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How China institutional changes influence industry development? The case of TD-SCDMA industrialization

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Abstract

China's science and technology progress had drawn much attention these years, including 15-year MLP that promote indigenous innovation. That is, China government attempts to encourage domestic firms conducting R&D, in order to reduce reliance on imported technology. This paper focuses on home-grown telecommunication standard (TD-SCDMA), and question how macro-level institutions influence development of TD-SCDMA industrialization in telecommunication mobile terminal and mobile equipment manufacturing industries.

This paper aims to examine: (1) how institutional legacies hinder the industrialization of TD-SCDMA; but after year 2009, (2) how the institutional changes have initiated to encourage the networking of TD-SCDMA supply chain to produce handset products. Through secondary data collection and interview, we clarify the interaction effect between China state-SOE vertical relationship and SOE-network horizontal relationship, to demonstrate how institutional changes turn TD-SCDMA industrialization around. Our main argument is that China state has undergone institutional learning and adaptation; hence, it prompt firm-level R&D as well as the formation of supply chain of TD-SCDMA mobile terminal industry.

Jelcodes:O20,L52

1. Introduction

China's science and technology (S&T) progress had drawn much attention these years. For instance, China government has increased R&D expenditure, or main innovation actors have shifted from public-sector to private-sector enterprises, and so on (Gabriele, 2002; Cao et al., 2009). Particularly, China government recent had formulated 15-year plan including 'indigenous innovation'(自主创新) policy that encourage domestic firms engaging in independent R&D, in order to reduce reliance on imported technology (Serger and Breidne, 2007).

The indigenous mentality is consistent with the paradoxical development strategy taken by Chinese government since economic reform. On one hand China state had taken open door strategy to induced FDI investment, yet on the other hand they continued the historical self-reliant development ideology (Kerr, 2010). As a result, China had integrated into global market mainly through low-end commodity productions, and yet still relied heavily on imported technology and parts for past 30 years (Steinfeld, 2004). So far biggest challenge of transforming China economy is to upgrade technology (Ernst and Naughton, 2008).

And China government actively set couple of standards as a realization of self-reliant development, with the goal prompting domestic firms equipped with technology capacity (Suttmeier and Yao, 2004). The goal is to have domestic production substituted imports (Zhou, 2006) and to avoid high amount of loyalty fee flow outwards (Naughton and Segal, 2000). The ambitious attempt is to counteract domestic market dominated by global production networks (GPN) leading flagship MNCs (Multi-national Corporations) in telecommunication sector, such as Qualcomm and Nokia (Wang and Tsai, 2010). In short, among all standards set by China, 3G

telecommunication standard (i.e. TD-SCDMA)¹ has drawn most attention. Not only TD-SCDMA is the only Chinese standard approved by international organization (i.e. ITU), but also China government had allocated tremendous resources and efforts which raised the debate on motivations (Suttmeier et al., 2006; Zhou, 2006; Yan, 2006; Kennedy et al., 2008).

However, these scholars analyze the development of TD-SCDMA technology from political, economic, or market views, and there's a theoretical gap to examine China's industrialization from comprehensively *institutional* framework, given the Chinese-characteristic institutional arrangements thwarting particular firms engaging R&D and innovation. That is, China state supports state-owned enterprises (SOEs) to pursue scale and scope in production (Nolan and Wang, 1999) or technological catch-up (Gabriele, 2002; Ernst and Naughton, 2008). But privileged resources from state without punishment prevent SOEs from R&D, and hence innovation capacity of SOEs is lower than non-state-owned type or *minying* firms (Steinfeld, 1998; Fuller, 2005, 2009; Li et al., 2007).

In TD-SCDMA case, state capitalizes most resources to SOEs Datang Group to develop related products, such IC chipset for TD-SCDMA handset. Also, state assigned Datang to coordinate patent (IPR sharing) and production spanning the supply chain, as Western industry alliance did (Fan, 2006a; Yan, 2006; Liu, 2008). However, there're not much commercialized results or innovation from Datang Group, neither the cooperation among firms on R&D and production. Therefore, we question: (1) how China country-specific institutional legacies hinder the TD-SCDMA industrialization?

¹ TD-SCDMA is short for one of the global 3G standard, Time Division-Synchronous Code Division Multiple Access. The other two standards WCDMA and CDMA 2000 created and embracing by European and American MNCs, respectively (cf. Hess and Coe, 2006; Wen and Yang, 2010 for knowledge and power control by MNCs).

Secondly, rather than debating on the motivations of TD-SCDMA standard setting (will elaborate more on section 2.1), we aim to advance empirical gap of evolving development of TD-SCDMA industry by examine the influence of different institutions in two time-periods. After 2009 China state changed to mandate another SOE, the biggest telecom operator China Mobile, to promote TD-SCDMA industrialization, instead. China Mobile managed to organize the TD-SCDMA mobile handset supply chain, in order to narrow the technology gap with global 3G standards (Wang and Tsai, 2010). In other words, some institutional changes had been initiated to encourage cooperative networking R&D and production among firms, and there's a leading firm, i.e. China Mobile, responsible for coordinating across the supply chain. So the second question is: (2) how institutional changes have triggered positive influence on TD-SCDMA industrialization development?

In all, this paper demonstrates the evolution of institutional changes and their effect on different outcomes of TD-SCDMA industrialization. We argue that China state had learned to select capable SOEs and adapted alternative form of sanctions to induce the firm implementing the national mission. It resulted in positive chain effects on capable SOEs and network of firms to invest more R&D resources on TD-SCDMA products. Consequently, the institutional changes had turn TD-SCDMA industrialization around.

The paper proceeds as follows: in section 2, we review literature regarding to TD-SCDMA standard and China industry development. In section 3, we describe the research methods. In section 4, we introduce evolution of the TD-SCDMA production networks and associated institutional arrangements. In section 5, we discuss the policy implication and conclude.

2. Literature Review

2.1 (Neo-) Techno-nationalism debate and beyond

Regarding the strategy of China government standard setting, Naughton and Segal (2000) assume that it is full of techno-nationalist spirit for serving both national security and domestic big market purposes. Suttmeier (2002) scrutinizes that the low innovation capacity of China telecommunication enterprise and China's economy interdependence with global market would challenge state's strategy. As for TD-SCDMA commercialization, Suttmeier and Yao (2004) depicted that billions of loyalty fee outwards to Western flagship MNCs drove China's standard strategy. There's a proverb indicating the ideology: "Third-class companies manufacture products, second-class companies conduct R&D, and first-class companies set standards." Anyhow, Suttmeier and other scholars propose neo-techno-nationalism scenario that China government supposes to cooperate and integrate more with MNCs, in order to accomplish goal of nationalism development.

Zhou (2006) refutes techno-nationalism view and emphasizes the developmental view that endogenous telecommunication industry can not be developed without state's support. Moreover, China state and business had reached consensus to set standards in order to "bypass the monopoly of established corporation" (p.56) on China domestic market. However, she claims that state-supported SOE "Datang itself was not aware the financial back hole caused" (p.59). At least, China government ends up "balance with the domestic telecommunication manufacturers who lean to foreign standards" (p.59).

Despite Zhou's justification of developmental view is too simplified², some scholars started to investigate China's internal political economic issue. For example, Suttmeier, Yao, and Tan (2006) reveal that divergent interests exist between China

² According to EA developmental state theories, the question is not whether state ought to intervene market or not, but the issue is to what degree (Evans, 1995) or how (Weiss and Hobson, 1995) that late-developed countries can catch up through intertwined state-business relationship.

state and business (apart from SOE Datang) as well as within state ministries. Hence, huge commercial interests captured and institutional fragmentation deter Ministry of Information Industry (MII) to fully support TD-SCDMA, despite subsidizing R&D funds and other efforts. Unintended, state's role retreats "from development state to a regulatory one" (p.33). More, China state had postponed 3G licensing, which contradicted the commercial interests of those firms who had already invested in TD-SCDMA.

Again, the *institutional perspective* had been overlooked that could broadly examine how China state failed to manage administrative guidance on local firms as East Asian states do (Johnson, 1982). By contrast, East Asian states can maintain particular kind of state-business relationship, such as interdependence governance (Weiss and Hobson, 1995) or embedded autonomy (Evans, 1995), in order to achieve national goal of catching-up industrialization and technology upgrade (Kim, 1997; Weiss, 2000). Yet, this paper does not try to evaluate whether China is another type of East Asian developmental state (cf. Howell, 2006 for review). Rather, we echo the call of 'bringing the institutions back in' (Weiss et al., 2003) and employ institutional perspective concerning how they affect industrial development (Haggard and Moon, 1990; Kang, 1995; Schneider, 1998; Haggard, 2004).

For example, Korean state punished bad performance and rewarded good performance private-sector actors, with shifting subsidies or other resources from bad to good business groups (i.e. Chaebols) (Amsden, 1989). Hence, Korean state built reciprocity relationship through link incentives to firms' performance, namely, degree of fulfillment state's export target. Moreover, the sustainability of reciprocity depends on state capacity, that is, able to benchmark firms' performance, monitor, and sanction

(Schneider, 1998)³. In other words, states “establish their credentials with private actors through industrial policies, subsidies, and other means; moreover, states simply repeat ‘pick winner’ plays to signal state’s credible commitment in the long term” (Haggard, 2004: p.62-63).

China state intimated East Asian development model and aggressively formulated a numerous of industrial policies (So, 2009). Yet, the issue of varieties of capitalism and country-specific institutional arrangement and economic structure should be considered (Haggard, 2004). As a whole, we need to understand what the China institutions were and are, then we infer from institutional perspective that how China state supported SOE, but in turn involuntarily “caused the financial back hole” (Zhou, 2006: 59). Furthermore, we conclude from institutional perspective why state re-assigned China Mobile to promote TD-SCDMA, and in turn China Mobile can launch commercialized handsets in the market.

2.2 China institutional arrangement and industrial development

China capitalism can be described as dualism industry structure⁴ that China central government privileges historical legacies of SOEs, meanwhile the local states incubate emergent TVEs (Town-village enterprises) or non-state *minying* (private) enterprises (Oi, 1992; Steinfeld, 1998; Hwang, 2003, 2008; Liao, 2005). In view of fast growth and rapid structural changes, the China state privileges SOEs as the window of imported technology and underwent reform, e.g. re-organization of corporate governance (Smyth, 2000; Thun, 2004). Consequently, Chinese technology

³ For Taiwan, Fields (1995) studied how the state created institutions and built reciprocity relationship with business actors.

⁴ China economy is characterized by “dualism model” that on one hand FDI invest and manufacture high-end ICT products in China due to government favorable terms. But on the other hand domestic firms engage in low-end non-ICT products. Worse, there’s no network relationship between FDI and domestic firms to diffuse technology (Wang, 2006). Also see *The China Review* 2006, volume 6 introduction for more discussion.

path also could be characterized as dual trajectories that central state supports state public-sector research institute R&D and SOEs targeted at high-tech sector, while the TVE or *minying* enterprises directly face market in low-tech sector (Gabriele, 2002; Ernst and Naughton, 2008)⁵.

To restructure SOEs, state employed ‘grasp the large, release the small’(抓大放小) strategy and intended to transform them into Western modern enterprises superior with scale and scope (Chandler, 1990), through administrative guidance M&A (mergers and acquisitions) to become a vertical integrated syndicate (Nolan and Wang, 1999; Nolan, 2001). The pillar industries, such as energy, transportation, aerospace, telecommunication, medical, and financial sectors, remained controlled by state and dominated by SOEs (Nolan, 2008). So China state directs national banks to exclusively channeled strategic loans into ‘national champions’ SOEs (Tsai, 2002), not only to compensate social responsibility (Lardy, 1998), but also to implement state’s industrial development or technological catch-up goals in high-tech sector (Nolan, 2001; Liao, 2005).

Also, state re-structured SOEs to advance their R&D capacity. Before reform, China followed Soviet command system that functions of R&D and production are divided into the separated units of public research institutes (GRIs) and SOEs. So the GRIs and SOEs had no autonomy and isolated, and such fragmented administration impeded the prerequisite interaction for innovation. However, through marketization, both GRIs and SOEs can choose to interact with one another, since state also dis-centralized profit accountability to each unit (Liu and White, 2001; White and Liu, 2001). The reform leads to two divergent outcomes: on one hand, Beijing-clustering GRIs initiated the boom of start-ups (Gu, 1999); mean while SOEs remained relative

⁵ Ernst and Naughton (2008) additionally categorize hybrid type which ownership is mixed of FDI and China governments, such as Lenovo, Haier, ZTE and Huawei. These hybrid firms had highest (i.e. architectural or incremental) innovation capacity among China’s three types of organizations.

low level of innovation, despite that some SOEs established in-house R&D department. Therefore, state once commanded hundreds of GRIs combined into SOEs (Huang et al., 2004), aiming to strengthen the R&D capacity of SOEs.

However, ‘the big and strong’ strategy (作大作强) confronted challenges from both severe global competition and internal bureaucracy interference (Nolan and Zhang, 2002). For instance, state arbitrarily turned down business expansion proposals of ambitious SOEs (Nolan, 2001). Most of all, the soft budget constraints does not link SOEs subsidies/loans with their performance, so SOEs do not have incentives to deploy resources on R&D (Steinfeld, 1998). Other related issues, such as state’s ownership or control on CEOs’ appointment (Pearson, 2005), also negatively influence on SOEs R&D incentives and innovative capacity (Fuller, 2005, 2009; Li et al., 2007)⁶.

Moreover, the formation of supply chains and their technology capacity were by undermined by eschewed state-SOE clientage policy and bureaucracy interference. For example, central or local states command M&A among firms not for business strategic (Nolan, 2001), or limit firms to partner from best suppliers for locality protectionism reason (Steinfeld, 2004). In turn, SOE’s suppliers are lack of economics of scale (Nolan 2001:88). Most of all, given the state-business patronage culture, self-interested firm tends to develop vertical/political relationship with governmental officials, rather to develop horizontal/commercial network relationship (Gilboy, 2003).

In sum, there’s lack of *institutional reciprocity relationship* between China state and SOEs (Moore, 2002) since that (1) neither state nor banks monitor how SOEs

⁶ Counterpart *minying* firms also do not engage in R&D, but for other reason. Since they’re excluded from formal bank loans and forcedly turn to black market for cash flow (Tsai, 2002). The financial constraints prevent them from investing on R&D, and fall in commodity manufacturing and price war for fast cash flow (Steinfeld, 2004).

make use of the privileged resources (Lardy, 1998), and that (2) state's reward or punishment is not relevant to SOE's performance (Li et al., 2007). Thus, the inefficient resources allocation arises, even under the aggressive industrial policy (Steinfeld, 1998). We extend to investigate how other institutional issues hinder the TD-SCDMA industrialization; most important, we also investigate how institutional learning and changes to turn the TD-SCDMA industrialization around, instead.

3. Research Method

3.1 Research scope and market situation

A telecommunication standard involved actors in private sectors spanning three industries, i.e. operator (service), equipment manufacturing (infrastructure building), and mobile handset (terminal) industries, and actors in public sectors like international organization and local governments (Hess and Coe, 2006: 1218). And three market situations in China differ: For the mobile handset industry, the domestic market has long been dominated by MNCs (e.g. standard: 2G GSM) since 1990's. And the R&D capacity of domestic firms, start-ups, joint-venture, and SOE, had been weak. (Cheung, 2005; Ni and Wan, 2008)

For the equipment manufacturing, local four firms had once successful substitute imports in (fixed line) switch product (Fan, 2006a; Hawrit, 2007), and Huawei excels in global marketing and R&D (Ernst and Naughton, 2008). By contrast, China government prohibits foreign firms to operate telecomm network service and regulates 'healthy competition' by re-organizing the business scope and restricting number of firms (Zhang, 2002; Yu et al., 2004; Pearson, 2005). China Mobile is biggest, both local and global, telecom operator with over 500 million users (BMI, 2010).

In short, the manufacturing of China (mobile) telecommunication market had been long dominated by MNCs, despite increasing local venture and SOEs. According

to China official statistics for 2002, the production volume of mobile switching, mobile base station and mobile phones are approximately 90 million, 4.5 million, and 120 million, respectively. Domestic firms only composed of 33%, 22% and 12.3%, respectively (MII, 2003) .

3.2 Research question and design

In short, we question whether China state had built reciprocity relationship with business actors by proper institutional arrangement as a whole, and whether it can be conducive to the commercialization and or industrialization of TD-SCDMA. The terms *commercialization* refers to individual firm-level (i.e. SOEs) R&D and innovation; while *industrialization* refers to network-level (i.e. the supply chain) R&D and innovation.⁷ The reason to observe these two indicators, representing for technology capacity of SOEs' and the formation of supply chains, is to evaluate effects from China institutional arrangements on both vertical (state-SOEs) and (inter-firm) horizontal relationship.

Through secondary data collection and interview, we attempt to clarify the interaction effect between China state-SOE and SOE-network, so the analysis framework is composed of three tiers of actors that SOE is in the middle position (shown as Figure 1). Combined with the state-SOE-network tier relationship, we explore: (1) how institutional legacies *hinder* TD-SCDMA commercialization and industrialization. Then, we examine: (2) what are the institutional changes and how these changes started to *encourage* the TD-SCDMA industrialization, instead.

Also, in view of that China state capitalizing on different SOEs and accompanying

⁷ Normally, the value chain mobile handset industry is mainly consisted of H/W producers (e.g. IC chipset, M/B, and final device assemblers) and S/W producers (e.g. O/S, contents provider, games). Since TD-SCDMA is the technology had never been exploited into commercial products, so China government had to find a way to organize or coordinate domestic handset upstream and downstream firms. And we analyze how firms can *collectively* R&D and improve TD-SCDMA products.

institutional changes, we further break framework into two time-periods: During stage 1 (2002- 2008) that China central government started to support Datang Group, aiming to commercialize TD-SCDMA technology into products. State also assigned Datang to lead TDIA for TD-SCDMA industrialization. In stage 2 (2009-present), China state turned to mandate China Mobile to promote TD-SCDMA, not only responsible for networking building and service providing, but also for organizing of mobile handset supply chain (Wang and Tsai, 2010).

4. Case studies

4.1 Institutional legacies: hinder TD-SCDMA development

4.1.1. State re-structures SOE and capitalizes on Datang Group

In 1993, the central-level research institute for telecommunication and post under Ministry of Post and Telecommunication (MPT)⁸, was split into three institutes. That is, Chinese Academy of Telecommunications Technology (CATT), Institute of Telecommunication Planning, and Institute of Post Planning. The staff of CATT had spun to initiate Datang various subsidiaries, such as Datang XiAn (大唐西安). Under state's 'big and strong' strategy, Datang Telecom Group, becoming one of central-level SOEs, was established 1999 and later listed in stock market, with attempt to consolidate business scope spanning telecommunication sector and increase the value of national assets.

From the organization chart of Datang Telecom Group (see Appendix 1), we can also observe that research units CATT co-exists and parallels to Datang Group's subsidiaries. Also, the 130 R&D staffs of Datang were transferred or recruited from CATT (Yan, 2006) that they possess the core technology of TD-SCDMA (Liu, 2008). It indicates that state attempts to increase the R&D capacity of Datang Group through

⁸ MPT combined with MEI (Ministry of Electronic Industry) to become MII in 1998.

organization restructuring and employee rotation. For instance, Mr. Lee Shi-He (李世鹤), the father of TD-SCDMA, was vice president of CATT, who first established Beijing Xinwei (北京信威) in 1995 for SCDMA scheme and later Datang Mobile (大唐移动) in 2002 for TD-SCDMA scheme.

In addition to human resources, MII, NDRC (National Development and Reform Commission), and MOST (Ministry of Science and Technology) jointly subsidize RMB\$ 700 million accumulated from 2002 to 2003 (Liu, 2005, 2008) and RMB\$ 1 billion accumulated to 2006 for TD-SCDMA R&D (Yan, 2006). Moreover, state directed national bank, such as Industry and Commerce Bank (ICBC), Construction Bank of China and Huasia Bank, to offer loans Datang group approximately RMB\$ 1.5 billion. Additionally, China Development Bank offered RMB\$ 38 billion during 2005~ 2007 for TD-SCDMA network building and testing (Liu, 2008: 63-64; Whalley et al., 2009: 13-14; Datang, 2010).

At the same time, state assigned Mr. Yang Hua (杨骅), CRO of Datang Group and vice president of Datang Mobile to the lead TD-SCDMA industry alliance (TDIA)⁹. The TDIA was designed to function as the platform of TD-SCDMA development, involving the activities of setting standard, sharing IPR, organizing supply chain, and coordinating among members (TDIA, 2010)¹⁰. In other words, the state established top-down TDIA mechanism to overcome the deficiency of inter-firm cooperation and trust for knowledge diffusion in China (Gilboy, 2003). Basing on Datang Group's standard and core technology, TDIA intends to promote patent pool and learning among supply chain members which is the foundation of TD-SCDMA

⁹ The initial members of TDIA are consisted of 17 domestic firms, 8 foreign/joint venture firms (cf. Sumttmeier et al., 2006: 42-43 for the list). The members are key manufacturers in mobile equipment, e.g. Datang, Huawei, Alcatel, Siemens, etc., and mobile terminal sectors, e.g. joint ventures of Datang, Phillips, and Samsung (Whalley et al., 2009: 17).

¹⁰ And for China numerous standards, such as AVS, RFID, EVD (Sumttmeier et al., 2006), there're corresponding industry alliances established by Beijing Zhongguancun committee of industry alliance (<http://zcia.org>), since Zhongguancun is China another scheme for 'indigenous innovation' cluster.

industrialization.

However, we argue that neither the restructuring of Datang Group can leverage the firm's innovation capacity, nor the top-down TDIA can promote network cooperation among China firms.

4.1.2 State pick loser SOE as national team

The R&D capacity of Datang Group as a whole is questionable, despite that Datang set home-grown TD-SCDMA standard (interview ES1). Since 1992, CATT had received national grant to undergo the earliest home-grown standard (SCDMA, 2G), but failed to commercialize due to weak R&D capacity in commercialize large-scale system development (Chen, 2005; Soh and Yu, 2010)¹¹. Second, Datang XiAn, founded in 1993 and specializing for telecommunication equipment manufacturing for digital automatic switching (SPC) product, can not compete with local *minying* enterprise Huawei and mixed enterprise ZTE since late 90's to early 2000's (Fuller, 2005: 201; Harwit, 2007; Liu, 2008). The table 1 is the snapshot of capacity of Datang, Huawei and ZTE that Huawei and ZTE outperformed Datang in sales, profit, R&D expenditure, and number of employment.

Table 1 China major telecommunication equipment manufacturer

Unit: US millions

	Huawei	ZTE	Datang
Year 2002			
Sales revenue	2,700	1,300	247
Profit	320	96	36
Employee	18,000	12,916	4,183
R&D density	17.8%	7.2% ¹	n.a.
Year 2004			

¹¹ Again, the SCDMA was developed by CATT and commercialized by Datang Xinwei, another spin off and subsidiary founded in 1995.

Sales revenue	5,600	4,100	1,800
Profit	459	752	-22
Number of Employee	22,000	17,000	4,000
R&D density	12.6%	9.9%	n.a.

Sources: (Fan, 2006a: 361; Fan, 2006b: 17; Liu, 2008:52)

Notes: The figure is 2001 data.

The SOEs were once protected by state through public purchase, but Datang SOEs can not compete with Huawei and ZTE eventually (Harwit, 2007). In addition, Huawei and ZTE began to export their products, particularly to countries in Southeast Asia, Central Asia, Eastern Europe, and Latin American (Liu, 2008). Not to mention that Huawei established global R&D center and accumulated experience in network building with global telecom operators (Ernst, 2008; Naughton and Ernst, 2008).

By contrast, the Datang Group is state-owned enterprise spin off from CATT, and they didn't directly confront market and no pressure for survival (interview ES1 and IS1). Although state continuously channeled national resources to compensate the loss (cf. Table 1 2004 negative profit) from developing TD-SCDMA and that Datang Mobile indeed deployed on R&D and accomplish some patents, Datang Group as a whole can not develop innovation capacity in designing parts and testing whole TD-SCDMA network system. One of the reason is that Datang Group lacked of associated knowledge and experience before (Soh and Yu, 2010).

The same situation occurs in TD-SCDMA mobile terminal products. The joint ventures IC design firms of Datang and MNCs, such as T3G or Commit, launched none of TD-SCDMA products to the market and ended up merged by ST-Ericsson or bankrupted. Likewise, Datang Mobile fruited no complete TD-SCMDA handset, so the state turned to university and public-sector research institutes to support the development of TD-SCDMA (Liu, 2008, 2009). It implies that not only there's no knowledge spillovers between local and MNCs alliance (Kennedy et al., 2008), but

also that Datang didn't benefit from JV neither to narrow up its' IC design capacity with MNCs.

In sum, we reveal that China state's inability to supervise on national resources allocated to equipment manufacturer SOEs since 1990's, and it further caused the vicious circles that SOEs Datang had not accumulated R&D capacity over time, from fixed line products to mobile products. Neither China state punished Datang's past bad performance in domestic market and failure in previous SCDMA scheme, nor evaluated the pessimistic R&D capacity of Datang for TD-SCDMA prospect.

Still, state maintained to support Datang for national indigenously target out of Datang's major contribution in setting standard approved by ITU. But again without state's monitor on firm's performance, that Datang can not develop new products as Huawei and ZTE. In fact, state picked the loser SOE as the national team, given the long-term and continuing missed "institutional reciprocity" in between.

4.1.3 Dysfunctional TDIA

TDIA also confronted frustration in knowledge sharing and organizing of supply network. There's no patent license-out or cross-license among member (Sumttier et al., 2006; Whalley et al., 2009), except occasional license out from Datang to ZTE and Putian (Soh and Yu, 2010). Theoretically, Datang supposed to invite and global companies, such as Huawei and ZTE, into the supply chain of TD-SCDMA and leverage on their experience. But Datang, as the father of TD-SCDMA, tried to protect and guard their child (interview ES1). On the other hand, the R&D capacity of Huawei and ZTE outperformed Datang, so Huawei and ZTE won't bother to join Datang on patent sharing and further on TD-SCDMA technology/product (interview RS4 and RS6). In other words, low capacity of mission-oriented SOEs can not convince global-reach but rival Chinese firms to cooperate on TD-SCDMA

industrialization, due to the Datang's protectionism and inter-firm power struggle.

Last institutional impeding factor is the weak IPR regime in China (Kennedy et al., 2008), and three conditions were still missing in China: the 'rules of game' for IPR, the enforcement environment and 3rd party arbitrations (interview RS6). In the process of reconciliation 'rules of game', the fragmented authority among line ministries made it difficult, since TD-SCDMA associated SOEs had played hardball (interview RS4). Thus, the top-down TDIA mechanism does not overcome the self-interested issue and encourage the 'collective action' of knowledge sharing among members.

Indeed, Chinese firms join TDIA is to monitor what other firms have done, rather than to share their knowledge (interview RS4). Worse, the firms care about their *presence* in TDIA more than what they can get from it, since joining TDIA itself is pertinent to their political influence (interview ES1)¹². The dysfunctional TDIA on promoting inter-firm cooperation is echoed by the indicators that size of TDIA is relative small than two industry alliances of competing standards, in term of the number of private-sector firms and total R&D investment (Fan, 2006a)¹³.

In short, state privileges single SOE but resulting in protective and competitive situations, which is negatively conducive to knowledge diffusion and network innovation among TDIA members. As a result, the technology capacity of indigenous mobile terminal remained the weakest part of TD-SCDMA commercialization (Wang and Tsai, 2010). Under the techno-nationalism ideology, China government had no

¹² Our observation is regarding the relationship among domestic actors on industrialization, not just between MNCs and China actors on standard setting. Yet, the results are consistent with the argument that MNCs participate in TD-SCDMA standard setting acted as goodwill gesture to China government and local firms (Kennedy et al., 2008). Also, the interests of China standard coalitions between MNCs and China side had gradually developed from divergence to convergence (Kennedy, 2006).

¹³ WCDMA has 27 companies as its main supporters, which includes Japan's NTT, European Ericsson and Nokia; while CDMA 2000 has most of its supporters in North America and Korea, such as Qualcomm, Motorola, and Samsung. These firms have invested US\$40 billion and US\$10 billion on R&D to support WCDMA and CDMA 2000, respectively. Moreover, there were over 50,000 and 10,000 worldwide R&D staff for WCDMA and CDMA 2000 systems.

choice but to hold 3G license.

4.2 Institutional changes: TD-SCDMA development turn-around?

4.2.1 The reshuffle of telecom giants

The deferring of issue 3G license had been debated that it proved to be another government inappropriate intervention that it damage the commercial interest of both local and foreign firms who had sunk invested (Suttmeier et al., 2006). Similarly, the cost/benefit for China government is pessimistic, since it had allocated huge resource to Datang (Zhou, 2006). But we observe the consecutive actions of state to clear up the mess, coupled with institutional changes.

On one hand, China state is always “trying to get the market right and avoid further wasting of (national) assets” (Pearson, 2005: p.411); hence, State Assets Supervision Administration Commission (SASAC)¹⁴ appointed Mr. Zheng Cai-Gi (真才基) as the CCP party secretary (党组书记) of CATT on Jun, 15, 2007 for preparation. Later in Jan.2008, Mr. Cheng was appointed as both President and CEO of Datang Group, and previous CEO was transferred to lead a local-level SOE in telecommunication sector¹⁵.

On the other hand, State assigned Mr. Li E-Chung (李毅中)¹⁶ as the new minister of MIIT¹⁷, who resolutely granted the 3G licenses: TD-SCDMA license to China Mobile, WCDMA to China Unicom, and CDMA 2000 to China Telecom. In addition, state recognized that what matters is not the *de jure* standard, but *de facto*

¹⁴ It's the one of regulatory bodies under State Council accounting for maximizing the value of 196 large SOEs in pillar industries. For telecommunication industry, these SOEs are: Datang, Putian, China Mobile, Shanghai Bell, and so on. (SASAC website, download 2010.09.10. <http://www.sasac.gov.cn/n1180/n1226/n2425/index.html>)

¹⁵ Datang Telecom Group website (history of company), download 2010.09.10. http://www.datanggroup.cn/templates/T_Contents/index.aspx?nodeid=16

¹⁶ Mr. Li E-Chung is famous for the ‘fire freighter’ management style.

¹⁷ In 2008, MII underwent further re-organization and combined with the information office unit of NDRC, to become the consolidated department MIIT (Ministry of Industry and Information Technology), in accordance to convergence trend of computer, mobile phone, and internet.

technology. Without technological capacity, the standard alone is meaningless (Interview, RS6). Therefore, MII deliberated from options (Interview ES1) and alter China Mobile promoting industrialization and leading supply chain, in order to leverage on China Mobile's 'size and capacity' and make TD-SCDMA 'big and strong' (Interview IS1).

4.2.2 State pick winner SOE as national team

By contrast to Datang, the state evolves to pick China Mobile as the new national team by assessing past performance as selection criteria. First, China Mobile has near 500 million (end of 2008) users, making it as the largest telecom operator worldwide (BMI, 2010). So it's a feasible path to migrate most China users from 2G (GSM) to home-grown standard (Interview, ES1). Second, China Mobile is most profitable and potential operator in China that China Mobile had the capacity and capital to promote TD-SCDMA (Interview ES1, SS2, ES1).

Yet, China state mandates China Mobile to promote TD-SCDMA is not for a few SOEs' commercial interests, but for national interests. So the decision arouses the paradox between state and business (Interview ES2 and RS5) that Mr. Wang Jian-Zhou (王健宙), President of China Mobile Group, once protested (Interview ES1). But the state threatens China Mobile: TD-SCDMA or none of 3G licenses. Coupled with impact on Mr. Wang's political career, China Mobile has no choice but to promote TD-SCDMA (Interview ES1). On the other hand, the state also subsidizes RMB\$10 billion (SinoCast, 2009) to compensate for potential loss estimated RMB \$30 billion each year (Interview RS5).

In short, China state changes institutional means of supporting core SOE by both subsidies and threat, rather than carrot without stick. The state also changes to assess SOE's past performance for prospects of TD-SCDMA. Despite the mandatory

mission, China Mobile indeed starts to recruit R&D staff with high salary (Interview RS5) and experiments several innovations on TD-SCDMA network deployment, mobile phone launch, and service package to users (Interview IS1).

4.2.3 Emergent of cooperative network

China Mobile, as a customer rather than rival of equipment manufacturers, had invested RMB\$148 billion during 2008 to 2010 through four stages bids of infrastructure construction (BMI, 2010; IEK, 2010). Both local and global firms, such as SOEs Datang and Putian, *minying* Huawei and MNCs Nokia-Siemens, all compete for TD-SCDMA network building (Wang and Tsai, 2010). The final winners are Huawei and ZTE, for their cheaper but good product quality than MNCs' and SOEs' (Interview ES2). It indicates that China Mobile also *selects* their cooperating partners basing on market performance as the foremost criteria. This is different from the previously protectionism signal that Datang sent, since the SOE was targeted to dominate China market under the umbrella of MIIT, and which formulated the national industrial policy.

China Mobile also realizes that the biggest problem of TD-SCDMA industrialization is the shortage of TD-SCDMA handsets in the market. Under the pressure from mission and profit, China Mobile urges their current partners (e.g. Nokia and Motorola) to produce TD-SCDMA products through replicating the same incentives tools that state imposed upon China Mobile. That is, China Mobile, basing on their market significance, threatens their main suppliers (e.g. Nokia and Motorola): TD-SCDMA products or none of other business (Interview IS1). On the other hand, China Mobile first offered RMB\$ 600 million to three chipsets designers and nine

handset suppliers¹⁸, to induce these leading firms to offer cheap products to penetrate China market. Thus, Nokia, HTC, Samsung and some local firms started to launch TD-SCDMA handsets. Most of all, China Mobile plays as a coordinator to integrate the supply chain, from upstream IC design firms to downstream manufacturers (Interview IS1).

In short, we scrutinize that vertical state-SOE relationship no longer undermine the horizontal relationship between China Mobile and their suppliers. We conclude that state has learned from lessons and selects winner SOE to implement the mission based on performance, rather than ideology alone. This sends the signal to market that there's no long protectionism for Datang. Also, state changes to induce SOEs with incentives and possible punishment, namely, through license control and career mobility. Furthermore, winner SOE reproduces the same 'carrot and stick' imposed on the global leading firms spanning the value chain of mobile phone industry. In turn, the experienced non-SOE firms has accelerated the development time and increased the varieties of new products (Wang and Tsai, 2010). In all, the institutional changes prompt the taking-off of TD-SCDMA commercialization and industrialization, despite there's a long way to go for indigenous innovation.

5. Discussion and conclusion

5.1 Discussion

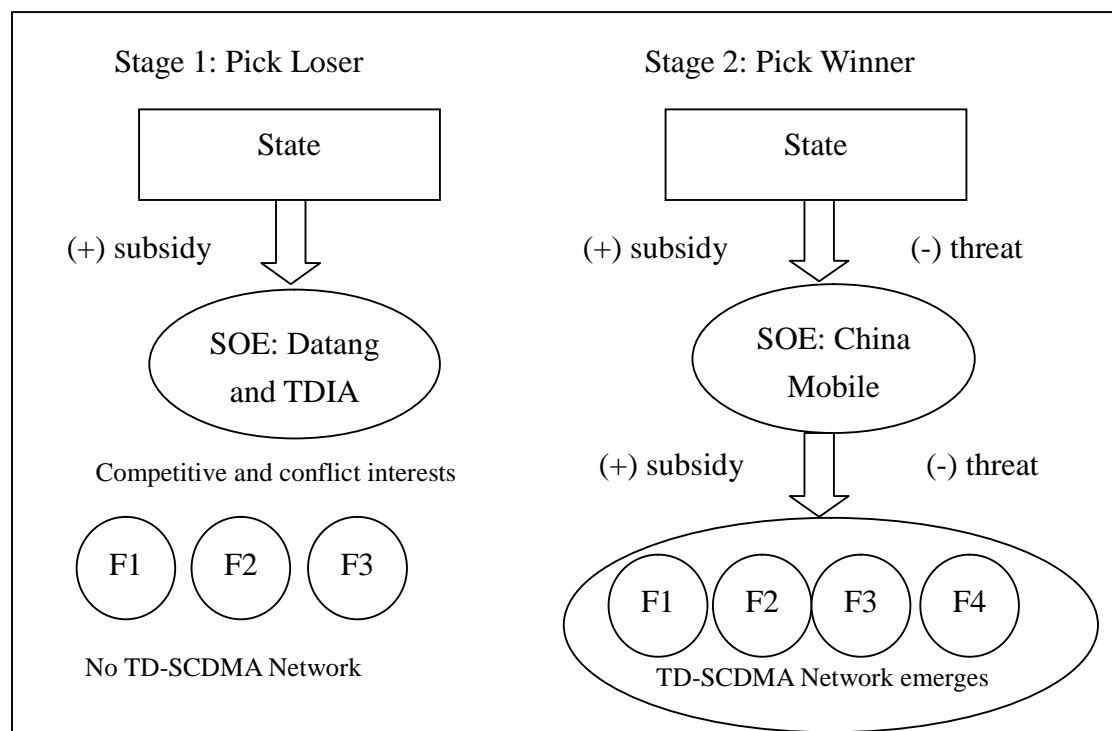
We present the institutional analysis clarifying why in early stage China state capitalized on a major SOE to engage in R&D and coordinate supply chain, but in vain. The innovation, particularly for unknown TD-SCDMA technology, requires not only efforts from a single big firm, but requires network innovation through social

¹⁸ China mobile website http://www.chinamobile.com/aboutus/news/200912/t20091217_13491.htm. revealed nine handset suppliers are Huawei, Haier, LG, Samsung, Motorola, ZTE, and so on.

interaction to continuously explore and exploit. However, without proper institutional arrangements, the ambitious industrial policies brought unintended results.

For the case of TD-SCDMA, we argue that: (1) in the period 1 (2002-2008) the strong state-SOE clientage remained lack of ‘institutional reciprocity’ in between. That is, state offered unconditional subsidies and resources centering on Datang SOEs to develop core technology of TD-SCDMA, without punishment linkage to their performance. As a result, the R&D capacity of Datang remained lower than *minying* firms Huawei. Worse, the low R&D capacity of Datang led to deferring 3G license, which in turn signals state protectionism and the doom future of TD-SCDMA.

Figure 1 Topology of institutional changes and impact



Also, ‘pick loser’ strategy furthered to discourage the formation of supply chain, despite of establishment of TDIA. Our case confirms that there’s the trade-off effect between state-SOE and SOE-network relationship (Gilboy, 2003). Instead of political culture aspect, we further to explore from institutional framework and offer

explanation how Datang-led TDIA failed to encourage collective action. Consequently, there's only the dysfunctional and political symbol of TDIA, but no knowledge sharing or formation of supply chain in telecommunication sector (shown as left part of Figure 1).

(2) Nevertheless, we observe the institutional changes after 3G licenses allocated (2009-present). China state alters to mandate China Mobile to lead TD-SCDMA promotion, instead. By contrast to Datang's case, we argue that China state starts to build 'institutional reciprocity' with China Mobile, but not by repeat games of performance evaluation and subsidy or punishment as Korea state did. Rather, China state learns to select capable SOE as national team by evaluating its past performance. Moreover, we discover that China state punishes SOEs in different way, not by decrease of subsidies, but by state's power in downgrading CEO positions and controlling access to license (rents), for cases of Datang and China Mobile respectively. Therefore, the linkage between performance and punishment indeed exists, still the problem is the timing of punishment is sometimes late and random (interview RS4).

Anyhow, under the state's 'pick (the) winners' strategy and mentioned institutional changes, China Mobile was forced to support TD-SCDMA commercialization and industrialization, in term of in-house R&D and networking of supply chain. For the latter, China Mobile 'pick (more) winners' from the market as well, coupled with some tools of subsidy and/or threat. In other words, China Mobile also managed to induce these firms developing TD-SCDMA products, in addition to WCDMA or CDMA ones. Under the new incentives and corporate power inherent from China Mobile 'size and capacity', supply chain of TD-SCDMA products is formed and composed of increasingly global leading firms, both domestic and

international firms. In sum, it implies there's the catalytic effect between state-SOE and SOE-network interaction, along with the institutional changes (shown as right part of Figure 1).

5.2 Conclusion

We focus on home-grown telecommunication standard (TD-SCDMA), and examine how macro-level institutions influence development of the industry. The China state used to channel privileged resources to SOEs without performance benchmarking, punishment and monitoring. Under missing credentials or institutional reciprocity between China state and SOEs, the goal of independent innovated could not be attained nor the endogenous industry be fostered.

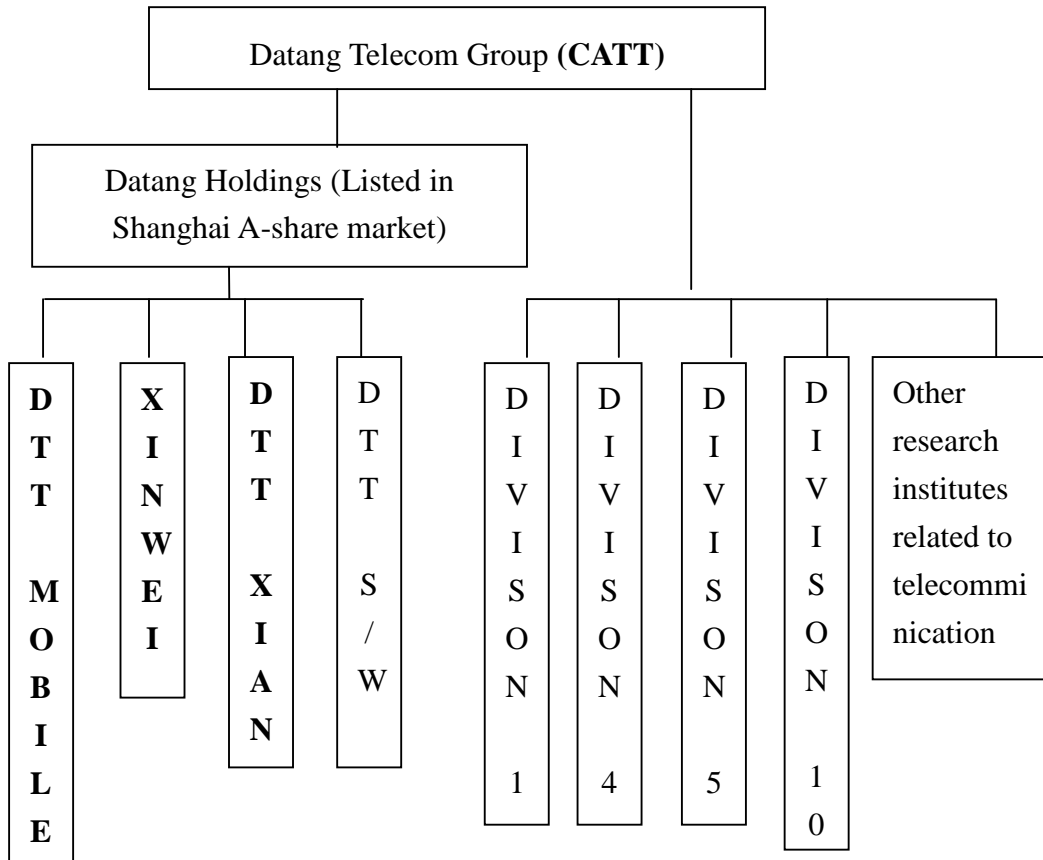
For the particular case of TD-SCDMA development, this paper contributes to discover that China state experiments and adapts institutions, along with the mentality adjusted from 'standard matters' to 'R&D capacity rules'. More, the macro-level institutional learning also leads to meso-level institutional adaptation in the telecommunication industry. China Mobile acts as a mediator between state and network of firms, with the resources re-distribution and demand for collective action through the whole supply chain. Therefore, China Mobile not only managed to offer users with innovative service and networking build through in-house R&D, but also to organize the preliminary formation of TD-SCDMA production networks.

Nevertheless, China-style 'carrot and stick' is not the repeated game of 'subsidies more or less' as Korea state had constructed. So the future question is whether the sustainable reciprocity or credentials relationship will be consolidated between China state and rest SOEs. Despite the turnaround situations observed, so far the domestic user of TD-SCDMA only reached 20 million (CWW, 2011)¹⁹, China 3G market share

¹⁹ New title: The user of TD-SCDMA exceeds 20 millions and terminal device are 632 types.

dominated by domestic equipment manufacturers is still lower than MNCs in general, and patents of TD-SCDMA are more concentrated in two MNCs, Qualcomm and Nokia (Wen and Yang, 2010). So another question is whether the institutional changes will eventually bring the significant effect, namely, indigenous innovation of Chinese firms and TD-SCDMA products substituting imports.

Appendix 1 Organization chart of Datang Telecom Group



Sources: adapted from MIC (2004) for organization chart in 2005

Notes: DTT is short for Datang.

References

- Amsden, A., (1989) *Asia's Next Giant: South Korea and Late Industrialization*, New York: Oxford University Press.
- BMI (2010) China Telecommunication report 2010 Q2, Business Monitor International (BMI), London: UK.
- Breznitz, D. and Murphree, M (forthcoming) *Run of the Red Queen: Government, Innovation, Globalization, and Economic Growth in China*. Yale University Press (May 31, 2011)
- Cao, C. Simon, D.F. and Suttmeier, R. (2009) China's innovation challenge, *Innovation: Management, Policy, and Practices*, 11(2), pp. 253-259.
- Chandler, A. D. (1990) *Scale and scope : the dynamics of industrial capitalism*. Cambridge, Mass. : Belknap Press.
- Chen E. H. (2005) The study of China's development in independent technical standards : case studies of the wireless communication standard-TD-SCDMA. Unpublished master thesis [in Chinese].
- Cheung, C. (2005) *Technology transfer and competition : the mobile handset industry in post-WTO China*. Wiesbaden [Germany] : Deutscher Universitäts-Verlag.
- Ernst, D., (2008) Can Chinese IT firms develop innovative capacities within global knowledge networks? In *Greater China's quest for innovation*. Henry S. Rowen, Marguerite Gong Hancock, and William F. Miller (eds). Stanford, Calif. : The Walter H. Shorenstein Asia-Pacific Research Center. Pp. 197-216
- Ernst, D. and Naughton, B. (2008) China's Emerging Industrial Economy: Insights from the IT Industry. In *China's emergent political economy: capitalism in the dragon's lair*, (eds), pp. 39-59
- Evans, P.(1995) *The Embedded Autonomy: States and Industrial Transformation*. Princeton, N.J. : Princeton University Press
- Fan, P. L. (2006a) Catching-up through developing innovation capacity: evidence from China's telecom-equipment industry, *Technovation*, 26, pp.359-368
- Fan, P. L. (2006b) Promoting indigenous capacity: The Chinese government and the catching-up of domestic equipment firms, *China Review*, pp.9-35
- Fuller, D. B. (2005) Creating ladder out of chains: China's technological development in a world of global production. MIT Political science dissertation.
- Fuller, D. B. (2009) China's national system of innovation and uneven technological trajectory: the case of China's integrated circuit design industry, *Chinese Management Studies*, 3(1), pp. 58-74.
- Gabriele, A. (2002) S&T policies and technical progress in China's industry, *Review of International Political Economy*, 9(2), pp. 333-373.

- Gilboy, G. (2003) Nodes without roads : pockets of success, networks of failure in Chinese industrial technology development, PHD dissertation, Massachusetts Institute of Technology.
- Gu, S.L. (1999) *China's industrial technology: market reform and organizational change*. London ; New York : Routledge.
- Haggard S., and Moon, C. (1990) Institutions and economy policy: Theory and a Korean case study, *World Politics*, 42 (2), pp. 210-237
- Haggard, S. (2004) Institutions and growth in East Asia. *Studies in Comparative International Development*, 38(4), pp.53-81.
- Harwit, E. (2007). Building China's telecommunications network: industrial policy and the role of Chinese state-owned, foreign and private domestic enterprises. *The China Quarterly*, 190, pp.311-332.
- Hess, M. and Coe, N.M. (2006) Making connections: global production networks, standards, and embeddedness in the mobile-telecommunications industry, *Environment and Planning A*, 38(7), pp. 1205-1227.
- Howell, J. (2006) Reflections on the Chinese state, *Development and Change*, 37(2), pp. 273-297
- Huang, C., Amorim, C., Spinoglio, M., Gouveia, B., and Medina, A. (2004) Organization, program and structure: an analysis of the Chinese innovation system policy framework. *R&D management* 34(4): 367-87.
- Huang, Y.S. (2003) *Selling China*. Cambridge: Cambridge University Press.
- Huang, Y.S. (2008) *Capitalism with Chinese characteristics: Entrepreneurship and the state*. Cambridge [England] ; New York : Cambridge University Press.
- IEK (2010) From TD-SCDMA to TD-LTE : a study on the potential market opportunities of China mobile broadband market. IEK, MOEA (Ministry of Economic Affairs) publish. Taipei: Taiwan [in Chinese].
- Johnson, C., 1982, *MITI and the Japanese Miracle*, Stanford, CA: Stanford University Press.
- Kennedy, S. (2006) The political economy of standards coalitions: Explaining China's involvement in high-tech standards wars, *Asia Policy*, 2, pp. 41-62.
- Kennedy, S., Suttmeier, R. P., and Sun, J. (2008) Standards, stakeholders, and innovation: China's evolving role in global knowledge economy, *NBR Special Report*, No. 15.
- Kerr, D. (2007) Has China abandoned self-reliance ? *Review of international political economy*, 14 (1). pp. 77-104.
- Kang, David C. (1995) South Korean and Taiwanese development and the new institutional economic, *International Organization*, 49(3), pp.555-587
- Kim, L. (1997) *Imitation to innovation : the dynamics of Korea's technological*

- learning*. Boston, Mass. : Harvard Business School Press,
- Lardy, N. R. (1998) *China's unfinished economic revolution*. Washington, D.C. :
Brookings Institution Press.
- Li, Y., Liu, Y. and Ren, F. (2007) Product innovation and process innovation in SOEs:
Evidence from Chinese transition, *Journal of Technology Transfer*, 32, pp.63-85.
- Liao, C. (2005) *The governance structures of chinese firms : innovation,
competitiveness, and growth in a dual economy*. New York : Springer.
- Liu, X.L. (2005) China's development model: An alternative strategy for
technological catch-up, Working paper march 22, 2005, Institute of Innovation
Research, Hitotsubashi University, Japan
- Liu, X.L. (2008) *Globalization, catch-up and innovation*. Beijing: Science Publisher
[in Chinese].
- Liu, X.L. (2009) Path-following or Leapfrogging in Catching-up: The Case of the
Chinese Telecommunications Equipment Industry Paper for the ISMOT 09
Conference, Zhejiang University, Hangzhou, China 23-25 September, 2009 .
- Liu, X.L. and White, S. (2001) Comparing innovation systems: a framework and
application to China's transitional context. *Research Policy* 30, pp.1091-14.
- MIC (2004) The current status of Datang groups' TD-SCDMA. Market Intelligence &
Consulting Institute (MIC), Taiwan.
- MII (2003). Yearbook of China Information Industry, electronics. Published by
Ministry of Information Industry. Beijing: China.
- Moore, T. G. (2002) *China in the world market : Chinese industry and international
sources of reform in the post-Mao era*. Cambridge, U.K. ; New York :
Cambridge University Press.
- Naughton, B and Segal, A. (2000) Technology development in the new millennium:
China in search of a workable model. Paper presented in annual meeting of
Innovation and Crisis: Asian Technology after millennium. MIT Japan Program,
Working Paper 01.03.
- Ni, N. and Wan, F. (2008) A configurational perspective of branding capacities
development economics: The case of the Chinese cellular phone industry, *Journal
of Brand Management*, 15, pp. 433-451.
- Nolan, P. and Wang, X. (1999) Beyond privatization: institutional innovation and
growth in China's large state-owned enterprise. *World Development*, 27(1),
pp.169-200.
- Nolan, P. (2001) *China and the global economy : national champions, industrial
policy, and the big business revolution*. Basingstoke, Hampshire [England] ; New
York : Palgrave.
- Nolan, P. and Zhang, J. (2002) The challenges of globalization for large China's firms,

- World Development*, 30(12), pp. 2089-2107.
- Nolan, P. (2008) *Integrating China : towards the coordinated market economy*. London ; New York : Anthem Press, 2008
- Oi, J.C. (1992) Fiscal reform and the economic and the local state corporatism in China, *World Politics*, 45: 99-126
- Pearson, M. (2005) The business of governing business in China: Institutions and norms of the emerging regulatory state, *World Politics*, 57(2), pp. 296-322.
- Schneider, B.R. (1998) Elusive synergy: Business-government relations and development, *Comparative Politics*, 31(1), pp. 101-122
- SinoCast China Business Daily News.(2009) MIIT Making TD-SCDMA Work Inspection Indices. London (UK): Jan 16, 2009. [Proquest download date: 2010.3.31]
- Serger, S.S. and Bredine, M. (2007) China's fifteen-year plan for science and technology: An assessment, *Asia Policy*, 4, pp.135-164.
- Smyth, R. (2000) Should China be promoting large-scale enterprises and enterprises group? *World Development*, 28(4), pp. 721-737.
- So, Alvin Y (2009) Rethinking the Chinese developmental miracle, In Hung, H.F.(ed.) *China and the transformation of global capitalism*, pp.50-64
- Soh, P.H. and Yu, J. (2010) Institutional environment and complementary assets: Business strategy in China's 3G development, *Asia Pacific Journal Management*, 27, pp. 647-675.
- Steinfeld, E. S. (1998) *Forging reform in China : the fate of state-owned industry*. Cambridge, U.K. ; New York : Cambridge University Press, 1998
- Steinfeld, E. S. (2004) China's shallow integration: Networked production and the new challenges for late industrialization, *World Development*, 32(11), pp. 1971-1987.
- Suttmeier, R. P. (2002) Globalization, structural Change, and the role of government in China's search for a national innovation strategy. Paper presented in UN university project on technological innovation.
- Suttmeier, R. P. and Yao, X.K.(2004) China's post-WTO technology policy: Standards, software, and changing nature of techno-nationalism, *NBR Special Report*, No. 7.
- Suttmeier, R. P., Yao, X., Tan, A.Z. (2006) Standards of power? Technology, institutions, and politics in the development of China's national standard strategies, *NBR Special Report*, National Bureau of Asian Research.
- Tsai, K. S. (2002) *Back-alley banking : private entrepreneurs in China*. Ithaca, N.Y. : Cornell University Press.
- Thun, E. (2004) Keeping up with the Jones: Decentralization, policy imitation and industrial development in China. *World Development*, 32: 1289-1308.

- Wang, J.H. (2006) China's dualist model on technological catching up: a comparative perspective. *The Pacific Review*, 19:3, 385-403.
- Wang, J.H. and Tsai, C.J. (2010) How Does China Restructure Global Production Networks? Working paper in Industry Studies Conference (ISA), 2010 May 6-7, University of Illinois, Chicago (UIC), USA.
- Weiss, L. (2000) Developmental states in transition: adapting, dismantling, innovating, not" normalizing, *The Pacific Review*, 13(1), pp. 21-55
- Weiss, L. (ed) (2003) *States in the Global Economy: Bringing Domestic Institutions Back In*. Cambridge, Cambridge University Press.
- Weiss, L. and Hobson, J.M. (1995) *States and economic development : a comparative historical analysis*. Cambridge, Mass. : Polity Press
- Wen, H. and Yang, D. (2010) The missing link between technological standards and value-chain governance: the case of patent-distribution strategies in mobile-communication industry, *Environment and Planning A*, 42, pp. 2109-2130.
- Whalley, J., Zhou, W. and An, X (2009) Chinese experience with global 3G standard-setting, Working paper in CESIFO, 2009 Feb. Munich, German.
- White, S and Liu, X.L. (2001) Transitional trajectory for market structure and firm strategy in China, *Journal of Management Studies*, 38, pp. 103-124
- Yan, H. (2006) The 3G Standard Setting Strategy and Indigenous Innovation policy in China: Is TD-SCDMA a Flagship? DRUID (Danish Research Unit for Industrial Dynamics) Working Paper No. 07-01
- Yu, L., Berg, S., and Guo, Q. (2004) Market performance of Chinese telecommunications: new regulatory policies, *Telecommunications Policy*, 28, pp.715-732.
- Zhang, B. (2002) Understanding China's telecommunications policymaking and reforms a tale of transition toward liberalization, *Telematics and Informatics*, 19, pp.331-349.
- Zhou, Y. (2006) State and commercial enterprise in China's technical standard strategies, *The China Review*, 6(1), pp. 37-65.