Daye, which had been exploited for more than two thousand years as one of China's most ancient mine sites.[30]

In 1876, Sheng proposed establishing China's first modern iron facility at Daye, but the proposal was set aside by Beijing until Zhang Zhidong was appointed the Gov-Gen of Huguang. Before Zhang was transferred from his previous post as Gov-Gen of Lianguang (Guangdong and Guangxi), he had planned to open an iron plant in Guangzhou, which, as the provincial capital of Guangdong, obviously had better access to foreign resources. The machines had been ordered from London, England, but the original blueprint was abandoned due to Zhang's transfer. In December 1889, Sheng re-proposed the iron/steel facility suggestion to Zhang, who approved it quickly and started convincing Beijing.[31] Before the plan was formally confirmed by Beijing, Zhang let Sheng send some assistants to prepare for the facility's operation. Sheng sent his nephew and another assistant to help with the facility's financing supported solely by Zhang's administration.[32] The machines ordered from London were transported to Hanyang, Hubei, but abandoned in construction as they prematurely became worthless, based on the officers' later re-evaluation reports during the building process. Finally, China's first modern iron/steel facility began to be constructed in 1890.

Along with other primary or secondary sources, I will use the *Hanyeping gongsi dangan ziliao- Sheng Xuanhuai Archive Selection* as my major primary source. This archival collection was compiled and published in 1984 from the archives held at the First Historical Archives, Beijing. The compilation includes thousands of reports, memoirs, contracts, public announcements, and items of mail and telegraph from/to Hanyeping from November 1889 to March 1908. Those first-hand well-preserved collections include the first foreign financial loan to Hanyeping from a German bank in 1899, hundreds of secret reports from local and central officials, original copies of contracts, financial records, and employee and inventory sheets.[33]

3. The Early Development and Lessons

Based on the archival records, the development of Hanyeping to 1911 can be divided into three broad stages: the *Guanban* (Bureaucrat Administration) period from 1889 to 1896, the *Guandu Shangban* (Bureaucrat Governance-Merchant Management) period from 1896 to March, 1908, and the last period of *Shangban* (Merchant Management).[34] The control of Hanyeping evolved from an absolute state control to a compromised official control, then to a nominal merchant control. Throughout these three stages, I can detect at least four recurring problems: impediments to corporate governance, the difficulty of corporate financing, the lack of experience in technology, and conflicts between traditional and modern concepts. An abundance of first-hand records reflect these specific problems. Particularly, in an early memo to Gov-Gen Zhang, advising China's iron business in December 1889, Sheng identified four key issues for success: Responsibility Monitoring (or Supervising), Location Selection, Capital

Sufficiency (or Accumulation), and Inventory for Production.[35] Sheng's foresight soon proved prophetically critical and might somehow curse Hanyeping as his concerns all turned into reality. Especially, governance turned out to be the biggest hazard. Sheng literally put responsibility monitoring as the key variable in the success of the steel business intended by the Empire. His warning did not present a viable solution, but his recognition of the seriousness of governance problems in the Qing Empire was astute. As Sheng had specifically warned, the governance issue would be significantly correlated with other specific problems.[36] This problem of governance first emerged in the decision-making on location during the construction stage, and continued throughout Hanyeping's later operation.

Zhang Zhidong chose the city of Hanyang over Daye (about 90 miles downstream of Hanyang) as the location for the new facility, on the grounds that the Hanyang location would provide better governance for the enterprise due to its proximity to the governor-general's seat of power in Wuchang, across the river from Hanyang.[37] Technologically, Hanyang was not an optimal choice as it had nothing to recommend it other than its proximity to Hankou and Wuchang, while it was not so far to Daye's ore mines. Wuchang was Zhang's administration center, and Hankou was the biggest inland treaty port city on the Yangtze River that could provide direct access to foreign resources and potential business partners. Later, this choice of location was frequently criticized because of the high transportation costs entailed in the operation of the facility. [38] While the location choice was controversial, the lot selected made it even worse. The major mills were built upon low wetlands beside the Yangtze River levee. This required a large initial outlay of money and labor to strengthen the levee, drain out the water, and raise the marshland

before plant construction could begin.[39] Even so, the foundation was still too soft to support heavy equipment. In the later stages of equipment updating, the facility continually had to consolidate the soil, but the soft foundations still frequently caused technological accidents.[40] In the end, the Hanyang Iron Plant land was converted into a warehouse for the storage of inventory by its successor and an alternative site closer to Daye and with better foundations was selected for the re-establishment of the new facility at Qingshan, downstream of Hanyang, during the second "five-year-plan" period in Communist China from 1958 to 1962.[41]

Despite Zhang's hope that locating the Iron Plant in Hanyang would increase its management efficiency, the evidence suggests that the compromised location did not provide the assumed geographical benefit for governance. On the contrary, it was beset from the outset by problems in the management of funds for the purchase of property and for the factory and machinery, as reflected in the outpouring of impeachment reports on official corruption in the archives.[42] An early case involved the impeachment of the county magistrate of Hanyang during the plant's construction, and another representative case involved a middle-level mine director named Lu, who was assigned to take charge of the acquisition of local mines but was frequently reported and impeached by his associates and local officials. Lu's case stood out as it lasted the longest and produced the most relevant records. In the end, Lu was symbolically warned about his "reckless" behaviors and he just got a minor penalty of losing vacation.[43] For almost all of the cases, no record indicates any further investigation or serious punishment for those accused of corruption, even during the tenure of Gov-Gen Zhang who was generally regarded as

morally superior and intolerant of corruption. From 1889 until 1907, Zhang only left his post in Huguang for brief periods totalizing about two and a half years.[44]

Another related indication of the failure of corporate governance was poor budgetary control as the spending for the facility skyrocketed during the process of construction. A project progress report to Sheng in 1891 stated: "Less than one-tenth of the construction planned has been finished, but it has already cost half of the original investment of one million taels of silver, besides a loan of two hundred thousand taels of silver from elsewhere."[45] Even worse, newly-installed machinery became non-functional so quickly due to the purchasing decisions of officials that some of it had to be abandoned during the construction because it would be worthless for the production yet not started. New machines were ordered, but no evidence suggests that financial and technological lessons had been learned from the early errors, as the same mistakes were repeated. Although claims of financial irregularities in the import of machines were frequently made, no records indicate anyone being held responsible for those wrong-doings.[46] No evidence indicates that the decision makers were directly involved in those corruptions, but it appeared that the decision makers were largely incapable of correcting those misbehaviors even when they realized the seriousness of the problems.

The accusations about over-spending had no result but merely accompanied a skyrocketing budget. Initially, the total budget was one million taels of silver from the treasury revenue refunded to Hubei by Beijing.[47] It was hoped that this investment would be at least enough for a facility with an annual iron production of two million tons (from an original one million tons that seemed to be technologically reasonable in that era based on the Hanyeping's archival records). Before the construction was completed, the total

expenditure had tripled to more than three million taels in 1892, of which two million was from refunds to the province from Beijing, 0.8 million from the provincial revenue of Hubei, and 0.2 million from loans from the merchants.[48] In December 1892, Zhang attempted to get some more funding from Beijing, but failed.[49] The situation was so dire that he feared no funds would be left to run the factory once its construction was completed. In his letter to the Chief Minister Li Hongzhang, asking to borrow some money as an advance payment taken from the funds for other planned state construction projects, Zhang argued: "the factory will have to be halted if finished next year (since no operating money is left)".[50]

Zhang's fears proved to be well-founded. The Hanyang Iron Plant was completed in September 1893 after two and a half years' construction, but no money was left to pay for the operating costs. Zhang had no choice but to consider private financing although it was not certain what he wanted as he was quite reluctant to let a government-originated business be operated by profit-oriented businessmen or private organizations. The *Guandu Shangban* policy was a feasible compromise, based on China's political reality during that time and advocated by *Yangwu* reformists, to utilize the private financing of merchants (*Shangban*) under the governance of governments (*Guandu*). Zhang believed that Sheng Xuanhuai was the perfect candidate to apply the *Guandu Shangban* policy for the facility's normal operation. First, Sheng had already been deeply involved in the project, and had strongly advised a merchant-style corporate approach to running the plant. Moreover, he had rich experience in dealing with the Westerners. However, Sheng had been stationed in Tianjin and Shanghai, dealing with other *Yangwu* business. He also seemed irreplaceable in the management of the Customs in Tianjin. Thus, Zhang

requested that Sheng send some assistants, so Sheng could remote-manage the mills from a thousand miles away. This unusual arrangement indicates Zhang regarded Sheng as the only qualified candidate in this iron/steel business. With the latter's aid, Sheng became one of the most prestigious *Yangwu* reformists and Gov-Generals of the Empire. After the fall of the Empire, Sheng built his business kingdom out of his early entrepreneurial effort but his commercial/industrial kingdom collapsed almost instantly after he died in 1916. The fortune accumulated by Sheng vanished quickly in the hands of his descendants, as was the case with many other local entrepreneurs in that era.

The central government approved Zhang's request, but the formal designation of Sheng as the chief director of the iron facility and its affiliates did not occur until three years later in 1896.[51] Before Sheng's formal designation to the iron business, one of Sheng's assistants, Zhong Tianwei, presented a memo in June 1893 about the *Guandu Shangban* policy for the new Hanyang iron facility. Forty suggestions in this memo presented a detailed schedule for corporate finance, pubic shares and profit distribution, regulations, industrial policies, corporate reports and plans for developing China's modern iron business.[52] The industrial policy was requested in detailed terms of taxation, franchises, protection of mining and sales, and other issues. Negotiable years of taxation waivers were requested along with a special license for the entry of iron and steel business, also the security guarantee of sales and mining from the harassment of local authorities or competitors. The thirteenth item clearly stated: "*Guandu Shangban*: the government will be responsible for auditing and protecting, while merchants will be responsible for production and sales, corporate finance and employment" The memorandum ambitiously proposed that the facility could develop into the biggest steel

syndicate in Asia. Appealing prospects included the fact that the Japanese General Consulate had expressed interest in buying steel from Hanyeping.

No documents from June 1893 to December 1895 have been preserved in the archives, and their editors suggest that no formal activity occurred during this period. Not until May 1896 did Sheng present a new *Zhaoshang batiao* (Eight Terms of Proclamation of Merchandizing) after his official appointment as the chief director of Hanyeping.[53] What happened during the two and a half years for which no documents exist? Was there nothing considered worthy of documenting by the officials, who reported even a minor fight of workers in their records? [54] It seems likely that the facility was at best in a half-idle condition since no evidence in the later archival records suggests any operation during this period, and the archives editors who would not hide such evidence if there were any. The most significant event during this period was the first Sino-Japanese War (1894-1895), in which China was defeated again, this time by a better student of the West. Japan destroyed the imperial *Beiyang* fleet in the North Chinese Sea. Consequently, Korea fell under Japanese control, Taiwan was ceded to Japan, and the Liaodong peninsula, occupied by the Japanese army, was restored to China only due to pressure from other Western countries. The defeat cost Beijing an indemnity of 200 million taels, three times the annual revenue of the Empire, and effectively ended the hope that the Hanyang Iron Plant would receive ongoing corporate financing from Beijing. In April, 1896, all assets of Hanyeping were formally transferred to the title of Sheng's control and Sheng became the representative of the Qing Dynasty in the Hanyeping Company.[55]

In theory, Sheng's appointment should have benefited the facility's management to some extent, as now Sheng could at least let his staff take direct responsibility for the

daily management of the facility without awaiting his immediate approval. Ever since 1891, even trivial expenditures such as a commission to a Belgium mining engineer for re-investigating some mines had to be approved by Gov-Gen Zhang and formally requested by Sheng under pressure from the Consulate-General of Belgium in Shanghai whose protection was requested by the Belgium engineer employed by Hanyeping.[56] This event reflects the problems in governance, and the inefficiency of the bureaucracy in corporate operations. Now the facility could finally start operating like a commercial firm rather than a branch of the bureaucracy. In May 1896, Sheng officially informed the foreign chief engineer that "the facility shall absolutely be commercially operated, and abandon the early bureaucratic pattern of losing money."[57] The telegraph business managed by Sheng may have accounted for most of his physical absence in the facility's daily operations.[58] Afterward this remote-control pattern dominated the facility's management. Certainly Sheng's staff needed to coordinate with local officials and their associates in Shanghai and Tianjin, where Sheng had been positioned since 1884.[59]

After his appointment, Sheng immediately turned to the issuing of stocks to revive the Iron Plant. In June 1896, a public offering was announced at Wuchang by Sheng who signed the statement as the chief director of the Board with his official title and rank.[60] The stock offering accumulated one million taels with another million in option rights for operating capital. Except for a full list of nine members of the Board of Directors in 1908, no information on the shareholders is available in the archival records, and the registry document of 1908 for Hanyeping clearly states that no original documents were preserved from its initial public offering.[61] Obviously, the board was not elected as the board members had been decided mostly by Sheng and his helpers before

the stock was issued, and their names were printed on the back of the stocks issued to investors as a possible guarantor approach to attract further investment. Later on, some board members were added or deleted due to voluntary resignations or death, again without detailed records and with no indication of any kind of election.[62] As well, the archives do not provide any information about the proportion of shares or the criteria for selecting the board members. However, all the "merchant" board members held official titles or ranks, either purchased or earned through the examination system, and their relations were complex and closely intertwined.

A great deal of evidence suggests that governance over the managers, who were mostly recommended by the board directors, was a controversial matter.[63] The chief executive of the Hanyang Iron Plant, Zheng Gongying, delegated by Sheng as his chief representative on the board, "voluntarily" resigned from the post less than eight months after his appointment.[64] In his letters requesting reassignment, Zheng cautiously complained that different sorts of cronyism and sophisticated relationships had exhausted his mind and talent, his health had deteriorated significantly and he felt deeply frustrated and powerless, but he hoped to "voluntarily" leave the post with Sheng's lenient understanding.[65] Lacking the acts to punish those misbehaviors under his supervision, Zheng suggested that he could not effectively manage the facility, and this suggestion is indirectly confirmed by a draft management report on July 31, 1897 by Sheng's nephew, Sheng Chunyi. As the standing chief executive for Zheng, Sheng Chunyi reported that some branch factories of the facility were stealthily producing and selling products by using the facility's resources and raw materials, without being acknowledged or audited by the managers supposedly in charge. Just in one case, a low-ranking local iron worker

privately produced two hundred iron seals for a tea shop and was caught red-handed.[66] The archives do not clarify whether this case was just the tip of the iceberg for no following investigation or punishment is documented as probably none actually occurred.

No evidence suggests that Zheng's successors faced an improved situation either. Another accusation report by another of Sheng's deputies highlights the seriousness of the problems in Hanyeping. This secret report, directly forwarded to Sheng, documented thirteen corruption cases involving stealing, cheating and asset tunneling, with the suspects' names, locations, stories and evidence.[67] But again, no further investigation was recorded in the archives and the matter just ended quietly.[68] No evidence suggests that Sheng could risk confronting the board directors possibly involved in or behind these cases. Most of them were officials in other administrative regions and offered support that Sheng could not reject, as suggested by the humble requests in Sheng's many letters/memos to his local colleagues. Nevertheless, some evidence indicated that Sheng's deputy staff had applied limited methods to deal with those situations, like increasing the rotation frequency and the use of dual-posts for some key management positions, and sealing cargo with special iron seals to prevent it from being switched with low quality cargo or going missing in transportation.[69] To remedy some of these problems, a monthly financial report system was established in 1897 by Zheng before his leaving to replace the annual reporting, but how well it worked is unclear, except that it contributed to escalating operation expenses.[70]

Hanyeping's archival records reveal that the problems in corporate governance were accompanied by a deterioration of corporate finance. A lack of working capital had continually hampered the facility's operation since the first day. Soon, the capital

collected from the share issue in 1896 was exhausted, but the plant was still far from realizing any profits. Short-term commercial loans from *qianzhuang* (money shop or credit firm) in Hankou became a major source of financing for the facility. Internal financing within the syndicated mills and mines was proposed in May 1899, but with no result.[71]. Every month the calls for financial aid were communicated from Hubei to Shanghai, so that the managers could find a way to make ends meet.[72] No evidence suggests any significant change in this situation. Two years after its commercialization, the plant in 1898 faced a net loss of more than three hundred thousand taels.[73] In 1900, the net loss reached more than 1.1 million. The facility could maintain its daily operation largely relying on short-term loans from local commercial organizations or businessmen, who usually demanded the government's underwriting guarantee for credits. The more the facility produced, the more it lost although the demand continued to increase,[74] partly because the facility was frequently commanded to provide products to other state-owned projects without complete payments or even records, while it had to pay advance revenue, taxes, and tariffs, which local governments and Beijing had initially promised to waive or refund but ignored quickly.[75]

Compared to the problems in corporate governance and finance, the deficiency in technological experience was a surmountable barrier. The Chinese seemed able to deal with it with relative ease with the aid of foreign engineers. For instance, the low quality of the coke from domestic production (the sulfur levels in the local coal were too high), plus a shortage of supply, interfering with the operating schedule, had caused the mills frequently to stop for damage repairs,[76] but after several months of "commercial" running from 1896, the quality of coke improved quickly, and the quantity of quality coke was

guaranteed by both domestic and foreign channels.[77] To secure the raw material supply and decrease the raw material cost, Sheng undertook the acquisition of local small mines, firstly in Daye and Pingxiang, then expanding to other regions, steadily pursued with the support of local authorities. The privately invested mines that opposed the acquisition were subject to confiscation.[78] The merged small mines could provide better quality control and lower costs. With a long-term training program from its initial stage, the facility opened a mining school that recruited child students as the technicians for the future. The new syllabus combined both Chinese traditional education in Confucianism and Western knowledge taught by foreign engineers from Germany, Belgium, England, Russia, USA and Japan. According to the foreign employee lists, the number of the foreign engineers that Hanyeping employed long-term floated around fifty.[79]

Although complaints about the "arrogant" behaviors of foreign employees frequently appear in the archives,[80] managing foreign workers also seems to have been comparatively easy and straightforward, as all foreign employment contracts, which were usually backed by the courts in the treaty ports and the foreigners' General Consulates in China, guaranteed the Board the right to fire any incompetent foreign employees.[81] Problems with regard to foreigners arose mainly from communication difficulties or conceptual differences between China and the West. Those conflicts, reflecting a clash between different values, did not necessarily occur between the foreigners and Chinese. More often, the conflicts occurred among locals with different views. For instance, the archives include frequent reports of local gentry resisting the opening of mines as these gentry claimed that mechanical mining destroyed the local *Fengshui* and contaminated the purity of their counties.[82] It appeared that financial compensation was also negotiated

for some local gentries to secure their cooperation with mining firms. Thus I may suspect that the concerns about *Fengshui* may not have been genuine, but an excuse to extort money from those new corporate firms. Officials reported that women and children were told to lie in the doorways and tunnels of mines to halt mining,[83] and violence and riots involving Hanyeping were frequently documented.[84] However, this resistance may not have been a permanent problem as the people would change their attitude if they realized they could soon enough benefit from these changes, as Olson argued in his discussion about destabilizing forces and rapid economic growth. The later records show that the local gentry gradually became increasing interested and involved in opening mines mainly affiliated with Hanyeping.[85]

4. The Deteriorating and Backward Condition

With more time for a gradual institutional transition, Hanyeping might have made its way out to profitability eventually, albeit in a sporadic manner. But time was not on the Chinese side at the turn of 19th century. Without fundamental changes in governance, the performance of Hanyeping deteriorated year by year. This deterioration accompanied an increasing tension between foreign imperialism and China. In a secret report to Zhang in August 1900 at the height of the Boxer disturbance, Sheng expressed his great worry that China's industrialization would fail as all major mine resources would sooner or later fall under foreign control, no matter how much China resisted it.[86] Defeated again in 1901, China was forced to pay another war indemnity of 450 million taels to the eight allied foreign powers. A few years later, the Russo-Japanese War broke out in 1904. China's administration was too weak to do anything but watch the war rampage over

Chinese territory. As the winner, Japan expanded its sphere of influence and concession area in Manchuria in northeast China.

China's deteriorating socio-political situation eventually undermined its early effort to build an autonomous industrial sector as represented by Hanyeping. At first, the central administration was concerned that foreign financing would weaken its control of the industry and would further undermine Chinese sovereignty.[87] Therefore, during the early stage of Hanyeping, despite a huge shortage of working capital, the facility remained solely reliant on domestic financing. However, foreign financing appeared unavoidable as domestic financing failed to sustain the facility's operating costs. With no choice, Hanyeping quit its long-term resistance to being financed by foreign banks that had shown great interest in the facility from the beginning, despite the financial predicament obviously observed in Hanyeping. Given the corrupt status of the corporate governance of the enterprise, the foreign lenders would reasonably require some control of the facility to secure their investments as the corrupted status of Hanyeping suggested a great chance of failing to deliver the return promised, resulting in a compromise in China's policy of retaining Chinese control of heavy industries.

As a result of the first Sino-Japan war, the Treaty of Shimonoseki granted the foreigners the right to open and finance factories in China. The first foreign loan for Hanyeping was in April 1899, collateralized by the coal inventory and Sheng's personal reputation.[88] The gate was opened and it would be hard to shut again. Later, the Japanese gained from Germans the exclusive right to issue foreign loans to Hanyeping. The archive complication does not give evidence of any changes of ownership or internal monitoring, except the fact that coals and iron ogres were more directly transferred to the

Japanese as recorded. In the later years after 1899, Hanyeping borrowed a series of long-term loans from the Japanese, collateralized by mines and machinery and an agreement to guarantee a supply of ore and coal from China to Japan.[89] The first contract for coal and ore was signed in April, 1899, and then renewed with increasing purchases and unfixed frequency every year.[90] In 1904, a deal of thirty years' financing for ore and coal sales was signed so that Hanyeping could continue its debt repayment first and then expand to some new projects.[91] With those new loans, Hanyeping could sustain its operation and continue with its mergers and acquisitions of smaller mines in central China. The monthly reports show that ore and coal shipments from Hanyeping to Japan became the dominant activities, while the facility's own iron and steel production became a sideshow. Hanyeping evolved from buying raw materials for its own iron/steel production backward to mainly selling its raw materials to other industrialized countries. This outcome totally deviated from the original intention of establishing Hanyeping in the name of "self-strengthening." Based on my theory expansion on Murphy, Shleifer and Vishny's "big push" model in the next chapter to follow, it is financially viable and economically privileged to have a syndicated coal/iron/steel/ firm at the early stage of industrialization or with a gap of profit and technology, but this privilege held by Hanyeping was obviously overwhelmed by other negative factors hampering its initial goals.

Despite the many adverse factors, China's emerging industrialists were still determined to struggle to establish an autonomous Chinese iron and steel industry free of foreign manipulation, although this struggle seemed a vain effort in view of China's chaotic political situation and international status at the time. The desire to be self-sustaining was at least nominally indicated by Hanyeping's long-term corporate policy

that forbade any foreign shares. Even in late 1907, during the formal merging of Hanyeping, the board clearly stated that the stock of Hanyeping would automatically lose its value and rights once it was held by any foreign agents, and ordered the English translation of this requirement to be printed on the back of the share certificates.[92] Sheng, as the chief director of Hanyeping for more than two decades, maintained the operation of Hanyeping nominally under the Chinese control until his death in 1916. In hindsight, the failure of Hanyeping to preserve its autonomy and attain profitability seems almost unavoidable, but Hanyeping would continue its struggle well into the Republican era before the Japanese invasion of China in the China-Japan War of 1937-1945.

5. Conclusion

It is pointless to speculate on what would have occurred in China's early industrialization if the wars of the late Qing period had not ended the way they did, but Hanyeping probably would still have failed unless its governance system had been improved enough to sustain its growth. Viewed as a corporation, China's first modern iron/steel facility was anything but a success, and its pioneering phase illustrates the critical importance of governance in modern business. The establishment of Hanyeping in 1889 was different to a "pseudo-solution" that Frederic Wakeman (1986) proclaimed for China's crisis in the 17th century,[93] as China's elite intellectual-officials offered a new developmental pattern by establishing corporate firms, more than just advocating another restoration of the dynastic order. Successful corporate finance requires a well-functioning corporate governance system, which should provide a structure enabling stockholders and management to pursue corporate objectives effectively. In the case of Hanyeping, I do

not observe such a system promoting information exposure or rewarding innovation and efficiency, except plenty of evidence of governance failures and hints of fraudulent behaviors. At the turn of the 19th century, China was just beginning its institutional transition to adopting for modern corporate concepts. Hence, lacking an effective governance mechanism, Hanyeping was doomed from the start as it would be both debased by insiders and raided by outsiders who were encouraged by the insiders, as observed in the incidents of corruption and private sales shielded by the board members.

The experience of Hanyeping shows that China's early industrialization was promoted mainly by the scholar-official elite. As William Baumol (1990) argued, the role of entrepreneurship, although critical in many ways, cannot totally replace an institutional mechanism to promote accountability and motivate efficiency.[94] Sheng Xuanhuai was an irreplaceable figure in China's newly-established iron sector, but his dominant role may not have been a positive sign for its long-term development, and the outsiders may never know how many entrenched problems in corporate management could be traced back to his influence. Although Sheng made great efforts to foster openness to innovation and his efforts produced gradual progress, he did not accomplish any significant changes in the institutional framework within which Hanyeping operated. His pioneering efforts could and did stimulate entrepreneurship, but the resulting over-dependence on him also put Hanyeping's steady progress at risk, while the over-dominance of an elite minority in corporate management, as reflected in this study, was another possible major source causing the failure of China's early corporate and industrial experiments.

Endnotes

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[2] Ibid. I, 2, in the preface; And the registry report to the Ministry of Agriculture and Commerce by Sheng in March, 1908, II, 672. In the following text this archive will be referred to as HYP in abbreviation.

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[16] Lin Qingyuan, Fujian chuanzhengju shigao (Fujian Shipping Bureau Historical Record) (Fuzhou: Fujian Renmin Publishing House, 1986), 99, 122.

[17] Ibid, 99

[18] All the equipment contracts and the foreign raw materials purchases contracts in HYP.

[19] Jonathan Spence, Chapter 8, 9-10, the Search of Modern China (NY: W.W. Norton, 1999).

[20] Ibid. Also Fujian Chuanzhengju shigao, 141-158.

[21] Randall Morck and Masao Nakamura, "A Frog in a Well Knows Nothing of the Ocean: A History of Corporate Ownership in Japan," in A History of Corporate Governance around the World: Family Business Groups to Professional Managers, ed. Randall K. Morck (Chicago: University of Chicago Press, 2005).

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[24] The Hubu governmental report, HYP I, 129-134; also other memorandums in HYP.

[25] Qing Yuan Lin, Fujian Chuanzhengju shigao (Fujian Shipping Bureau Historical Record) (Fuzhou: Fujian Renmin Publishing House, 1986), 174.

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[28] Zhang, Zhidong 张之洞 (1837-1909), refers to his biography in Qing shi gao.

[29] The memorandum about the history of Hanyeping, by Li, Weige, in April 1905, HYP II, 485.

[30] Check the local even yearbook of Daye, Hubei province, China.

[31] The proposal report by Sheng to Zhang, HYP, I, 6-8.

[32] Zhong, Tianwei, and Sheng, Chunyi, and their reports in HYP I, 11-15.

[33] HYP, the preface 2. Also HYP, II, 24.

[34] HYP, the preface 1-2, Also HYP, II, 96-99.

[35] Ibid, HYP I, 6-8.

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[37] Ibid, the report of Zhong Tianwei to Sheng, November 1890, HYP I, 21-22.

[38] Ibid. HYP, I.22. Also the late records, for instance, HYP I, 379, 383, 460-462, especially the operating report by Zheng to Sheng, in February 1897, HYP I, 333-334.

[39] The base project report, HYP I, 26, 48-49.

[40] The foreign engineer reports, HYP I, 27, 595.

[41] The later Wugang Steel Group in Wuhan and HYP, I, 22.

[42] The impeachment report on the local officials in the project constructions. HYP I,17, 23,

[43] The documents addressed to Sheng about impeaching Lu, HYP I, 452, 468-469, 476, 478, 547-548, 593, 598, 606-609, 615, and 616.

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[45] HYP I, 23-26

[46] The machines purchasing report. HYP I, 15, 45-47.

[47] HYP I, 15-16.

[48] HYP I,28-32

[49] The letters between Li and Zhang, HYP I, 28-31, 42-45, and 56

[50] HYP I,29

[51] HYP I,70-72

[52] HYP I,57-64

[53] HYP I, 66-69

[54] The management report, HYP I,424

[55] HYP, 70; April 14 is the date when Sheng arrived at Hubei as his official designation.

[56] The requesting report to Zhang by Sheng from Shanghai. HYP I,19

[57] Ibid, the notice letter from Sheng in May, 1896, HYP I, 70.

[58] The telegraph collections and related reports in HYP.

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[60] The public announcement, HYP, 76-77.

[61] The informing report and the registry record to the Ministry of Industry and Commerce in March, 1908, HYP, II, 672-673, 674-676.

[62] Ibid.

[63] The letters by Zheng to Sheng, in February, 1897, HYP I, 333.

[64] The reports from Zheng to Sheng, from June 1896 to August 1897, HYP I, 81-619.

[65] Ibid, the reassignment requesting reports by Zheng to Sheng, HYP I, 326, 333-334, 363,413, 488-489, 491.

[66] Ibid, the report to Sheng, HYP I, 614.

[67] HYP II, 55-61.

[68] The early secret reports about cheating and frauds, for example, HYP I, 255-256.

[69] HYP I, 376-377. Also the report on the stealing of thirteen box of explosive in 689.

[70] HYP I, 418.

[71] The internal financing proposal HYP, II, 116-120.

[72] The report HYP I, 321-322, 497, II, 168, and 181-82.

[73] HYP II, 45.

[74] HYP II, 202-3.

[75] HYP I, 64, II, 37, 198-200, 202-203, 206, 404-405, etc. Also II, 67, 435-436.

[76] The damage reports, HYP I, 84-84, 113, 121,149, 171, 182, 191, 449, 460-462, 595, etc.

[77] The coke deals from both local regions and foreign countries in HYP, for example, I, 85-87, 114, 124, 185, 201, 379, 545, 555, 625, etc.; The records indicate that the facility imported cokes from foreign countries as the supplement of domestic supply.

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[79] The reports on the mining schools, HYP I, 28,191, 253-254, 453-457.

[80] The reports about foreign engineers, HYP I, 316, 460, 534-535, 599-601,602,614, etc.

[81] Ibid, it has a typical copy in 180 and II, 39-41, along with other foreign employment contracts. Also the case of laying-off the Germany chief engineer, HYP I, 474, 520, 526, 534-537,637-639, 640-641, 670-671, etc.

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[89] As indicated by the numerous iron-ore and coal sale contracts and transportation records in HYP II, 92-96, 173-174, 176, 190, 205, 256,260, 262-263, and 272, 282-285, 301, 358, 490, etc.

[90] Ibid. Also those contracts, particularly HYP II, 92-96, 173-74, 176, 190.

[91] HYP II, 486-489.

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CHAPTER 2

A THEORY EXPANSION FROM "INDUSTRIALIZATION AND THE BIG PUSH"

1. The Original Model Setup and Motivation

Addressing simultaneous industrialization, Murphy, Shleifer and Vishny (1989) argue that the existence of the Pareto-ranked multiple equilibriums envisioned in the big push literature require that the economy be capable of sustaining two alternative levels of industrialization for simultaneous moves. These authors' analyses start from a simple setup that assumes a one-period economy with a representative agent holding a Cobb-Douglas utility function. This agent has an income of y and an endowment of L units of labor supplied in-elastically; he owns all the profits of this economy; his wage is taken as numeraire, and the budget constraint is given by

$$y = \prod + L . \qquad (1)$$

Each good is produced in its own sector with two types of firms: a competitive fringe of firms that convert one unit of labor input into one unit of output with a constant return to scale (cottage production) technology, and a monopolist firm with access to an increasing return (mass production) technology, which needs the input of F units of labor and allows an additional unit of labor to produce $\alpha > 1$ units of output. The monopolist in each sector decides whether to industrialize or abstain from production altogether. Here an agent will industrialize only if he can earn a profit at the charged price that equals one. When the income is y, the profit of a monopolist who spends F to industrialize is

$$\pi = (1 - 1/\alpha)y - F = ay - F . \qquad (2)$$

Here, a is the difference between the price and the marginal cost or mark-up. If a fraction n of the sectors in the economy industrializes, the aggregate profit is

$$\Pi(n) = n(ay - F). \tag{3}$$

Substitute (3) into (1), and thus I can have

$$y(n) = (L - nF)/(1 - na). \tag{4}$$

The numerator is the amount of labor used for actual production after investment outlays. One over the denominator is the multiplier implying that an increase in effective labor raises income by more than one if the expansion of the low-cost sectors raises profits. In turn, this implies that the impact of the marginal firm on y is bigger than the firm's own profit because this profit is redistributed as income, and this redistribution increases demand for other firms, thus creating a pecuniary spillover. Murphy et al. (1989) note that this externality should not be a real "externality" as usually argued from the technological aspect, as the spillover works exclusive through profits. Thus it has

$$\frac{dy(n)}{dn} = \frac{\pi(n)}{1 - na}. \tag{5}$$

Here $\pi(n)$ is the profit of the last firm to invest. Thus, a firm's spillover is positive if, and only if, its own profits are positive, as the multiplier changes only the magnitude of the effect of a firm's investment on income, not the sign. This implies a unique Nash equilibrium in which either all firms industrialize or none of them do, i.e., no big push occurs. Afterwards, Murphy et al. (1989) present three modified situations in which a firm engaging in an unprofitable investment can still benefit other sectors; thereby, they get away from a unique result of equilibrium and generate a "big push". The first condition relies on a wage premium in mass production. The second one emphasizes the dynamic nature of investment, while the third one has an infrastructure

investment with two sectors of different fixed costs. All three mechanisms present a set of values for F that permits multiple equilibriums and thus the possibility of a big push.

Examining incentives in economic behaviors, Murphy et al.'s models can be used to explain the role of intuitional coordination. As well, many economists highlight the connections among structural dynamics, investment, and economic growth. Schumpeter (1934) advises studying economic growth as a dynamic process or a repetitive phenomenon of "creative destruction" in which some firms move ahead while others fall behind, and he criticizes analyzing economic growth as a linear process of the "representative firms". Hirschman (1958) argues that the economic development can generate successive phases of disequilibria and a gradual accumulation of technical and organizational know-how. Ocampo (2002) notes that if not all sectors have the same capability to inject dynamism into the economy, the externalities or complementarities with distributive effects among firms may have seemingly sudden jumps in this process.

The above views motivate us to expand Murphy et al.'s models with compatible assumptions for analyzing how some multiple equilibriums also lead to a simultaneous investment across sectors. Addressing a structural differential between two sectors, I note that the simultaneous industrializations can be realized via a coordinated dynamic process. This expansion does not attempt to complicate the early interpretation, but to highlight some ignored perspectives that might not have been paid enough attention to by Murphy et al. (1989). The argument can help illustrate how some forms of cross-sector or economic integrations, like cartels, multinational enterprises, can play a big push role in coordinating industrialization.

Motivated by these ideas, I will expand Murphy et al.'s (1989) definitive setup to demonstrate that opportunities exist for unprofitable firms to industrialize under some conditions if others are profitable enough to push the former. If having a universal return to scope proxy by α or a fixed cost F is too generalized, this issue raises a question: what would exactly occur if agents presented differentiated α and F. Murphy et al. stated that the source of the multiplicity of equilibriums was the pecuniary externalities generated by imperfect completion with large fixed costs in the earlier model. Therefore, compatible modification of those parameters, intuitively, should also buttress the key concept that a big push is possible owning to pecuniary externality although some industrialized firms capture only a fraction of the total contribution of their investment. I am interested in illustrating this mechanism more explicitly in a stratified structure.

2. A Modification with a Two-Stratified Sector

I can assume this one-period model has two correlated sectors: sector 1 has the L_1, α_1 and F_1, and sector 2 has the L_2, α_2 and F_2. Similarly, each sector has a monopolist, and the economy has to select a faction n_1 or n_2 for industrialization. To highlight their correlation, I assume sector 1 has a fixed fraction of g, and sector 2 has a fraction of 1-g in this two-sector economy. This difference can be interpreted as two sectors having different access to technology and investment packages owing to different financing and technical capability. Due to this exogenous constraint, the two sectors can take only the given investment package at the given time. Shleifer's discussion of cyclical equilibrium and innovation with details can partially justify this setup as the overlapping of

technological updating periods may just create such stratified conditions as usually observed in reality (1986). Then this modification has

$$y_1 = \prod(n_1, n_2) + L_1, \tag{6}$$

$$y_2 = \prod(n_1, n_2) + L_2, \tag{7}$$

$$\pi_1 = \frac{\alpha_1 - 1}{\alpha_1} y_1 - F_1 = a_1 y_1 - F_1, \tag{8}$$

$$\pi_2 = \frac{\alpha_2 - 1}{\alpha_2} y_2 - F_2 = a_2 y_2 - F_2, \tag{9}$$

$$\prod(n_1, n_1) = g n_1 (a_1 y_1 - F_1) + (1-g) n_2 (a_2 y_2 - F_2). \tag{10}$$

The parameters of n_1 and n_2 wait to be decided by the two sectors. The labor endowment L may expand to any human or physical capital endowment. The equation (10) specifies that two sectors redistribute their loss/profit in their correlated economy as in the original setup. Substitute (10) into (6) and (7), and then I can have the following:

$$y_1 = \frac{(1-g) n_2 a_2 (L_2 - L_1) - [g n_1 F_1 + (1-g) n_2 F_2] + L_1}{1 - [g n_1 a_1 + (1-g) n_2 a_2]}, \tag{11}$$

$$y_2 = \frac{g n_1 a_1 (L_1 - L_2) - [g n_1 F_1 + (1-g) n_2 F_2] + L_2}{1 - [g n_1 a_1 + (1-g) n_2 a_2]}. \tag{12}$$

Note that a_1 and $a_2 \in [0,1)$, $\forall g, n_1, n_2 \in [0,1]$. Both equations can be easily converted to the original (4) if I can let $g = 1$ or $g = 0$, or $\alpha_1 = \alpha_2 = \alpha$, and $L_1 = L_2 = L$. So my assumptions are compatible with the original model. Similarly, it has

$$\frac{\partial y_1}{\partial n_1} = \frac{g(a_1 y_1 - F_1)}{1 - [g n_1 a_1 + (1-g) n_2 a_2]} = \frac{g \pi_1}{1 - [g n_1 a_1 + (1-g) n_2 a_2]}, \tag{11-a}$$

$$\frac{\partial y_1}{\partial n_2} = \frac{(1-g)[a_2 (L_2 - L_1) + a_2 y_1 - F_2]}{1 - [g n_1 a_1 + (1-g) n_2 a_2]} = \frac{(1-g)[a_2 (L_2 - L_1 + y_1 - y_2) + \pi_2]}{1 - [g n_1 a_1 + (1-g) n_2 a_2]}, \tag{11-b}$$

$$\frac{\partial^2 y_1}{\partial n_2 \partial n_1} = \frac{g(1-g)[a_1 a_2 (L_2 - L_1) + a_1 (a_2 y_1 - F_2) + a_2 (a_1 y_1 - F_2)]}{\{1-[g n_1 a_1 + (1-g) n_2 a_2]\}^2}, \quad \text{(11-d)}$$

$$\frac{\partial y_2}{\partial n_2} = \frac{(1-g)(a_2 y_2 - F_2)}{1-[g n_1 a_1 + (1-g) n_2 a_2]} = \frac{(1-g)\pi_2}{1-[g n_1 a_1 + (1-g) n_2 a_2]}, \quad \text{(12-a)}$$

$$\frac{\partial y_2}{\partial n_1} = \frac{g[a_1 (L_1 - L_2) + a_1 y_2 - F_1]}{1-[g n_1 a_1 + (1-g) n_2 a_2]}, \quad \text{(12-b)}$$

$$\frac{\partial^2 y_2}{\partial n_2 \partial n_1} = \frac{g(1-g)[a_1 a_2 (L_1 - L_2) + a_2 (a_1 y_2 - F_1) + a_1 (a_2 y_2 - F_1)]}{\{1-[g n_1 a_1 + (1-g) n_2 a_2]\}^2}. \quad \text{(12-d)}$$

The equations (11-a) and (12-a) indicate that if other factors are fixed, the reaction of income from n relies on $\pi_{1, y_1 = L_1}$ and $\pi_{2, y_2 = L_2}$ which are produced by the sector itself before transferring its pecuniary externality. Note that (11-d) and (12-d) are greater than zero is neither necessary nor sufficient to have that (11-b) and (12-b) are greater than zero, and vice versa. As for this interaction effect, (11-d) and (12-d) should be incorporated with these first-order differential equations. For the sake of simplicity, I can postulate that sector 1 performs better by specifying $\pi_{1, y_1 = L_1} > \pi_{2, y_2 = L_2}$ or $a_1 L - F_1 > a_2 L - F_2$. I can consistently simplify these parameters to convert those equations into the original setup or simpler interpretations. As well, the two sectors are interchangeable.

3. Mixed Strategy versus Pure Strategy

Obviously, the optimal solution should be located in the corner point of n_1 or n_2, where $1 \geq n_1, n_2 \geq 0$. It can be sufficiently proved that the maxima solution should be in the corner point of n by using an explicitly formulized approach as in Appendix A. Then four possibilities or scenarios can be analyzed more specifically for this artificial exclusive economy.

Scenario 1: both industrialize

$$y_1 = \frac{(1-g)a_2(L_2 - L_1) - [gF_1 + (1-g)F_2] + L_1}{1 - [ga_1 + (1-g)a_2]} \tag{13}$$

$$y_2 = \frac{ga_1(L_1 - L_2) - [gF_1 + (1-g)F_2] + L_2}{1 - [ga_1 + (1-g)a_2]} \tag{14}$$

Scenario 2: both do not industrialize

$$y_1 = L_1 \tag{15}$$

$$y_2 = L_2 \tag{16}$$

Scenario 3: sector 1 industrializes while sector 2 does not

$$y_1 = \frac{-gF_1 + L_1}{1 - ga_1} \tag{17}$$

$$y_2 = \frac{ga_1(L_1 - L_2) - gF_1 + L_2}{1 - ga_1} \tag{18}$$

Scenario 4: sector 2 industrializes while sector 1 does not

$$y_1 = \frac{(1-g)a_2(L_2 - L_1) - (1-g)F_2 + L_1}{1 - (1-g)a_2} \tag{19}$$

$$y_2 = \frac{-(1-g)F_2 + L_2}{1 - (1-g)a_2} \tag{20}$$

The decision to industrialize will depend on the above equations. I can analyze the set of perfect information before examining information asymmetry. With perfect information, the two sectors should select simultaneous industrialization if the following equations are greater than 0.

(13) – (15) = (14) – (16) =

$$diffy1 = \frac{g(L_1a_1 - F_1) + (1-g)(a_2L_2 - F_2)}{1 - [ga_1 + (1-g)a_2]} \tag{21}$$

(13) – (17) = (14) – (18) =

$$diffy2 = \frac{(1-g)[ga_2(L_1a_1 - F_1) + (1-ga_1)(L_2a_2 - F_2)]}{(1-ga_1)\{1-[ga_1 + (1-g)a_2]\}} \tag{22}$$

(13) – (19) = (14) – (20) =

$$diffy3 = \frac{g\{(1-g)a_1(L_2a_2 - F_2) + [1-(1-g)a_2](L_1a_1 - F_1)\}}{[1-(1-g)a_2]\{1-[ga_1 + (1-g)a_2]\}}. \tag{23}$$

Assume the setup of incomplete information: each sector can observe only the signs of profit/loss itself, or say the signs of $\pi_{1,y_1=L_1}$ and $\pi_{2,y_2=L_2}$, but not the scope of the profit/loss of its opposite sector. As a result, agents cannot know the exact signs of (22) and (23) if one sector is profitable and the other sector is at a loss. Note the condition of (22)>0 and (23)>0 is sufficient to have (21)>0. This result can be easily proved: according to the constrictions on g and a (both are between zero and one), the signs of (21)-(23) are decided by $\pi_{1,y_1=L_1}$ and $\pi_{2,y_2=L_2}$ with their weights and sizes. If (22)>0 and (23)>0, at least one of $\pi_{1,y_1=L_1}$ and $\pi_{2,y_2=L_2}$ is greater than zero. If both $\pi_{1,y_1=L_1}$ and $\pi_{2,y_2=L_2}$ are greater than zero, it means (21)>0; If only one of $\pi_{1,y_1=L_1}$ and $\pi_{2,y_2=L_2}$ is greater than zero, and I further assume $\pi_{1,y_1=L_1} > 0$ and $\pi_{2,y_2=L_2} < 0$. As $g > ga_2$ and $1-g < 1-ga_1$ (22)>0, $ga_2\pi_{1,y_1=L_1} + (1-ga_1)\pi_{2,y_2=L_2} > 0$, given the above, then $g\pi_{1,y_1=L_1} + (1-g)\pi_{2,y_2=L_2} > 0$, it simply implies (21)>0. The similar proof also stands for $\pi_{1,y_1=L_1} < 0$ and $\pi_{2,y_2=L_2} > 0$. If (21) <0, at least one of $\pi_{1,y_1=L_1}$ and $\pi_{2,y_2=L_2}$ < zero, the sectors can choose either to invest alone or to take no action. Specifically, sector 1 can choose to industrialize alone if the following (24)>0 and (22)<0:

$$(17) - (15) = (18) - (16) = diffy4 = \frac{g(a_1L_1 - F_1)}{1-ga_1}. \tag{24}$$

Similarly, sector 2 can choose to industrialize alone while sector 1 should stay put if (21)-(24) all are less than zero, and the following (25) is greater than zero:

$$(19)-(15)=(20)-(16)=diffy5=\frac{(1-g)(a_2L_2-F_2)}{1-(1-g)a_2}. \tag{25}$$

I also have (17)-(19) = (18)-(20) =

$$diffy6=\frac{g[1-(1-g)a_2](a_1L_1-F_1)-(1-ga_1)(1-g)(a_2L_2-F_2)}{(1-ga_1)[1-(1-g)a_2]}. \tag{26}$$

As these two sectors are interchangeable, I can skip scenario 4 and concentrate on the other three scenarios. If (21)-(25) are all less than zero, no one will want to industrialize. Note that if (24)<0 and (25)<0, then (21)<0 and (22)<0. Actually, if (24)>0 and (25)>0, this condition implies (21)>0, (22)>0 and (23)>0. Now consider if only sector 1 is profitable, so they know $\pi_{1,y_1=L_1}=\alpha_1L_1-F_1>0$, and $\pi_{2,y_2=L_2}=\alpha_2L_2-F_2<0$, but nothing else. In this case, the mixed strategy that each player can take a combination of random choices for industrialization can be found under information asymmetry. Based on the game theory, if sector 1 takes a probability of P_1 to industrialize, and sector 2 takes a probability of P_2, both sectors will decide independently. This situation can lead to the mixed-strategy equilibrium, and the expected returns would be

$$E(y_1)=P_1P_2(13)+(1-P_1)(1-P_2)(15)+P_1(1-P_2)(17)+(1-P_1)P_2(19), \tag{27}$$

$$E(y_2)=P_1P_2(14)+(1-P_1)(1-P_2)(16)+P_1(1-P_2)(18)+(1-P_1)P_2(20). \tag{28}$$

I can check the indifferent equations of the two sectors in this game set. Sector 1 should have $P_2(13)+(1-P_2)(17)=P_2(19)+(1-P_2)(15)$; similarly, sector 2 should have $P_1(14)+(1-P_1)(20)=P_1(18)+(1-P_1)(16)$, which will lead to the following:

$$P_1=\frac{(20)-(16)}{(20)-(16)+(14)-(18)}=\frac{(25)}{(25)-(22)}, \tag{29}$$

$$P_2 = \frac{(15)-(17)}{(15)-(17)+(13)-(19)} = \frac{(24)}{(24)-(23)}. \quad (30)$$

Here, for the equation of (29), if (25)>0, it should have (22) <0, and similarly for (30), if (24)>0, it should have (23) <0. For the same reason, if (25) <0, it should have (22) >0, and if (24) <0, it should have (22) <0. To get the mixed strategy, it needs the signs of (24) and (25) to be different; otherwise the situation has $P_1 = P_2 = 1$ or $P_1 = P_2 = 0$ as I assume $P_1, P_2 \in [0,1]$. If the sector has no information of the size of the opposite side's profit/loss but postulates it from its own status, the mixed strategy equilibrium will result. These inequality function combinations imply that if an agent is profitable, he may be optimistic enough to underestimate the loss of the other side, while the non-profitable side can be too passive to recognize the profit earned by its opposite side. Both conditions make general sense. This mixed strategy can lead to a pure Nash Equilibrium if these two sectors definitely know the signs of (23) and (22) with respect to (24) and (25). The payoff difference can be compared between these two information scenarios. If (22)>0 and (23)>0, both should industrialize in coordination, and the payoff difference will be

$$\begin{aligned}
&(13) - E(y_1) = (14) - E(y_2) \\
&= (1-P_1)(1-P_2)[(13)-(15)] + P_1(1-P_2)[(13)-(17)] + (1-P_1)P_2[(13)-(19)] \\
&= (1-P_1)(1-P_2)[(14)-(16)] + P_1(1-P_2)[(14)-(18)] + (1-P_1)P_2[(14)-(20)] \\
&= (1-P_1)(1-P_2)(21) + P_1(1-P_2)(22) + (1-P_1)P_2(23)
\end{aligned} \quad (31)$$

I have argued that (22)>0 and (23)>0 does not necessarily demand that (24)>0 and (25)>0, but that (24)>0 and (25)>0 is sufficient to have (22)>0 and (23)>0. Given that (25)>0 and (24)>0, the scenario of (21) <0, (22) <0 and (23) <0 would not happen because the condition (25)>0 and (24)>0 conflicts with the condition (22) <0, and (23) <0. Thus, if (25)>0 and (24)>0, this situation will have $P_1 = P_2 = 1$ and (31) =0, which is a fine result to expect. Similarly, if (24) <0 and (25) <0, this condition will directly lead to

(22)<0 and (23)<0, and thus $P_1 = P_2 = 0$, so that no one would industrialize in this case. All these projections are based on a static setup without considering the interaction effect on the parameters due to the change of the industrialization status.

The special scenario that deserves more examination is the possible scenario that one sector is profitable and the other one is not; for instance, (24)>0 and (25)<0. In an imperfect information scenario, the agents know only that (24)>0 and (25)<0, but not know the exact signs of (22) and (23). In the condition of (22)>0, (23)>0, (25)<0 and (24)>0, the payoff difference between imperfect information and complete information will still be (31). Note here, that if the mixed strategy can exist, I should find the pure Nash Equilibrium Pareto optimal to the mixed strategy equilibrium. In the next scenario, Let us still assume that the two sectors know (24)>0 and (25)<0, but that they do not know if sector 1 is profitable enough to push coordinated acts through. If (22)<0, (23)<0, (25)<0 and (24)>0, sector 1 should industrialize alone. Then the payoff difference between the pure Nash Equilibrium and the mixed strategy equilibrium equal to

$$\begin{aligned}
&(17) - E(y_1) = (18) - E(y_2) \\
&= P_1P_2[(17)-(13)] + (1-P_1)P_2[(17)-(19)] + (1-P_1)(1-P_2)[(17)-(15)] \\
&= P_1P_2[(18)-(14)] + (1-P_1)P_2[(18)-(20)] + (1-P_1)(1-P_2)[(18)-(16)] \\
&= -P_1P_2(22) + (1-P_1)(24) - (1-P_1)P_2(25)
\end{aligned} \tag{32}$$

Because (22)<0, (23)<0, (25)<0 and (24)>0, this condition leads to (32)>0, which means in the above scenarios, the mixed strategy equilibrium with imperfect information is always Pareto inferior to the pure Nash Equilibrium with perfect information, given that one sector is profitable while the other one is not. This result is consistent with the intuition that complete information should usually entail better outcomes. Thus this mixed strategy status can always improve via the use of any mechanism, for instance, a

cartel or other corporate integrations that decreases information asymmetry. Hviid (1992) typically argued that a cartel could act both as a strategy-coordination device and as an information-sharing device. As the conclusion states, a decrease of information asymmetry can improve efficiency in coordinated industrialization.

4. The Breaking of Fellowship and its Implications

Murphy et al.'s starting model suggests that the representative agent own/share the aggregate profits of industrialization (investment) in the economy. This sharing of interest creates a fellowship in a relatively exclusive economy, such as an industrial syndicate or a small regional economy. This simple aggregate demand spillovers model concludes that a universal positive profit is critically demanded for simultaneous industrialization. However, this expansion illustrates that some agents do not need their own positive profits for simultaneous moves, assuming that the agents with different technologies and profits still share their aggregate profits; in some circumstances, the unprofitable sectors can industrialize with others and still everyone is better off. This presents a Kaldor-Hicks improvement, a change that the relatively profitable sector in my modification would be able to compensate the related sector and still be better off from a simultaneous industrialization (the change)—Kaldor criterion, while no sector could not afford to bribe the other sector to prevent the change—Hicks criterion. Nevertheless, if such a sharing profit/loss does not exist and the profit is owned separately, it leads to

$$y_1 = \prod(n_1, n_2) + L_1, \tag{6a}$$

$$y_2 = \prod(n_1, n_2) + L_2, \tag{7a}$$

$$\pi_1 = \frac{\alpha_1 - 1}{\alpha_1} y_1 - F_1 = a_1 y_1 - F_1, \tag{8a}$$

$$\pi_2 = \frac{\alpha_2 - 1}{\alpha_2} y_2 - F_2 = a_2 y_2 - F_2, \tag{9a}$$

$$\Pi_1(n_1, n_1) = n_1(a_1 y_1 - F_1). \tag{10a}$$

$$\Pi_2(n_1, n_2) = n_2(a_2 y_2 - F_2). \tag{10b}$$

In this case, two factors share no direct profit/loss. Then it will have

$$y_1^{\cdot} = \frac{L_1 - n_1 F_1}{1 - n_1 a_1} \tag{11a}$$

$$y_2^{\cdot} = \frac{L_2 - n_2 F_2}{1 - n_2 a_2}. \tag{12a}$$

The payoff difference of the two scenarios will be (11)-(11a), and (12)-(12a)

$$\begin{aligned} y_1 - y_1^{\cdot} &= \frac{(1-g)n_2 a_2 (L_2 - L_1) - [g n_1 F_1 + (1-g) n_2 F_2] + L_1}{1 - [g n_1 a_1 + (1-g) n_2 a_2]} - \frac{L_1 - n_1 F_1}{1 - n_1 a_1} \\ &= \frac{(1-g)[n_2(1 - n_1 a_1)(a_2 L_2 - F_2) - n_1(1 - n_2 a_2)(a_1 L_1 - F_1)]}{[1 - g n_1 a_1 - (1-g) n_2 a_2](1 - n_1 a_1)} \end{aligned} \tag{11b}$$

$$y_2 - y_2^{\cdot} = \frac{g[n_1(1 - n_2 a_2)(a_1 L_1 - F_1) - n_2(1 - n_1 a_1)(a_2 L_2 - F_2)]}{[1 - g n_1 a_1 - (1-g) n_2 a_2](1 - n_2 a_2)}. \tag{12b}$$

$$\begin{aligned} \Delta Y_1 = g(y_1 - y_1^{\cdot}) &= \frac{(1-g)g[n_2(1 - n_1 a_1)\pi_2 - n_1(1 - n_2 a_2)\pi_1]}{[1 - g n_1 a_1 - (1-g) n_2 a_2](1 - n_1 a_1)} \\ &= k[n_2 \pi_2 - \frac{(1 - n_2 a_2)}{(1 - n_1 a_1)} n_1 \pi_1] \end{aligned} \tag{11c}$$

$$\begin{aligned} \Delta Y_2 = (1-g)(y_2 - y_2^{\cdot}) &= \frac{(1-g)g[n_1(1 - n_2 a_2)\pi_1 - n_2(1 - n_1 a_1)\pi_2]}{[1 - g n_1 a_1 - (1-g) n_2 a_2](1 - n_2 a_2)} \\ &= k[n_1 \pi_1 - \frac{(1 - n_1 a_1)}{(1 - n_2 a_2)} n_2 \pi_2] \end{aligned} \tag{12c}$$

Where $k = \frac{g(1-g)}{1-gn_1a_1-(1-g)n_2a_2} > 0$, and $0 > g > 1$. From an individual aspect, everyone consents to share the aggregate profit only if (11c) ≥0 and (12c) ≥0 that leads to

$$\Delta Y_1 = k[n_2\pi_2 - \frac{1-n_2a_2}{1-n_1a_1}n_1\pi_1] \geq 0 \qquad (11d)$$

$$\Delta Y_2 = k[n_1\pi_1 - \frac{1-n_1a_1}{1-n_2a_2}n_2\pi_2] \geq 0 \qquad (12d)$$

Both (11d) and (12d) are satisfied only if it has $n_1\pi_1(1-n_2a_2) = n_2\pi_2(1-n_1a_1)$. Therefore, a simultaneous industrialization cannot occur in a profit-sharing setup unless $n_1\pi_1(1-n_2a_2) = n_2\pi_2(1-n_1a_1)$. Here the profit π is not necessarily positive to maintain this fellowship. It can have $n_1 = n_2 = 1$ for the simultaneous scenario; thus I will need $\pi_1/\pi_2 = (1-a_1)/(1-a_2)$. Let us further suppose $n_1\pi_1(1-n_2a_2) = n_2\pi_2(1-n_1a_1)$, it means $n_1 - n_1a_1 - n_1n_2a_2 = n_2 - n_2a_2 - n_1n_2a_1 \Rightarrow n_1 = \frac{n_2(1-a_2)}{[1-a_1+n_2(a_1-a_2)]}$, suggesting that one sector's industrialization level is a nonlinear function of the other's industrialization level before both sectors have full industrialization dynamically realized. I can also have $\frac{\Delta n_1}{\Delta n2} = \frac{(1-a_2)[(1-a_1+n_2(a_1-a_2)]-(1-a_2)(a_1-a_2)n_2}{[1-a_1+n_2(a_1-a_2)]^2} = \frac{(1-a_2)(1-a_1)}{[1-a_1+n_2(a_1-a_2)]^2} > 0$.

This result implies that two sectors' industrialization progress should be positively correlated had they formed a fellowship of sharing. In this mechanism, everyone must industrialize with others to maintain their fellowship of sharing; otherwise, one sector may lose its initiative to be fellowshipped. I can examine to what extent this pecuniary externality affects the overall payoff indexed by $\Delta Y_1 + \Delta Y_2$, which is defined as

$$\Delta Y_{total} = \Delta Y_1 + \Delta Y_2 = k[\frac{n_2 a_2 - n_1 a_1}{1 - n_1 a_1} n_1 \pi_1 + \frac{n_1 a_1 - n_2 a_2}{1 - n_2 a_2} n_2 \pi_2]$$
$$= k(n_2 a_2 - n_1 a_1)[\frac{n_1 \pi_1}{1 - n_1 a_1} - \frac{n_2 \pi_2}{1 - n_2 a_2}] \quad (12\text{-e})$$

If $n_2 a_2 < n_1 a_1$, $\frac{n_1 \pi_1}{1 - n_1 a_1} < \frac{n_2 \pi_2}{1 - n_2 a_2}$, as $k = \frac{g(1-g)}{1 - g n_1 a_1 - (1-g) n_2 a_2} > 0$, then $\Delta Y_{total} > 0$.

This is possible if $\pi_1 \ll \pi_2$ while $a_2 < a_1$. The latter's loss can be caused by a huge initiating investment F. If the relatively profitable but low technical sector compensates the other sectors with a high technical level but a low initial payoff level, the whole economy can be better off as indicated by $\Delta Y_{total} > 0$. Particularly, if all are losing money and facing an imperative technology updating, the whole economy will be better off in a simultaneous industrialization if they can share loss than if they industrialize individually. And it seems a viable strategy to industrialize simultaneously by binding sectors with different productive levels, particularly in the early industrialization phase or a syndicate with different sub-branches.

It must be noted that this fellowship of sharing is quite fragile due to the strict equilibrium conditions. If (12-e)<0, this fellowship is meant to be broken because the overall payoff is not improved consequently. In the longer term, I expect $\pi_1(1-a_2) = \pi_2(1-a_1)$, or $\pi_1 / \pi_2 = (1-a_1)/(1-a_2)$, while two sectors demand (11d) and (12d) ≥ 0 that directly leads to (12-e) = 0. To obtain an overall improvement from this fellowship, those sectors should have the equilibrium conditions strictly satisfied. Otherwise it will be better off to break this fellowship to improve the overall welfare. I also note that if one sector is profitable while the other sector is not, the fellowship of sharing will be potentially broken from some individual agents' aspect, because it cannot

satisfy $n_1\pi_1(1-n_2a_2)=n_2\pi_2(1-n_1a_1)$, although the overall payoff can be improved by the formation of fellowship. The individual aspect is more consistent to Murphy, Shliefer Vishny's original proposition. Here I must remind readers that my focus is on the closed economy as a whole and on its overall efficiency. From a more specified scenario, my interpretation makes sense similarly as Murphy, Shleifer and Vishny's three modifications about the "big push" opportunities. In sum, the expansion of the unbalanced gap of technology and profitability, among the sectors within an exclusive economy body, will increase the chance and benefit of "big push" or simultaneous industrialization. While this gap is diminishing, the fellowship is becoming less attractive.

5. Multiple-Equilibriums under Certain Circumstances

Murphy, Shleifer and Vishny (1989, P1017) generally interpret the possibility of a big push as the coexistence of two equilibriums for some parameter values of the fixed investment F. We can examine whether such a set of parameters also exist in this modified model, and I find such multiple-equilibriums do exist under certain conditions. If (24)>0>(25), sector 1 should at least partially industrialize. As it can still have (21)>0 given that (24)>0>(25), both partial and simultaneous industrializations present some Pareto improvement from the status of no industrialization. Therefore, should the economy select the second best optimum of simultaneous industrialization instead of this partial industrialization if (22)<0? From a static view, this partial industrialization appears to be the best solution for maximizing profit in the short run; but it might not be in the long-term dynamics. A set of possible parameters for n,a,g,L,F can be easily attained to satisfy (21)>0, (22)=0, and (24)>0 (or an alternative scenario (21)>0, (23) =0,

and (25)>0). Consequently, both scenarios 1 and 3 (or 4) are pure Nash Equilibriums, which definitely present multiple equilibriums leading to a big push. Similar situations can also apply to the condition of (24)=0 and (25)<0 or (24)<0 and (25)<0. In either case, this condition also presents multiple-equilibriums.

Some other factors may also create multiple equilibriums in this modified setup. Please note that in reality, economic motives cannot be always reasonable for some agents in some scenarios. If $a_1L_1 - F_1 \geq 0 \geq a_2L_2 - F_2$, then (24)>0>(25); if sector 1 is profitable enough to expand positive spillover effects to sector 2, this situation can still have (22)>0 and (21)>0, and thus a simultaneous industrialization. If (24)>0>(25), (22)>0 is a sufficient condition for (21)>0. In this case, although sector 2 has itself a net loss, these two sectors still should industrialize together. In other words, if the spillover effects are not considered, both sectors should coordinate industrialization while sector 2 appears to be losing money. To have sector 2 coordinate, more motives may be needed as sector 2 will apparently incur a loss in doing so. Sector 2 may not coordinate its investment unless it has the assurance of a promised subsidy. In formulized terms, sector 2 may have no investment coordination if (22)<C, where C>0 stands for an extra compensation required.

If 0<(22)<C, (24)>0>(25), the biased expectation just creates another coexistence of multiple equilibriums: a partial industrialization or a simultaneous act of two sectors. In another scenario where (21)<0, the firms should select either a partial industrialization or not act. Anyone might require a privileged position if he moved first. In this case, the monopolist might require a high return; otherwise, he will stay put. In this case, if (21)<0 given that (24)>0>(25), sector 1 would not invest if (24)<B, where B stands for a bonus

required for the pioneering activity. This condition similarly creates another coexistence of multiple-equilibrium when 0<(24)<B. In sum, the bigger C and B are, the more likely the coexistence of multiple-equilibriums is. A decrease in the values of B and C implies a decrease in the gap between their rational expectations and the overshooting targets of corresponding agents. All these arguments, somehow correlated with the agent problem and biased expectations, are addressed in a static setup which may ignore more possibilities of the co-existence of multiple equilibriums.

6. Other Multiple Equilibriums and the Prisoner's Dilemma

If further considering the interaction effect of industrialization specifically in a dynamic setup, the readers may note that the scenarios of multiple-equilibriums and even the prisoner's dilemma become more possible. To demonstrate this from the earlier argument, I can rearrange the early analysis into to the following table. Here all the numbers bracketed are referring to those equation numbers in the former discussion.

		Sector 2	
		Go industrialization	No Industrialization
Sector 1	Go industrialization	(13) (14)	(17) (18)
	No industrialization	(19) (20)	(15) (16)

Table 1: The Game of Coordinated Industrialization

To get a prisoner's dilemma in this two-player coordination game, I need to have (19)>(13)>(15)>(17) for sector 1, as well as (18)>(14)>(16)>(20) for sector 2. In this assumed dilemma scenario, I can have a pure Nash Equilibrium, which is the scenario of

no industrialization with a payoff of (15) and (16). However, this Nash equilibrium is not Pareto optimal as indicated by (13)<(15) and (14)<(16); the coordinated acts of two sectors can improve everyone's welfare without sacrificing any one's benefit. If the parameters are fixed for four conditions, finding consistent parameters needed for the prisoner's dilemma can be more difficult. Specifically, in order to have (19)>(13)>(15)>(17), and (18)>(14)>(16)>(20), it needs (19)-(13)=(23)>0, (13)-(15)= (21)>0, and (15)-(17)=(24)>0, or (23)<0, (21)>0, and (24)<0, and similarly, (22)<0, (21)>0, and (25)<0. Apparently, (24)<0 and (25)<0 will lead to (21)<0, conflicting with the required condition in which (21)>0.

However, if those parameters are conditioned by the agents' industrialization status owing to their interaction in the process, it implies that none of them, except the endowment, would be fixed with the agent's status. To make the idea explicit, I can rewrite (13)—(20) with regards to the two sectors' specific status. Then it has

Scenario 1': both industrialize

$$y_1 = \frac{(1-g)a_{2,++}(L_2 - L_1) - [gF_{1,++} + (1-g)F_{2,++}] + L_1}{1 - [ga_{1,++} + (1-g)a_{2,++}]} \tag{13'}$$

$$y_2 = \frac{ga_{1,++}(L_1 - L_2) - [gF_{1,++} + (1-g)F_{2,++}] + L_2}{1 - [ga_{1,++} + (1-g)a_{2,++}]} \tag{14'}$$

Scenario 2': both do not industrialize

$$y_1 = L_1 \tag{15'}$$

$$y_2 = L_2 \tag{16'}$$

Scenario 3': sector 1 industrializes while sector 2 does not

$$y_1 = \frac{-gF_{1,--} + L_1}{1 - ga_{1,--}} \tag{17'}$$

$$y_2 = \frac{g a_{1,+-}(L_1 - L_2) - g F_{1,+-} + L_2}{1 - g a_{1,+-}} \tag{18'}$$

Scenario 4': sector 2 industrializes while sector 1 does not

$$y_1 = \frac{(1-g) a_{2,-+}(L_2 - L_1) - (1-g) F_{2,-+} + L_1}{1 - (1-g) a_{2,-+}} \tag{19'}$$

$$y_2 = \frac{-(1-g) F_{2,-+} + L_2}{1 - (1-g) a_{2,-+}} \tag{20'}$$

By inserting the status information, as presented by the signs in the subscripts of the parameters, I can have dynamic elements conveniently incorporated into the setup. This implies more space for parameters and thus more co-existences of multiple equilibriums with a possible prisoner's dilemma. Intuitively, the increased choice of parameters may increase the possibility of the coexistence of multiple-equilibriums, just as in those three mechanisms in Murphy et al.'s original analysis. If (13')>(17') and (15')>(17') for sector 1, while (14')>(19') and (16')>(20') for sector 2, two Nash equilibriums would spontaneously rise in this dynamic setup.

Underneath these two Nash equilibriums is the idea that the effect of industrialization should be more dynamically addressed. If one sector industrializes alone, no one may make money; thus no one wants to go first. However, if the two sectors decide to industrialize in coordination, they can create an increasing scope of economy, which can be realized through two channels: first, the coordinated acts can increase the production parameter α, and thus increase a as the difference between the price and the marginal cost or the mark-up; second, the simultaneous moves can decrease the fixed investment F. The two sectors can share some cost in their coordination, and then both can make themselves more profitable or less costly. Notice here that only the sum of their

weighted returns needs to be positive, explicitly indicating that even if one sector loses money individually, coordinated acts still make industrialization mutually optimal.

If incomplete information is present, this economy can hypothetically create a prisoner's dilemma in the setup. Assume (13')>(15') and (15')>(17') for sector 1, while (14')>(16') and (16')>(20') for sector 2. As each sector may have only some individual information, they will not industrialize first as

$$(20') - (16') = (25)|_{a_2 = a_{2,-+},\, F_2 = F_{2,-+}} < 0, \qquad (25')$$

$$(17') - (15') = (24)|_{a_1 = a_{1,+-},\, F_1 = F_{1,+-}} < 0. \qquad (24')$$

The above inequality functions are not sufficient but are illusory enough to have

$$(19') - (13') > 0, \qquad (23')$$

$$(18') - (14') > 0. \qquad (22')$$

Thus the static setup missing status information can wrongly lead to (22')-(25'), but as I discussed, a logical reasoning should lead to another result as the following

$$(13') - (15') = (14') - (16') = (21)|_{a_1 = a_{1,++},\, a_2 = a_{2,++},\, F_1 = F_{1,++},\, F_2 = F_{2,++}} > 0 \qquad (21')$$

The above leads to (19')>(13')>(15')>(17'), and (18')>(14')>(16')>(20'). As long as this is recognized by two sectors, it implies a standard scenario for a prisoner's dilemma, in which each player knows it would be better off if everyone coordinates in the game, but they also believe whoever makes the first move will be less optimal from a lagged static viewpoint. A standard solution for this dilemma is to further integrate the two players' payoffs. If each sector can exchange some portions of its payoff with the other, the prisoner's dilemma will be eliminated based on the game theory. This integration can be realized through either a benefit exchange or a corporate integration. In

doing so, each sector can also access more complete information and thus decrease the coordination problems.

7. A Further Exploration of Economic Coordination Research

Our major research theme is economic coordination, which generally addresses how economic arrangements interact with different forces based on how effects are measured. Coordination, referred to as *a cooperation of different agencies as well as the harmonizing of method and result* by Cooper (1926), was first analyzed from a vertical prospective within a particular industry like the farm sector. In defining the nature of the firm, Coase (1937) stated that the firm's vertical integration could have a supersession of the price mechanism that would frequently fail in an imperfect competition setup, and that some firms could serve the integrating power in a differentiated economy. He argued that both the price mechanism and the entrepreneurs could serve as a coordinating instrument, and that information asymmetry and forecasting difficulties could impede transactions while firms with increasing specializations could compensate for those deficiencies and improve efficiency.

Koller (1950) noted that a more complete vertical integration, as a continued expansion of farm cooperatives, could facilitate the flow of farm commodities based on the cooperatives' financing capacities and production facilities. Addressing the major problem for vertical expansion with increased capital requirements, Jamison (1960) argued that cooperative organizations hold admirably suitable distinct characteristics in many cases. Davison and Mighell (1964) analyzed the optimum degree of integration in the farm and non-farm stages of production beyond the agricultural sector. Many

researchers, such as William G. Bursch et al. (1971), Purcell, (1973), and Peter J. Barry et al.(1992), further studied vertical integration. Hamilton and Stiegert (2000) summarized that vertically aligned private or public organizations could generate strategic advantages with similar effects from direct government export subsidization. Particularly, both upstream vertical restraint and downstream equity sharing could lead to advantageous trade positions in the international market.

Other studies have addressed more general senses. Rosentein-Rodan (1943) argued that coordinated industrialization (or investment) is a solution to the underdevelopment problem. He stated that the whole industry to be created should be treated and planned like one huge firm or trust if complementary and efficiency effects are to be considered; therefore, the institutional framework should encourage incentives for investments profitable in terms of the social marginal net product but unprofitable for the private marginal net product; also, investment should concentrate on establishing basic industries or public utilities that could improve external-economies. He further explored two types of industrialization: the "Russian model" aimed at self-sufficiency, featured by the construction of all stages of industries in a vertical industrial concern; and an alternative way to take advantage of substantial international capital and division of labor. Rosentein-Rodan (1944), from a world economy viewpoint, stated that the best strategy was with the latter for most less-developed economies.

Rosentein-Rodan's normative economic opinion on international industrialization coordination conflicted somewhat with the advantage argument for vertical integration. The implied question is how well an authority or an agent can coordinate investment in economic development with differentiated status. If this coordinated industrialization (or

investment) worked well in an international scope, would it be logical to apply it to a relatively small economy with similar structures? The answer would probably rest on the institutional framework supported by the economy. Examining possible sources of capital formation in underdeveloped areas, Nurkse (1953) stressed that only after an economy had developed a broad base for utilizing capital would private foreign capital make positive effects to capital accumulation. Stressing that industrialization usually presented a dynamic pattern, Scitovsky (1954) attributed the assumptions of perfect divisibility, the static approach, and the divergence between the profitability of investments and its desirability to the inapplicability of the general equilibrium theory for problems of industrialization. Fleming (1955) noted that economies generated by factor-producing industries could increase the chances that expansion in one sector would generate spillovers in other sectors that were not "vertically" related to the former; the necessary additional capital should be obtainable on easy terms from different mechanisms so that diversified development in a variety of industries would more likely play a mutually supporting and validating role as advocated by the balanced-growth doctrine.

Examining the Pareto-ranked equilibriums in an artificial economy with different invention cycles and thus multiple cyclical equilibriums and implementation cycles, Shliefer (1986) suggested profitable equilibriums need not be the most efficient. Shleifer and Vishny (1988) further argued that an imperfectly competitive firm's profit was positively related to the aggregate income, which could arise with the profits of all firms in the presence of pecuniary externality and aggregate demand spillovers. Expanding the early discussions, Murphy et al. (1989) argued that a coordinated investment program could help achieve the industrialization of each sector at a lower explicit cost than that for

those industrialized piecemeal. Their theory was supported by Morck et al.'s (1990) firm-level evidence that the market was not a dominant force in explaining why some firms invested and others did not, although the market did exert pressures on managers.

Many early studies suggested that impediments of economic or corporate growth usually presented some form of coordination failures in some specific institutional frameworks. Morck et al. (1988, 2004) indicated that an older firm' Tobin's Q was lower when the firm was managed by a member of the founding family than when managed by an officer unrelated to the founders, for entrusting the governance of a country's great corporations to a few wealthy families could promote an undesirable distribution of trust that would encourage political rent-seeking and retard economic growth. Lenway et al. (1996) also found that the group lobbying for trade protection in the steel sector in the US could reduce incentives to innovate, reward poor performance, and frustrates the normal Schumpeterian process of creative destruction. Gal-Or (1991) noted that an oligopoly could have both advantageous and disadvantageous implications for firms' profits if agents had access to private information about their costs.

Morck et al. (2000) examined the link between the value of Japanese firms and their ownership structure related to the bank group in Japan. Their evidence suggested that the firm value would rise monotonically with increased managerial ownership and equity ownership by corporate block-holders. Faccio et al. (2001) examined the "crony capitalism" in East Asia and Western Europe. After controlling industry-specific factors, these authors found that group-affiliated firms in Europe paid higher dividends than in Asia, especially in the presence of multiple large shareholders, suggesting that firms would dampen insider expropriation in Europe but exacerbate it in Asia. Bae et al. (2002)

found evidence from the Korean business groups consistent with the tunneling hypothesis about those chaebo-affiliated acquisitions, instead of the value-adding hypothesis. Examining the high levels of debts and the underinvestment problem for some firms, Kahl (2002) argued that inefficiencies will arise if creditors lack the information needed for quick and correct liquidation decisions, providing a different explanation from those addressing creditors' coordination or an inefficient design of bankruptcy law.

However, some studies suggested that multinational corporate organizations presented a different story with brighter aspects. To answer why investors valued multi-nationality, Morck and Yeung (1991) found that multi-nationality could increase the positive impact of R&D and advertising spending on a firm's Tobin's q, but by itself, may have no significant direct-impact. This finding is consistent with the internalization theory suggesting that intangible assets with public good properties were necessary to justify direct foreign investment, but inconsistent with the portfolios diversifying hypothesis. Examining fifty subsidiaries of multinational firms, Martinz and Jarillo (1991) found a link between firms' strategies and their use of different coordination mechanisms. These authors found that subsidiaries pursuing strategies with a high degree of integration with their corporate parent could make more extensive use of both "formal" and "subtle" coordination mechanisms. Markides and Ittner (1994) examined 276 US international acquisitions from 1975 to 1988, and found that the effect of international acquisitions increased the market values of the acquiring firms. All these findings suggested that multinational integration should improve coordination or efficiency.

Addressing coordination in a critical look at the Keynesian model, Clower and Leijonhufvud (1975) argued that the possibility of coordination failures depended directly

on the stability of disequilibrium adjustment and the extent of external shocks exposed to the system. In an effort to coordinate coordination failures in Keynesian Models, Cooper and John (1988) interpreted strategic complementarities in agents' payoff functions as a basis for macroeconomic coordination failures. Frankel and Rockett (1988) examined the effects of international coordination when policymakers did not agree on macroeconomic models, but were still able to agree on a cooperative policy package believed to improve welfare, and found that this package could most often move the target variables in the wrong direction. Chari and Kehoe (1990) found that coordination could provide gains even if non-removable domestic distortions, such as distorting taxes, existed.

Ghosh and Mason (1991) argued that an activist policy could produce large welfare losses in the absence of learning when policymakers believed in the wrong model. As well, the model learning could cause coordinated policies to dominate uncoordinated ones or exogenous monetary targets. Durlauf (1993) argued that coordination problems could cause aggregate and individual industry volatility. His model illustrated how the growth of leading sectors could lead a takeoff to high aggregate production equilibrium and generate interesting cross-sectional and intertemporal dynamics. Bohn and Gorton (1993) noted that models of coordination failure presented multiple equilibriums that were not first-best due to externalities, while some economic institutions and government policies should be interpreted as mechanisms for internalizing externalities and promoting the best equilibrium in these settings. Olson (1996) argued that economic performance was determined mostly by the structure of incentives that should also be coordinated as spontaneous individual optimization may not be sufficient for growth.

Generally speaking, studies on economic coordination dealt with four core sub-questions: why coordinate, what to coordinate, who should coordinate, and how to coordinate? Some economists think many economic structures are reflected neither in price signals from supply or demand, nor in aggregate economic measures; hence, methodologically, coordination should be addressed more from a meso-economic approach incorporating concepts from game theory, dynamic theory, institutional theory, etc. This essay attempts to incorporate these ideas into consideration.

8. Conclusion

My discussion indicates that a decrease of information asymmetry may increase the chances of coordinated industrialization and Pareto efficiency. A big push opportunity can exist in a stratified multi-sector economy with pecuniary externalities, especially when an unbalanced gap of profit and technology existed among different sectors within a relatively closed economy body. The big push opportunity can rise when the relatively profitable sector has a relatively low technological level and its counterpart present a higher technological level but a lower profit level that may be resulted from the huge initiating investment. This theory expansion, compatible to the original model of Murphy, Shleifer and Vishny (1989), complements their arguments while presenting some similar circumstances for the big push conditions. Stressing economic coordination more from a grouping aspect, my analysis suggests that sometimes the strict optimality in maximizing the short-term interest may not be the most efficient approach in a dynamic long-run, and that simultaneous industrialization depend largely on information asymmetry and the reasoning of relatively independent agents. If information is incomplete, or an agent has a

biased expectation because of his differentiated status in the economy, or the agent has a static rather than a dynamic view of economic development, the Pareto-ranked multiple-equilibriums can spontaneously arise with a big push opportunity. When these equilibriums exist, then a big push affected by any form of information sharing or benefit integration cross those sectors can help to solve some investment coordination problems and accelerate the pace of industrialization.

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Appendix

Subtract (15) from (11), and (16) from (11):

(15)— (11) = (16)—(12) =

$$diffy = \frac{(1-g)n_2(a_2L_2 - F_2) + gn_1(a_1L_1 - F_1)}{1-[gn_1a_1 + (1-g)n_2a_2]} \tag{27}$$

Then I have the following partial differential equations:

$$\frac{\partial diffy}{\partial n_1} = \frac{g\{[1-(1-g)n_2a_2](a_1y_1 - F_1) + a_1n_2(1-g)(a_2y_2 - F_2)\}}{\{1-[gn_1a_1 + (1-g)n_2a_2]\}^2} \tag{27-a}$$

$$\frac{\partial diffy}{\partial n_2} = \frac{(1-g)[(1-gn_1a_1)(a_2y_2 - F_2) + a_2n_1g(a_1y_1 - F_1)]}{\{1-[gn_1a_1 + (1-g)n_2a_2]\}^2} \tag{27-b}$$

$$\frac{\partial^2 diffy}{\partial n_1 \partial n_2} = g(1-g)\frac{a_2[1+n_1a_1g-(1-g)n_2a_2](a_1y_1 - F_1) + a_1[1-n_1a_1g+(1-g)n_2a_2](a_2y_2 - F_2)}{\{1-[gn_1a_1 + (1-g)n_2a_2]\}^3} \tag{27-c}$$

By setting (27-a) = 0 and (27-b) = 0, I can have the following:

$$n_1^* = \frac{1}{g}\frac{(a_2y_2 - F_2)}{a_1(a_2y_2 - F_2) - a_2(a_1y_1 - F_1)} = \frac{1}{ga_1}[1 - \frac{a_2(a_1y_1 - F_1)}{a_2(a_1y_1 - F_1) - a_1(a_2y_2 - F_2)}] \tag{27'-a}$$

$$n_2^* = \frac{1}{1-g}\frac{(a_1y_1 - F_1)}{a_2(a_1y_1 - F_1) - a_1(a_2y_2 - F_2)} = \frac{1}{(1-g)a_2}[1 + \frac{a_1(a_2y_2 - F_2)}{a_2(a_1y_1 - F_1) - a_1(a_2y_2 - F_2)}] \tag{27'-b}$$

I can examine the sufficient conditions for the maxima of the above stationary point:

$$\frac{\partial^2 diffy}{\partial n_1^2} = \frac{2g^2a_1\{[1-(1-g)n_2a_2](a_1y_1 - F_1) + a_1n_2(1-g)(a_2y_2 - F_2)\}}{\{1-[gn_1a_1 + (1-g)n_2a_2]\}^3} \tag{27''-a}$$

$$\frac{\partial^2 diffy}{\partial n_1^2} = \frac{2(1-g)^2a_2[(1-gn_1a_1)(a_2y_2 - F_2) + a_2n_1g(a_2y_2 - F_2)]}{\{1-[gn_1a_1 + (1-g)n_2a_2]\}^3} \tag{27''-b}$$

It is quite obvious that the maximum of (27) will be located on the corner point as it has $\left.\frac{\partial^2 diffy}{\partial n_1^2}\right|_{n_1=n_1^*} = \left.\frac{\partial^2 diffy}{\partial n_2^2}\right|_{n_2=n_2^*} = \left.\frac{\partial^2 diffy}{\partial n_1 \partial n_2}\right|_{\substack{n_2=n_2^* \\ n_1=n_1^*}} = 0$ by inserting (27-a) into (27''-a) and (27-a) into (27''-a). Therefore, this stationary point cannot be the maximum or minimum, and I should search in the corner points.

CHAPTER 3

AN EMPIRICAL STUDY ON THE DEVELOPMENT OF CHINA'S STEEL INDUSTRY

1. Introduction

As one of the largest developing economies, China became the biggest steel producer in the world in 1996 when its annual crude steel production exceeded 100 million metric tons; it continued climbing and tripled in 2005.[1] This growth, especially after 1979, is frequently used as a symbol for its economic achievement by the Beijing administration. After more than a century of struggle, China seems to have partially realized its industrialization goal as indexed by its steel industry.

From the beginning, Chinese governments have played the role of major investor and financier of China's steel industry and dominated its development. However, their influence was complex and dependent on many institutional factors. This specific study firstly examines government intervention and its influence on China's steel sector from a macro-historical perspective. Examining the recent changes at the industrial level, I also explore the performance of China's steel sector with those relevant institutional factors at the firm-specific level, such as government interference and local business environment. I also note that the relevant structure of investment significantly affected the performance of China's major steel firms in a complicated way.

The essay will be structured as follows: I will first have a short historical review on China's steel industry to illustrate some fundamental issues and the progressive pattern of China's recent economic reforms. The aggregated performance and trends in recent

decades are examined next. Some significant structural changes are explored along with those gradual reforms in China's steel sector. Then focusing on a transitional period from 1993-1999, I will apply the generalized estimating equations method to examine influential factors on the firm-specific performance of China's major steel firms. My information is obtained mainly from public sources such as government reports, business reports, and yearbooks. As noted in many empirical studies of China, some inconsistency and incompleteness of data can limit the soundness of the results.

2. A short historical review

The development of China's steel sector can represent its industrialization process as, I believe, no other sector can claim a superior position in China. I must explore the historical background and institutional factors first because, as North states, the economic changes are incremental, gradual, and constrained by the historical past (2005). China has such a vastly sophisticated situation that paradoxical features present themselves in many aspects. A short review, according to three major historical events, the Xinhai Revolution (1911), the founding of the People's Republic of China (1949), and the Chinese Communist Party's third central meeting of the Eleventh Central Committee (1978), should help to develop our understanding of this topic.

2.1. The first three stages of China's steel industry full of chaos and struggles

Government intervention has dominated the early stages of China's steel business until recently. China's steel industry was established in the late 19th century by the Confucian scholar-official elites such as Governor General Zhang Zhidong (1837-1909)

and Sheng Xuanhuai (1844-1916). As I argued in the specific study of the Hanyeping Company, government intervention was a political legacy linked to elite-centered Confucianism in China. Traditional Confucian beliefs and culture encouraged government intervention in social management. However, this cultural argument is inadequate to explain China's economic development despite its key role in explaining China's modern transitions. More institutional factors should be generally approached. Due to its complex dichotomies, Zurndorfer notes that Confucian culture may serve as both impediment and stimulus to economic advancement in many confusing narratives (2004). [2] Nevertheless, at least one Confucian incompatibility to the machinery economy—the ignorance of technology and innovation—can be noted, besides other specific institutional factors.

Actually, this ignorance of technology and innovation seemed easily corrected as shown in my Hanyeping study, while other misconceptions would appear more elusive. For instance, the Confucians highly valued the position of compromise, but such a position did little to help attain an appropriate position. In fact, compromise often led to polarization or backward tendencies. Other similar incompatibilities may include the confusing attitude toward competition, the tendency towards cronyism, and the denigration of self-interest and anti-hierarchy notions. Just as John M. Keynes said, "the difficulty lies, not in the new ideas, but in escaping from the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds".[3]

The Confucian scholar-official elites started China's steel industry by active government intervention. Without sufficient institutional transition, the early efforts of China's steel industry failed largely because those reforms were not intended to change

the fundamental structure of China, and thus their approach failed to get effective governance for the agents. Without sufficient institutional transition, governance problems quickly accumulated. My historical study shows that Hanyeping Company lacked an effective governance mechanism. Ending with a compromised policy — *Guandu Shangban*, or Official Supervision and Private or Mercantile Management — the corporate trial of Hanyeping was largely a failure, but it gave rise to new ideas. This compromised policy inevitably resulted in "Bureaucratic Capitalism" that spontaneously expanded but was continuously interrupted by the wars rampaging through China during the era of the Republic of China (1911-1949).[4]

China's steel industry, inherited from the Qing Empire, experienced a spontaneous growth after 1911. China's industrial development in the Republic of China period (1911-1949) accompanied repeated destruction by wars. Political disturbance was the tenor of China's early industrialization. Provincial governments frequently claimed independence from the central government, while revolutions were continuously instigated. In interior China, wars came and went. Only the sectors such as mining, which need less corporate financing or technology but provided a quick cash flow, could thrive. A specific study by Wright (1984) shows that the importance of supply considerations, and thus ultimately of political stability, was more significant than the shortages of capital and entrepreneurship to China's mining sector, which had substantial growth between 1895 and 1937.[5] Wars could easily sabotage the normal operation of other industries. For instance, in 1921 when China's central administration abruptly announced the changes to the rail standards for the national railroad project, Hanyeping was forced to abandon the whole inventory of completed rail, causing a complete stop of its business because some local governments

refused to use the same rail standard to prevent other warlords using railroads for cross-region aggression. As a major historical factor, China's domestic chaos greatly stimulated aggression by the Japanese imperialists. The second Sino-Japanese war broke out in 1937. The Japanese began bombing China's industrial centers, trying to destroy its willingness to continue the war. To avoid total destruction of the mills, the Chinese administration transported all movable machinery inland and destroyed all non-movable equipment and buildings as it retreated.

After defeating the Kuomintang (KMT) and claiming Mainland China in 1949, the Chinese Communist Party (CCP) attempted to rebuild the industrial sectors with socialist strategies. Studies on China's nationalization in the 1950s reveal that China adopted a relatively mild way to finish the task. Generally speaking, the CCP treated enterprises differently; the party administration confiscated the state-owned assets left by the KMT and nationalized most private enterprises in stages. Almost all of China's steel mills were in the confiscated category. Meanwhile, the People's Bank of China issued new currency to finance the nationalized firms. Copying the Soviet model, Beijing established its Central Planning Committee (CPC) in 1950 and started the first "five-year plan" in 1953. Supervised by the CPC, the State Bureau of Metallurgical Industry took direct charge of the iron and steel business.

This planned economy period (1949-1978) was also full of cyclic reconstruction and chaos. After engaging in three consecutive major wars, the Sino-Japanese war (1937-1945), the civil war (1946-1949), and the Korean War (1950-1953), the CCP made the steel projects a priority among all those key plants aided by the Soviet Union. A few earlier studies have detailed research on those aid projects.[6] China's most essential steel

plants, such as the Angang group in northeast China and Panchihua group in southwest China, started operating in the first two "five year" plan periods.[7] The steel sector resumed being solely financed by governments. Corporate financing through other ways was mostly labeled as anti-socialist and thus forbidden. The Soviet Union helped Beijing build key plants to create more plants in the operation-learning process.

This approach largely succeeded in the steel industry—most of China's steel groups today can be traced to those key plants. This plan went well before being derailed by the "Great Leap Forward" (1958-1960). The Chinese Government hoped this movement would accelerate the country's industrialization as represented by its steel sector; instead, ironically, China experienced a huge backward economic shift that was wrought with politicized goals. Power struggles and ideological disputes dominated economic issues with serious results. From 1958 to 1959 a nation-wide hysteria for steel appeared in China, but the output was so poor that the overall industrial growth turned out to be negative. Lacking coordination across China's economic sectors, the steel sector also had its growth frustrated.[8] Moreover, this hysteria led to huge ecological destruction as so many trees were cut down to supply those backyard furnaces. The huge loss of crops in this period, worsened by the cheating of local bureaucrats, lead to a massive famine forever ingrained in China's mass consciousness. An economic recovery occurred after the "Great Leap Forward", but it was soon negated by another self-destroying movement. The "Cultural Revolution" (1966-1976), regarded as an unprecedented human catastrophe and economic disaster, was like a civil war that lasted for a decade without visible frontlines and that nearly brought China's collapse.

2. 2. The transitional period with progressive reforms (1979-present)

China's steel industry had a stable growth after the Great Leap Forward, but its technology was almost stagnant during the period of political turmoil. China's annual crude steel production in 1978 had increased to 31.78 million metric tons from 148,000 metric tons in 1949, still far below Beijing's expectation. After thirty years of isolation from the West, Beijing requested an imperative solution to update the stagnant state of its technology. It was swiftly delivered when Beijing resumed importing western technology which soon became one of the most important policies. In 1978, the successor to China's first steel syndicate, Hanyeping, —the Wugang group—took on this historical mission. This deal was made for a steel plate line, mainly supplying China's automobile industry. The Schloemann-Siemag (SMS) Company from Germany received the equipment contract, and the production consulting contract was signed with a Japanese company named Tayssen. This deal officially opened a new era in China. Meanwhile, a new steel plant was initiated on the outskirts of Shanghai. Experienced workers were called from all over China to form this Baosteel group that quickly developed into China's biggest steel group in about two decades.

New ideas poured in with the flow of international trade and capital. Meanwhile Beijing initiated a series of corporate reforms. The steel sector stood at the frontier of these reforms. In the early 1980s, corporate reforms started the division between corporate staff and political bureaucrats. The CCP committee officials, nominally paralleled with operation executives, were gradually excluded from business and merged into the human resource sectors as the worker union representatives. Those union deputies occupied certain seats on the board of directors according to the individual

arrangements of the mills. Following the managerial reforms, a series of corporate taxation reforms in the middle 1980s were closely followed by price reforms. All reforms gradually progressed without clear-cut timetables or roadmaps while overlapping one another and other social transitions with dynamic adjustments.

The corporate taxation reforms progressively collapsed the former dual-account system that was copied from the Soviet State-Owned Enterprises (SOE) to collect revenue (income account) and finance the operation cost (expenses account). This reform proceeded in an adapting timetable: at first, the SOEs kept their corporate dual-accounts, but they were given the right to maintain accounts for retaining some profit for their own use. As long as the profit quota was reached, corporate finance gradually became SOEs' own prerogative. After those preparations, Beijing expanded the price reforms aimed to replace government commands in commodity exchanges. Initially a dual-track price system ran parallel between government agents and markets.

As noted by many economists, inevitably, corruption soon became rampant in the steel business in the late 1980s. But Beijing could quickly contain problems exposed in the trial sectors, and then adjusted measures for further reforms. In the late 1990s a public price network of steel products, listing non-discriminative prices to all buyers and sellers was completed. As part of the finance reforms, large steel SOEs initiated their finance companies from the early 1990s. Those finance companies were licensed by Beijing and capitalized by their parent groups to provide short-term loans. In addition to providing commercial credit and internal financing, they also acted as investment dealers, while their parent groups started public listings in the Shenzhen and Shanghai stock markets and the Hong Kong H-board. All those subjects can be an interesting study for the future.

After 1978, ideological disputes started to fade away in China's economic advance. For decades, China's economy had been frequently impeded by political conflicts caused by ideological disputes. Most of those disputes just provided convenient weapons to label and attack political dissidents. Shelving those arguments, Beijing apparently attempted to focus on the modernization process with the least ideological disturbance. A tentative division of economic and ideological issues may decrease the level of political intervention to some extent. The readers may ask whether this enforced cognitive division can sustain long-term growth. After all, most economic issues cannot avoid politics. Nevertheless, at least the people could momentarily bypass some political constraints, and thus focus more on economic targets than on abstract ideologies.

Stiglitz (1999), Roland and Verdier (1999), and Lin (2004) suggested that China presented an incremental pattern in its transition to a market economy.[9] This pattern seems consistent with Beijing's pragmatism principle. China's corporate reforms were progressively practiced in a series of trials, mostly in the steel sector before being widely expanded. Those specific lessons in China, as typically experienced by its steel sector, can be used to highlight how critical it is to consciously apply the dynamic coordinating principle in economic behavior that Schumpeter (1912) has strongly advocated.[10]

China's story may also support relevant viewpoints around the "big push" theory and the idea of coordinated investment articulated by Rosenstein-Rodan (1943).[11] As Murphy, Shleifer and Vishny (1989) noted, governments could promote investment coordination and contribute to the industrialization of one section and enlarge the market size in other sectors.[12] They also stated that "persuasion and encouragement of investment alone might be an effective enough approach since these steps might

coordinate agents' plans on a better equilibrium".[13] But active government interference prevailed in China's steel business through those early stages. As it turned out, this pattern failed as it lacked an effective mechanism to sustain financially-efficient decisions. After 1978, China became increasingly dependent on market forces, instead of direct administrative commands, to persuade agents to make sound decisions. This transition is indicated particularly by the fact that China's metallurgical ministry, that held a superior position for decades, was quietly disbanded in 2001 after a three-year final adjustment and patient coordination.[14]

3. Some empirical analysis on the recent performance of China's steel industry

This section examines the recent performance of China's steel industry from the overall and firm-specific level. I will focus on those major state owned enterprises (SOE) and on the latest two decades when data is readily available. I present some significant structural transitions in the recent development of China's steel sector, and then the panel data collected is used to examine some institutional and investment factors in those steel SOEs' firm-specific performance.[15] The availability of data forces me to focus on approximately seventy top steel enterprises of China in the short period of 1984-1999. In the end I will address some current trends and problems in China's steel industry.

3.1. The structural transitions of China's steel industry

Since 1978 the steel sector has kept up an average growth of two to three million metric tons per year for more than twenty years.[16] Based on the official statistical categories, China's steel sector includes a series of sub-industries: mine exploration,

industrial design, project construction, technologies research, mining, coking and supplementary materials. Most large steel groups in China contained complete sub-systems, and were managed like small communities scattered across China.

Insert Table 1 and its Plot Here

This self-sustaining feature was mainly because of political consideration regarding readiness for wars, as indicated by the geographical distribution of mills. Most old mills were scattered across the interior of China that was less economically developed or cost-efficient but relatively difficult to reach during wars. China's economic-geographic division is inherited from the planning economy era when the country was divided into six big regions, correspondent to six military zones. Plot 1 shows the significant shift in the regional production of that time. This shift may indicate that more consideration came from market factors in the building of new steel plants after the 1970s. The production weight of the North-East region declined dramatically probably because most steel firms of this region were state-owned old firms and suffered slower upgrading of technology and greater exhaustion of natural resources.

Insert Table 2-A-B and its Plot Here

Table.2-A gives the number of China's steel enterprises after 1980. Table.2-B lists the top fifty Chinese iron and steel enterprises, all of which had an annual steel production above half a million tons in 2000. The total annual production of the Big Five accounted for about 33% of the total in China and about 85% for the top fifty plants.[17] Thousands of local small mills accounted for the remaining 15%. As a great deal of local benefit was involved, the exact statistics for this partition may be inaccurate. Those small

mills, with low technological levels, usually hire part-time technicians from other mills. Their markets are at the margins of large steel SOEs as they mostly target small orders ignored by larger mills. Most of their production is geared to the construction industry, with a huge demand that fluctuates with China's booming infrastructure projects.

In 2004 nearly five thousand iron and steel plants existed in China. The capacity statistics after 2002 are unavailable, perhaps due to the changes in statistical standards. A fluctuation in the number of mills from 1997-1999 can be spotted. The early plummeting of the number of mills could be a result of the preparation for the disbandment of the metallurgical ministry in this period. The East-Asia financial crisis in 1998 may also have attributed to this fluctuation. Table 2-A shows the number of plants jumped by 178.01% from 1998 to 2000 and it has kept increasing since then. From 1998 to 2004 this number increased to 4992, a growth of 363.08% from the 1098 mills in 1998. This may not be coincidental since Beijing started its deregulation in the steel sector around 1998. Multiple-source financing was endorsed to develop China's booming steel business. Most new small mills were built and financed by towns and private investors, indicating an investor structural transition in the steel business.

Insert Table 3 and its Plot Here

Some local reports may reveal more information. For instance, Hebei province, the biggest iron and steel producing region in China because of the richness of its mines, accounted for an average of about 20% of the national production in pig iron, crude steel, and product steel in 2001-2003. According to the local statistics in 2005, Hebei had 204 iron and steel enterprises left, but only 40 of them had the annual production capacity of above half a million tons. This status was disfavored by Beijing from the perspective of

surplus capacity, low efficiency and high environmental costs. Beijing frequently sent out messages to adjust the local steel firms. In 2003, three of the biggest local steel groups in Hebei's Tangshan City, Tangshan Iron and Steel group, Tangshan Guofeng Iron and Steel group and Tangshan Hentong Steel Plate, initiated a merging. This deal was obviously endorsed by Beijing and local governments. As hoped, this specific case initiated a wave of acquisition of small mills. Table 3 shows a swift local adjustment. From 2004 to 2005, Hebei's steel output was slightly increased while the number of local mills plummeted by 47.42%. It is hard to imagine that this dramatic adjustment could be so swiftly achieved without any government influence. But the local reports also suggest this local merging event was dominated more by the enterprises' business negotiation than by direct government commands.

Many studies showed that in the early 1990's for the first time the steel sector faced a product supply surplus in China. The yearbooks also show that it was a structural surplus: the supply of low quality steel was too big while the supply of high-grade steel product was far below the demand. Most surpluses were concentrated in the iron-steel construction products, such as wire and rod products, and were largely supplied by thousands of local small mills. Even as the biggest steel producer, China still had to import a large percentage of its steel from the international markets because its current technology could not satisfy those special requirements.

Insert Table 4 and Its Plot Here

Based on China's industrial statistics system, the major products of its steel sector include three categories: pig iron, crude steel, and product steel. Table 4 and its plot indicate a significant reversal in China's major steel production. In the beginning of the

plotted period, pig iron was more widely produced, but the production of crude steel and product steel gradually caught up. In 1996 China became the biggest iron and steel producer, but still more pig iron was made. The quantity of product steel surpassed pig iron and crude steel in 2000 while crude steel also surpassed pig iron. After the reversal, the production gaps continued expanding. More production of down-stream products means more additional values. This stylized fact suggests that China's steel sector became more interested in producing the high-valued steel product instead of the gross output indexed by the total production that was more stressed in the planning economy era.

Insert Table 5 and Its Plots Here

With a sustained growth, China's expanding steel sector became actively involved in international business. A few official statistics collected indicate how the fluctuation of China's imports and exports of iron and steel products was impacted in a cyclic pattern. In the last 25 years China greatly increased both its steel exports and imports in the world steel business. But China still had more imports than exports of iron and steel in both tonnage and value, even after it became the biggest iron and steel producer in 1996. I lack the official figures from 2005, which was generally predicted to have been the first year in which a reversal in China's import and export of steel occurred. The tables below list the biggest importers and exporters of China's steel industry in 2004.

Insert Table 6-8 and Its Plots Here

The table of Imported Iron Ore & Iron Output in China from 1980-2002 shows that China became increasingly dependent on the world iron ore market for its iron and

steel production. In the past several years, the escalating price of iron ore created a great deal of uncertain factors for China's iron sector's incorporation into the world market. In 2004, more than 52.5% of the iron produced in China was from the iron ore imported from Austria, Brazil and India. It is critical to know the game rules in the international expansion of China's steel groups. This international competition was significantly reflected by the events of 2006 during the bitterly-prolonged price negotiation between the major iron ore suppliers represented by the Rio Tinto Group and BHP Billiton from Australia, Companhia Vale do Rio Doce from Brazil, and China's steel industry represented by the Baosteel steel group and the Chinese Steel Enterprise Association. Experiences from China's steel industry will incite more interest in future study.

3.2. Some empirical examinations on the firm-specific performance

As argued earlier, a sustainable sectorial growth requires the coordination of interrelated sectors in the economy because one industry alone cannot prosper when the whole economy has been sabotaged. The coordination principle should also be applied to the investment dimension. Thus it is expected that some transitional features of investment have been occurring with other structural changes in China's steel sector. Based on China's industrial statistics system, the fixed investment is divided into two broad categories with strict distinctions: the capital construction investment (CCI) and the technical updating (and/or transformation) investment (TUI). Generally speaking, the CCI is aimed at capacity expansion. If the new projects are affiliated with the existing firms but can expand the original production capacity, the relevant spending should be counted as CCI. It also includes costs for the full-scope removal and for the rebuilding of

factories due to environmental regulations, or damages from uncontrollable natural hazards, and most new transportation projects such as ports and railroads. After Beijing and local governments approve the investment proposals, the firms can start accumulating funding from internal or external sources. In particular, the overhauls and the purchase of new machines in the CCI projects cannot be calculated as TUI.[18]

TUI is normally requested by the full-fledged enterprises for their technological updating or transformation for quality improvement. It can be regarded as continuing investment to update the existing technology, while CCI aims more at expanding production capacity. The TUI projects usually imply shorter cycles than the CCI projects. After 1978 the SOEs had more rights in deciding their own technical updating and transformation. Correspondingly, more technical updating was financially supported by the firms themselves. But the building of major new steel projects was still largely controlled by Beijing and the provincial governments. According to the classic economic theory, technological updating investment should generally provide better economic efficiency than capital construction investment, assuming no agency problems in both investment activities. But I sincerely suspect two investment categories with different properties would still present the same level of agent problems.

Insert Table 9 and Its Plots Here

The plots for each period from 1953 to 2003 show this significant reversal in the investment structure of China's steel industry. Plot 9-B shows the weight of the technical updating investment in the total fixed investment kept increasing, while the annual total fixed investment also kept increasing as from Plot 9-C. This stylized fact suggests that Beijing probably realized that simply increasing the investment in new project could not

maintain corporate growth or economic health. The dynamic structure of investments appears more critical than the total values. In the earlier stage the effects of investment can be significant, but they will become elusive following the law of diminishing profits. Based on the classic economic theory, the key is technology. The increasing weight of technology updating investment presents a logical transition in China's steel sector. On the macro-level, this reversal indicates that Beijing started consciously applying the market principle in its transition. Nevertheless, I doubt that this structural transition affected performance of China's major steel SOEs universally at the firm-specific level. As China's economic reforms have generally followed an incremental pattern in the last two decades, as described earlier, dichotomies are expected in those adjustment periods, and the data available, collected for 1993-1999, happens to be for those periods. The following paragraph will specifically describe the data and variables for the examinations.

Please keep in mind that the inconsistency in China's statistical system may greatly limit the soundness of my empirical findings. I try to interpret the original data as consistently as possible. The panel data includes most of China's major steel SOEs, most of which are listed in Table 5-B. The performance is indexed by the gross sale or the profit before tax over the total asset, the net fixed asset, and the number of employees, which will also be used as the dependent variables. The major explanatory factors include three dummy variables, the age of mills, the fixed effect of years, and the values of two types of cumulative fixed investments over total assets, net fixed assets and worker force size. Three dummy variables include a Region index, a Group index and a political interference index conveniently named Large. The Coastal/Southeast region (Region=1) represents a relatively open environment while the Inland region (Region=0) generally

has a relatively conservative culture. The Group index can present a possible advantage of internal financing. For dummy variable Group=0, this firm was not grouped into a syndicate holding some diversified business like mining or service. The large index can represent the level of government interference for those steel SOEs. For the index of Large=1, this firm was regarded as a large key plant that would be more likely interfered with by Beijing and less controlled by provincial governments or municipal authorities. This Large index may be better renamed as Political Influence, as Large=1 implies more direct political intervention by Beijing that had historically granted itself with the authority and responsibility for those assumingly large steel firms since 1949.

Initially I attempted to use a technological index as a control variable in the regressions. The Cobb-Douglas function, usually taken in a form of $Y = F(K,L) = AK^aL^b$, (where Y = Output; K = Capital input; L = Labor input; A = Technology or Total Factor Productivity), could be applied here to get TFP for the further regressions. The necessary data is not available or complete in my sample due to some statistical changes after the corporate reforms. Nevertheless, it remains an intuitive idea if more data becomes available in the future. Before performing any further tests at the firm-specific level, I will first examine the descriptive characteristics relating to profitability, labor and growth.

Insert Table 10-A-B Here

Table 10-A shows that the group characteristics and the government intervention level present similar features in profitability, labor payroll and growth indexes. The Large and Group samples have smaller means in the gross sale over total asset, the profit before tax over total asset, and the net fixed asset, but show larger means in the average

payroll and most growth indexes, implying some extreme observations in the sample. A higher average payroll indicates a higher labor cost in those steel SOEs. Their managers can be more privileged because their payroll is usually higher than the steel workers'. In the data collected, both the workers' and managers' payroll are pooled for calculation. Thus I cannot exclude the possibility of the agents' motive of self-interest in the decisions of M&A in China's steel SOEs, just as in the analysis by Morck, et al. (1990).[19]

If the managers' payoffs were more correlated to market share, the managers may have an incentive to increase their firms' size as an evaluation proxy measurement. If more information was available, I would examine whether such agent problems also prevail in the expanding M&A events in China's steel sector. However, the mean and median growth of the average payroll are lower in the group and large firms, probably because the remaining groups have more space to increase the workers' payroll from a lower starting point, and thus they are catching up with regard to the weight of labor costs within their total production costs. For the average growth of sale and total assets, their means are higher in the group and large firms, but their medians are lower. It suggests that not all cases of grouping are being positively related to the growth of sales or total assets. Next I apply the GEE analysis addressing the firm performance with respect to the explanatory variables. The regressions will take the general form as follows:

$$\text{Performance Index/scale}_{i,t} = \sum Y_i \times \text{Year}_i + l_i \times L_{i,t} + g_i \times G_{i,t} + r_i \times R_i + a_i \times A_{i,t} + \sum s_k \times \log(\text{Scale factor}_{k,i,t}) + \sum_{k=1}^{2} i_k \times \text{Investment}_{k,i,t} / \text{Scale factor}_{i,t}$$

$$\text{Investment}_{1,i,t} = \text{Cumulative Capital Construction Investment of N years} = \sum_{k=1}^{N} \text{Captial Construction Investment}_{t-k,i}$$

$$\text{Investment}_{2,i,t} = \text{Cumulative Technical Updating Investment of N years} = \sum_{k=1}^{N} \text{Techincial Updating Investment}_{t-k,i}$$

In the above equations, the subscript i would stand for the firm i, k stands for those two investment types, t stands for the year i, and n stands for the lagged years in

finishing those investments. I need to estimate those coefficients of those explanatory variables as indexed correspondingly. Here the performance indexes are the profit before tax and the gross sales, and the scale factors refer to the total fixed assets, the net fixed assets, plus the worker force size and the fixed effect of year as the explanatory factors in the regressions. The cumulative investment of the lagged one year and three years are used for robustness examination. The data sample presents a highly significant positive correlation between the total asset and the net fixed asset. Thus to avoid colinearity problems, I include only one of these two variables in each regression. The correlation coefficient matrix is reported in 10-B. As the GEE analysis does not result in an R-square statistic, I apply a generalized linear model procedure to estimate the extent of variance explained by the model. These GEE regressions, clustered by the firms, provide the Huber-White empirical standard error estimators that are reported as follows.

Insert Table 11-A-L Here

Based on my theory expansion derived from Murphy, et al. (1989), the "big-push" or simultaneous industrialization may arguably increase profitability, and the result relies on sub-sectors' positions. In certain circumstances a relatively profitable sub-sector can subsidize the unprofitable sector to expand the latter's production, and thus all are benefited by the coordinated act. This benefit of fellowship arises only if the low technology sub-sectors can produce greater profits. Because such a condition is not solid, I project that China's SOE steel syndicates may present dubious advantages during the adjustment period. Moreover, if the coefficient for the group index was insignificant, the performance indexes may not be positively correlated with the technical updating

investment, as it cannot necessarily imply efficiency improvement in the following years as assumed from the updated technological level.

My preliminary hypothesize can be specifically stated as follows. The sign of Group is elusive due to the unclear advantages of internal financing; the coefficient of Large is mostly likely negative due to direct governmental interference by Beijing; the coefficient of the Region index probably will have a positive sign as the openness of the business environment should promote performance; the TUI perhaps presents different (possibly negative) effects compared to the CCI of those major steel SOEs in the regressions on the firm-specific performance of China's major steel SOEs during the transitional years of 1993-1999,. The age of mills can also be elusive because most SOE mills were established in the 1950-1960, except a few new ones like the Baosteel group.

The regression results using one-year lag are consistent with my propositions and the three-year robustness examination. No significant relationship is found between the group dummy and the performance except in one regression, but I find a significant negative sign of the large dummy, which suggests more inefficiency and bureaucracy could exist in those steel SOEs closely-linked to Beijing. The evidence also indicates that the performance indexes present a significantly negative correlation with the cumulative technical updating investment ratios and a significantly positive one with the cumulative capital construction investment ratios. The negative relationship between the lagged TUI and the firm-specific performance probably implies some agency problems in the investment decisions of China's major steel SOEs during the late 1990s, meanwhile the weight of TUI presents an increasing trend in China's steel industry at the macro-level. This finding entails more specific analysis at the firm-specific level.

Insert Table 12 Here

To doubt-check the effects of those two investment categories, I apply regressions further to the first difference of those firm performance variables. The first difference of two performance indexes—the profit before tax over net fixed asset and the gross salve over net fixed asset—are selected to report as the other repeated regressions provide similar but weaker results. Table 12 shows that the first differences of the selected indexes are significantly negatively correlated with the cumulative technical updating investment, while its counterpart—the cumulative capital construction investment—presents some significant positive or insignificant coefficient signs. The dummy variables generally lost explanatory power in those regressions. The new findings also confirm that something could be potentially and relatively wrong in the decision-making of the technical updating investment in those major state-owned steel firms in China.

3.3. Current problems and trends

China's economic transition since 1979 can be compressed into the following pattern; Beijing emphasized political and constitutional issues, while a highly decentralized condition gradually began to characterize China's economic development. This pattern looks somewhat similar to the *Guandu Shangban* policy advocated by the Confucian elites one century ago in the early stage of China's industrialization. The results of this policy largely depended on the success of institutional transitions, in which Zhang Zhidong and Sheng Xuanhuai failed in their early efforts to save the falling

Empire. It can be obviously noted that in China's steel industry, currently, both problems and trends stem from the same origin: the institutional transitions in China.

The core issue for China's economic transition to succeed probably lies in the reform of ownership, which is still politically-sensitive but openly-debatable in China. The reform in financing is directly related to the ownership reform and it has been in process for two decades. As an attempt to decrease government interference in business, Beijing resumed issuing steel stocks to the public in the late 1980s when two national stock markets were established in Shanghai and Shenzhen. In the mid-1990s about thirty major steel groups had their sub-companies publicly listed in Shanghai, Shenzhen or Hong Kong. Still the governments hold the largest share in all major steel firms of China.[20] In this process, information exposure became an obvious obstacle in China's financial reforms. Because information was not transparent, the public had reasons to suspect that the steel SOEs' managers could fake figures to satisfy private interests.

Many researchers note that the Merging and Acquisition in China's steel sector has accumulated momentum in recent years. Were it not for the agency problem, the inter-sector or intra-sector M&A would help to expand the economy, but I doubt all M&A cases can promote efficiency without supplementary measures or constitutional support. In the last few years, reshuffling in China's steel business occurred so dramatically that M&A cases were announced almost every month. In late 2004, the Baosteel group announced another Second Public Offering of its common stock shares. The new stock issue planned to raise 28 billion Yuan for new M&A and project funding.[21] Immediately following the announcement of Baosteel's SPO, the Wugang group in Central China publicized its reconstruction plan, planning to merge some large local steel

groups, including the Chongqing group in Southwest China and the Hang Zhou group in East China. After the merging, both the size and market of Wugang approached that of Baosteel.[22] But a new Tangang group in East China soon changed the ranking, after regrouping three major local steel groups in Hebei province in 2005.

In the late 1990s Beijing accelerated deregulation of China's steel industry and the SOEs were more independently managed by their executives who were appointed by the diversified owners and backed by the firms' CCP committee. Those managers may voluntarily get involved with M&A activities to maximize their private interest, from increasing market shares or production efficiency. Publicly, Beijing handed the M&A decisions to the steel SOEs. But the final approval for major M&A among China's steel SOEs was still largely held by Beijing. Generally speaking, China still has a number of unsettled political concerns, aside from those unsettled disagreements on how to transfer the very large shares of state ownership to the public. Beijing cannot avoid the eventual constitutional transitions, although it is a positive sign that the coordination principle is consciously applied by Beijing in the macro and micro spheres.

Another major problem in China's steel sector is the difficulty of technical updating and innovation. This problem has been particularly well demonstrated by my early analysis on the firm-specific performance of China's major steel SOEs in 1993-1999. Based on the official statistics in 2000, China hired the largest number of steel workers, about three million, yet China's share of added value for the metal industry worldwide was less than 2%. An average Chinese steel worker produced about 100 tons per year, far below other steel producers in the world, who produced an average of 800 to 1000 tons per year.[23] Moreover, the difficulty of technical updating in China's steel sector

created serious pollution. Beijing was frequently involved in closing small polluting mills, but the results were not bright: each time the most polluting mills could easily re-open without solving their problems because other issues, such as employment and taxation, were higher priorities for local governments. Technical updating or innovation, with some effective regulation enforcement, can solve those environmental problems; the difficulty of technological updating can be solved by the financing reforms. Were the payoff for investors guaranteed, the investment would flow into the most demanded fields. Of course, M&A may be a viable solution to technical updating or innovation as large firms can relatively easily afford those technical and financial burdens.

The development of China's steel sector took a progressive path consistent with its complicated past. Those transitions are irreversible and I think that keeping a distance from any political or ideological conflict looks to be a good strategy for gaining steady development opportunities, but it is too unrealistic to succeed in any institutional transitions without considering politics. These political factors are beyond my focus here. Hopefully, Beijing can continue its economic advance with less political interference in its future reforms. Overall, Beijing still has a lot to do to resolve those problems, and I expect to see more transitions in its pioneering steel sector.

4. Conclusion

This essay presents some empirical findings regarding China's steel industry that can inform future studies. A deregulation trend dominated the recent development of China's steel business. This happened with some significant structural transitions. This study shows that governmental intervention needs to be implemented with extreme

caution, as indicated by China's experience. This essay supports some viewpoints addressed by the "big push" theory. Government interference is not viable in China's current situation. Examining the firm-specific performance of China's major steel SOEs, I find that some political intervention residue still presents a negative effect while environmental openness presents a positive one in the transitional period examined.

The weight of technical updating investment continually increased in China's steel sector at the macro level. But more specific evidence shows that at the firm level, the performances of China's major steel firms significantly negatively correlated with their technical updating investment, while their capital construction investment presents positive effects from 1993-1999. It suggests that the fixed asset investment to expand capacity is more positive to the firm-specific performance of China's steel SOEs during those transitional years. This may be due to some agent problems in the decisions of technological updating investment in China's steel SOEs during the transitional period from 1993-1999. These problems suggest that more institutional transitions can be ongoing in the move toward a complete market economy in China.

Endnote:

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[1] The Chinese Iron and Steel Industry Yearbook (1985-2005), published by China's Ministry of Metallurgical Industry, later the State Bureau of Metallurgical Industry under the State Commission of Economics and Trade, then the Chinese Iron and Steel Enterprise Associate. The figure of 2005 is attained from the media report and should be confirmed in the unpublished steel yearbook of 2006.

[2] Harriet T. Zurndorfer, Confusing Confucianism with capitalism: Culture as impediment and/or stimulus to Chinese economic development (2004).

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[4] Albert Feuerwerker, China's early industrialization (Athenaeum: Harvard University Press, 1970).

[5] Tim Wright, Coal Mining in China's economy and society 1895-1937, Literature and Institutions Cambridge Studies in Chinese History, (Cambridge: Cambridge University Press, 1984).

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[7] M. Gardner Clark, Development of China's Steel Industry and Soviet Technical Aid, New York State School of Industrial and labor Relations from Cornell University, (1973)

[8] The annual iron & steel product picture as indicated by Table 1 and its plots.

[9] Joseph E. Stiglitz, "Whither Reform? Ten Years of the Transition", At the Annual World Bank Conference of Development Economics(1999). Gérard Roland, and Thierry A. Verdier, "Transition and the Output Fall" Economics of Transition (1999), 7(1), pp. 1-28. Justin Yifu Lin, "Lessons of China's Transition from a Planned Economy to a Market Economy", CCER Working paper series, Beijing University (2004), 1-40.

[10] Joseph A Schumpeter, The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle(Cambridge: Harvard University Press, 1934)

[11] Paul N Rosentein-Rodan, "Problems of industrialization of eastern and south-eastern Europe", the Economic Journal, June-Sep., 1943, Vol.53, P202-211.

[12]Kevin Murphy, Andrei Shleifer and Robert W. Vishny, "Industrialization and the big push", The Journal of Political Economy, Oct., 1989, 97, no.5, Page 1024.

[13] Ibid, Page 1019.

[14] The government announcement, State Commission of Economics and Trade of China, 2001, No.36.

[15] Details of this theory expansion can be found in the other chapter of my early study.

[16] Data source: Chinese Iron and Steel Industry Yearbook (1985-2005).

[17] Based on the statistics in 1998, the Big Five: Baosteel in Shanghai, Wugang in Wuhan, Angang in Liaoling, Shougang in Beijing, and Bao (tou) gang in Inner-Mongolia.

[18] Chinese Investment Dictionary (Shanghai: Shanghai Social Science Institute, 1990), P959.

[19] Randall Morck, Andrei Shleifer and Robert Vishny, "Do Managerial Objectives Drive Bad Acquisitions?" Journal of Finance 45(1), (1990), 31-48.

[20] Zhao Lingfeng and Li Kai, "The empirical study of the capital structure analysis of the listed steel sector in China", Metallurgical management and economics, 2003, 16, 35-39.

[21] About 3.4 billion US dollars based on the contemporary exchange rate between Renminbi (RMB) and U.S dollars in the early 2004, mostly pegged at rate of 1-8.2 to 8.3.

[22] By June 2005, this SPO has been realized before the finish of my draft.

[23] Data source: the Chinese Iron and Steel Industry Yearbook (2003).

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Appendix

Table.1. Regional Distribution of China's Crude Steel Annual Output for 5 Decades

Region	1950	1970	1980	1990	1998	2000
North	12.72	19.96	21.51	22.69	26.10	26.82
North-East	82.83	37.32	26.44	20.89	14.30	14.16
East	1.95	23.70	24.74	27.57	31.60	31.91
Mid-South	0.90	13.57	15.05	16.64	15.80	15.95
South-West	1.61	4.51	10.34	9.38	8.80	8.93
West	0	0.94	1.91	2.82	3.40	3.34

Note: the regions are refereed for the statistical categories from the planning economy era.
Data source: "The rising of the Chinese steel industry in 20th century" by Zhang Shourong in World technological Research and Development 2001; Engineering Science of China, June 2001 Vol.3.No.6;

Plot.1. the regional distribution of the crude steel annual output in China

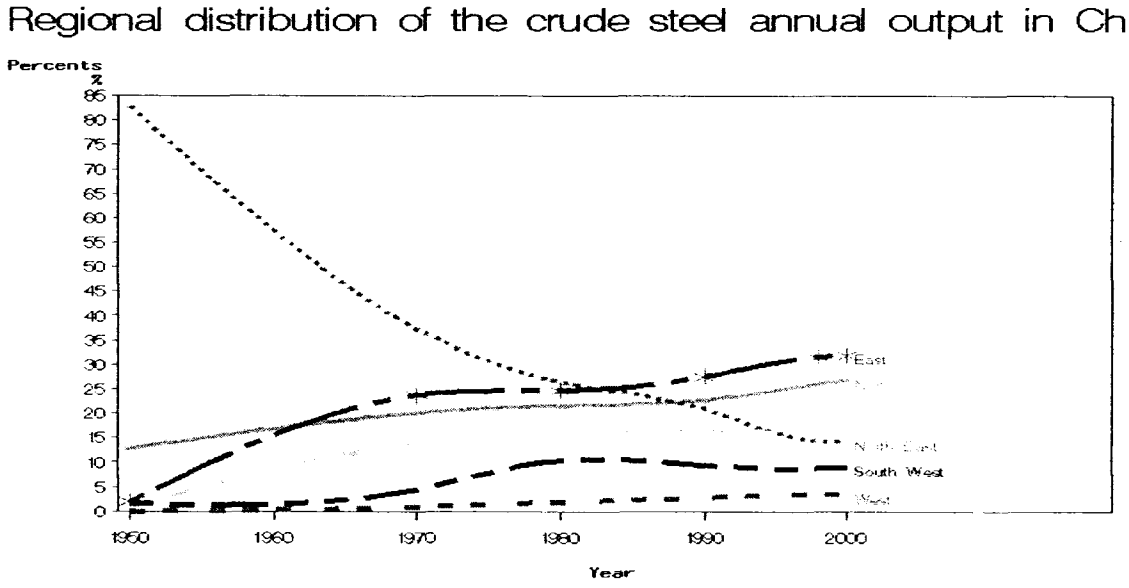


Table.2-A. General Information of the Steel Industry of China after 1980

	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1.number of firms	1332	1318	1598	1639	1495	1516	1078	1042	2997	3176	3333	4119	4992
A: 0.5-1 m tons	2	6	12	17	18	18	18	18	13	11	8	-	-
B: Above 1 m tons	12	12	16	21	24	28	34	30	37	47	41	-	-
C: Above 5 m tons*				4	4	4	4	4	4	4	8	13	-

* Data source: Chinese iron and steel industry yearbook 2001-05.

Table.2-B. Top 50 Chinese Annual Steel Production (above half one million tons) in 2000

No.	Name of steel group or company	Production (Metric tons)	Year of Establishment
1	上海宝钢集团 Shanghai Baosteel (Group) Co.	1773.47	
	(宝山钢铁 (集团)公司 Baoshan Iron & Steel Corp.)	1130.42	1978
2	鞍山钢铁集团公司 Anshan Iron & Steel (Group) Co.	881.24	1919
3	首钢总公司 Capital Steel Corp.	803.26	1919
4	武汉钢铁(集团)公司 Wuhan Iron & Steel (Group) Co.	665.17	1955
5	本溪钢铁(集团)有限责任公司 Benxi Iron & Steel (Group) Co. Ltd	422.34	1905
6	包头钢铁集团有限责任公司 Baotou Iron & Steel (Group) Co. Ltd	392.48	1954
7	马鞍山钢铁股份有限公司 Maanshan Iron & Steel (Group) Co. Ltd	392.24	1911
8	攀枝花钢铁(集团) Panzhihua Iron & Steel (Group) Co.	359.5	1965
9	唐山钢铁集团有限责任公 Tangshan Iron & Steel (Group) Co. Ltd	319.55	1943
10	舞阳钢铁有限责任 Wuyang Iron & Steel Co. Ltd	315.01	1970
11	济南钢铁集团总公司 Jiannan Iron & Steel (Group) Corp.	303.03	1958
12	凌源钢铁公司 Lingyuan Iron & Steel Co.		1966
13	安阳钢铁集团有限责任公司 Anyang Iron & Steel Group Co. Ltd	243.43	1958
14	太原钢铁(集团)公司 Taiyuan Iron & Steel Group Co.	242.87	1934
	(宝钢上海第一钢铁公司 Baoshan Shanghai No.1 Co.)		1943
15	莱芜钢铁集团有限公司 Laiwu Iron & Steel Group Co. Ltd	214.02	1970
16	酒泉钢铁集团有限责任公司 Jiuquan Iron & Steel Group Co. Ltd	192.59	1958
17	天津天钢集团有限公司 Tianjin Tiansteel Group Co. Ltd	190.08	1935
18	昆明钢铁集团有限责任公司 Kunming Iron & Steel Group Co. Ltd	85.26	1953
19	南京钢铁集团有限公司 Nanjing Iron & Steel Group Co. Ltd	177.65	1958
20	重庆钢铁集团有限责任公司 Chongqing Iron & Steel Group Co.Ltd	177.32	1940
21	新余钢铁有限责任公司 Xinyu Iron & Steel Co. Ltd	164.87	1958
22	通话钢铁集团有限责任公司 Tonghua Iron & Steel Group Co. Ltd	152.44	1965
	(宝钢上海五钢 Baosteel Group, Shanghai No.5 Co.)	151.84	1958
23	广州钢铁集团有限公司 Guangzhou Iron & Steel Group Co. Ltd	150.55	1957
24	江苏沙钢集团有限公司 Jiangsu Shasteel Group Co. Ltd	147.38	1975
25	水城钢铁集团有限责任公司 Shuicheng Iron & Steel Group Co. Ltd	147.21	1966
	凌源钢铁公司 Lingyuan Iron & Steel Co.)	144.82	1966
	宝钢上海浦东钢铁 Baosteel Group, Shanghai Putong Co.	140.11	1982
26	韶关钢铁集团有限责任公司 Shaoguan Iron & Steel Group Co. Ltd	135.05	1966
27	杭州钢铁集团公司 Hangzhou Iron & Steel Group Co.	126.61	1957
	(宝钢上海梅山有限公司) Baosteel Group Meishan Co. Ltd.	125.11	1969
	(湘潭钢铁集团有限责任公司) Xiangtan Iron & Steel Group Co.)	120.9	1982
28	宣化钢铁集团有限责任公司 Xuanhua Iron & Steel Co. Ltd	120.71	1919
29	福建省三明钢铁厂 Fujian Sanming Iron & Steel Works	117.1	1959
30	邢台钢铁集团有限责任公司 Xingtai Iron & Steel Co. Ltd	116.61	1958
31	新疆八一钢铁集团责任公司 Xinjiang Bayi Iron & Steel Group Co. Ltd	114.85	1951
32	鄂城钢铁集团有限责任公司 Echeng Iron & Steel Group Co. Ltd	111.39	1957
33	承德钢铁集团有限责任公司 Chengde Iron & Steel Group Co. Ltd	105.06	1953
34	广西柳州钢铁(集团)公司 Guangxi Liuzhou Iron & Steel (Group) Co.	104.34	1958
35	天津天钢集团有限公司 Tianjin Tiansteel Group Co. Ltd	102.78	1935

36	石家庄钢铁有限责任公司	Shijiazhuang Iron & Steel Works	102.38	1957
37	青岛钢铁集团公司	Qingdao Iron & Steel Group Co.	100.09	1959
38	长治钢铁(集团)有限公司	Changzhi Iron & Steel (Group) Co. Ltd	87.73	1947
39	萍乡钢铁有限责任公司	Pingxiang Iron & Steel Co. Ltd	80.32	1954
40	新兴铸管(集团)公司	Xingxin Pipe (group) Corp	78.44	1970
41	华菱钢铁集团有限责任公司	HuaLing Iron & Steel Co. Ltd	78.32	1959
42	江阴兴澄钢铁有限公司	Jiangyin Xingcheng Iron & Steel Co. Ltd	75.37	1970
43	山西省新临钢钢铁有限公	Shanxi New Linfen Iron & Steel Co. Ltd	74	1998
44	南昌钢铁有限责任公司	Nanchang Iron & Steel Co. Ltd	73.58	1958
45	天津钢管公司	Tianjin Pipe Corp.	63.55	1990
46	合肥钢铁集团有限公司	Hefei Iron & Steel Group Co. Ltd	63.3	1958
47	江苏锡钢集团公司	Jiangsu Xisteel Group Co.	60.65	1958
48	江阴兴澄钢铁有限公司	Jiangyin Xingcheng Iron & Steel Co. Ltd	60.11	1970
49	舞阳钢铁有限责任公司	Wuyang Iron & Steel Co.	55.08	1970
50	成都钢铁厂	Chengdu Iron & Steel Works	50.11	1958

Note: All figures are all in 10,000 metric tons. Data source: Chinese Iron and Steel Industry Yearbook 2001

Table.3. Basic Statistics on All Provincial Iron & Steel Industry of China in 2004

Province (region)	Total # of Enterprises	Gross output	Fixed asset Investment	New Investment	Investment to expand capacity	Investment in renovation
Total	4992	15664.45	1920.95	607.23	766.89	512.04
Beijing	33	476.60	7.78	0	3.08	4.69
Tianjin	161	668.33	41.71	14.87	1.05	25.33
Hebei	388	2422.61	243.38	103.90	71.17	59.20
Shanxi	311	824.58	92.13	27.05	46.52	10.82
Inner Mogolia	177	372.63	111.93	74.32	27.55	9.66
Loaoning	324	1370.79	211.53	16.82	95.31	95.15
Jilin	40	178.58	14.76	5.20	0.27	9.15
Heilongjiang	35	82.33	14.38	5.55	6.08	1.75
Shanghai	158	1063.01	98.30	2.60	58.57	37.03
Jiangsu	665	2113.74	129.84	20.59	97.22	11.76
Zhejiang	351	403.74	58.88	22.63	34.63	0.76
Anhui	74	399.00	72.95	15.08	26.51	29.76
Fujian	128	267.59	27.40	13.70	10.44	2.35
Jiangxi	48	263.07	38.84	7.73	11.49	19.57
Shangdong	241	1141.56	186.90	73.42	71.09	41.33
Henan	168	535.39	66.74	40.74	22.55	3.38
Hubei	109	558.29	88.25	23.97	18.76	43.86
Hunan	215	366.67	74.64	24.97	15.29	34.39
Guangdong	250	485.20	64.58	40.56	23.59	0.43
Guangxi	164	211.48	37.58	12.49	21.19	3.11
Hainan	7	7.35	2.31	1.05	0.45	0.81
Sichuan	266	520.76	73.87	15.77	39.81	18.07
Chongqing	71	129.51	18.34	9.61	1.24	6.65
Guizhou	242	167.96	19.48	7.51	3.73	7.94
Yunnan	126	213.36	41.86	11.18	12.97	17.53
Tibet			0.41	0.28	0	0.07
Shangxi	45	97.68	13.07	1.03	10.40	1.54
Gansu	96	137.34	35.87	5.06	22.28	8.49
Qinghai	29	37.78	4.61	1.81	0.42	2.16
Ningxia	46	34.62	5.15	2.18	0.59	2.31
Xinjiang	24	112.90	23.48	6.07	13.62	2.97

Note: The numbers for total amount are in 100 million Yuan. Data source: the Yearbook of 2005.

Table.4: Major Production of the Chinese steel industry for each period 1949-2004

Year	Pig Iron	Rude Steel	Product Steel	Iron-Ore Production	Coke	Ferroalloy
1949	25	15.8	14	59	53.60	0.09
Recovery period(1950-1952)	436	286	221	934	642	4.89
F1st "five plan"(1953-1957)	1998	1667	1320	5750	2819.90	29.38
2nd "five plan"(1958-1962)	8362	5590	3857	36175	16476.90	220.28
adjustment era(1963-1965)	2720	2949	2131	8245	3551.90	82.53
third "five plan"(1966-1970)	6145	6577	4658	20325	7841.40	226.11
4th "five plan"(1971-1975)	11456	11494	7774	44145	16693.10	373.77
5th "five plan" (1976-1980)	15692	14758	10519	53267	21112.70	449.72
6th "five plan" (1981-1985)	19090	20305	15709	58984	21478.70	548.54
7th "five plan"1986-1990)	28328	29586	23145	82977	31115.60	1027.95
8th "five plan"(1991-1995)	43362.5	42944.59	37447.23	114226.53	49582.35	1576.13
1995	10529.27	9535.99	8979.8	26191.86	13501.83	431.88
1996	10722.45	10123.68	9338.12	25228.27	13643.09	419.88
1997	11511.38	10891.1	9986.67	26861.18	13901.99	403.54
1998	11852.1	11458.84	10737.75	24689.09	12214.27	347.08
1999	12532.99	12395.41	12102.15	23723.01	11989.07	380.08
2000	13101.48	12850	13146.00	22256.19	12184.12	402.92
2001	15554.25	15163.44	16067.61	21701.47	13130.77	450.82
2002	17079.2	18224.89	19250.06	23261.94	11637.32	489.28
2003	21366.68	22233.60	24108.01	26271.93	17775.72	637.38
2004	25185.05	27279.79	29723.12	31130.35	20966.35	900.20

Note: All numbers are in 10,000 metric tons. Data source: Chinese Iron and Steel Industry Yearbook 2005.

Plot.4. Annual average production of the Chinese steel industry1949-2004

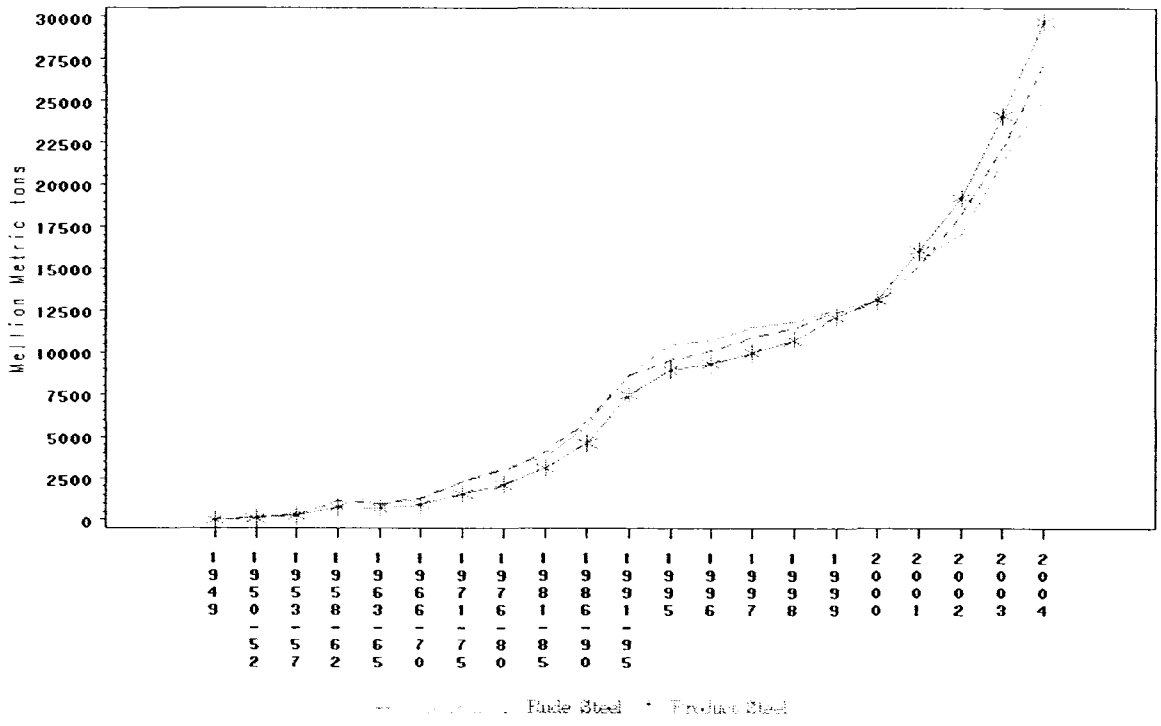


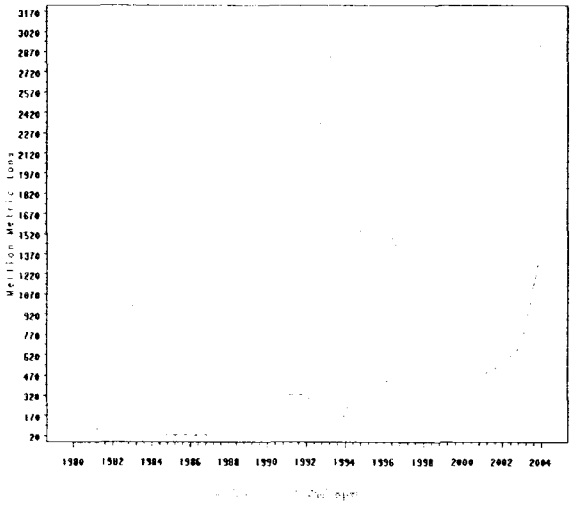
Table.5 Chinese Steel Imports & Exports1980-2004

Year	Steel Import (Million Metric tons)	Steel Import (10,000 US Dollars)	Steel Export (Million Metric tons)	Steel Export (10,000 US $)
1980	500.64	224010	46.85	12323
1981	331.86	136189	61.72	15242
1982	393.78	184130	110.1	24906
1983	978	320056	49.2	11200
1984	1331.4	407962	20.3	4977
1985	1963.49	581011	18.12	6521
1986	1742.23	518669	19.74	4654
1987	1174.94	386000	27.33	6409
1988	851.05	397070	65.83	22843
1989	819.72	466666	78.07	27112
1990	368.26	207600	208.98	61970
1991	332.59	235300	329.33	98560
1992	617.81	334800	326.7	99160
1993	3026	1107600	112.00	53000
1994	2282.84	874400	174.35	74600
1995	1397.23	667270	592.82	233252
1996	1598.38	710039	421.53	175367
1997	1322.45	651141	461.89	193414
1998	1241.55	628677	356.6	168698
1999	1486.27	700775	368.44	141319
2000	1596.14	853589	620.6	222933
2001	1721.73	896359	474.14	186704
2002	2448.81	1236585	545.50	218321
2003	3716.85	1991581	695.57	310496
2004	2930.27	2078723	1423.10	833632

Data source: Chinese Iron and Steel Industry Yearbook 2005.

Plot.5 Chinese Steel Imports & Exports 1980-2004

A: Chinese Steel Import & Export in million metric tons



B: China Steel Import & Export in 10 thousand US dollars

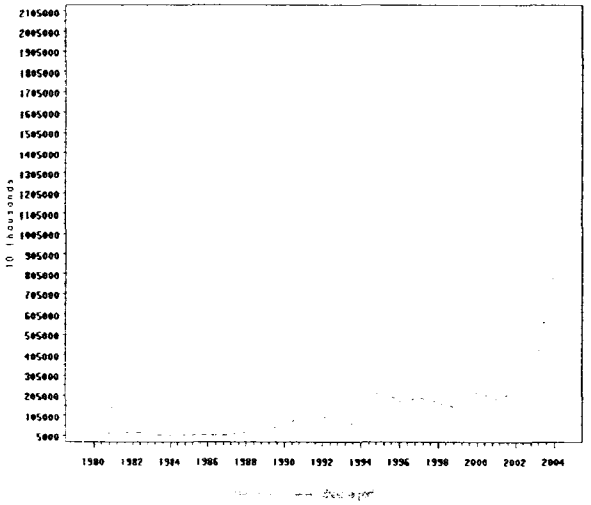


Table.6 Imported Iron Ore & Iron Output in China1980-2002

Year	Imported Iron Ore (1)	Iron from Imported Ore (2)	National iron output (3)	Percents of Iron from imported over Nation iron output (4)=(2)/(3)
1980	725.36	467.97	3802	12.309%
1985	1011.40	652.52	4679	13.946%
1990	1419.12	915.56	6237	14.679%
1995	4115.00	2654.84	10529	25.215%
1996	4387.00	2830.32	10721	26.400%
1997	5510.58	3555.21	11511	30.885%
1998	5177.07	3340.04	11852	28.181%
1999	5527.40	3566.06	12533	28.453%
2000	6997.16	4514.29	13101	34.458%
2001	9230.83	5955.36	15554	38.288%
2002	11149.59	7193.27	17079	42.118%
2003	14812.84	9556.65	21367	44.726%
2004	20808.86	13525.76	25674	52.683%

Note: All numbers are in 10,000 metric tons. Data source: Chinese Iron and Steel Industry Yearbook 2005.

Plot.6 Imported Iron Ore & Iron Output in China 1980-2002

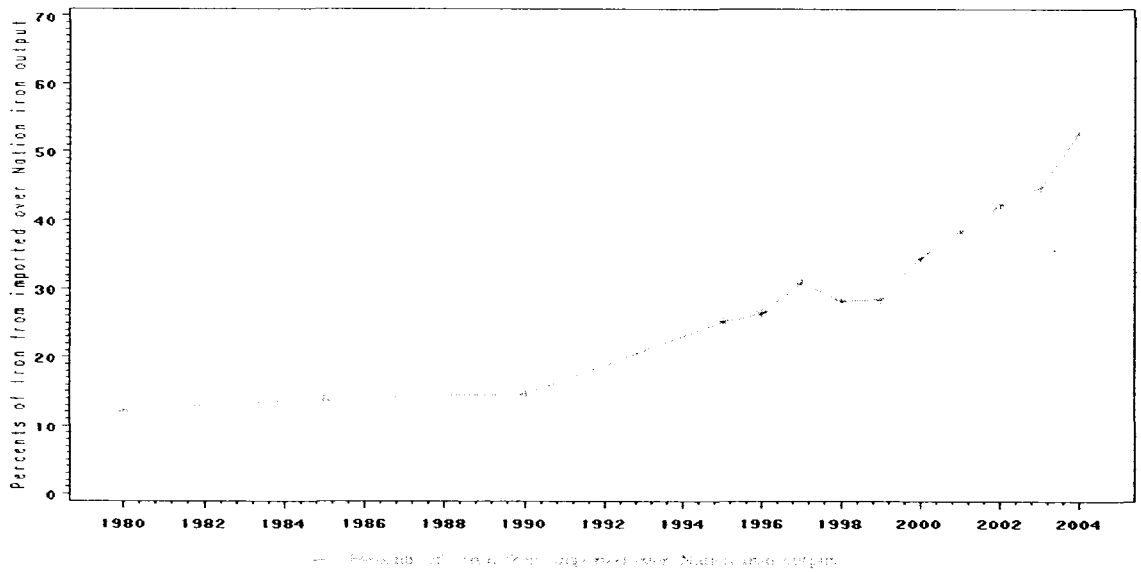


Table.7 Major Suppliers of Steel Products Imported by China 2003-2004

	2004		2003	
	Steel volume Imported (Tons)	Steel values Imported (US $)	Steel volume Imported (Tons)	Steel values Imported (US $)
Total Imported	2930.27	2078722.63	3716.95	1991633.76
Japan	779.43	576681.17	725.21	443749.06
Korea	494.19	418045.14	517.41	315587.05
Taiwan (China)	488.04	370461.68	598.89	361950.35
Russia	233.82	97663.99	344.63	128114.24
Hazakhstan	108.81	52373.88	131.68	46795.71

Note: All volume numbers are in 10,000 metric tons, while all value numbers are in ten thousand dollars.
Data source: Chinese Iron and Steel Industry Yearbook 2005.

Table.8 Major Importers of Steel Products Exported by China 2003-2004

	2004		2003	
	Steel volume Imported (Tons)	Steel values Imported (US $)	Steel volume Imported (Tons)	Steel values Imported (US $)
Total Imported	1423.10	833632.47	695.56	310505.99
Korea	341.47	170006.32	149.39	47319.81
U.S.A	194.63	133784.99	71.34	39616.75
Hong Kong(China)	114.23	61416.23	105.73	38153.20
Italy	79.00	42028.82	33.85	12838.50
Japan	69.28	47100.81	22.72	14648.14

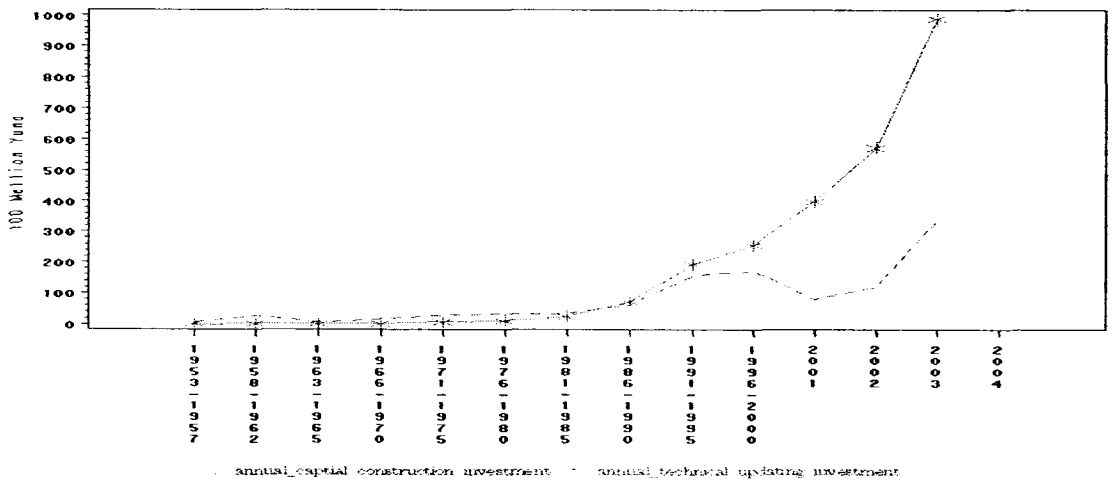
Note: All volume numbers are in 10,000 metric tons, while all value numbers are in ten thousand dollars.
Data source: Chinese Iron and Steel Industry Yearbook 2005.

Table.9. China Iron & Steel industry fixed investment 1953-2004

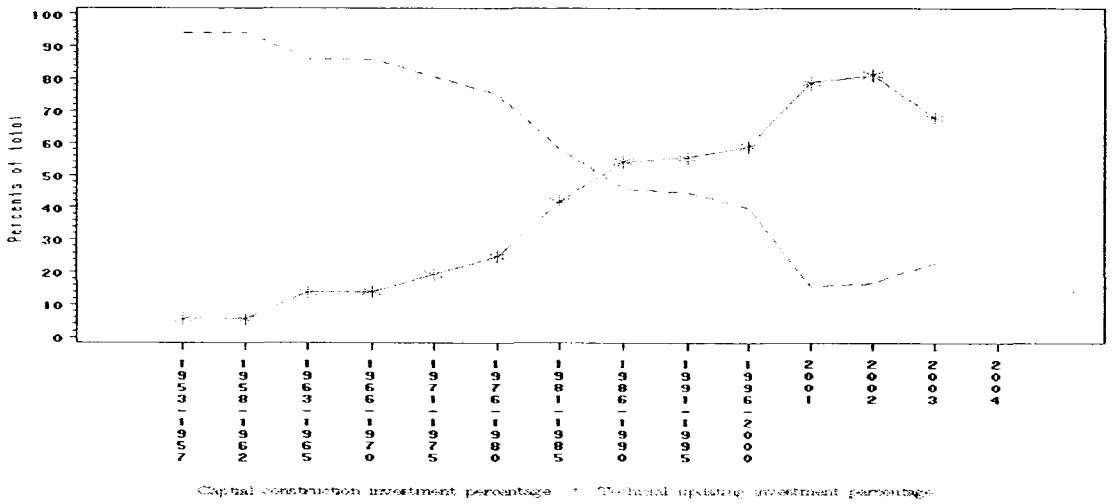
	Total fixed investment	Capital Construction fixed Investment		Technical updating and transformation Investment	
Year		Total	Percents (%)	Total	Percents (%)
first "five plan"(1953-1957)	40.22	37.93	94.31	2.29	5.69
second "five plan"(1958-1962)	139.61	131.67	94.31	7.94	5.69
adjustment phase(1963-1965)	24.01	20.7	86.21	3.31	13.79
third "five plan"(1966-1970)	96.12	82.65	85.99	13.47	14.01
fourth "five plan"(1971-1975)	177.86	143.34	80.59	34.52	19.41
fifth "five plan" (1976-1980)	220.85	165.89	75.11	54.96	24.89
sixth "five plan" (1981-1985)	291.69	169.76	58.2	121.93	41.8
seventh "five plan"1986-1990)	657.85	301.36	45.81	356.49	54.19
eighth "five plan"(1991-1995)	1743.96	778.23	44.62	965.73	55.38
1996-2000	2163.23	859.84	39.75	1275.85	58.98
2001	505.6	79.18	15.66	398.39	78.8
2002	704.28	117.91	16.74	572.36	81.27
2003	1453.11	333.75	22.97	988.60	68.03
2004	1920.95				

Note: The numbers for total amount are in 100 million Yuan.
Data source: Chinese Iron & Steel Industry Yearbook 2003.

Plot 9.A Average annual investment of China's steel industry 1953-2003



Plot 9.B. Average annual investment percentages for each period 1953-2003



Plot 9.C. Average annual total fixed investment for each period 1953-2003

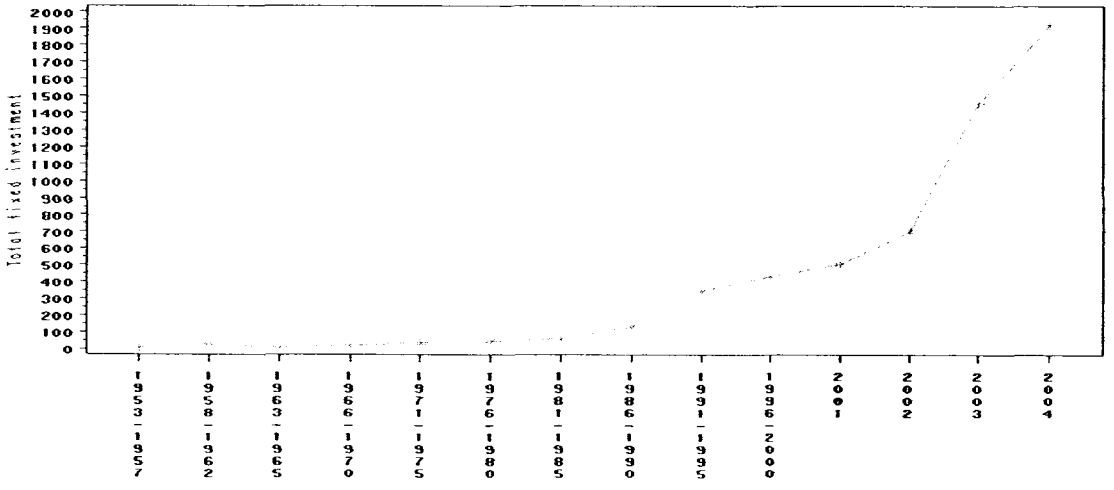


Table.10-A Descriptive Characteristic of Investment, Profit and Labor of China's major steel firms 1984-1999

	Group		Individual		Large		Small/Medium	
	Mean Size	Median	Mean Size	Median	Mean Size	Median	Mean Size	Median
Profit/Total Asset	0.015 278	0.008	0.017 211	0.007	0.012 191	0.007	0.017 298	0.008
Profit/Net fixed Asset	0.035 272	0.019	0.071 209	0.020	0.029 189	0.017	0.064 292	0.022
Gross sale/Total Asset	0.556 278	0.496	0.662 211	0.611	0.497 191	0.448	0.669 298	0.611
Workers' Ave. Payroll	8909 267	8481	7318	7063 210	8921 188	8352	7745 289	7403
Growth of Gross Sale	2.319 256	0.043	0.222 204	0.038	3.275 179	0.006	0.187 281	0.050
Growth of Ave. Payroll	0.128 256	0.085	0.217 205	0.170	0.177 181	0.121	0.161 280	0.122
Growth of Net Fixed Asset	0.464 255	0.088	0.342 203	0.200	0.562 180	0.103	0.312 278	0.139
Growth of Total Asset	0.594 278	0.081	0.137 210	0.134	0.772 274	0.098	0.159 298	0.105

Table10-B Pearson Correlation Coefficients of the Key Variables

Pearson Correlation Coefficients, N = 475
Prob > |r| under H0: Rho=0

CCCI=cummulative captial construction investment (CCCI)
CTUI=cummulative technical updating investment (CTUI)

	lag1_CCCI_net	lag1_CTUI_net	lag1_CCCI_total	lag1_CTUI_total	lag1_CCCI_per	lag1_CTUI_per	net asset_per	total asset_per
lag1_CCCI/net fixed asset	1 475	-0.00081 0.9859 475	0.97681 <.0001 475	-0.00174 0.9699 475	0.5139 <.0001 466	-0.00172 0.9705 466	0.00824 0.8592 466	0.06887 0.1377 466
lag1_CTUI /net fixed asset		1 475	-0.0007 0.9879 475	0.99994 <.0001 475	-0.00631 0.8919 466	0.99978 <.0001 466	-0.01731 0.7093 466	-0.01728 0.7098 466
lag1_CCCI/total asset			1 475	-0.00126 0.978 482	0.479 <.0001 472	-0.00144 0.9751 472	0.02112 0.6493 466	0.04823 0.2958 472
lag1_CTUI/Total asset				1 475	-0.00669 0.8847 472	0.99973 <.0001 472	-0.01656 0.7214 466	-0.01761 0.7028 472
lag1_CCCI/ per capita					1 472	-0.00318 0.945 472	0.42952 <.0001 466	0.65264 <.0001 472
lag1_CCCI/per capita						1 472	-0.00611 0.8954 466	-0.00708 0.8781 472
net asset/per capita							1 471	0.90023 <.0001 471
total asset/ per capita								1 478

Table.11. Panel Regression Result for the Firm-Specific Performance of China's Major Steel SOEs in 1993-1999.

Note: the explanatory variables include some firm-specific ratios, two dummy variables and three ratios of cumulative investment over total assets. Two types of investment include the capital construction investment and the technical updating investment. Three dummy variables refer to the group index (if Group=0, thus it was not yet incorporated into a corporate group with relative diversified business correlated with the steel production), the Large index (if Large=0, it means that the steel firm was not defined as a large key steel plants directly controlled by the central administration of Beijing, thus it would be under the supervision of provincial governments or local governments), and the Region index (if Region=0, the plant is located in the inland region, otherwise it is located in the Coast/East-South Region). Here are the explaining formulas.

$$\text{Performance Index/scale}_{i,t} = \sum Y_t \times Year_t + l_i \times L_{i,t} + g_i \times G_{i,t} + r_i \times R_i + a_i \times A_{i,t} + \sum s_k \times \log(\text{Scale factor}_{k,i,t}) + \sum_{k=1}^{2} i_k \times \text{Investment}_{k,i,t} / \text{Scale factor}_{i,t}$$

And the performance index/scale is the following six independent variables:

$\text{Proft/Total Asset}_{t,i} = \text{Profit before tax}_{t,i} / \text{Aggregated Asset}_{t,i}$.

$\text{Proft/Net Fixed Asset}_{t,i} = \text{Profit before tax}_{t,i} / \text{Net Fixed Asset}_{t,i}$

$\text{Proft/Per capita}_{t,i} = \text{Profit before tax}_{t,i} / \text{Worker size}_{t,i}$

$\text{Sale/Total Asset}_{t,i} = \text{Gross Sale/Aggregated Asset}_{t,i}$.

$\text{Sale/Net Fixed Asset}_{t,i} = \text{Gross sale}_{t,i} / \text{Net Fixed Asset}_{t,i}$

$\text{Sale/Per capita}_{t,i} = \text{Gross sale}_{t,i} / \text{Worker size}_{t,i}$

The explanatory variables also include the followings:

$$\text{CumulativeCapitalConstructionInvestmentof N years} = \sum_{k=1}^{N} \text{CaptialConstructionInvestment}_{t-k,i}$$

$$\text{CumulativeTechnicalUpdatingInvestmentof N years} = \sum_{k=1}^{N} \text{TechincialUpdatingInvestment}_{t-k,i}$$

$\text{CCCI}_N \text{ per capita}_{i,t} = \text{Cumulative Capital Construction Investment of N years/Worker Size}_{i,t}$

$\text{CTUI}_N \text{ per capita}_{i,t} = \text{Cumulative Technical Updating Investment of N years/Worker Size}_{i,t}$

$\text{CCCI}_N/\text{Total Asset}_{i,t} = \text{CumulativeCapital Construction Investmentof N years/Total Asset}_{i,t}$

$\text{CTUI}_N/\text{Total Asset}_{i,t} = \text{CumulativeTechnical Updating Investmentof N years/Total Asset}_{i,t}$

$\text{CCCI}_N/\text{NetfixedAsset}_{i,t} = \text{CumulativeCapitalConstructionInvestmentof N years/NetFixedAsset}_{i,t}$

$\text{CTUI}_N/\text{NetfixedAsset}_{i,t} = \text{CumulativeTechnicalUpdatingInvestmentof N years/NetFixedAsset}_{i,t}$

$\text{Total asset per capital}_{i,t} = \text{Aggregated Asset}_{t,i} / \text{Worker Size}_{t,i}$

$\text{Net fixed asset per capital}_{i,t} = \text{Net fixed asset per capital Gross sale}_{t,i} / \text{Worker Size}_{t,i}$

Note that N here is the number of cumulative years of lagged. I choose N=1 and N=3 in my following regressions;

Table 11-A

Profit /Total Asset

CCCI=cummulative captial construction investment (CCCI)

lag year=1

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		-0.1885	0.0480	<.0001	-0.1900	0.0485	<.0001	-0.1862	0.0475	<.0001
Large		-0.0273	0.0083	0.0010	-0.0284	0.0081	0.0005	-0.0265	0.0082	0.0012
Group		0.0006	0.0067	0.9333	-0.0003	0.0065	0.9669	0.0010	0.0066	0.8792
Year	1993	0.1006	0.0150	<.0001	0.0998	0.0144	<.0001	0.1009	0.0151	<.0001
Year	1994	0.0485	0.0100	<.0001	0.0478	0.0099	<.0001	0.0490	0.0101	<.0001
Year	1995	0.0071	0.0064	0.2710	0.0063	0.0063	0.3199	0.0075	0.0065	0.2506
Year	1996	-0.0026	0.0058	0.6513	-0.0042	0.0056	0.4532	-0.0017	0.0059	0.7670
Year	1997	-0.0174	0.0087	0.0467	-0.0176	0.0087	0.0431	-0.0173	0.0088	0.0501
Year	1998	-0.0033	0.0049	0.4983	-0.0035	0.0050	0.4832	-0.0033	0.0049	0.5015
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		-0.0001	0.0002	0.6951	-0.0001	0.0002	0.7490	-0.0001	0.0002	0.6962
Region		0.0105	0.0062	0.0935	0.0103	0.0063	0.1048	0.0108	0.0062	0.0832
lag1_CCCI/Net Fixed Asset		0.0052	0.0023	0.0224						
lag1_CTUI/Net Fixed Asset		0.0000	0.0000	0.9962						
lag1_CCCI/Total Asset					0.0445	0.0356	0.2121			
lag1_CTUI/Total Asset					0.0000	0.0001	0.9653			
lag1_CCCI/Per Capita								0.0000	0.0004	0.9502
lag1_CTUI/Per Capita								0.0000	0.0000	0.8504
log_Net Fixed Asset		0.0188	0.0103	0.0678	0.0189	0.0103	0.0676	0.0186	0.0103	0.0708
log_Worker Size		-0.0027	0.0105	0.7969	-0.0025	0.0105	0.8094	-0.0027	0.0106	0.7993
Net Fixed Asset/Per Capita		0.0000	0.0004	0.9212	0.0000	0.0004	0.9191	0.0000	0.0004	0.9162
Observations usesd		466								
R-Square		0.3333			0.3386			0.3323		
Adj R-Squ		0.3111			0.3166			0.3101		

Pannel Data collected in the Chinese Iron and Steel Industry Yearbook 1984-2000

Table 11-B

Sale /total Asset

CCCI=cummulative captial construction investment (CCCI)

lag year=1

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		0.5031	0.2632	0.0559	0.4899	0.2691	0.0687	0.5152	0.2611	0.0485
Large		-0.1698	0.0354	<.0001	-0.1779	0.0339	<.0001	-0.1663	0.0351	<.0001
Group		-0.0224	0.0346	0.5172	-0.0282	0.0325	0.3865	-0.0205	0.0345	0.5526
Year	1993	0.4498	0.0882	<.0001	0.4442	0.0829	<.0001	0.4491	0.0886	<.0001
Year	1994	0.1017	0.0429	0.0177	0.0960	0.0419	0.0220	0.1013	0.0434	0.0194
Year	1995	0.0361	0.0355	0.3094	0.0305	0.0340	0.3699	0.0364	0.0360	0.3126
Year	1996	-0.0310	0.0307	0.3134	-0.0423	0.0298	0.1554	-0.0285	0.0308	0.3538
Year	1997	-0.0531	0.0278	0.0558	-0.0549	0.0276	0.0470	-0.0544	0.0282	0.0541
Year	1998	0.0495	0.0907	0.5850	0.0485	0.0908	0.5931	0.0485	0.0906	0.5924
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		0.0003	0.0011	0.7885	0.0004	0.0010	0.7041	0.0003	0.0011	0.7833
Region		0.0716	0.0420	0.0878	0.0701	0.0425	0.0993	0.0731	0.0417	0.0795
lag1_CCCI/Net Fixed Asset		0.0283	0.0138	0.0407						
lag1_CTUI/Net Fixed Asset		-0.0004	0.0001	0.0021						
lag1_CCCI/Total Asset					0.2884	0.2480	0.2449			
lag1_CTUI/Total Asset					-0.0009	0.0005	0.0502			
lag1_CCCI/Per Capita								0.0014	0.0019	0.4729
lag1_CTUI/Per Capita								-0.0001	0.0000	0.0067
log_Net Fixed Asset		0.0069	0.0408	0.8664	0.0073	0.0411	0.8596	0.0050	0.0407	0.9016
log_Worker Size		-0.0009	0.0495	0.9863	0.0004	0.0496	0.9942	0.0000	0.0497	0.9993
Net Fixed Asset/Per Capita		-0.0018	0.0014	0.2033	-0.0018	0.0014	0.2045	-0.0019	0.0014	0.1709
Observations usesd		466								
R-Square		0.2894			0.2974			0.2886		
Adj R-Squ		0.2658			0.2740			0.2648		

Table 11-C

Profit/ Net Fixed Asset — CCCI=cummulative captial construction investment (CCCI)

lag year=1 — CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		-0.3783	0.1687	0.0249	-0.3741	0.1668	0.0249	-0.3713	0.1655	0.0249
Large		-0.0801	0.0305	0.0085	-0.0791	0.0302	0.0089	-0.0787	0.0299	0.0084
Group		-0.0132	0.0215	0.5386	-0.0129	0.0214	0.5477	-0.0124	0.0212	0.5603
Year	1993	0.3268	0.0555	<.0001	0.3268	0.0556	<.0001	0.3248	0.0565	<.0001
Year	1994	0.1705	0.0528	0.0012	0.1710	0.0530	0.0012	0.1685	0.0540	0.0018
Year	1995	0.0153	0.0221	0.4880	0.0156	0.0222	0.4823	0.0143	0.0227	0.5300
Year	1996	-0.0078	0.0196	0.6919	-0.0071	0.0198	0.7201	-0.0078	0.0206	0.7056
Year	1997	-0.0523	0.0311	0.0921	-0.0523	0.0311	0.0927	-0.0543	0.0315	0.0850
Year	1998	-0.0036	0.0123	0.7700	-0.0035	0.0123	0.7744	-0.0051	0.0124	0.6791
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		0.0003	0.0006	0.6428	0.0003	0.0006	0.6227	0.0003	0.0006	0.6337
Region		0.0558	0.0213	0.0089	0.0564	0.0213	0.0081	0.0565	0.0213	0.0079
lag1_CCCI/Net Fixed Asset		0.0176	0.0093	0.0570						
lag1_CTUI/Net Fixed Asset		-0.0001	0.0001	0.1567						
lag1_CCCI/Total Asset					0.0428	0.0248	0.0842			
lag1_CTUI/Total Asset					-0.0004	0.0003	0.1509			
lag1_CCCI/Per Capita								0.0017	0.0009	0.0637
lag1_CTUI/Per Capita								0.0000	0.0000	0.2084
log_Net Fixed Asset		0.0588	0.0567	0.2996	0.0582	0.0566	0.3038	0.0574	0.0567	0.3111
log_Worker Size		-0.0321	0.0626	0.6082	-0.0319	0.0627	0.6103	-0.0311	0.0631	0.6222
Net Fixed Asset/Per Capita		-0.0005	0.0019	0.7872	-0.0005	0.0019	0.7925	-0.0007	0.0019	0.7210
Observations usesd		466								
R-Square		0.2934			0.2929			0.2930		
Adj R-Squ		0.2699			0.2694			0.2694		

Table 11-D

Sale /Net Fixed Asset — CCCI=cummulative captial construction investment (CCCI)

lag year=1 — CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		4.4963	0.7722	<.0001	4.5637	0.7796	<.0001	4.5525	0.7750	<.0001
Large		0.0470	0.1514	0.7562	0.0703	0.1553	0.6508	0.0414	0.1520	0.7855
Group		-0.0085	0.1195	0.9430	0.0030	0.1199	0.9800	-0.0091	0.1163	0.9376
Year	1993	1.2380	0.2293	<.0001	1.2457	0.2333	<.0001	1.1825	0.2195	<.0001
Year	1994	0.3553	0.1858	0.0558	0.3683	0.1892	0.0516	0.2917	0.1796	0.1044
Year	1995	-0.1191	0.1364	0.3822	-0.1082	0.1385	0.4350	-0.1601	0.1355	0.2375
Year	1996	-0.3155	0.1055	0.0028	-0.2918	0.1067	0.0063	-0.3541	0.1054	0.0008
Year	1997	-0.2870	0.0975	0.0033	-0.2836	0.0981	0.0038	-0.3365	0.0988	0.0007
Year	1998	-0.1128	0.0775	0.1454	-0.1104	0.0779	0.1562	-0.1500	0.0802	0.0613
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		0.0051	0.0056	0.3582	0.0052	0.0057	0.3638	0.0053	0.0055	0.3380
Region		0.6460	0.1562	<.0001	0.6550	0.1560	<.0001	0.6468	0.1552	<.0001
lag1_CCCI/Net Fixed Asset		0.1707	0.1903	0.3696						
lag1_CTUI/Net Fixed Asset		-0.0021	0.0005	<.0001						
lag1_CCCI/Total Asset					0.1143	0.2554	0.6546			
lag1_CTUI/Total Asset					-0.0061	0.0014	<.0001			
lag1_CCCI/Per Capita								0.0370	0.0157	0.0183
lag1_CTUI/Per Capita								-0.0005	0.0001	<.0001
log_Net Fixed Asset		-0.8771	0.1792	<.0001	-0.8851	0.1800	<.0001	-0.8957	0.1766	<.0001
log_Worker Size		0.6882	0.2206	0.0018	0.6884	0.2220	0.0019	0.7101	0.2148	0.0009
Net Fixed Asset/Per Capita		0.0156	0.0074	0.0337	0.0158	0.0074	0.0335	0.0119	0.0064	0.0617
Observations usesd		466								
R-Square		0.5459			0.5434			0.5510		
Adj R-Squ		0.5307			0.5281			0.5360		

Table 11-E

Profit/ Per Capta

CCCI=cummulative captial construction investment (CCCI)

lag year=1

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		-3.4586	0.6914	<.0001	-3.4197	0.6758	<.0001	-3.3992	0.6770	<.0001
Large		-0.5567	0.1535	0.0003	-0.5449	0.1533	0.0004	-0.5319	0.1604	0.0009
Group		0.0440	0.1591	0.7823	0.0489	0.1596	0.7593	0.0566	0.1682	0.7365
Year	1993	1.2374	0.4645	0.0077	1.2398	0.4659	0.0078	1.2525	0.5213	0.0163
Year	1994	0.9909	0.4356	0.0229	0.9970	0.4364	0.0223	1.0116	0.5004	0.0432
Year	1995	0.3793	0.3220	0.2388	0.3839	0.3229	0.2345	0.3958	0.3689	0.2832
Year	1996	0.1263	0.3230	0.6957	0.1367	0.3226	0.6716	0.1561	0.3857	0.6856
Year	1997	-0.0595	0.2375	0.8020	-0.0581	0.2382	0.8072	-0.0502	0.2847	0.8599
Year	1998	-0.1977	0.1893	0.2963	-0.1967	0.1887	0.2972	-0.1911	0.1638	0.2434
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		-0.0088	0.0039	0.0262	-0.0087	0.0039	0.0254	-0.0088	0.0039	0.0243
Region		0.2577	0.0951	0.0067	0.2630	0.0959	0.0061	0.2666	0.0947	0.0049
lag1_CCCI/Net Fixed Asset		0.1249	0.0930	0.1795						
lag1_CTUI/Net Fixed Asset		-0.0001	0.0004	0.9022						
lag1_CCCI/Total Asset					0.2056	0.2721	0.4500			
lag1_CTUI/Total Asset					-0.0002	0.0013	0.8641			
lag1_CCCI/Per Capita								-0.0042	0.0489	0.9318
lag1_CTUI/Per Capita								0.0000	0.0001	0.9320
log_Net Fixed Asset		-0.3114	0.2777	0.2620	-0.3165	0.2772	0.2536	-0.3168	0.2778	0.2542
log_Worker Size		0.6636	0.3198	0.0380	0.6643	0.3203	0.0381	0.6610	0.3266	0.0430
Net Fixed Asset/Per Capita		0.1129	0.0179	<.0001	0.1130	0.0178	<.0001	0.1135	0.0212	<.0001
Observations usesd		466								
R-Square		0.6368			0.6361			0.6360		
Adj R-Squ		0.6247			0.6240			0.6239		

Table 11-F

Sale /Per Capita

CCCI=cummulative captial construction investment (CCCI)

lag year=1

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		12.5696	6.1781	0.0419	13.2297	6.4420	0.0400	12.7923	5.6805	0.0243
Large		0.5913	1.0430	0.5708	0.8090	1.0989	0.4616	-0.0633	1.0319	0.9511
Group		0.9569	0.9904	0.3340	1.0602	0.9907	0.2845	0.6818	0.8796	0.4383
Year	1993	9.0847	3.1384	0.0038	9.1490	3.1760	0.0040	7.3535	2.3138	0.0015
Year	1994	7.0338	3.1807	0.0270	7.1543	3.2520	0.0278	4.9884	2.2575	0.0271
Year	1995	4.2399	2.4457	0.0830	4.3378	2.4692	0.0790	2.8493	2.0397	0.1624
Year	1996	2.1757	1.9348	0.2608	2.3892	1.9938	0.2308	0.5742	1.4602	0.6941
Year	1997	1.1349	1.6352	0.4877	1.1650	1.6501	0.4802	-0.3263	1.1238	0.7715
Year	1998	0.0962	1.5580	0.9508	0.1170	1.5624	0.9403	-0.9903	1.1486	0.3886
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		0.0567	0.0484	0.2421	0.0573	0.0498	0.2500	0.0615	0.0401	0.1249
Region		3.4350	0.9372	0.0002	3.5236	0.9384	0.0002	3.2702	0.9043	0.0003
lag1_CCCI/Net Fixed Asset		1.8082	2.0321	0.3736						
lag1_CTUI/Net Fixed Asset		-0.0116	0.0050	0.0193						
lag1_CCCI/Total Asset					1.8696	2.9455	0.5256			
lag1_CTUI/Total Asset					-0.0353	0.0147	0.0165			
lag1_CCCI/Per Capita								1.0333	0.3367	0.0021
lag1_CTUI/Per Capita								-0.0028	0.0010	0.0034
log_Net Fixed Asset		6.0157	2.9614	0.0422	5.9361	2.9533	0.0444	5.6489	2.2644	0.0126
log_Worker Size		-8.4812	3.7425	0.0234	-8.4766	3.7592	0.0241	-7.8651	2.8022	0.0050
Net Fixed Asset/Per Capita		0.4340	0.2526	0.0858	0.4355	0.2533	0.0855	0.3262	0.2111	0.1222
Observations usesd		466								
R-Square		0.6048			0.6015			0.6778		
Adj R-Squ		0.5917			0.5882			0.6671		

Pannel Data collected in the Chinese Iron and Steel Industry Yearbook 1984-2000

Table 11-G

Profit /Total Asset — CCCI=cummulative captial construction investment (CCCI)

lag year=3 — CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		-0.1998	0.0502	<.0001	-0.1999	0.0500	<.0001	-0.1976	0.0500	<.0001
Large		-0.0282	0.0087	0.0012	-0.0299	0.0086	0.0005	-0.0271	0.0084	0.0013
Group		0.0007	0.0069	0.9148	-0.0003	0.0066	0.9637	0.0012	0.0067	0.8605
Year	1993	0.1052	0.0155	<.0001	0.1033	0.0142	<.0001	0.1057	0.0155	<.0001
Year	1994	0.0528	0.0105	<.0001	0.0512	0.0103	<.0001	0.0535	0.0105	<.0001
Year	1995	0.0108	0.0068	0.1102	0.0088	0.0066	0.1838	0.0115	0.0068	0.0887
Year	1996	0.0014	0.0060	0.8210	-0.0014	0.0059	0.8076	0.0025	0.0060	0.6797
Year	1997	-0.0137	0.0087	0.1134	-0.0147	0.0086	0.0893	-0.0134	0.0087	0.1231
Year	1998	0.0001	0.0048	0.9841	-0.0004	0.0048	0.9415	0.0003	0.0048	0.9472
Year	1999	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	
Age		-0.0001	0.0002	0.7031	0.0000	0.0002	0.8017	-0.0001	0.0002	0.7098
Region		0.0099	0.0064	0.1204	0.0101	0.0063	0.1097	0.0101	0.0064	0.1111
lag3_CCCI/Net Fixed Asset		0.0043	0.0034	0.1959						
lag3_CTUI/Net Fixed Asset		0.0000	0.0000	0.2159						
lag3_CCCI/Total Asset					0.0444	0.0392	0.2571			
lag3_CTUI/Total Asset					0.0001	0.0001	0.1960			
lag3_CCCI/Per Capita								0.0000	0.0002	0.9333
lag3_CTUI/Per Capita								0.0000	0.0000	0.1789
log_Net Fixed Asset		0.0214	0.0113	0.0575	0.0207	0.0111	0.0631	0.0211	0.0115	0.0675
log_Worker Size		-0.0047	0.0113	0.6794	-0.0039	0.0114	0.7337	-0.0047	0.0116	0.6881
Net Fixed Asset/Per Capita		-0.0003	0.0005	0.5783	-0.0003	0.0005	0.5600	-0.0002	0.0005	0.6773
Observations usesd		458								
R-Square		0.3378			0.3448			0.3370		
Adj R-Squ		0.3153			0.3225			0.3145		

Pannel Data collected in the Chinese Iron and Steel Industry Yearbook 1984-2000

Table 11-H

Sale /total Asset — CCCI=cummulative captial construction investment (CCCI)

lag year=3 — CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		0.4631	0.2748	0.0920	0.4547	0.2751	0.0984	0.4701	0.2741	0.0864
Large		-0.1779	0.0355	<.0001	-0.1930	0.0344	<.0001	-0.1744	0.0346	<.0001
Group		-0.0263	0.0354	0.4579	-0.0348	0.0325	0.2846	-0.0245	0.0352	0.4858
Year	1993	0.4610	0.0920	<.0001	0.4461	0.0801	<.0001	0.4621	0.0913	<.0001
Year	1994	0.1136	0.0450	0.0117	0.0999	0.0430	0.0201	0.1150	0.0442	0.0092
Year	1995	0.0499	0.0373	0.1810	0.0334	0.0347	0.3357	0.0520	0.0361	0.1502
Year	1996	-0.0167	0.0323	0.6058	-0.0397	0.0322	0.2177	-0.0134	0.0313	0.6689
Year	1997	-0.0385	0.0283	0.1734	-0.0461	0.0278	0.0973	-0.0381	0.0281	0.1750
Year	1998	0.0582	0.0948	0.5389	0.0546	0.0949	0.5649	0.0578	0.0948	0.5421
Year	1999	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	
Age		0.0004	0.0011	0.7103	0.0006	0.0010	0.5465	0.0004	0.0011	0.7073
Region		0.0692	0.0430	0.1075	0.0705	0.0424	0.0969	0.0702	0.0426	0.0998
lag3_CCCI/Net Fixed Asset		0.0181	0.0204	0.3739						
lag3_CTUI/Net Fixed Asset		-0.0003	0.0001	0.0109						
lag3_CCCI/Total Asset					0.3157	0.2774	0.2552			
lag3_CTUI/Total Asset					-0.0007	0.0005	0.1550			
lag3_CCCI/Per Capita								0.0005	0.0011	0.6176
lag3_CTUI/Per Capita								-0.0001	0.0000	0.0143
log_Net Fixed Asset		0.0036	0.0459	0.9378	-0.0005	0.0452	0.9914	0.0041	0.0467	0.9301
log_Worker Size		0.0058	0.0545	0.9151	0.0118	0.0552	0.8310	0.0045	0.0548	0.9351
Net Fixed Asset/Per Capita		-0.0018	0.0019	0.3544	-0.0020	0.0021	0.3415	-0.0021	0.0022	0.3533
Observations usesd		458								
R-Square		0.2911			0.3039			0.2906		
Adj R-Squ		0.2670			0.2802			0.2665		

Table 11-I

Profit/ Net Fixed Asset CCCI=cummulative captial construction investment (CCCI)

lag year=3 CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		-0.4022	0.1781	0.0239	-0.3942	0.1749	0.0242	-0.3955	0.1759	0.0246
Large		-0.0841	0.0323	0.0093	-0.0816	0.0319	0.0105	-0.0807	0.0312	0.0097
Group		-0.0140	0.0223	0.5291	-0.0133	0.0223	0.5529	-0.0121	0.0218	0.5783
Year	1993	0.3341	0.0590	<.0001	0.3343	0.0593	<.0001	0.3349	0.0587	<.0001
Year	1994	0.1769	0.0565	0.0017	0.1780	0.0570	0.0018	0.1780	0.0560	0.0015
Year	1995	0.0214	0.0243	0.3781	0.0224	0.0248	0.3650	0.0231	0.0245	0.3446
Year	1996	-0.0017	0.0214	0.9372	0.0001	0.0220	0.9975	0.0012	0.0214	0.9545
Year	1997	-0.0457	0.0314	0.1458	-0.0452	0.0315	0.1518	-0.0460	0.0310	0.1384
Year	1998	0.0015	0.0118	0.8988	0.0018	0.0118	0.8778	0.0003	0.0116	0.9775
Year	1999	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	
Age		0.0003	0.0006	0.6341	0.0003	0.0006	0.5988	0.0003	0.0006	0.6331
Region		0.0546	0.0218	0.0121	0.0558	0.0218	0.0104	0.0557	0.0218	0.0106
lag3_CCCI/Net Fixed Asset		0.0201	0.0113	0.0758						
lag3_CTUI/Net Fixed Asset		0.0000	0.0001	0.9828						
lag3_CCCI/Total Asset					0.0373	0.0360	0.2997			
lag3_CTUI/Total Asset					0.0000	0.0002	0.9854			
lag3_CCCI/Per Capita								0.0009	0.0008	0.2301
lag3_CTUI/Per Capita								0.0000	0.0000	0.8841
log_Net Fixed Asset		0.0617	0.0639	0.3342	0.0603	0.0637	0.3440	0.0631	0.0651	0.3324
log_Worker Size		-0.0335	0.0707	0.6360	-0.0329	0.0709	0.6426	-0.0356	0.0716	0.6197
Net Fixed Asset/Per Capita		-0.0009	0.0026	0.7307	-0.0008	0.0026	0.7464	-0.0014	0.0029	0.6376
Observations usesd		458								
R-Square		0.2960			0.2949			0.2949		
Adj R-Squ		0.2721			0.2710			0.2710		

Table 11-J

Sale /Net Fixed Asset CCCI=cummulative captial construction investment (CCCI)

lag year=3 CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		4.4799	0.7889	<.0001	4.5938	0.8000	<.0001	4.5508	0.7940	<.0001
Large		-0.0085	0.1539	0.9557	0.0375	0.1593	0.8138	0.0275	0.1551	0.8592
Group		-0.0487	0.1213	0.6879	-0.0309	0.1231	0.8017	-0.0251	0.1187	0.8323
Year	1993	1.1510	0.2331	<.0001	1.1665	0.2409	<.0001	1.1536	0.2299	<.0001
Year	1994	0.2707	0.1919	0.1585	0.2959	0.1974	0.1340	0.2747	0.1885	0.1449
Year	1995	-0.1856	0.1356	0.1712	-0.1574	0.1402	0.2613	-0.1702	0.1394	0.2220
Year	1996	-0.3892	0.1124	0.0005	-0.3463	0.1129	0.0022	-0.3622	0.1105	0.0011
Year	1997	-0.3251	0.1010	0.0013	-0.3119	0.1012	0.0021	-0.3381	0.1014	0.0009
Year	1998	-0.1722	0.0767	0.0246	-0.1647	0.0775	0.0336	-0.1966	0.0822	0.0168
Year	1999	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	
Age		0.0054	0.0054	0.3151	0.0056	0.0057	0.3220	0.0054	0.0054	0.3216
Region		0.6425	0.1570	<.0001	0.6568	0.1569	<.0001	0.6555	0.1565	<.0001
lag3_CCCI/Net Fixed Asset		0.2545	0.2094	0.2242						
lag3_CTUI/Net Fixed Asset		-0.0016	0.0004	0.0004						
lag3_CCCI/Total Asset					0.2365	0.2995	0.4298			
lag3_CTUI/Total Asset					-0.0044	0.0012	0.0004			
lag3_CCCI/Per Capita								0.0160	0.0101	0.1143
lag3_CTUI/Per Capita								-0.0004	0.0001	0.0011
log_Net Fixed Asset		-0.9655	0.1964	<.0001	-0.9815	0.1976	<.0001	-0.9367	0.1982	<.0001
log_Worker Size		0.7945	0.2387	0.0009	0.7973	0.2409	0.0009	0.7579	0.2405	0.0016
Net Fixed Asset/Per Capita		0.0237	0.0086	0.0058	0.0246	0.0085	0.0039	0.0149	0.0092	0.1044
Observations usesd		458								
R-Square		0.5542			0.5474			0.5509		
Adj R-Squ		0.5391			0.5320			0.5357		

Table 11-K

Profit/ Per Capta

CCCI=cummulative captial construction investment (CCCI)

lag year=3

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		-3.7021	0.7029	<.0001	-3.6541	0.6835	<.0001	-3.5366	0.6763	<.0001
Large		-0.5326	0.1576	0.0007	-0.4949	0.1573	0.0017	-0.4565	0.1636	0.0053
Group		0.0969	0.1475	0.5113	0.1156	0.1504	0.4422	0.1079	0.1335	0.4187
Year	1993	1.4744	0.4180	0.0004	1.5015	0.4274	0.0004	1.5449	0.4176	0.0002
Year	1994	1.2058	0.4111	0.0034	1.2338	0.4162	0.0030	1.2963	0.4071	0.0015
Year	1995	0.5534	0.3010	0.0660	0.5864	0.3081	0.0570	0.6305	0.2944	0.0322
Year	1996	0.2981	0.2828	0.2918	0.3463	0.2905	0.2333	0.4043	0.3058	0.1861
Year	1997	0.0667	0.2204	0.7622	0.0824	0.2247	0.7139	0.1548	0.2855	0.5876
Year	1998	-0.0843	0.1755	0.6310	-0.0766	0.1718	0.6558	0.0065	0.1115	0.9533
Year	1999	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	
Age		-0.0090	0.0042	0.0299	-0.0092	0.0042	0.0293	-0.0089	0.0040	0.0269
Region		0.2507	0.0953	0.0085	0.2537	0.0939	0.0069	0.2579	0.0942	0.0062
lag3_CCCI/Net Fixed Asset		0.0553	0.1410	0.6949						
lag3_CTUI/Net Fixed Asset		0.0004	0.0003	0.2034						
lag3_CCCI/Total Asset					-0.3941	0.7602	0.6042			
lag3_CTUI/Total Asset					0.0012	0.0009	0.2089			
lag3_CCCI/Per Capita								-0.0404	0.0346	0.2429
lag3_CTUI/Per Capita								0.0001	0.0001	0.4471
log_Net Fixed Asset		-0.1018	0.2238	0.6492	-0.1012	0.2206	0.6465	-0.2125	0.2799	0.4477
log_Worker Size		0.4373	0.2351	0.0629	0.4297	0.2342	0.0665	0.5254	0.2843	0.0646
Net Fixed Asset/Per Capita		0.0936	0.0225	<.0001	0.0942	0.0224	<.0001	0.1190	0.0446	0.0077
Observations usesd		458								
R-Square		0.5264			0.5274			0.5489		
Adj R-Squ		0.5104			0.5114			0.5336		

Table 11-L

Sale /Per Capita

CCCI=cummulative captial construction investment (CCCI)

lag year=3

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|	Estimate	Emprical Standard Error	Pr > |Z|
Intercept		12.5574	4.6156	0.0065	13.7209	5.1440	0.0076	12.3691	4.3784	0.0047
Large		-0.5175	0.8811	0.5570	-0.0054	0.9566	0.9955	-0.5737	0.9314	0.5379
Group		-0.3227	0.7609	0.6715	-0.1152	0.7419	0.8766	-0.1310	0.7176	0.8551
Year	1993	5.9991	1.8317	0.0011	6.2068	1.9185	0.0012	5.6111	1.7372	0.0012
Year	1994	4.3391	2.1048	0.0393	4.6401	2.2656	0.0406	3.8555	1.8894	0.0413
Year	1995	2.2836	1.6532	0.1672	2.6213	1.6899	0.1209	1.9963	1.7215	0.2462
Year	1996	0.4028	0.9911	0.6844	0.9110	1.0499	0.3855	0.0695	1.1873	0.9534
Year	1997	0.2821	0.9981	0.7774	0.4409	1.0188	0.6652	-0.3818	1.0056	0.7042
Year	1998	-1.0144	0.7135	0.1551	-0.9275	0.7188	0.1969	-1.8189	0.8040	0.0237
Year	1999	0.0000	0.0000		0.0000	0.0000		0.0000	0.0000	
Age		0.0636	0.0362	0.0791	0.0651	0.0396	0.1001	0.0627	0.0332	0.0588
Region		3.1868	0.8684	0.0002	3.3249	0.8679	0.0001	3.2836	0.8462	0.0001
lag3_CCCI/Net Fixed Asset		2.4571	2.0992	0.2418						
lag3_CTUI/Net Fixed Asset		-0.0083	0.0036	0.0204						
lag3_CCCI/Total Asset					1.2012	2.7956	0.6674			
lag3_CTUI/Total Asset					-0.0251	0.0105	0.0168			
lag3_CCCI/Per Capita								0.4134	0.2232	0.0640
lag3_CTUI/Per Capita								-0.0019	0.0008	0.0241
log_Net Fixed Asset		1.9597	1.5342	0.2015	1.8149	1.4861	0.2220	2.9285	1.5504	0.0589
log_Worker Size		-3.7383	2.2924	0.1029	-3.7318	2.3265	0.1087	-4.6596	2.2104	0.0350
Net Fixed Asset/Per Capita		0.7910	0.0447	<.0001	0.8010	0.0410	<.0001	0.5444	0.1225	<.0001
Observations usesd		458								
R-Square		0.7251			0.7155			0.7553		
Adj R-Squ		0.7157			0.7059			0.7470		

Pannel Data collected in the Chinese Iron and Steel Industry Yearbook 1984-2000

Table 12-A

First Difference of Profit/ Net Fixed Asset

CCCI=cummulative captial construction investment (CCCI)

lag year=1

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Standard Error	Emprical Pr > |Z|	Estimate	Standard Error	Emprical Pr > |Z|	Estimate	Standard Error	Emprical Pr > |Z|
Intercept		-0.0879	0.0719	0.2214	-0.0863	0.0717	0.2286	-0.0810	0.0705	0.2505
Large		-0.0180	0.0156	0.2467	-0.0177	0.0155	0.2548	-0.0149	0.0155	0.3388
Group		-0.0135	0.0178	0.4504	-0.0134	0.0179	0.4557	-0.0119	0.0178	0.5052
Year	1994	0.1951	0.0460	<.0001	0.1953	0.0460	<.0001	0.1994	0.0470	<.0001
Year	1995	-0.0913	0.0293	0.0018	-0.0912	0.0293	0.0019	-0.0880	0.0295	0.0029
Year	1996	0.0068	0.0339	0.8414	0.0070	0.0340	0.8372	0.0110	0.0348	0.7513
Year	1997	-0.0421	0.0303	0.1641	-0.0421	0.0303	0.1645	-0.0396	0.0304	0.1937
Year	1998	0.0914	0.0839	0.2760	0.0915	0.0839	0.2757	0.0931	0.0840	0.2677
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		-0.0003	0.0003	0.2888	-0.0003	0.0003	0.2954	-0.0003	0.0003	0.2499
Region		0.0099	0.0101	0.3280	0.0101	0.0102	0.3191	0.0111	0.0103	0.2817
lag1_CCCI/Net Fixed Asset		0.0074	0.0051	0.1499						
lag1_CTUI/Net Fixed Asset		-0.0004	0.0001	<.0001						
lag1_CCCI/Total Asset					0.0200	0.0208	0.3357			
lag1_CTUI/Total Asset					-0.0011	0.0002	<.0001			
lag1_CCCI/Per Capita								-0.0013	0.0013	0.3006
lag1_CTUI/Per Capita								-0.0001	0.0000	<.0001
log_Net Fixed Asset		0.0680	0.0513	0.1849	0.0679	0.0514	0.1861	0.0685	0.0514	0.1830
log_Worker Size		-0.0699	0.0663	0.2917	-0.0699	0.0663	0.2917	-0.0716	0.0667	0.2825
Net Fixed Asset/Per Capita		-0.0020	0.0019	0.2776	-0.0020	0.0019	0.2782	-0.0019	0.0018	0.2925
Observations usesd		349								
R-Square		0.2265			0.1640					
Adj R-Squ		0.1290			0.1289					

Table 12-B

First Difference of Sale /Net Fixed Asset

CCCI=cummulative captial construction investment (CCCI)

lag year=1

CTUI=cummulative technical updating investment (CTUI)

Parameter		Estimate	Standard Error	Emprical Pr > |Z|	Estimate	Standard Error	Emprical Pr > |Z|	Estimate	Standard Error	Emprical Pr > |Z|
Intercept		0.3150	0.4110	0.4434	0.3901	0.4193	0.3522	0.4795	0.4273	0.2619
Large		-0.0941	0.0883	0.2863	-0.0777	0.0896	0.3863	-0.0813	0.0898	0.3653
Group		-0.0432	0.0746	0.5622	-0.0382	0.0756	0.6134	-0.0292	0.0731	0.6897
Year	1994	0.7296	0.1949	0.0002	0.7378	0.1966	0.0002	0.6482	0.1991	0.0011
Year	1995	-0.8038	0.1746	<.0001	-0.7998	0.1759	<.0001	-0.8566	0.1793	<.0001
Year	1996	-0.4978	0.1163	<.0001	-0.4895	0.1150	<.0001	-0.5305	0.1181	<.0001
Year	1997	-0.1998	0.0759	0.0085	-0.1987	0.0771	0.0100	-0.2649	0.0789	0.0008
Year	1998	-0.0626	0.1055	0.5528	-0.0623	0.1056	0.5548	-0.1152	0.1089	0.2899
Year	1999	0.0000	0.0000	.	0.0000	0.0000	.	0.0000	0.0000	.
Age		0.0031	0.0019	0.0937	0.0033	0.0019	0.0809	0.0034	0.0019	0.0766
Region		0.1821	0.0615	0.0031	0.1924	0.0617	0.0018	0.1919	0.0609	0.0016
lag1_CCCI/Net Fixed Asset		0.3283	0.0661	<.0001						
lag1_CTUI/Net Fixed Asset		-0.0013	0.0004	0.0025						
lag1_CCCI/Total Asset					0.8944	0.1862	<.0001			
lag1_CTUI/Total Asset					-0.0039	0.0012	0.0015			
lag1_CCCI/Per Capita								0.0427	0.0157	0.0066
lag1_CTUI/Per Capita								-0.0003	0.0001	0.0065
log_Net Fixed Asset		-0.2983	0.1463	0.0415	-0.3064	0.1490	0.0397	-0.3419	0.1517	0.0242
log_Worker Size		0.3190	0.1809	0.0778	0.3185	0.1838	0.0831	0.3594	0.1872	0.0549
Net Fixed Asset/Per Capita		0.0053	0.0042	0.2086	0.0055	0.0043	0.2045	0.0013	0.0038	0.7321
Observations usesd		349								
R-Square		0.3106			0.3039					
Adj R-Squ		0.2817			0.2747					

Pannel Data collected in the Chinese Iron and Steel Industry Yearbook 1984-2000

Synthesis

The case study of Hanyeping Iron/Coal/Mining Company indicates governance insufficiency was a predominant cause of the failure of China's earliest industrial/commercial cartel. In its early industrialization stages, China's traditional institutional system seemed to present more negative aspects and constrained itself to take an easy converging path toward the machinery economy. The second chapter expands the "big push" theory by Murphy, Shleifer and Vishny to illustrate that some strict circumstances are needed to have a "big push" chance. My analysis compatibly expands their argument and more generally highlights a few possible scenarios that I think should be meaningful in addressing those relevant debates.

The third essay empirically analyzes the most recent performance of China's steel industry also within the institutional framework. Government interference is found to be negatively correlated with the steel firms' performance index that was positively correlated to the local business atmosphere of openness as indexed by the geographical location of mills. The advantage of being syndicated or grouped seems to be elusive probably as the grouping benefits are constrained by other restraining factors. Because of various features of the capital construction investment and the technical updating investment, these two major types of fixed investment present the opposite correlation with the steel firms' performance in my data sample. The empirical findings suggests that problems exist differently in these two major investment domains, which are potentially correlated to some other institutional factors entailing more examination in the future.