

Chinese institutions and standardization: The case of government support to domestic third generation cellular standard

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Abstract:

There are unique and distinct institutional processes associated with the Chinese government's support of the domestically developed third generation (3G) cellular standard, TD-SCDMA. After postponing several times, China awarded three third generation cellular licenses in January 2009: a TD-SCDMA license to China Mobile, a CDMA 2000 license to China Telecom and a WCDMA license to China Unicom. The Chinese government has demonstrated a clear bias in favor of TD-SCDMA. This article examines the role of formal and informal institutions in shaping the Chinese 3G landscape. This paper makes two contributions to the literature. First, this work extends studies on institutional theory focusing on standardization to the context of China. Second, unlike most ICT research which deals with standards originated in the West, this paper's focus on developing country-originated standard provides novel and unique insights related to institutional processes.

Keywords: institutions | China | 3G cellular communications | standardization | compatibility | TD-SCDMA | ITU | telecommunications | Chinese government

Article:

China is rapidly evolving as an innovation powerhouse. Among many visible examples, one is particularly telling: acceptance of China's Time Division-Synchronous Code Division Multiple Access (TD-SCDMA) as a global third generation (3G) cellular standard by the International Telecommunications Union (ITU). Among 16 proposals submitted for IMT-2000 standards, the

ITU selected TD-SCDMA as one of the three global 3G standards. The other two standards are U.S. based CDMA 2000 and Europe's Wide band CDMA (W-CDMA) (Table 1).

Table 1. A comparison of the three 3G cellular standards.

	CDMA 2000	W-CDMA	TD-SCDMA
Developed by ^a	Qualcomm Inc (US-based)	Nokia Oyj and Ericsson AB (Europe-based)	Chinese Academy of Telecommunications, Datang, Huawei, ZTE, Siemens (China-based)
First launched, operator, country, (year) ^b	SK Telecom, South Korea (October 2000)	NTT DoCoMo's FOMA, Japan (October 2001)	China Mobile Communications (Soft launch in April 2008)
2G version	CDMA One	GSM	None
Standard accepted by	The 3rd Generation Partnership Project 2 (3GPP2): The participating associations are ARIB/TTC (Japan), China Communications Standards Association, Telecommunications Industry Association (North America) and Telecommunications Technology Association (South Korea).	The 3rd Generation Partnership Project (3GPP): The groups are the European Telecommunications Standards Institute, Association of Radio Industries and Businesses/Telecommunications Technology Committee (ARIB/TTC) (Japan), China Communications Standards Association, Alliance for Telecommunications Industry Solutions (North America) and Telecommunications Technology Association (South Korea) ^c .	3GPP
Where	166 operators in 73	162 networks in service in 72	1 operator (China

	CDMA 2000	W-CDMA	TD-SCDMA
used	countries, 275 million subscribers (September 2006) ^d	countries, representing almost 70% share of all 3G networks (June 2007) ^e	Mobile Communications) (June 2008)
Major markets	The Americas	Europe and Japan	Likely to be China
Availability of handset products	950-plus (February 2006) ^f	Over 650 (June 2007) ^f .	About 100 (May 2008) (developed by 20 vendors) ^g . 30 manufacturers had TD-SCDMA handset production licenses (May 2008) ^b .
Duplexing scheme used	Frequency Division Duplex (FDD) (supports two-way radio communication by using two distinct radio channels).	Frequency Division Duplex (FDD) (supports two-way radio communication by using two distinct radio channels).	Time Division Duplex (TDD) (uses a single frequency to transmit signals in downstream and upstream directions).

a Asakawa (2007).

b CMCC opens second round of TDSCDMA handset tenders (2008).

c 3GPP (Retrieved from <http://en.wikipedia.org/wiki/3GPP>); 3rd Generation Partnership Project 2 (Retrieved from <http://en.wikipedia.org/wiki/3GPP2>).

d CDG: Cdma 2000 user base hits 275 m due to rapid migration to 3G (2006).

e Morse (2007).

f Nearly 100% of CDMA handsets is CDMA2000-enabled (2006).

g Chambers (2008).

The question of when China would issue 3G cellular licenses had been anybody's guess for several years. In January 2009, China awarded a TD-SCDMA license to China Mobile, a CDMA 2000 license to China Telecom and a WCDMA license to China Unicom. China Mobile had made a soft launch of 3G services based on TD-SCDMA in April 2008.

There are several signals indicating that the Chinese government's favor has gravitated toward the TD-SCDMA. For instance, in October 2002, the Ministry of Information Industry (MII) allocated 155 MHz of 3G radio frequency spectrum to TD-SCDMA compared to 60 MHz for CDMA 2000 and W-CDMA each (Zhang & Prybutok, 2005). Another point in TD-SCDMA's favor is the MII's formal endorsement in January 2006 of the standard as the Chinese national 3G standard. The Chinese government has thus demonstrated a clear bias towards TD-SCDMA.

The central idea of this article is that while it may be natural for a government to favor a domestic standard, there are unique and distinct institutional processes associated with the Chinese government's support of TD-SCDMA. Many idiosyncratic and unusual features such as strong nationalism, the state's deep entrenchment in the economy, regulative uncertainty, professional/trade associations' roles and importance of business and social networks are deeply reflected in China's institutional landscape (Kshetri, 2007). For this reason, Gao & Lyytinen (2000, p. 720) have noted that the Chinese Telecommunications industry “presents an interesting case study” . This paper seeks to explain institutional forces and logic associated with the Chinese government's decision to support TD-SCDMA.

This paper makes two contributions to the literature. First, this paper extends studies on institutional theory focusing on standardization activities to the context of China. Past standardization studies have mainly dealt with institutional processes operating at industry, trade and professional associations, and inter-organizational levels (Hess & Kemerer, 1994) and the evolution of vertical standards ([Markus et al., 2006],[Steinfeld et al., 2005] and [Wigand et al., 2005]). In most cases, standardization activities reported in the literature are voluntary (Montealegre, 1999). In contrast, organizations operating in the value chain of a standard are likely to face coercive pressures in China. The current work supplements prior studies by providing insights on institutional influence in the development of a standard.

Second, existing research conducted in the context of developing world has focused on measures taken to facilitate the diffusion of standards originated in the West ([Braa et al., 2007] and [Montealegre, 1999]). Chinese government actions in 3G cellular standardization, on the other hand, seem to be centered on capturing the value chain around 3G and enhancing national pride. This paper's focus on a standard originated in the developing world provides novel and unique insights related to institutional processes.

In addition to theoretical significance, this paper's focus on cellular standardization in China is important from managerial and policy standpoint. First, origination of ICT standards in developing countries such as China can help the creation of a sustainable information society.

The contribution of the new innovation regime to a sustainable information society and identification of policies to promote such an end have been identified as important research and policy issues (Bohlin, Brousseau, & Hulten, 2001). Second, given the size of the Chinese cellular market, China's actions in wireless standards are important for the world. In this light, this article identifies the risks and rewards associated with China's unique institutions.

2. Literature review

2.1. Neo-classical economic models and their limitations

Neo-classical economic models explain standardization related activities in terms of rational decision makers' choices (Farrell & Saloner, 1986). These models, however, fail to consider important mechanisms associated with standardization activities such as self-reinforcing effects. Prior research has shown that new businesses may create self-reinforcing effects by “encouraging similar activities and repelling dissimilar ones” (Ryder, 2004, p. 1663). This logic can be applied to self-reinforcing mechanisms in the telecommunications standardization activities.

Arthur (1988) proposed four sources of self-reinforcing processes: large set-up or fixed costs; learning effects (improvement through experience); coordination effects (advantages in going along with others); and adaptive expectations. As the example above indicates, these self-reinforcing processes are tightly linked to the development of a technological standard. Since telecommunication standardization has these attributes, it can be considered as a self-reinforcing activity that cannot be fully explained by neo-classical economic models. Arthur (1996) also identified key effects of self-reinforcing mechanisms, which include path-dependence (past events affect future development) and lock-in (after the adoption of a technology, it is impossible to develop competing technologies).

It is recognized that, due to a self-reinforcing process, standardization activities may lead to possible inefficiency, that is, the best solution may not necessarily win. A classic example of a self-reinforcing process is the diffusion of the standard QWERTY keyboard layout. As more and more people learned to use this design, it became difficult for competing keyboards to dominate the market. Arthur (1996) argued that self-reinforcing processes, which are social mechanisms responsible for an alternative solution (e.g., technological standard) to take a lead over others, are outside the scope of neo-classical models.

2.2. Institutional influence in standardization

There has been a surge of research interest in institutional influence on standardization (Table 2). Researchers in various social science disciplines have recognized that neo-classical economic models fail to explain behaviors and outcomes observed in standard setting activities ([Arthur, 1988], [North, 1990] and [Nickerson and Zur Muehlen, 2006]).

Table 2. A literature review of the institutions-standardization nexus.

	Level of institutions	Technology studied	Type of standard	Main findings
Braa et al. (2007)	National	Health information standards (HIS)	Interoperability/Performance	<p>Urban and rural areas in developing countries are characterized by the uneven development of the basic infrastructure to support health standards.</p> <p>Vertical programs funded by international donors lead to increased complexity and fragmentation in HIS.</p>
Ciborra and Hanseth (1998)	Inter-organizational/industry	Customer relationship management (CRM), corporate Internet/intranet	Compatibility/interoperability	Increase in installed base leads to establishment of institutions and rise of interests in the technology.
David and Shurmer (1996)	Public and quasi-public institutions International organizations	Telecommunication networks	Compatibility/interoperability	<p>Institutional mechanisms need adaptations to be effective for new networks.</p> <p>Governments have to play active roles in standardization activities.</p>
Montealegre (1999)	National	Technology service	Performance	Standard setting requires support from a number of institutions such as the government, academic community, private sector, and the international institutions.
Nickerson and Zur Muehlen (2006)	Multiple-institution system	Web services	Anticipatory/reference	<p>Multiple-institution system might be slow but more effective in standard making.</p> <p>There is no coercive and normative power to drive a complex standards effort to completion due to weak institutionalization of Internet standard making.</p>

Level of institutions	Technology studied	Type of standard	Main findings
			<p>Standards motivated by business goals may face resistance.</p> <p>Standard makers who value the freedom may provide continuous support to the current chaos of the Internet standards making environment.</p>
Steinfield, et al. (2005)	Inter-organizational/industry	Various IT systems	Compatibility/interoperability Collective actions among industry participants, performance effects, and structural effects influence industry-level inter-organizational IT-driven coordination systems.

An example of institutional influence is David and Shurmer's study (1996), which indicated that institutional mechanisms at the international level need adaptations to be effective for new telecommunications networks. They emphasized the importance of governments' role in reinforcing steps toward these institutional transformations.

Montealegre (1999) examined the roles of newly created national institutions in facilitating standard setting activities in Latin America. In Ecuador, the Information Corporation, a nonprofit institution was created by private and academic institutions. Similarly, in Peru, the Red Científica Peruana (RCP), which was formed by nongovernmental and academic institutions, performed regulatory functions.

A growing body of literature highlights the importance of industry as well as trade associations in shaping the standardization activities (Hess & Kemerer, 1994). To support e-commerce activities, many industries have formed associations ([Steinfield et al., 2005] and [Wigand et al., 2005]). The increase in installed base also leads to establishment of institutions and rise of interest in the technology (Ciborra & Hanseth, 1998).

2.3. Assessment of the literature and the importance of institutions–ICT standardization nexus studies in the Chinese context

Many fundamental considerations related to standardization are not fully addressed. First, researchers have neglected to pay enough attention to standardization issues (Lyytinen & King,

2006). Second, previous literature has mainly focused on standards originated in the West ([Braa et al., 2007] and [Montealegre, 1999]).

Third, prior researchers have noted that the Chinese economic, political and social systems have many unusual and idiosyncratic features (Terrill, 2005). The Chinese economic system arguably exhibits a higher deviation from the assumptions of neo-classical models than other economies (Hermann-Pillath, 2006). Due to the unique historical, political, and social contexts in China, it is appropriate to introduce institutional model to explain standardization activities.

3. Institutions and standardization in China: some propositions

In order to understand the relevance of the institutional processes affecting standardization activities in China, this section presents key events associated with the evolution of TD-SCDMA (Table 3). Chinese policy makers have envisioned TD-SCDMA as a means to leapfrog in the global technological race. There is a narrow window of opportunity. As the chief technology officer of a multi-company Sino-foreign joint venture in Shanghai said: “If they miss 3G, they will have to wait 15 more years to get 4G. So they have to be there, and this is why they have invested in TD-SCDMA” (Clendenin & Mannion, 2002, p. 2).

Table 3. Emergence of TD-SCDMA: A timeline.

Date	3G and TD-SCDMA related event
1992	The “3G” idea was first conceived at the 1992 World Administrative Radio Conference (WARC).
1997	ITU called for proposals for IMT-2000 to define an “anywhere, anytime” standard for the future of universal personal communications.
1998	Datang was separated from the China Academy of Telecommunications Technology.
Jun. 29, 1998	China sent TD-SCDMA proposal for the IMT-2000. The proposal was signed by the Minister and two Vice-Ministers of the MII.
Jul. 1998	Datang and Siemens signed an agreement for the joint development of TD-SCDMA.
Dec. 1998	Third Generation Partnership Project (3GPP) was accepted by six standards setting bodies: ETSI, ARIB and TTC of Japan, ANSI of the USA, and the TTA of Korea.
Nov. 5, 1999	ITU accepted five IMT-2000 standards as radio interface standards: TD-SCDMA, together with SC-TDMA (UMC-136), MC-TDMA (EP-DECT), CDMA2000 and WCDMA.
May 2000	At the World Radio Conference, ITU accepted TD-SCDMA as one of the three 3G standards.
Early 2001	Siemens' cumulative investment for the TD-SCDMA project amounted \$1 billion.
Mar. 16, 2001	TD-SCDMA was accepted by the 3GPP.
Apr. 11, 2001	First test of TD-SCDMA was successfully conducted in Beijing.
Oct. 23, 2002	Chinese MII allocated 155 MHz for TD-SCDMA and 60 MHz for each CDMA2000 and W-CDMA.
Oct. 30, 2002	TD-SCDMA alliance was established by eight domestic vendors.
Nov. 2003	Motorola released a TD-SCDMA module library for the MRC6011 Reconfigurable Compute Fabric (RCF) device.
Jan. 2006	The MII formally endorsed TD-SCDMA as a Chinese national standard.
August 2006	SK Telecom signed a MOU with China's National Development and Reform Committee (NDRC) to help China develop TD-SCDMA.
Apr. 2008	China Mobile made a “soft launch” of 3G services based on TD-SCDMA standard in eight cities.
Aug. 2008	Beijing Olympics planned. Only TD-SCDMA-based 3G services were available.

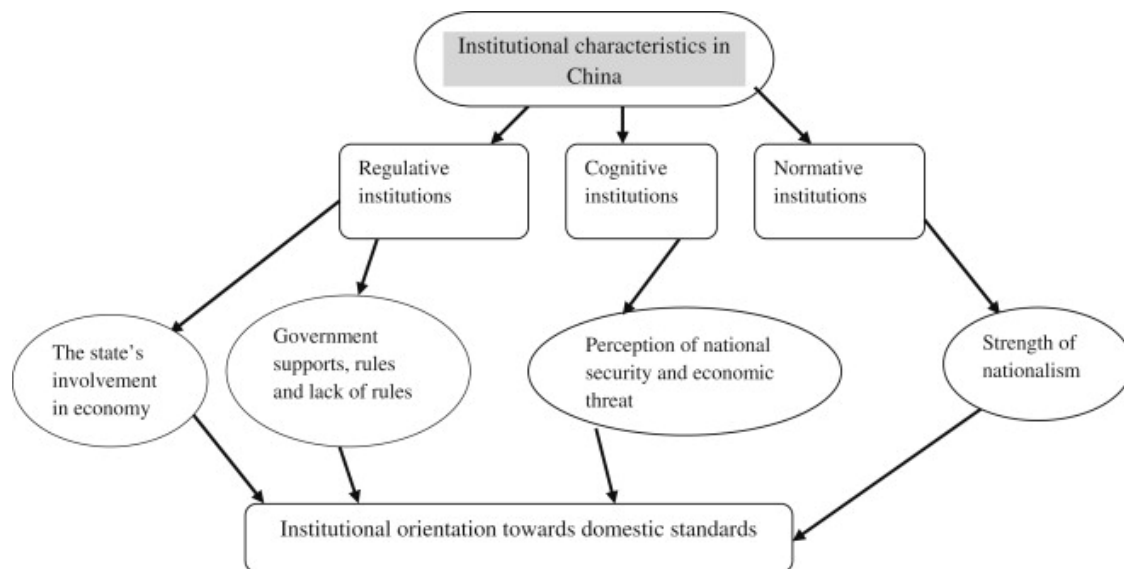
Date	3G and TD-SCDMA related event
January 2009	China awarded a TD-SCDMA license to China Mobile, a CDMA 2000 license to China Telecom and a WCDMA license to China Unicom

Source: [Yan, 2003] and [Yan, 2004], Sharp supply GSM wireless phones to China (2003).

Institutions are “macro-level rules of the game” (North, 1990, p. 27), which include formal constraints such as rules, laws, constitutions and informal constraints such as social norms, conventions and self-imposed codes (North, 1996). This paper employs Scott's (2001) three institutional pillars - regulative, cultural-cognitive, and normative - as an analytic tool.

Legitimacy related to regulative, normative and cognitive institutions can be mapped with “legally sanctioned behavior”, “morally governed behavior”, and “recognizable, taken-for-granted behavior”, respectively (Scott, Ruef, Mendel, & Caronna, 2000, p. 238).

TD-SCDMA may well be an inefficient standard relative to other more proven standards. However, the various institutional processes that guide standardization related decision making have favored TD-SCDMA and made the inefficiency related concerns less important compared to many other countries (Fig. 1).



3.1. Regulative institutions

Regulative institutions consist of “explicit regulative processes: rule setting, monitoring, and sanctioning activities” (Scott, 2001, p. 52). In the current context, regulative institutions consist of regulatory bodies (e.g., the Chinese MII and the Chinese Communist Party (CCP)) and existing laws and rules that influence bias towards TD-SCDMA.

3.1.1. Government supports, rules and lack of rules

A standard's chance of dominating the market increases if it is supported by a governmental body (Teece, 1998). In order to maximize economic and technological benefits, the state can employ regulatory power to influence technological standards (Macinnes, 1994). A government may deviate from an international standard and erect technical barriers (Barrett & Yang, 2001).

It has been suggested that in China “the law is marginalized and the legal system relegated to a lowly position in a spectrum of meditative mechanisms, while at the same time available for manipulation by powerful sectors within the state and the society at large” (Myers, 1996, p. 188). The lack of clear policies has been a focus of concern. Therefore, the following is postulated:

P1a. Formal laws and government supports in China are likely to favor a domestic standard.

P1b. A weak rule of law in China is more likely to favor a domestic standard than a foreign standard.

3.1.2. The state's involvement in the economy

China's most notable feature is the state's deep entrenchment in the economy. According to the UBS, the state accounts for at least 70% of the Chinese economy compared to less than 7% in India (Pei, 2006a). As of 2001, in 70% of large- and medium-sized corporatized enterprises, CCP members were on the board of directors (Pei, 2006a).

The development of a standard is influenced by the orientation and standards of firms in vertical relations (David & Greenstein, 1990). In China, many firms in vertical relations with TD-SCDMA are state-owned, which are arguably neither real enterprises nor regulatory agencies (Gao & Lyytinen, 2000). They helped enrich and strengthen the TD-SCDMA's ecosystem by facilitating the development systems and components that are interoperable and compatible with TD-SCDMA (Table 1). By 2006, about 20 manufacturers had developed over 100 handset models based on TD-SCDMA (Chinese 3G standard finds support, 2006). Local manufacturers such as ZTE and Huawei were arguably among the biggest supporters of TD-SCDMA standard, although they also made handsets and equipment for the competing 3G standards (Shannon, 2006).

Similarly, in 2000, the TD-SCDMA Forum was established by eight companies. The forum was created as a venue for sharing information and promoting the development and commercialization of TD-SCDMA (Wilhelm, 2001). In 2003, China Mobile persuaded major system producers to invest in TD-SCDMA. In 2005, TD-SCDMA Forum announced a plan to promote TD-SCDMA as an international standard. Thus, the proposition:

P₂. The state's involvement in the economy in China favors a domestic standard over a foreign standard.

3.2. Cognitive institutions

Cultural-cognitive institutions are “the shared conceptions that constitute the nature of social reality and the frames through which meaning is made” (Scott, 2001, p. 57). Although carried by individuals, cognitive programs are social in nature (Berger & Luckmann, 1966). Motivations associated with the support of TD-SCDMA can be explained in terms of political cognitive factors. Mental maps of political elites or “persons who by virtue of their institutional positions have a high potential to influence national policy making” (Moore, 1979, p. 674) determine a nation's technological landscape.

3.2.1. Perception of national security and economic threat

David and Steinmueller (1994) argue that one of the major motivations behind technology policies and standard-setting initiatives is to achieve national goals such as protection of domestic employment and reduction in foreign dependence. Governments tend to use standards as instruments to promote such objectives (Bar & Borrus, 1987). The government can take standardization related measures to overcome consumer abuses arising from businesses' myopia, greed, and economic power (Hart, 1998).

In China, the outflow of royalties has been a focus of concern. China wants to reverse the flow of fees. Chinese policy makers think that developed countries tend to see developing countries as ‘markets’ for the transnational corporations’ products, which threatens their economic security (China Economic Times, 2000).

Not surprisingly China has been working to create domestic standards in many other ICT industries such as computer operating systems and audio-video compression. In the 1990s, China took aggressive actions in developing DVD and CD standards. Enhanced Versatile Disc (EVD) was China's response to create a red-laser DVD-like format, which was unsuccessful. Likewise, Super Video CD (SVCD) was developed by the government-backed China Recording Standards Committee. However, SVCD could not perform well in the market.

Another motivation behind technology policies and standard-setting for regulatory bodies is to enhance defense capabilities (David & Steinmueller, 1994). Policy makers are realizing the increasing influence of technologies in national security (Kshetri, 2004).

Xu Guanhua, then Chinese vice minister of the science and technology, thought that high technology affects national security: military security, economic security, and cultural security. Regarding military security, Guanhua argued that developed countries have put many hi-tech arms into actual battles and discussed the likelihood of ICT exporting countries installing software for coercing, attacking or sabotaging (China Economic Times, 2000).

Computer hardware and software imported from the U.S. and its allies into China are subject to detailed inspection in the country. Chinese technicians take control of such imports and resist or closely monitor if Western experts install them (Adams, 2001). Thus, the propositions:

P_{3a}. Political elites' perceptions of economic threats affect standardization activities in China.

P_{3b}. Political elites' perceptions of political and military security threats affect standardization activities in China.

3.3. Normative institutions

Normative components introduce “a prescriptive, evaluative, and obligatory dimension into social life” (Scott, 2001, p.54). Elements of normative institutions also include trade associations (e.g., TD-SCDMA Forum and China Mobile Association Committee (CMAC)).

3.3.1. Strength of nationalism

Nationalism and patriotism are important triggers for Chinese bias towards domestic standards. Central to this perspective is a prescriptive dimension that entails the principal of self-reliance and national pride. Since Mao Zedong's time, this principle has been guiding the Chinese economic system.

As early as the early 1970s, the Chinese Communist Party (CCP) emphasized the importance of standardization to “quickly build a socialist economy as well as an imperative means to ensure quality, advance performance, and rationalize the economy” (HGK, 1972, p.4). Since the 1980s, China made several attempts to develop a Chinese computer operating system. Some notable achievements include the development of Chinese Character DOS (CCDOS), database management system, network communication system, and middleware products. The CCDOS, launched in 1982, was largely unsuccessful.

Although attachment with one's nation leads to actions “which are disinterested or self-sacrificing” (Salmon, 1995, p. 296), the effects of patriotism are highly visible among Chinese. The CCP arguably bolsters its legitimacy through nationalism, invoking a deep sense of Chineseness among citizens (Barme, 1999).

Nationalism and patriotism affect Chinese consumers' bias towards products characterized by a high degree of Chineseness. For some segments of the Chinese population, local brands enjoy a higher degree of consumer trust than foreign ones and such a tendency is higher in China than in many other countries. Although many Chinese consumers pride themselves on using foreign brands, there is a sizeable segment of Chinese consumers that prefer China-originated products. Moreover the degree of preference for domestic versus foreign product is a function of the origin of the foreign product. For instance, partly due to a long history of hostility between China and Japan, Japanese brands tend to receive negative publicity in Chinese media. There are also instances of consumer boycotts of Japanese products and local retailers' ban of Japanese goods (Horn, 2009).

There are a number of pieces of evidence indicating that Chineseness in technologies co-varies positively with Chinese consumers' likelihood of doing business with a company (Kshetri, 2007). Zhou and Hui (2003) found that symbolic benefits associated with products offered by Chinese companies rather than improved quality were primary motivational forces. Note that symbolic benefits of products can be measured in terms of the extent to which they satisfy customers' underlying needs related to emotion, social approval or personal expression. These benefits are thus related to the extrinsic advantages of a product that go beyond the functional qualities (Kshetri & Cheung, 2002). A McKinsey Quarterly (2006) article explained that Chinese consumers have strong national pride and multinational companies are likely to lose important segments if they are perceived as too foreign. Thus it is proposed that:

P₄. The strength of nationalism is positively related to government's measures to favor domestic standards in China.

4. Methodology

The above propositions based on institutional processes related to China's standardization activities represent the positivistic research tradition. In order to evaluate these propositions, a two-pronged approach is used. The first and the major approach is the use of a historical and critical approach (Mason, McKenney, & Copeland, 1997) to trace the emergence of 3G standards in China. This added the richness and insights in interpreting the various nuances of cellular standard development as well as the role of institutions. The second is analysis of primary data collected by a qualitative survey of key informants in the 3G industry in China. This approach provides confirmation of the interpretations from the historical analysis. The simultaneous use of two approaches allows triangulation leading to higher credibility and confidence in the results.

The above point about triangulation may warrant elaboration. Triangulation is related to methodological pluralism, which entails systematically selecting "context-, situation- and use-specific" methodologies rather than adhering to a particular methodology (Razzaque, 1998, p. 9). Studies utilizing only one method are "more vulnerable to errors linked to that particular method" than studies that utilize multiple methods (Patton, 1990, p.188). In the context of this research, methodological pluralism within qualitative research is worth noting, which entails combining and adapting different qualitative techniques to achieve the objectives of a particular investigation (McLeod, 1996).

This paper has mainly combined two of what Hall and List (1999, p. 291) refer as the "three legs of qualitative stool"—interviews and document analysis. However, this paper also benefitted from the third leg—observations, albeit not formally documented in the paper. Different qualitative methods have unique strengths and weaknesses and a combination will amplify the strengths and compensate for the weakness so as to increase the intellectual and methodological power of qualitative research (Hall & List, 1999, 297).

The historical approach (Mason et al., 1997) consist of six steps: (1) start with a set of focusing questions, (2) select a domain, (3) gather evidence, (4) present and analyze evidence, (5) determine patterns, and (6) tell the story. The propositions presented earlier represent the focusing questions. China and cellular standards are the domain. Evidence was gathered from various sources from the very early days of cellular activities, starting in 1992 (see Table 2). The remaining steps are presented in subsequent sections.

This paper has placed a primary emphasis on Chinese political and national elites' perceptions and views on 3G standardization and more broadly ICT policies. Archival and media searches focused on direct quotes of the views expressed by national elites. They include legislators, governmental officials, political party officials, leaders of various interest groups, etc. (Table 4). It is noteworthy that there has been a good amount of media coverage on 3G standardization.

Table 4. Chinese political and national elites' views on 3G standardization.

Regulative institutions	
Yu, Dehai, director of the New Industry Research Department	December 2004: "TD-SCDMA...is favored by the Chinese Government and the standard itself is developing faster than expected. And It is favorable for investors to invest more in the TD-SCDMA system while betting on China's 3G development" ^a .
Xu, Guanhua, science and technology minister	May 2005: "We will continue to support TD-SCDMA and encourage more and more firms from home and abroad to join the development of the technology" ^b .
Zhang, X., vice-director, Nat'l Dev. and Reform Comm. (NDRC)	May 2005: "We have full confidence in the business prospects of TD-SCDMA and will support the commercialization of the standard" ^b .
Xi, Guohua, MII Vice Minister	December 2005: "TD-SCDMA must take a place in Chinese 3G and it may be run by a strong operator" ^c .
Wang, X. MII Minister	2006: "The timing for issuing 3G licenses will be determined by the market".
Xi, Guohua, MII Vice Minister	April 2007: "The pre-commercial trial of TD-SCDMA has nothing to do with the issuing of 3G licenses.... We will let the operators make decisions on their own which standard they will

Regulative institutions	
	use and the government will only decide how many 3G licenses will be issued" ^d .
Xi, Guohua, MII Vice Minister	May 2007: "we will let operators choose which standard they want to use. But the government will decide how many 3G licenses are issued" ^e .
Former Datang Mobile chief scientist Li Shihe, "father of TD-SCDMA	April 2008: "To date the relevant government departments have still not introduced any clear plan for the development of TD-SCDMA. Nobody has stood up and said whether they're even going to use this or not, or which operator will adopt it... ".
Normative institutions	
Wu, Jichuan, Comm. minister	December 2000: China would not pay foreigners for the intellectual property rights used in domestically produced and deployed telecommunications technology.
Chen, H., TD-SCDMA Forum Chief Secretary	June 2007: "Foreign companies need to get serious about TD-SCDMA as they are less likely to get anywhere with W-CDMA and CDMA 2000 in the near future" ^f .
An engineer at ZTE	August 2007: "...we would not end up paying 3% of the price for patent licensing..." ^g .
Yang, Peifang, China Aca. of Telecomm.	May 2007: "The three world standards will all be used in China. The introduction of the other two standards will help improve TD-SCDMA" ^e .
Yang, Hua, secretary general, TD-SCDMA Industry Alliance	"If we use an overseas standard, then the technology is controlled by foreign manufacturers. If China has its own standard, then the domestic enterprises can master the technology by themselves, so they can be at the same competitive level with overseas manufacturers" ^h .
Cognitive institutions	

Regulative institutions	
Zhang, Xiaoqiang Secretary-General, NDRC	August, 2003: “TD-SCDMA has been the first international standard accepted by ITU and validation of TD-SCDMA key system have finished, which has significant meaning” ⁱ .
Xu, Guanhua, vice minister of the science and technology	June 2000: “...transnational corporations are not only unwilling to transfer technologies but also try to monopolize or occupy the market instead. The development of high technology, therefore, will bear great impact on national security”... First, economic security. After the Cold War, contests between countries have shifted from the military to economic field... Second, cultural security. Internet has added another wing for the spread of Western culture... Third, military security. High technology has become essential to national defense. Western developed countries are paying increasing attention to hi-tech arms and have put many of them into actual battles ^j .
Xu, Guanhua, science and technology minister	March 2006: “The 3G service will play an important role in promoting China's telecommunications market” ^k . April 2006: IP disputes have been a “devastating blow”... “Chinese firms have to pay 20 to 40 percent of the price of every mobile phone or computer to an overseas patent holder” ^l .

a MoC (2004).

b MoC (2005).

c Dickie (2005).

d Foreign phone operators to get equal access to China's 3G market (2007).

e USITO (2007).

f Morse (2007).

g Asakawa (2007).

h Goodman (2003).

i TDSCDMA-FORUM (2003).

j China Economic Times (2000).

k 3G service in China necessary: Ministry (2006).

l Poor IP protection costs China \$1 billion (2006).

For primary data, participants included senior Chinese professionals at the policy making level in government ministries, telecommunication developers, and engineers/managers in industry who understand the development of national technological/3G cellular standards and their implications. The selection of the participants was primarily based on their positions that allow them to understand the national decision processes associated with the 3G development, and secondarily by the authors' access to the participants. The selected research participants had experience as well as knowledge of technological and policy dimensions of the 3G standardization processes and the environment in China.

The survey was administered to 20 people, and 12 responses were received. Given the nature of this study, while no formal test of non-response bias was possible, no notable differences were observed in the groups representing respondents and non-respondents. Six respondents were from industry and the other six came from government organizations. An open-ended semi-structured questionnaire was prepared to elicit responses. Extreme care was exercised in framing the questions so as to allow the respondents to answer freely without steering them in any particular direction.

Each author placed each of the statements of the participants as well as quotations of Chinese political and national elites' into one of the four categories: economic force, regulative institution, normative institution, and cognitive institutions. The final selection of participants' quotations under an institutional pillar was based on agreement among the three authors. Only quotations in which full agreement among the three authors took place were included in the study.

5. Historical and critical analysis

5.1. Government support, rules and lack of rules affecting TD-SCDMA (P_{1a-1b})

In markets with two or more standards, small changes in initial conditions may shape the competitive landscape (Arthur, 1994), which may result in one technology's gaining a sufficient lead and even locking in the market to become the de facto standard. This can occur even when the dominant technology is distinctly inferior to the alternatives.

The Chinese government has used its regulatory power to turn the initial condition in TD-SCDMA's favor. Until early 2009, TD-SCDMA was the only 3G standard in China. A standard is less likely to be successful if it is launched without developing the technology and a greater

body of knowledge (Krueger, 1991). The government used its power to provide such resources in favor of TD-SCDMA.

Just as important are some of China's formal rules that favor TD-SCDMA. In 2002, the MII document No. 479 allocated 155 MHz for TD-SCDMA compared to 60 MHz for CDMA 2000 and W-CDMA each. In 2006, the MII formally endorsed TD-SCDMA as a national standard.

A standard's success hinges on having well-developed systems and components that are interoperable and compatible, which help create “a coherent, customer-facing solution” (Adner, 2006, p. 98). Chinese regulative institutions have helped form innovation ecosystems around TD-SCDMA. The political elites have encouraged domestic and foreign companies to invest in TD-SCDMA's value chain (see Table 4).

5.2. The state's involvement in the economy and TD-SCDMA (P_2)

There are persuasive arguments to support the notion that state priorities come ahead of shareholders' profits for Chinese Telecommunications companies. Telecommunications companies are rapidly developing TD-SCDMA centric products and services. China Mobile launched 3G services based on TD-SCDMA although W-CDMA is the natural upgrade path to 3G for the company. Global cellular players, which betted against TD-SCDMA, revised their strategies and moved toward incorporation of this standard. In 2003, Motorola released a TD-SCDMA module library for the MRC6011 Reconfigurable Compute Fabric (RCF) device, which was designed to handle the complex processing step of TD-SDCMA development.

Estimates suggest that mobile operators in China are 70% state-owned (Zhang & Prybutok, 2005). Compared to the West, Chinese cellular companies are more government-centric and less consumer-centric. The MII Vice Minister, Xi Guohua noted that a strong operator would run TD-SCDMA (Dickie, 2005). Not surprisingly, China Mobile, the carrier with the most resources, launched TD-SCDMA. As of the mid-2009, China Mobile spent US\$6.5 billion on TD-SCDMA network and had plans to spend \$8.2 billion by the end of 2009 to expand coverage to 200 cities (Hong, 2009).

Without support from firms in vertical relations, TD-SCDMA operators could find difficult to attract consumers. Because of the Chinese government's pressure, many firms in vertical relations with TD-SCDMA are increasing their orientation toward this technology (Table 4).

5.3. Perception of economic and national security threats and TD-SCDMA (P_{3a-3b})

TD-SCDMA's success could help China achieve various goals. China is trying to move into higher gear beyond manufacturing. TD-SCDMA is part of broad efforts to capture the value chain around 3G cellular technology, cut the outflow of royalty payments to foreign companies and advance its technological gear. Chinese companies own most of the TD-SCDMA intellectual property (Shannon, 2006). Chinese companies supply most of the TD-SCDMA handsets,

network equipment and other components. Hua Yang, secretary general of the TD-SCDMA Industry Alliance noted: “If we use an overseas standard, then the technology is controlled by foreign manufacturers. If China has its own standard, then the domestic enterprises can master the technology by themselves, so they can be at the same competitive level with overseas manufacturers” (Goodman, 2003, p. E.01). Similarly, one of the survey respondents said: China prefers the TD-SCDMA since it is the China's own standard and it will benefit national telecommunication development.

Most of the core TD-SCDMA IP rights are held by Chinese companies. The standard's origins means that most of the major players in the TD-SCDMA value chain are likely to be Chinese. Beijing hopes to contribute to the success of domestic firms in key segments of the cellular industry (Steinbock, 2007). For instance, most of the TD-SCDMA equipment is supplied by the Chinese vendors. Likewise, in July 2008, China Mobile reportedly awarded TD-SCDMA handset orders of 200,000 units to 19 vendors, of which domestic vendors won 85%. Marukawa (2009, p. 430) notes: “Since Japanese manufacturers are not involved in the development of this technology, they will be handicapped in competition among TD-SCDMA handsets” .

Chinese government has expressed concerns over security issues. In 2004, Beijing raised the ire of U.S. manufacturers by forcing them to embed a Chinese-designed data encryption technology known as WAPI on all WiFi equipment sold in the country. Although critics labeled this measure as a trade barrier, Beijing maintained that the reason was a matter of making China's wireless networks safe for users. Since China is increasingly relying on wireless data in its communications infrastructure, WiFi's insecurity is of concern (Gillmor, 2003).

Military threats have been a major concern for the Chinese government in software and operating systems used in government agencies. So far, 3G has been primarily for public usage. Nevertheless, if government agencies use advanced 3G applications, it will have bigger national security implications. The national security concern has been reflected in some technologies used in the 3G industry. In 2004, Datang selected Linux for its 3G TD-SCDMA handset's operating system. A vice director of software research at the Chinese Academy of Sciences said Linux would protect the government from attacks by foreign hackers.

5.4. The nationalism effect on TD-SCDMA (P4)

Several political normative factors, such as desire for the representation of Chineseness in ICTs, may also lead to Chinese policy makers' bias towards TD-SCDMA. In the Chinese policy landscape, there has been a strongly expressed desire for the representation of Chineseness in ICTs. One of the survey respondents said that TD-SCDMA's success would enhance national pride. The Chinese are interested in having domestically developed 3G standards and setting standards for the world.

The CCP expects that a richer and more technology-orientated economy might help increase its respect. International mega-events such as the Olympic Games provide significant opportunities for demonstrating national achievements in technology.

Consider the 2008 Beijing Olympics. This mega-event clearly was a tremendous opportunity for Chinese to internationalize a national image. The Olympics could help promote a positive image worldwide using 3G as a showcase of China's economic and technological success.

Ideally, China wanted to delay 3G licenses until TD-SCDMA can compete with CDMA-2000 and W-CDMA (Kong, 2006). During the Olympics, however, the Chinese government also wanted to show the world its technological prowess. For the Olympics, Beijing did not have much time to gaze at the walls. There was a feeling that it would be in China's best interest to deploy 3G sufficiently before the mega event rather than waiting for the TD-SCDMA's maturity. One of the research participants noted that many foreigners would visit China during the Olympics. The participant went on saying that 3G mobile services were available in foreign countries and China must provide 3G services to the foreign visitors. The participant also emphasized that the Chinese Olympic committee promised to provide 3G services. Another respondent put the issue this way: Olympic Games need 3G technology. It will help China to show good image to the world.

6. Analysis of primary data

In analyzing the primary data, each completed questionnaire was examined to identify reasons for selecting technology and cellular standards, and particularly the TD-SCDMA standard by the Chinese government. Besides the regulative (R), cognitive (C), and normative influences (N), another influence frequently cited was economic necessities and rational choice (E).

Table 5 shows the frequency of occurrence of each influence as cited by the respondents. Note that a respondent may cite an influence multiple times and is counted accordingly. Some representative responses are presented in Table 6.

Table 5. Perceptions of reasons for selecting 3G cellular standards.

Influence	Frequency—raw count	Frequency percentage (%)
Regulative (R)	7	9.9
Cognitive (C)	6	8.6
Normative (N)	44	62.0
Economic/Rational (E)	14	19.7

Table 6. Research participant's perceptions of 3G standardization.

Regulative institutions
The government has given priority to China's own standard. At the meantime China has not discarded the international standards.
The government should give adequate time to China Mobile to implement TD-SCDMA, which is a not well established standard.
Chinese government prefers TD-SCDMA.
Normative institutions
I would prefer the combination of WCDMA and TD-SCDMA since, on one hand, it could meet the market demand in most countries in the world except the U.S.; on the other hand, it will promote Chinese National industry development.
China prefers the TD-SCDMA since it is the China's own standard and it will benefit national telecommunication development.
TD-SCDMA is not as mature as the other two standards. This action (TD-SCDMA's launch before the other two standards) will help TD-SCDMA's development.
If a country uses the standards and core technology which developed by another country, this country will never become strong, and would not be competitive in the world market.
Promoting TD-SCDMA is important. The lessons from 1G and 2G are that China should make decision based on not only quality and maturity of the technology, but also long-term consideration at macro-level.
TD-SCDMA's success would enhance national pride.
Many foreigners will come to China during the Olympics. 3G mobile services are available in foreign countries. China must provide 3G services to these people. In addition, the Chinese Olympic committee promised to provide 3G services.
Olympic Games need 3G technology. It will help china to show good image to the world.
Cognitive institutions
China does not have any control on CDMA-2000 and WCDMA standards.

Regulative institutions

China should develop its own telecommunication standard and protect information security.

If the telecommunication industry has its own standards, it will raise national pride and patriotism.

Telecommunication is tightly linked with national security. If China has its own standard, the national security will be guaranteed.

TD-SCDMA is China's own 3G.

TD-SCDMA is China's own 3G standard. The intellectual property right belongs to China.

TD-SCDMA will enable the national industry development and get rid of the high patent cost of foreign standard.

The institutional forces combined have a frequency of 80% compared to 20% for the economic rationale. Despite a small size, they represent a major support for the application of the institutional theory in support of standardization process in a developing country. While the economic issues matter, the institutional forces dominate.

Among the institutional forces, the normative influence seems to dominate. Note that the regulative influence may have been under-represented in the sample, as there was not a direct way of capturing it. China's ability to regulate is a fact given its political system and is well supported in popular and academic writings. Since it is a given in China, respondents may not be reporting it. On the other hand, the support for cognitive influence, although existent, is not widely shared by the pool of professionals, who participated in this research. In summary, while there is some level of support for all the propositions, clearly proposition four is strongly supported.

7. Discussion and conclusions

The institutional analysis allowed to gain insights into the complex phenomenon of standardization in China. The primary and secondary data provided support for most of the propositions. This research did not find enough evidence to support the proposition related to national security threat (Proposition 3b). However, as noted earlier, national security concerns have been raised about several technologies (e.g., Datang's selection of Linux as the operating system) that are used in 3G cellular phones.

While the research participants also mentioned factors related to economic necessities and rational choice, the emphasis was much lower compared to institutional factors. Complex institutional logic and processes discussed above are beyond the scope of neo-classical models. Neo-classical economic models cannot capture institutional logic such as the importance of internationalizing national positive image through the Olympic Games and the desire for China to have its own standard.

Past literature has examined standards that originated in economies characterized by a free market economy. Chinese economy is not yet a free market economy. China's emerging entrepreneurs are far from free market ones and are generally supportive of the CCP's authoritarian agenda of unity and stability (Pei, 2006b). In this context, domestic and foreign firms in the 3G cellular technology's value chain are likely to face pressures to have TD-SCDMA centric strategies.

China has a unique combination of regulative, normative, and cognitive institutions, which influence each other through unique and distinctive mechanisms. Political and national elites' cognitive and moral judgments regarding domestic and foreign standards are reflected in regulative institutions. Likewise, the state-sponsored nationalism affects cognitive and normative institutions from the standpoint of ICT standardization.

A lack of focus on the consumer was illustrated by the lack of development of end-user computing. Historically, the emphasis has been on technical and operational aspects rather than on end-user computing (Ming-te et al., 1988). Terrill (2005, p. 54) argues that "because China remains an authoritarian state, we cannot know what the Chinese people want". In the same vein, the delay in issuing 3G licenses indicates a low degree of government's orientation towards consumers and citizens.

The following additional observations are made.

7.1. Symbolic and substantive responses to institutional pressures

Various institutional actors differ in terms of power to affect an organizational outcome. The exact nature of decoupling is a function of relative powers of competing organizational interests (Westphal & Zajac, 2001). Clearly, substantial responses cannot be made to appease actors that oppose diametrically. The substantive response relates to the actor that is perceived to be more powerful and the symbolic response relates to the actor perceived to possess less power (George, Chattopadhyay, Sitkin, & Barden, 2006). The government acts as a mediator for various institutional actors. Institutional pressures to provide more favorable treatment to TD-SCDMA are stronger than for other two standards.

In some cases, symbolic actions constitute measures that just satisfy the minimum expectation of the less powerful actor. For instance, MII officials have emphasized that the three world standards will all be used in China. The government has taken symbolic actions to respond to

pressures related to W-CDMA and CDMA-2000. Beijing's substantive actions are in TD-SCDMA's favor. TD-SCDMA's early launch helped it gain excess inertia. In other cases, formal structures that are not implemented in practices represent symbolic actions. For instance, Wang Xudong, MII Minister noted: "The timing for issuing 3G licenses will be determined by the market" (Shannon, 2006).¹ However, there is little evidence regarding the influence of market and consumer forces in China's 3G policies.

A similar point can be made about China Mobile's 3G related actions. Investors own 25% of the company's shares and the Chinese government owns the remaining (Chandler, 2007). Investors are worried that the company might have overspent on TD-SCDMA. Speaking of expectations of multiple institutional actors facing China Mobile, CEO Wang Jianzhou said: "As head of a state-owned enterprise, my duty is to maximize the value of state assets. As CEO of a listed company, my job is to enhance value for our shareholders" (Chandler, 2007). From China Mobile's standpoint, however, the government is a more powerful actor compared to investors. This is reflected in the company's support of TD-SCDMA.

7.2. Changed economic and political conditions

Prior researchers have recognized that institutional mechanisms need adaptation to be effective for new standards (David & Shurmer, 1996). In China, many conditions that hindered the development of domestic standards have changed. Unlike standards developed in the past, recent standards are more market-oriented and are integrated with the outside world. Furthermore, China has made a significant progress on the intellectual property rights (IPR) front (Kshetri, 2009). The changes in formal institutions undoubtedly facilitate the development of indigenous standards.

7.3. Path dependence and 3G standardization in China

The path dependence approach argues that different events steer history in a particular direction, which can influence the path a technology undertakes ([Arthur, 1988] and [North, 1990]). GSM was China's preferred standard for the digital 2G network. As of 2007, China Mobile's GSM networks covered 98% of China's population (Clark, 2007). At another turn in history, TD-SCDMA was accepted by 3GPP, the GSM standardization group. Technically, W-CDMA and TD-SCDMA complement each other. While W-CDMA is the natural upgrade path for GSM, China Mobile made a soft launch for TD-SCDMA, which involved dual-mode GSM/TD-SCDMA handsets. The path taken by China in the 2G networks and the complementarity of W-CDMA and TD-SCDMA allowed China Mobile to meet the government's demand without expending a lot of resources.

China has been influenced by different and significant paths adopted by Japan and South Korea. For instance, SK Telecom launched the CDMA 2000 service in October 2000. Other cellular operators—KTF and LG Telecom also launched CDMA2000 services in May 2001. As of 2004,

South Korea used, produced and exported more 3G phones per capita than any other country. Likewise, in May 2001, Japan's NTT DoCoMo started testing of its 3G network--FOMA based on W-CDMA and launched commercially on October 1, 2001. Another operator, KDDI began offering 3G services in April 2002 based on CDMA2000. Early 3G deployment allowed Japan to create a first mover advantage. These initiatives by its neighbors prompted China to develop its own 3G standard and services.

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