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The Political Economies of Wireless in Japan and South Korea: The Politics Standard-setting and Liberalization †

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The ICT sectors of Japan and South Korea (hereon, Korea) developed rapidly since the early 1990s, especially in wireless and broadband services. In particular, the two countries have extremely advanced wireless markets, producing notable service innovations linked to sophisticated hardware, cutting-edge networks and extremely profitable carriers. As we will see, the two markets share many common outcomes and defining characteristics, but have very different relationships to global markets. The basic question this paper asks is: how did they get there?

The usual answer is "some mix of market dynamics and government policies." A plethora of studies have focused on particular aspects of the logic of competition in each market or effects of particular policy choices, while others provide a laundry list of market outcomes and policies. However, I argue that since wireless telecom is a sector in which standards and spectrum allocation have the power to significantly shape (and reshape) market actors and how they compete against each other, we must understand the politics driving these choices to fully understand how their markets developed.

This paper examines and compares the politics driving the choices of cellular standards and the processes of liberalization – the introduction of competition (through spectrum allocation) and changes to rules governing market competition – in Japan and Korea's wireless markets.

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I. Introduction

The ICT sectors of Japan and South Korea (hereon, Korea) developed rapidly since the early 1990s, especially in wireless and broadband services.[1] In particular, the two countries have extremely advanced wireless markets, producing notable service innovations linked to sophisticated hardware, cutting-edge networks and extremely profitable carriers. As we will see, the two markets share many common outcomes and defining characteristics, but have very different relationships to global markets. The basic question this paper asks is: how did they get there?

The usual answer is "some mix of market dynamics and government policies." A plethora of studies have focused on particular aspects of the logic of competition in each market or effects of particular policy choices, while others provide a laundry list of market outcomes and policies. However, I argue that since wireless telecom is a sector in which *standards* and *spectrum allocation* have the power to significantly shape (and reshape) market actors and how they compete against each other, we must understand the *politics* driving these choices to fully understand how their markets developed. This is especially true for Japan and Korea, countries where the government can become a political actor, attempting to shape policy choices towards strategic ends.

This paper examines and compares the politics driving the choices of cellular standards and the processes of liberalization – the introduction of competition (through spectrum allocation) and changes to rules governing market competition – in Japan and Korea's wireless markets.

Expectations

The accumulated knowledge about Japan's and Korea's strategic policymaking gives us several expectations in their choices of standards and liberalization. First, choosing a standard involves decisions including: whose technology and intellectual property is selected, how it is developed, what players are advantaged, and how will domestic choices affect the interaction between the domestic and international markets. Therefore, it is reasonable to expect the two governments' choice of standards to follow their typical developmental trajectories: nurturing the technological capacities of domestic firms, protecting domestic markets against foreign imports and direct investment until deemed internationally competitive (or in crisis), and actively supporting opportunities to promote exports.

Second, we expect that in the process of liberalization, the two governments used spectrum allocation as a strong "industrial policy" tool to carefully shape the contours of the market – which actors entered when, and under what terms – through bureaucratic discretion.

Implications

This study suggests itself to several empirical and theoretical areas of interest. Technologically, wireless and landline telecommunications are converging, but if the political dynamics driving policymaking in the two areas are different, both within each country, and across countries, we do not expect convergent networks to develop similarly across the world.

This has implications for services innovation and global competition. Different IT networks can be conducive to different types of experimentation and innovation, raising the

[1] Kushida, Kenji, and Seung-Young Oh. forthcoming. The Political Economies of Broadband in South Korea and Japan. *Asian Survey*.

possibility for new services and killer applications to arise from Japan or Korea's network environment. Understanding how their respective markets developed, and how the policies and politics shaped them can prove critical in preparing for the next round of global competition, since killer applications are almost never predicted in advance.[2]

Examining the interactions between market dynamics, politics, and institutions thrusts us into broad debates of political economy. How to governments deal with rapidly growing industries that require extensive regulation – standards and spectrum allocation? This study provides a data point in the debate over state capacities – what decisions are strategic, and what are the governments' capacities for making such decisions – in states that were once considered "developmental." Institutional change, and feedback loops from changes in market dynamics are also easy to track when market actors and competitive dynamics can be reshuffled at critical junctures – when spectrum is allocated and standards decided.

Roadmap

In this paper, we first examine the key developments and distinctive outcomes of Japan's and Korea's wireless markets. Then, we trace the standard-setting and liberalization processes as the sectors moved from analog to digital standards. We do so by examining the market dynamics before and after the new standard and liberalization, followed by the politics driving the decisions. We then do the same for the shift from the first digital standard to the "third-generation" standard.

II. The Key Outcomes and Distinctive Characteristics of Japan and Korea's Rapid Cellular Development

Since this paper at its core asks how the Japanese and Korean cellular markets developed to reach their current form, we must first provide an overview of the distinctive *outcomes* of the two countries' development, and the often-noted *characteristics* of their markets.

Rapid Growth

While wireless telecommunications has grown worldwide at an astonishing pace since the late 1980s, the growth of cellular services in Japan and Korea during the mid to late 1990s was especially rapid. In Japan, the number of subscribers began to double every year from 1993 until 1996, surpassing the number of fixed lines in 2000. In Korea, the number of subscribers doubled every year from 1995 until mid-1998, with mobile subscriptions surpassing fixed lines also in 2000. This rapid growth of cellular services dramatically altered the logic of competition in telecommunications markets in each country, drastically increasingly the importance of regulations shaping them.

Table 1: Japan's and Korea's Fixed Lines versus Mobile Subscribers (Millions)

2 As Zysman and Newman note, "Again and again the waves of innovation that disturb global markets emerge from enduring national structures." Zysman, John, and Abraham Newman. 2006. Frameworks for Understanding the Political Economy of the Digital Era. In How Revolutionary was the Digital Revolution? National Responses, Market Transitions, and Global Technology, edited by J. Zysman, and Abraham Newman. Stanford, CA: Stanford University Press. p.5

	Japan		Korea	
	Fixed	Mobile	Fixed	Mobile
1990	545	9	133	1
1991	563	14	146	2
1992	577	17	156	3
1993	588	21	167	5
1994	607	43	176	10
1995	623	117	186	16
1996	640	269	196	32
1997	657	383	204	69
1998	624	473	201	140
1999	621	568	256	234
2000	620	668	259	268
2001	613	748	258	290
2002	608	811	257	323
2003	602	867	251	336
2004	596	915	236	366
2005	581	965	237	383

Source: ITU World Telecommunication Indicators Database 2006

In a comparative perspective, their experience was not unique among other OECD countries, since rapid growth of cellular services occurring everywhere. While Japan was a front-runner for G-8 countries in the mid-1990s, small European countries such as Finland and Denmark were ahead of both Japan and Korea in terms of penetration. However, what does stand out about the growth of Japan and Korea is that they experienced spurts of growth that were more rapid, with starting points well below other countries. Japan's growth spurt was from 1994 until 1996, and Korea's was from 1996 until 1999.[3]

Table 2: Mobile cellular telephone subscribers per 100 inhabitants, G8 Countries plus Denmark, Finland

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	3	3	4	7	10	16	25	27	36	49	63	74	83	88	95	100
Finland	5	6	8	10	13	20	29	42	55	63	72	80	87	91	96	100
France	0	1	1	1	2	2	4	10	19	37	49	62	65	70	74	80
Germany	0	1	1	2	3	5	7	10	17	29	59	68	72	79	86	96
Italy	0	1	1	2	4	7	11	20	36	53	74	88	96	98	108	124
Japan	1	1	1	2	3	9	21	30	37	45	53	59	64	68	72	75
Korea	0	0	1	1	2	4	7	15	31	51	58	61	68	70	76	79
UK	2	2	3	4	7	10	12	15	25	46	73	77	83	91	102	110
USA	2	3	4	6	9	13	16	20	25	31	39	45	49	55	63	71

Source: ITU World Telecommunication Indicators Database 2006

[3] Note that countries such as Italy with extremely high penetration rates include a large number of prepaid subscriptions. Note also that Japan and Korea relied the least on prepaid cellular services. [see appendix]

Table 3: Growth rates of Mobile cellular telephone subscribers per 100 inhabitants over previous year - G8 Countries plus Denmark, Finland (percent)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	18	20	69	40	63	59	9	33	36	28	17	13	6	8	5
Finland	23	20	26	38	51	46	44	31	15	14	12	8	5	5	5
France	32	16	30	54	47	88	135	92	90	35	26	4	8	6	8
Germany	85	73	82	40	49	48	50	68	68	105	16	5	10	10	11
Italy	117	38	54	85	75	64	83	75	48	40	20	9	2	10	15
Japan	58	24	24	103	170	129	42	23	20	17	12	8	7	5	5
Korea	107	63	73	102	70	93	115	103	66	14	5	11	3	8	4
UK	13	19	50	73	45	26	22	68	82	59	6	8	10	12	7
US	41	44	43	49	37	29	24	24	23	26	16	9	12	14	14

Source: ITU World Telecommunication Indicators Database 2006

Most existing explanations cite the following *characteristics* as explanations: introduction of *competition*, *subsidies*, and *close carrier-manufacturer R&D relations*. Both countries had a lower level of competition than other OECD countries until a relatively large number of competitors entered the market, which quickly lowered service prices. The handset *subsidies* paid by carriers to retail outlets allowed consumers to purchase handsets cheaply. When combined with the rapid improvements in service offerings and handset performance, enabled by *close carrier-manufacturer R&D* ties, cellular services quickly became attractive to consumers. All of these came together in 1994 for Japan, and 1996 for Korea, driving the sudden subscription growth.[4]

Sophisticated Handsets

Japanese and Korean handsets have been pushing the forefront of technological sophistication for some time – since at least the mid-1990s for Japan, and from the late 1990s and early 2000s for Korea. The most sophisticated handsets are only available for the respective domestic markets (despite Korea's success in export markets) where cellular service providers take full advantage of their features. Japanese handsets since the mid-1990s were first to market with polyphonic ring tones, color displays, and cameras.[5] More recent developments, common with Korean handsets include IC chip-embedded handsets that act as train passes, debit cards, music players and televisions. Korean handsets have pushed miniaturization, with some 2006 models the dimensions of a stack of about four credit cards.

Popular explanations include the *carrier-manufacturer R&D ties* enabling new handsets to be rolled out at the same time that carriers implement new services, and the *subsidization* of handsets, allowing expensive features to be added rapidly without affecting

[4] ITU. 2005. Ubiquitous Network Societies: the Case of Japan: International Telecommunication Union.; ITU. 2005. Ubiquitous Network Societies: the Case of the Republic of Korea: International Telecommunication Union.; Funk, Jeffrey. 2004. Mobile Disruption: The Technologies and Applications Driving the Mobile Internet. Hoboken, NJ: John Wiley & Sons.

[5] Color displays appeared in late 1999, and camera-embedded handsets (along with picture mailing services) appeared in late 2000. In early 2001, handsets that could download java applets, enabling applications to run on the handset without further downloads (I-appli), appeared.

prices faced by consumers.[6] In Japan's case, another factor often cited is the intense *competition between a large number of domestic equipment manufacturers.*[7] The manufacturers compete with each other on the basis of features rather than cost, due to the retail subsidies, and the dominance of carriers in marketing; they subordinate manufacturers' brands under the carrier brand, since they buy the handsets outright from manufacturers. This is in stark contrast to the US, a bigger market, and Europe, both characterized by multiple national carriers with a few international equipment companies such as Nokia, Ericsson, Siemens, and Alcatel.[8].

Rapid 3G Deployment

Japan and Korea were exceptionally quick to deploy extensive third-generation (commonly known as 3G) cellular networks and services.[9] Let it suffice here to say that in the late 1990s, 3G was hailed as the technology that would revolutionize cellular markets worldwide by enabling fast Internet and data connections and seamless global roaming. Influenced by the telecom Investment bubble that burst in 2000-2001, many European carriers bought wireless spectrum for 3G at extremely high prices through auctions. However, after the bubble burst, many were unable to pay to their license fees, let alone invest in costly 3G network infrastructure.

In this context, Japan and Korea were among the first countries to deploy 3G networks, with CDMA2000 1x (an earlier version of full-scale the 3G standard CDMA2000) introduced in Korea in October 2000, and W-CDMA in Japan in May 2001. In 2004, over 85 percent of the approximately 15 million 3G subscribers were in Korea and Japan.[10] Moreover, each country has both of the two major competing, incompatible 3G standards, W-CDMA and CDMA2000.[11] Since W-CDMA is positioned as an upgrade from the globally dominant, Europe-centered 2G standard, GSM, and CDMA2000 is a direct upgrade from the CDMA standard especially prevalent in the US, each country will have domestic players compatible with global markets even if one of the two 3G standards becomes globally dominant.

Table 4: 3G Growth in Japan (millions), carriers in parenthesis

[6] For example, ITU 2005a, ITU 2005b, Funk 2004,; Tokushuu "Keitai 2.0" no shougeki: daihenkaku ni naku hito warau hito [Special Feature - The shock of "Mobile 2.0": those who cry and laugh at the major change]. 2006. *Shukan Daiamondo*, pp. 43-44.

[7] At one point in the late 1990s, the list of manufacturers included NEC, Sharp, Sony, Denso, Fujitsu, Panasonic, Mitsubishi, Casio, Kyocera, Sanyo, Toshiba, Hitachi, Pioneer, and Kenwood.

[8] Funk, Jeffrey. 2002. *Global Competition Between and Within Standards: The Case of Mobile Phones*. New York, NY: Palgrave.; Henten, Anders, Henning Olesen, Dan Saugstrum, Su-en Tan. 2003. New mobile systems and services in Europe, Japan, and South Korea. *CTI Working Papers no. 74, Center for Tele-Information, Technical University of Denmark*. p.7.

[9] In mobile communications, analog standards that prevailed across the world until the mid-1990s are referred to as first generation (1G), the digital standards currently dominating the world as second-generation (2G), and high-speed digital systems first commercialized in the early 2000s as 3G. The International Telecommunications Union (ITU), a branch of the United Nations approves the major cellular standards.

[10] ITU Korea 2005. Includes W-CDMA and CDMA2000 1xEV-DO, though some argue that the latter is not truly 3G because it is a more advanced version of the same technology that is ITU approved.

[11] We will return to the politics of creating 3G standards later.

	W-CDMA (DoCoMo, Vodafone*)	CDMA2000 (KDDI)
2002	0.15	4.6
2003	2	11.7
2004	16.8	25.7
2005	22.4	20.6
2006	38.1	25.1

Source: Telecommunications Carriers Association, Japan
* Vodafone Japan purchased by Softbank in 2006

Table 5: 3G Growth in Korea (millions)

	CDMA2000 1x*
2001	0.4
2002	16.7
2003	24.8
2004**	38.2
2005***	48.1
2006	54.1

Source: MIC
Note: Carriers have been reluctant to release WCDMA subscription figures, as they were extremely low from their inception in 2003 until 2006, when WCDMA HSDPA services commenced. As of early March 2007, SKT had approximately 160 thousand, and KTF had approximately 170 thousand, according to the NIA.
*includes EV-DO
** as of June
*** as of November

Existing explanations stress *governments' pro-active moves to facilitate 3G deployment* and *their standards licensing strategies*, the *pioneering R&D efforts* of carriers and manufacturers, and handset *subsidies.*[12]

High Penetration of Mobile Internet

Both Japan and Korea sport high levels of cellular Internet penetration. Introduced in early 1999, Japan's cellular Internet services grew to 11 million out of 51 million cellular users by May 2000, and 83 million out of 95 million subscribers by February 2007.[13]

Common explanations again stress the *R&D capabilities of the carriers* and *close carrier-manufacturer ties*, solving the chicken-and-egg problem faced in other countries and regions – namely that handset manufacturers were unwilling to manufacture Internet service enabled handsets until they could be sure that carriers would provide services, and carriers waiting to develop services until handsets capable of running them appeared.[14] In Japan and Korea, carriers could ensure that Internet service enabled handsets would be rolled out at the

[12] ITU 2005a, ITU 2005b, Funk 2004
[13] Telecommunications Carrier Association of Japan (TCA). <http://www.tca.or.jp/>
[14] Funk, Jeffrey. 2001. The Mobile Internet: How Japan Dialed up and the West Disconnected. Kent, UK: ISI Publications.

same time that services were introduced. Adoption by consumers was, of course, facilitated by the *subsidies* allowing them to buy the new handsets cheaply.

Diverging Performance in International Handset Markets

While Japan and Korea had in common the rapid growth of cellular markets, the international performance of their cellular equipment manufacturers could not have contrasted more. While Japanese firms enjoyed a significance presence in global markets for analog cellular equipment until the mid-1990s, they retreated significantly thereafter. By 2001, they had dropped out of the top five manufacturers, with little more than a sliver of global market shares, though the joint venture between Ericsson and Sony, creating SonyEricsson, led to somewhat of a resurgence (from the standpoint of Japanese manufacturers – Ericsson had enjoyed larger market shared previously). Korea equipment firms, however, began gaining global market share rapidly since the late 1990s. By early 2006, Samsung and LG were ranked third and fourth.

Table 6: Global Handset Shares: 1999-2002 (percent)

	1999	2000	2001	2002
Nokia	26.9	30.6	35	35.8
Motorola	16.9	14.6	14.8	14.8
Ericsson*	10.5	10	6.7	5.5
Samsung	6.2	5	7.1	9.8
Siemens	4.6	6.5	7.4	8.2
Panasonic	5.5	5.2		

Source: Gartner Dataquest cited at [http://cellular.co.za/stats/stats-handsets.htm, last accessed 12/06]
* SonyEricsson from 2001

	2006**
Nokia	34.9
Motorola	21.4
Samsung	13.5
LG	7.3
SonyEricsson	6.2

** Jan through March
Source: Nikkei

Common arguments attribute this difference in international performance to *choices over standards*.[15] While the CDMA standard pioneered and used in Korea became a mainstream standard in North America, Japan's PDC standard remained confined to its domestic market. Therefore, Korea's equipment manufacturers could use their domestic market as a springboard for exports, but Japan's equipment manufacturers were "stuck" in their domestic market, though protected from imports. *Close carrier-manufacturer ties*

[15] Funk 2002, Cole, Robert E. 2006. Telecommunications Markets in World Markets: Understanding Japan's Decline. In *How Revolutionary was the Digital Revolution? National Responses, Market Transitions, and Global Technology*, edited by J. Zysman, and Abraham Newman. Stanford, CA: Stanford University Press.

exacerbated the situation, as Japanese firms scrambled to keep up with constant upgrades handed down by carriers.

Services Innovation: Cellular Internet Services

The final outcome of our interest is the service innovation of cellular Internet services, and the means by which they spread across the world. While spreading from Japan to become commercially successful worldwide, they were not directly carried by Japanese carriers or equipment firms.

NTT DoCoMo pioneered cellular Internet services in 1999 with its i-mode service by creating a business model that was "open-but-owned" – open in the sense that third parties and users could create content, but owned in the sense that carriers controlled the gateway to the content, and could offer businesses the ability to be incorporated into carriers' payment systems.[16] This "revenue-sharing" business model created a significant industry for cellular Internet content, driving the wild commercial success of cellular Internet services in Japan to the point that revenue from data transmissions rapidly approached that of voice communications.[17] Their success in Japan contrasted with WAP (Wireless Access Protocol), a set of protocols touted in Europe as the foundation for successful cellular Internet services, but which disappointed participants as the initial commercialization was not successful.

As of early 2007, there 6 million i-mode subscribers in 15 countries, including Germany, France, Italy, where domestic carriers offer i-mode services.[18] The Britain-based multinational carrier Vodafone took the Japanese cellular Internet business model and spread it widest. Vodafone Live!, a service technologically based on Japanese carrier J-phone's Internet connection service, was introduced in 2002 and was adopted by 27 million subscribers worldwide by the end of 2005.[19]

Credible explanations vary widely, including a strong DoCoMo president, successful in-house entrepreneurship, subsidies, as well as the familiar close carrier-manufacturer ties and carrier R&D capabilities.[20]

III. From Analog Origins to Digital Competition

We begin by tracing cellular services from their point of origin, examining market actors and the dynamics of competition between them.

Monopoly analog (1G)

The first cellular services operated using analog standards (analog cellular telephony is also known as "first generation," or "1G"), with national markets worldwide relatively fragmented among proprietary national standards, with a few exceptions such as in the Nordic countries.[21] In both Japan and Korea, analog cellular services were initially operated by monopoly incumbent operators, whose high prices and limited service areas contributed to low population penetration.

[16] Funk calls these "micro-payments" (Funk 2004)
[17] data
[18] http://www.nttdocomo.com/services/imode/global/ [last accessed 3/6/07]
[19] Vodafone annual report 2006, p.15 In March 2003, there were 1 million subscribers in 10 countries.
[20] Funk 2004 p.11,
[21] For an overview, see Steinbock, Dan. 2003. Wireless Horizon: strategy and competition in the worldwide mobile marketplace. New York, NY: AMACOM. pp. 45-50

The origins of the two countries' carrier-manufacturer relations can be seen clearly from this period. The two countries started at significant different points – while Japan's analog network equipment and handsets were provided by domestic firms dependent on the incumbent's large R&D resources, Korea was dependent on foreign technology and imported equipment. In addition to the carrier-manufacturer relationships, this initial difference became significant in the *politics* of subsequent developments, including introducing competitors and creating a digital standard.

Japan's Analog Cellular Market and R&D Regime

Japan's mobile services began in 1979, when Nippon Telegraph and Telephone (NTT), the state-owned monopoly, pioneered in car phones. Cellular service began in 1987, using NTT's proprietary analog cellular standard, HiCap.

R&D resources were concentrated in NTT from its inception in the late 1800s as a government bureaucracy commissioned to build national communication infrastructure. An R&D regime involving NTT receiving massive procurement budgets from the government, subsidizing R&D efforts of a "family" of equipment firms such as NEC, Fujitsu, Hitachi, and Oki, began in the prewar era. These manufacturers owe much of their technological capacity to NTT, who made them compete for procurement shares with each other on the basis of quality, but paying them on a cost basis, effectively subsidizing their R&D in other areas such as consumer electronics.[22] These relationships persisted well through the postwar period, making it natural for NTT to develop its own cellular standard and get its "family" firms to provide equipment.

NTT's monopoly continued until the late 1980s, when two new competitors, IDO and DDI, entered the market. Until then, adoption rates were low, service prices were high, and Japan lagged behind other advanced industrial nations in cellular adoption.[23]

Korea's Analog Cellular Market and R&D Regime

Korea's analog cellular services began in 1984, when Korea Telecom (KT), the incumbent monopoly operator, commenced services. In 1988, the cellular division of KT was spun out to create Korea Mobile Telecommunications (KMT), a majority-owned subsidiary. KMT's monopoly continued until 1996, during which its cellular services grew slowly. Korea, like Japan, lagged behind many other advanced industrial countries in cellular adoption during this time (see table 2). In 1994, KMT was sold to the SK group, later renamed SKT (to simplify, in this paper KMT after 1994 will be labeled SKT, though the name change occurred in 1997).

The analog standard used in Korea, known as Advanced Mobile Phone Service (AMPS), relied largely on American firms such as Motorola and AT&T for infrastructure and handsets. The Korea telecom sector was younger than that of Japan, largely due to the devastation of the Korean war and its prewar history, and Korea did not develop the same type of carrier-led R&D regime. Korea's R&D efforts were focused on its landline network, and government R&D organs such as ETRI, rather than KT by itself, helped finance firms

22 See Anchordoguy, Marie. 2001. Nippon Telegraph and Telephone Company (NTT) and the Building of a Telecommunications Industry in Japan. Business History Review (75, Autumn):507-541.; Fransman, Martin. 1995. Japan's Computer and Communications Industry: The Evolution of Industrial Giants and Global Competitiveness. New York, NY: Oxford University Press.

23 Figures will be presented later.

such as Samsung, LG, Daewoo, Daeyung, Donyan, and Hyundai in developing digital landline equipment, such as exchanges.[24]

Competition Introduced: The Logic of Competition in Digital Markets

In both countries, similar market dynamics developed after competitors – a large number compared to other OECD countries – were introduced. In Japan's case, competitors were introduced in two waves, first in the late 1980s offering analog services, and later in the mid-1990s with digital services. In Korea's case, the timing of new entrants coincided with the introduction of digital services, in 1996. In both countries, once four or five competitors entered the market, prices decreased, and the terms of competition shifted towards the rapid improvement of handsets and coverage areas. It was at this point that the two country's respective booms in cellular adoption occurred. First, we survey the market dynamics.

Competition in Japan's Analog and Digital Services

Japan's first competitors to NTT, IDO and DDI, began analog services in 1988 and 1989, respectively. IDO competed again NTT in the greater Tokyo and Central Japan regions, while DDI competed against NTT in all other regions, including Osaka.[25] These competitors quickly devoured NTT's market share, reducing it from 96 percent in 1988 to 65 percent in 1991. The new entrants were first to market with small handsets such as Motorola's *MicroTAC* – the first to fit comfortably in a shirt pocket, and roughly half the size of NTT's existing handsets. This was a shock to NTT, which prided itself on its technological sophistication, and had just introduced its new handset, in itself a dramatic improvement from its previous "shoulderphone." NTT hastened to use its extensive R&D resources and close relations with "family" equipment firms to create a handset half the size of that of Motorola.[26]

In 1992, the wireless division of NTT was spun out as NTT DoCoMo. Under the leadership of a dynamic president, DoCoMo quickly improved its service coverage area, which had hitherto been optimized for carphones.

In 1994, the digital cellular standard, PDC, was introduced, at the same time that four new competitors entered the markets. That year, a policy change allowed handsets to be sold directly to customers; until then, consumers "rented" handsets on a monthly fee basis. Combined with DoCoMo's abolishment of costly deposit fees, originally for the rental of handsets, Japan's cellular services suddenly became more affordable and usable for consumers, leading to an upsurge of subscribers.[27]

Further intensifying competition was the entry of three carriers in 1995 utilizing an alternative wireless system, named PHS (Personal Handyphone System). PHS services became extremely popular due to several performance attributes: the handsets were technologically simpler (similar to cordless phones) than cellular handsets, enabling higher performance, such as Sharp's model offering 400 hours of standby time[28]; PHS services

[24] Jho, Whasun. 2003. Building Telecom Markets: Evolution of Governance in the Korean Mobile Telecommunications Market, Political Science, Northwestern University, Evanston, IL. p. 186.

[25] Masuno, Daisuke. 2006. Gyoukai Kenkyu Shiriizu: Tsushin [Industry Analysis Series: Telecom]. Tokyo, Japan: Nihon Keizai Shimbun Sha.

[26] NTT DoCoMo. 2001. NTT DoCoMo junenshi: Mobairu furontia e no chousen [NTT DoCoMo Ten Year History: The Challenge Towards Mobile Frontier]. p.8

[27] Kushida, Kenji. 2002. The Japanese Wireless Telecommunications Industry: Innovation, Organizational Structures, and Government Policy. *Stanford Journal of East Asian Affairs* (2):55-70.

[28] PHS no Kashikoi Sentaku [The Smart Choice of PHS]. 1995. *Ekonomisuto*, June 20, 68-71.; Yasusa buki ni "shinai" wo kuu: daini jiyuuka no hikigane ni [Penetration "metropolitan" Areas With Low Price as a Weapon: Becoming a Trigger for the Second Liberalization]. 1995. *Nikkei Business*, July 3, 50-52.

offered clearer voices since it relied on the public ISDN infrastructure; lower monthly fees (less than 3000 yen versus 7000 to over 8000 yen for cellular subscribtions); per-minutes fees at a fourth of cellular services, and cheap base stations that could be installed inside subway terminals and stations. PHS services put significant pressure on cellular carriers to improve their handsets, lower subscription fees, and improve their service coverage areas.[29]

As cellular service prices decreased, coverage areas improved, cellular handsets came closer to matching the PHS performance, and carriers led by DoCoMo improved their networks to increase voice transmission quality, the merits of PHS faded, leading their decline (though we will examine the decline of PHS again later).

In sum, in both analog and digital eras, an increasing number of competitors – DDI and IDO for analog, followed by digital carriers as well as PHS providers – shifted the terms of carrier competition towards lower service prices, improved coverage areas, and mobilizing the carrier-equipment manufacturers teams to rapidly shrink and enhance handsets. It was within these market conditions that the dramatic increase in Japan's cellular subscribers occurred.

Competition in Korea's Cellular Market – Digital Services

In Korea, four competitors to SKT entered the market in 1996 and 1997, just as SKT's digital services commenced. The new entrants, Shinsegi Telecom, Korea Telecom Freetel (later renamed KTF), LG Telecom, and Hansol, all used the same digital standard, CDMA.

This shift to the digital CDMA standard from the American analog AMPS standard provided the entry point for Korean manufacturers into cellular equipment. Korea was first in the world to commercialize CDMA technology, developed in conjunction with the US start-up firm, Qualcomm. Qualcomm held the core intellectual property, but Korean manufacturers were given rights to distribute CDMA handsets worldwide in exchange for paying royalties and a percentage of their sales to Qualcomm.

The transition of Korea's entire domestic market to CDMA in effect swept out the hitherto dominant foreign manufacturers, mainly Motorola. With no expertise in CDMA, Motorola's share equipment plummeted, even as Korea's cellular market expanded rapidly.[30] In 1995, it had slightly over half the market share, but by 1999, domestic manufacturers had over 90 percent of the market.[31]

[29] The average weight of digital cellular phones were reduced from approx. 200g in early 1995 to 100 by April 1997. (Funk 2002, 187)

[30] Motorola worldwide had enjoyed dominance in analog equipment, but it was blindsided by the transition to digital standards in Europe and Asia, dramatically losing market share worldwide. (Steinbock 2003)

[31] Yang, Heedong, Yougjin Yoo, Kelle Lyytinen, Joong-Ho Ahn. 2003. Diffusion of Broadband Mobile Services in Korea: The Role of Standards and its Impact on Diffusion of Complex Technology System: Case Western Reserve University.

Table 7: Korean Domestic Cellular Equipment Shares Before and After the Digital Standard

Vendor	1995	1996		1997
		Analog	Digital	Analog and digital
Samsung	44	41.5	44.5	59
Motorola	51	40.6	0.5	
LG	3	5.7	24.3	33
Hyundai	2	3.8	9.2	4
Qualcomm		0	13.6	
Others		8.5	4.9	
Total	100	100	100	100

(Source: Jho 258)

With five carriers in the market, Korea's cellular subscription fees and per-minute charges dropped rapidly. KMT was under intense market pressure, evidenced by their rapid drop in market share – from approximately 66% in 1997 to 43% in 1999. Shinsegi's service, which commenced in 1996, reached 100,000 subscribers within seven months, and a million in a year. The other new entrants, offering what is known as PCS services – essentially cellular services using higher frequencies – could offer lighter phones and better service coverage areas, partly due to the denser cell requirement.[32] New entrants discounted their services, and roaming agreements, such as between KTF and Hansol, allowed them to share the construction and operating costs networks in provincial areas.[33]

The logic of competition moved towards subsidies for handsets. PCS carriers initially offered larger subsidies as they attempted to battle incumbents, and incumbents began countering by increasing their subsidies as well. Subsidies for a typical handset costing around 440 USD began at around 160 USD in 1997, but escalated to the point that handsets were given away for free by 1999. These subsidies were given in exchange for ever-longer obligatory subscription periods, starting at one year in 1997, and reaching three years by 1999, during which subscribers wanting to terminate their subscription had to pay back the subsidy.[34] These were the market conditions in which Korea's massive increase in subscribers occurred. (note the shift in terms of competition from per-minute prices for to subsidies in chart 1 below – though cheaper to begin with, Korea's per minute charges did not decrease as dramatically as Japan)

Exports from Korea began in earnest in the late 1990s, as CDMA became one of the standards. As the domestic market became saturated, and subsidies became the object of political contention (as we will see in the next section), Samsung, LG and others began focusing on exports. They were effectively able to use their domestic market as a platform for exports, with R&D efforts in the domestic market bearing fruit in international markets, as Samsung overtook Sony Ericsson to become the third largest manufacturer in 2001.

Thus, by the late 1990s, many the Korean cellular industry's defining characteristics had developed. A set of domestic cellular equipment manufacturers had been nurtured as the domestic market shifted to analog to the digital CDMA standard through a government,

[32] Higher frequencies meant more base stations were needed, since they signal did not travel as far, which in turn allowed for smaller handsets

[33] Jho 2003, pp.283-236. New entrants also did not need to offer facility deposit requirements (ibid).

[34] Kim, Han-joo, Sang-kyu Byun, Myeong-cheol Park. 2004. Mobile handset subsidy policy in Korea: historical analysis and evaluation. *Telecommunications Policy* 28:23-42.

carrier, and manufacturer centered R&D regime, subsidies became an integral part of the logic of competition.

Table 8: Mobile Cellular Monthly Charges (USD)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Japan	75	107	124	140	109	104	97	103	85	76	72	53	38	35	40	42	36	36
Korea	..	..	..	..	..	38	37	35	34	34	35	27	19	13	15	14	12	12

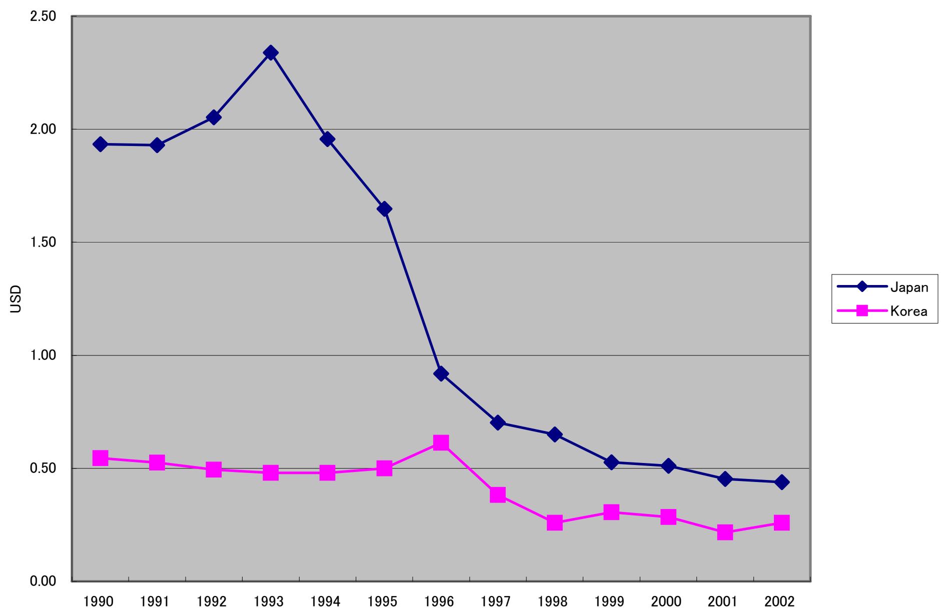
Source: OECD Telecommunications Database 2006

Table 9: Mobile Cellular Connection Charge (USD) – the amount needed upfront to subscribe to cellular services

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Japan	316	340	362	412	205	96	25	22	23	26	28	25	24
Korea*	13	12	12	11	11	12	87	74	50	59	44	39	40

Source: ITU World Telecommunications Indicators Database 2006
* deposits required before 1996 are not included in these figures

Chart 1: Average cost in USD for 3 minute cellular call



Source: ITU World Telecommunications Indicators Database 2006

The Politics and Policies Shaping Markets and Actors

Now that we have laid out the market dynamics as the industry moved from analog to digital standards, we examine the politics and policies driving the entry of competition, choices over standards, relationships between carriers, manufacturers and the government, and general terms of competition.

The Politics of Orchestrating Competition in Japan

The politics leading up the initial entry of competitors in Japan involved a battle between the Ministry of Posts and Telecommunications (MPT) and the US government, mobilized by Motorola, in the context of broader US-Japan trade disputes of the late 1980s.

Privatization of NTT in the mid-1980s, the result of a complicated political battle, resulted in MPT gaining vast regulatory powers. In both landline and wireless markets, it used its formal and discretionary powers to orchestrate the entry of competitors and micromanage competition.[35] However, it did not necessarily get its own way on many issues involving conflicts between powerful interests; orchestrating new cellular competitors was one such issue.

MPT's initial plan was to orchestrate the entry of a single competitor by consolidating interested firms into a consortium, IDO.[36] However, a second carrier, DDI, which wanted to use Motorola equipment (and therefore the AMPS standard), used US governmental pressure as a bargaining lever to attempt entry into the market. MPT argued that since NTT was licensed to half the available spectrum, there would not be enough available spectrum for two additional competitors.[37] They also attempted to deny DDI's request on the basis for its potential lack of profitability.[38] Motorola lobbied the US government, arguing that if there was only one competitor to NTT, and it adopted NTT's proprietary standard, Motorola would be effectively shut out of Japan – a non-tariff barrier. In the context of the broader US-Japan trade friction of the late 1980s, high-level political involvement led to a series of compromises.

The initial compromise plan in 1987 allowed both carriers to enter the market, but in different geographic regions. IDO received the greater Tokyo area and Eastern Japan, while DDI was given Western Japan (interestingly enough, it was administrative guidance rather than a legal decree in this geographic division). However, Motorola was dissatisfied at being excluded from Tokyo, and stepped up pressure on the Japanese government. This led MPT to adjust the service areas, giving DDI Northern Japan as well.[39] Motorola, still unsatisfied, went so far as to demand a specific new company be set up to use only its equipment.[40]

Finally, in May 1989, in a fascinating turn of events, IDO announced that it would adopt Motorola's standard *in addition to* the proprietary NTT standard. This made little business sense, since IDO was proposing to create a second network, incompatible with the

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[35] See Kushida, Kenji. 2006. Japan's Telecommunications Regime Shift: Understanding Japan's Potential Resurgence. In *How Revolutionary was the Digital Revolution? National Responses, Market Transitions, and Global Technology in the Digital Era*, edited by A. Newman, and John Zysman. Stanford, CA: Stanford University Press.; Kushida, Kenji. 2005. The Politics of Restructuring NTT: Historically Rooted Trajectories from Actors, Institutions, and Interests. *Stanford Journal of East Asian Affairs* 5 (2):29-36.; Vogel, Steven K. 1996. *Freer Markets, More Rules: Regulatory Reform in Advanced Industrial Countries*. Ithaca, NY: Cornell University Press.

[36] Members included Toyota, Tokyo Electric Power Company, and others.

[37] The issue at hand was the projected magnitude of cellular phone growth – conservative estimates put it as 3 million by the late 1990s, but more aggressive estimates put it at 30 million. (former Telecommunications Deliberation Council Member, personal interview, February 2007.

[38] A MPT official at the telecommunications bureau was quoted as saying "We think it would be difficult for two more companies to go into this business... N.T.T. is now using more than half of the available channels, and besides, *we doubt that two more companies could both make a profit* [italics added]**.''" (**"Japanese Barriers Slow Motorola Mobile Phone" The New York Times. December 15, 1986, p.D1)

[39] "Daini-Denden-Motorola Team Gets Wider Car Telephone Service Area" Jiji Press Ticker Service, April 22, 1987.

[40] "Motorola Makes Broader Demands On Japan" Jiji Press Ticker Service, July 11, 1989.

network it had already installed. Behind this decision was Toyota, the major shareholder of IDO, which feared the escalation of trade friction that could damage it automobile exports. IDO's management was opposed, but had little choice other than to accept the plan, especially in the face of Toyota's threat to withdraw from guaranteeing loans needed by IDO to build its networks.[41]

The Politics Shaping NTT DoCoMo

Japan's strongly carrier-led wireless R&D regime has its origins in the institutional history of NTT and the politically-induced spin-out of its wireless division, NTT DoCoMo. We have already seen the origins of NTT's R&D capabilities supporting its "family" of manufacturers, but it not pre-determined that DoCoMo would get the wireless research labs.

The spinout of DoCoMo was the product of a series of negotiated settlements in broader debates over the breakup of NTT – a complex sequence of negotiated settlements in which numerous political actors aligned either with NTT or MPT in resisting or advocating a complete breakup of NTT.[42] When DoCoMo was spun out as a result of an amendment to the NTT Law in 1991, it received NTT's extensive wireless R&D labs, despite several voices of concern within MPT that it would give DoCoMo an unfair competitive advantage.[43]

PHS as Industrial policy: The rise and fall of PHS

PHS services, which shaped the terms of competition in cellular services from the mid to late 1990s, was the product of MPT's industrial policy efforts. Assuming that conventional cellular subscriptions would be too expensive for the masses, MPT used its R&D resources, acquired in the political settlement during the privatization of NTT, to conduct field experiments, set the standard, and to commercialize the technology. It orchestrated competition by directing the existing carriers to join PHS services, resulting in three consortia or joint ventures – NTT Personal Communication Network (JV of NTT and DoCoMo), DDI Pocket (subsidiary of DDI), and Astel (consortium including Japan Telecom and KTT).[44]

By 1998, price differentials had closed significantly, the service areas were comparable, cellular voice quality had improved, and handsets were comparable in size and functionality.[45] However, the biggest difficulty in the cost structure for PHS carriers was their reliance on NTT's ISDN network. Without any regulatory support, they were at the mercy of NTT's interconnection rates, which sapped half of their revenue.[46] Moreover, the PHS standard was domestic to the extreme – foreign manufacturers had not input and were not given the specifications until right before the services were rolled out.[47]

[41] This is common knowledge supported by several sources, including ibid.; Naoe Shigehiko, David Hytha, who was involved in the negotiations on the Motorola side.

[42] For details of these debates, see Vogel 1996, Vogel, Steven K. 2000. Creating Competition in Japan's Telecommunications Market. *Japan Information Access Project Working Paper*.

[43] The contrast they cited was AT&T's complete breakup, with the Bell Labs not going to any of the "Baby" Bells. (Nakamura, Ichiya. Personal Interview, Stanford, October 2002)

[44] Murase, Emily. 2003. Keitai Boomu: The Case of NTT Docomo and Innovation in the Wireless Internet in Japan. In *PhD Dissertation, Communications Department, Stanford University*. Stanford, CA. p.42

[45] In addition, an unfortunate social trend linked PHS to young teenagers rather than serious businesspeople. Possessing a phone with the PHS prefix "070" was considered to be negative.

[46] Funk 2002

[47] ibid.

The number of PHS carriers declined in the late 1990s, but they provided an impetus for pushing the logic of market competition towards data services, as we will see in depth later.

The Politics of Choosing PDC

In contrast with Korea, Japan's choice of the digital standard, PDC, was politically relatively simple.

On the technological front, PDC enabled the government to avoid redistributing spectrum, a potentially politically messy affair. When it became clear that the analog standard would be insufficient to accommodate the burgeoning number of subscribers, the European GSM standard examined as one possibility. However, it became immediately clear that GSM as a system required 10 MHz to implement, while PDC required only 5MHz. Since NTT had already been allocated 10MHz, but IDO and DDI had only been granted 5MHz. Choosing PDC allowed the government to retain the status quo.[48]

Since NTT had begun research on the digital PDC standard and its research had continued when the wireless R&D labs were given to NTT DoCoMo, it was natural for DoCoMo to prefer its own standard. Other domestic carriers did not have the R&D strength to create their own standard, and equipment manufacturers had no incentive, since they could also rely on information passed down from carriers. In 1992, MPT decided that new entrants to be licensed in 1994 would use the PDC standard.

Two new entrants were given spectrum at the 1.5 GHz frequency in 1992, the Digital Phone group under the umbrella of Japan Telecom, and Tsuka Cellular with Nissan as the main investor.[49]

The Politics of Orchestrating Competition in Korea

The first round of liberalization in Korea's cellular telecom market revolved around several critical issues: limiting chaebol influence in the sector, choosing a digital standard, and limiting foreign influence to develop domestic capacities.

Balancing the Giants and Foreigners

In the early 1990s, a political struggle over chaebol involvement in telecom services came to the fore, part of the broader tension generated between the government and chaebol, as chaebol influence over the economy as a whole increased.[50] Chaebol were interested in the growing telecom services market, but the government continually rejected their attempts to enter, fearing they would dominate the market. In 1991, a political battle ensued, with chaebol aligning with MCI and MOTIE, who oversaw high tech manufacturing and exports, against MOC. The MOC tried, but was unsuccessful in getting the incumbent Democratic Liberal Party to weigh in on their side.[51]

This debate continued over the scope and timing of allowing competitors into cellular services. MIC hoped to have a second carrier commence services by 1994, but MOTIE, closely aligned with equipment manufacturers, opposed. MOTIE argued that service

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[48] I am indebted to former Telecommunications Deliberation Council member Professor Naoe Shigehiko for explaining this point (personal interview, Tokyo, Feb 2007).

[49] Masuno 2006, pp. 20-21

[50] Cite appropriate author.. The government's concern about excessive influence of chaebol in telecom services was part of a larger pattern of tension between economically dominant chaebol and the government.

[51] Jho 2003, pp. 203-206.

competition should wait one or two years for domestic manufacturers to increase their ability to provide infrastructure and equipment to prevent further reliance on imports. The EPB weighed in on MOTIE's plan. Foreign companies, predictably, joined MOC's side with Motorola attempting to alleviate MOTIE's concerns by promising it would transfer technology to Korean firms.[52]

There was little need for a domestic debate over limiting foreign participation, however, and MOC was able to stipulate that foreign interests would have enter Korea's telecom services market as members of consortia led by domestic firms, and without management rights. Six consortia ended up applying to be the second mobile carrier, each with some foreign participant.[53]

In 1992, a license was awarded to Daehan Telecom (Greater Korean Telecom) consortium, but allegations of favoritism due to President Roh's close relationship with one of the main shareholding Sunkyung group, led to its returning the license.[54] MOC waited until the political leadership changed to conduct a second round of licensing in 1994, which thrust the issue of orchestrating new competitors into the debate over Korea's digital standard.

In this second attempt, the government included the provision that the second mobile carrier would use CDMA.[55] Shinsegi, a consortium led by the steel company POSCO, won the license. Shinsegi wanted to build a GSM rather than CDMA-based network, since CDMA had yet to be commercialized, but MIC rejected its wishes.[56]

Choosing CDMA

A key concern of the Korean government in choosing a digital cellular standard was to reduce its dependence on foreign equipment, and to build up the competitiveness of domestic equipment manufacturers. Given Korea's success at exports due to its domestic market able to act as a launching pad, many analyses tend to credit the government for its far-sighted strategy. In particular, they ETRI, the research arm of MOC, for collaborating with US firm Qualcomm, then a small startup firm with 40 employees, to commercialize CDMA based on a technological evaluation.[57] However, the often-underplayed political debate surrounding the selection and commercialization process resulted in a firmer commitment to the standard, a faster rollout of CDMA, and the rise of MOC as the industry's lead agency.

The initial push for CDMA came from government led-initiative, with MOC subsidizing the initial development. In 1988, MOC published a document outlining its plans, which it expanded in 1990 to include the development of an entire mobile communications system. In the first phase, MOC gave ETRI (placed under control of MOC in 1992) the task to develop digital technology, and it brought together representatives from government, the scientific community, and large equipment manufacturers such as Samsung, LG, Hyundai, and Maxon. [58] This close government-industry collaboration sparked a major conflict between MOC and MOCIE.

MOCIE' status had been declining by the early 1990s, and did not want to lose jurisdiction of the equipment manufacturers. In 1993, it published a report criticizing MOC's

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[52] Jho 2003, pp. 208-210.
[53] Jho 2003, pp. 213-214.
[54] Ibid., , 214-215
[55] ibid, 215
[56] ibid, 2003, 218
[57] For example, see ITU 2005b, p. 23.
[58] Jho 2003, 237-239

plans for CDMA, arguing that TDMA should be the underlying technological choice, as it was the basis for GSM and had the potential to become the dominant global standard. MOCIE launched TDMA research programs, getting manufacturing companies to join in its efforts.[59]

MIC immediately opposed MOCIE's efforts, arguing that CDMA was technological superiors and more flexible in its future applications. Later in 1993, MOC strengthened its plans for CDMA, moving the deployment date for commercial CDMA deployment services by two years, and exerting its full jurisdictional authority to promulgate that CDMA be the only domestic digital standard.[60]

Manufacturers were left in a position where they could only follow MOC, since following MOCIE and TDMA would only allow them to manufacture exports, and be locked out of the domestic market. Thus, they limited their participation in MOCIE's GSM project, and MOC secured its jurisdiction over manufacturers at the expense of MOCIE.[61]

	Timing of entry desired	Standard advocated
MOC	Early	CDMA
MOTIE	Later	TDMA

Commercializing CDMA

In commercializing CDMA, a second round of research was conducted largely by industry, with a task force under KMT coordinating activities. The government subsidized approximately $6.7 million (from the Information Promotion Fund, obtained through taxes on carriers' profits). In 1994 KMT contracted LG to provide base stations and handsets, and Shinsegi selected Samsung in 1995.[62] It was this process that gave rise to the close carrier-manufacturer relationships in R&D.

Spinning out and Privatizing KMT

The spinout of KMT was a relatively straightforward process, without the type of broader political entanglements that led to Japan's spinout of NTT DoCoMo. The relatively powerful MOC, recognizing the operational inefficiency of KT, contended that KT would be unable to focus adequately in improving the efficiency of mobile services. Therefore, it spun out KMT as a wholly owned subsidiary.[63]

Privatizing KMT was slightly more complicated than the spinout, but much simpler than the politicized debates in Japan over privatization of NTT. According to the TBL, KMT needed to be privatized by 1993, with KT disposing its approximately two thirds share of KMT. Though reluctant, the government ended up giving Sunkyung, the fifth largest chaebol in Korea at the time, management rights when it purchased 23 percent of the shares. KMT was renamed SKT in 1997.[64]

[59] ibid 241-242
[60] ibid 243
[61] Jho 2003, 244
[62] ibid. 255-256
[63] ibid. 183
[64] ibid. 218-221

Shaping the Terms of Competition: Political Fights Over Subsidies

In contrast to Japan, where the terms of competition in which carriers offered large subsidies to retailers, in exchange for charging higher subscription prices to consumers, subsidies became a significant policy issue in Korea. The debate pitted the MIC, concerned with market share and equipment manufacturers' financial health, against the KCC and KFTA, who's main interest was in assuring fair competition and anti-collusive behavior.

Few policies shaped the logic of competition in Korea's cellular markets more directly than policies regulating the subsidies paid by carriers to handset manufacturers. MIC regulated the terms of subsidies under the Telecom Business Act, which required that carriers report the terms and conditions of adhesion contracts such as price and service provisions.[65]

With the rapid inflation of subsidy amounts to the point that carriers were giving handsets away for free, but with correspondingly long contracted lock-in periods, several branches of government started becoming concerned. MIC proposed a subsidy cap (approximately $125), and the Korean Fair Trade, reacting to consumer complaints, ordered abolishment of the penalty clause forcing subscribers to return subsidies when terminating their contract early. The core of the problem was that carriers were not required to fully explain or give documentation to subscribers about the penalty in the contract when entering into it.[66]

The market dynamics reacted to the abolishment of this penalty clause abruptly. Consumers were no longer locked into their contracts, and began switching handsets at a rapid pace, since carriers still competed on the basis of subsidy amounts. However, this raised Korean imports for components in 1999, just as political concern about Korea's balance of payments was high, as it had to meet IMF bailout conditions involving balance of payments. MIC was in favor of carriers curtailing subsidy amounts to ensure their profitability, and in September 1999, KTF, LG Telecom, Hansol PCG and Shinsegi agreed to subsidy caps, though they later broke ranks and began offering higher subsidies again. However, the KFTC fined carriers for this arrangement, since from their perspective, this amounted to industrial collusion. This was too much for MIC, which banned subsidies altogether in June 2000.[67]

Following the handset subsidy ban, demand for handsets shrank dramatically, from monthly sales of between 1.4 and 2 million units before the ban, to 250 thousand immediately following it. This led MIC to announce plans such as allowing installment sales of handsets to alleviate the suffering of equipment manufacturers. It also tried to encourage competition between carriers by exempting subscribers switching from incumbent to new carriers from certain fees [find out more precise]. However, this time, the KCC, whose primary institutional concern was fair competition, weighed in, arguing that the asymmetrical regulation hindered fair competition. The KCC and MIC also investigated the market between mid 2000 and 2001, finding that subsidies, now illegal, were continuing to some extent, and fining carriers engaged in the practice.[68]

Korea's generally more active consumer groups (compared to Japan), also organized protests through a couple groups against carriers. They called for the abolishment of subsidies and up to 40% lower subscription fees, going so far as to organize a rotating sit-in in front of the Ministry.[69]

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[65] Kim et al., 2004
[66] ibid
[67] ibid
[68] ibid
[69] ibid

Table 10: Three phases of subsidies

	1997-1999	4/1999-5/2000	6/2000 – 2006	2006 ~
Phase	Subsidy wars (without)	Subsidies without Penalty clause	Subsidy ban	Subsidy re-introduction
Market effects	Escalation to free handsets, 3 year lock-in	Free handsets, rampant user switches	Slower rate of domestic handset turnover, focus on Global markets	
Bureaucratic friction		MIC vs KFTC	MIC vs KCC	

IV. The Rapid Deployment of 3G

The International Political Fights over 3G Standard-Setting

The international negotiations over 3G standard-setting were complex and intensely political, yielding a compromise that surprised many participants and confused observers.[70] The ITU had planned since the late 1980s to create a global digital standard, in its initiative IMT-2000 (International Mobile Telecommunciatons-2000). By the late 1990s, European participants such as Nokia did not think they could win in competition against the Japanese, leading to a coalition between Japanese and European players.[71] With Qualcomm pressuring the US government into action, the ITU had to compromise and certify two IMT-2000 standards, compromising its goal of promulgating a single global standard.

The two standards, W-CDMA was set forth as an upgrade from GSM, the standard which dominated Europe, and with the most subscribers worldwide. CDMA2000, the standard pushed by Qualcomm, could be achieved through incremental upgrades of its existing CDMA standard.

In both Japan and Korea, announcement of a limited number of 3G licenses (three), sparked consolidation of carriers.

Japan

In Japan, the initial process of awarding 3G licenses was relatively uncontroversial. In 1999 the government announced that it would allocate three licenses. This led to consolidation in late 2000, as several landline and mobile carriers merged to become KDDI, creating a third national competitor in addition to NTT DoCoMo and J-Phone. All three licenses were granted that year by Ministerial decision, free of charge. In making the license free, the government wanted to ensure that carriers, especially DoCoMo's competitors, had enough capital to build out 3G networks on schedule.

DoCoMo commenced W-CDMA services in October 2001, as did J-Phone in Devember 2002. KDDI, upgrading its CDMA network, began offering CDMA2000 1x in April 2002. DoCoMo's W-CDMA service (named FOMA), did not take off as rapidly as the company had hoped, largely due to technical issues making handsets larger with shorter battery life, and relatively poor coverage area.[72] As handsets became smaller with longer

[70] For a detailed analysis, see Cowhey, Peter F., Jonathan D. Aronson, John E. Richards. 2006. The Peculiar Evolution of 3G Wireless Networks: Institutional Logic, Politics, and Property Rights. In *How Revolutionary was the Digital Revolution? National Responses, Market Transitions, and Global Technology*, edited by J. Zysman, and Abraham Newman. Stanford, CA: Stanford University Press.
[71] Steinbock 53-54
[72] Put simply, it was in effect a substitute for existing 2G services, but with poorer performance attributes.

battery life, and improved coverage area, W-CDMA subscriber began to grow. Meanwhile, KDDI's CDMA2000 1x grew rapidly, as it was a simple upgrade for most users. J-Phone was slow in its investment into 3G, trailing behind the others.

Service innovations such as KDDI's "chaku-uta" introduced in December 2002, allowing highlights of CDs to be downloaded and played on handsets, became quite popular.

Competition between the three carriers led to KDDI's introduction of flat-rate data services (2.4Mbps downstream) in November 2003 with its CDMA2000 1x EV-DO, another incremental upgrade. DoCoMo followed in June 2004, but restricted the number of flat-rate users until Feb 2006.[73]

With this services infrastructure in place, in November 2004 KDDI introduced "chaku-uta full" allowing a full CD quality song to be downloaded. Within 16 months, it recorded 50 million song downloads. DoCoMo's W-CDMA service (at 384Kbps) was too slow to download full songs, delaying its introduction of a similar service until June 2006, right before its introduction of W-CDMA HSDPA (High Speed Downlink Packet Access), allowing 3.6 Mbps downloads.[74] During [time period], KDDI steadily acquired more subscribers per month than DoCoMo.

Challenges to Japan's spectrum allocation process

Son Masayoshi, founder of Softbank, the firm that pushed the new regulatory structure in broadband to its extreme, altering the terms of competition by initiating price wars, mounted a challenge to Japan's spectrum allocation policies.[75] Son, noting the high revenue per user of Japanese carriers, wanted to enter the cellular services market and cause an equivalent price shock.

In 2000, when the spectrum for 3G was licensed, each of the three carriers were given 20 MHz, but it was discovered that KDDI's spectrum, adjacent to PHS spectrum, caused conflicts in PHS services. MIC allocated a small portion of the spectrum as a buffer, but to keep competition fair, it designated equivalent portions of other carriers as unused buffers as well. Son, discovering this, lobbied the minister of MIC and regularly visited MIC to obtain usage of this spectrum. In December 2003, MIC went so far as to open public comments on the issue, but in March 2004, it rejected Son's efforts, supported by the carriers who had already obtained spectrum.[76]

Later that year, Son launched his second attack. Soumusho had decided to reorganize spectrum in the summer of 2004, and in a new type of challenge to regulators, he took out a full ad Japan's major daily newspapers twice, calling for users to voice their opinions to lower service prices. He also held a press conference criticizing MIC's lack of transparency in spectrum allocation decisions. When MIC opened a public comment period, it received over 30 thousand comments – an unprecedented number by far – most of them appealing for Softbank to enter. At the end of September, MIC announced a compromise; it would open a new frequency, 1.7 GHz. However, Son was not placated, insisting that 800MHz, the bandwidth used by other 3G services, was what he wanted. He filed a lawsuit again MIC in October 2000, only the second time the ministry had been sued. He called for new methods to

[73] Masuno 30
[74] ibid.
[75] Kushida and Oh 2007.
[76] Communications, Nikkei. 2005. Fuunji Tachi ga Makiokosu Keitai Denwa Houkai no Jokyoku: Shirarezaru Tsushin Sensou no Shinjitsu [The opening tune of the destruction of the cellular phone order, brought about by adventurers: the truth of the telecommunications wars revealed]. Tokyo: Nikkei BP.pp. 8-10

assign spectrum, criticizing that negotiations between MIC and the existing carriers were not open, and that the carriers took post-retirement bureaucrats. Son even went to FCC chairman Michael Powell to ask him to put diplomatic pressure on Japan.[77]

From MIC's point of view, Son's criticism was puzzling, since he had early been insisting that they license TD-CDMA, third 3G standard approved by the ITU that had not been commercialized yet. Since MIC had treated the reorganization of spectrum as a technical matter, and had been debating optimal allocation for several years. In December 2004, MIC convened a study group to take recommendations, and Son rescinded his lawsuit in hopes of convincing them. However, in late January, they rejected the wishes of new entrants to use the 800 MHz bandwidth.[78]

In November of that year, three entrants, Softbank, eAccess, and IP Mobile, were granted licenses and spectrum. However, in April 2006, Softbank bought Vodafone's Japan operations at 1.75 trillion yen (approximately 14.5 billion US at 1$ = 120 yen), receiving its share of the spectrum and returning the allocation it had received earlier allocation. Softbank's purchase of Vodafone was an attractive proposition for the British company, which had run into financial difficulties in its global operations. The leveraged buyout – the largest in Japan's history, gave it a tidy monetary profit, it had already benefited from the know-how used in its Vodafone Live! Services, and Japan had moved beyond Europe in its 3G services, meaning that its investments into Japanese network infrastructure was not directly beneficial to the rest of its operations.

Korea

In 1999, MIC announced that it would award three 3G licenses to consortia, sparking a wave of consolidations. Between December 1999, and April of the following year, SK Telecom acquired Shinsegi Telecom, and in 2001, KTF acquired Hansol.

While consortia led by SKT, KTF, acquired licenses for W-CDMA, they delayed launching W-CDMA services, focusing instead on upgrades to their existing CDMA networks (called cdma2000 1x and 1xEV-DO), which cannot be upgraded to W-CDMA.[79] As other parts of the world hesitated to launch W-CDMA services, equipment manufacturers were able to continue using their domestic market as a springboard for exports.

3G licenses

In 2000, MIC published a timetable for licensing 3G. Concerned about excessive competition, it limited the number of licenses to three, and it again favored consortia to limit chaebol and foreign participation. Three consortia, SK, KT, and LG, applied.

Since two competing standards were available, another battle between MIC, carriers, and equipment providers erupted. MIC took the position that W-CDMA should be adopted by one or two carriers because wide support in Europe and initial projections predicted that it would be more widely adopted. Existing 2G carriers, SKT, KTF, and LGT, also argued for W-CDMA. However, equipment manufacturers including Samsung, Hyundai, and small CDMA equipment providers strongly preferred CDMA2000 – though they did not take a strong public position. With CDMA2000, a direct and incremental upgrade from their

[77] Nikkei Communications 2005, pp. 27-30
[78] ibid 31 - 45
[79] Park et al

existing CDMA service, would allow them to utilize much of their existing technological expertise, and their existing export market in the US seemed to be headed to CDMA2000.[80]

The government, in balancing these interests, urged carriers to adopt cdma2000 to facilitate exports. Later in 2000, MIC considered delaying offering the W-CDMA license to give time for equipment manufacturers to gain technological competitiveness in it first, hoping that two carriers would choose CDMA, and one would choose W-CDMA. However, none of the carriers took the government's recommendations, with all three applying for W-CDMA licenses in October 2000. The government then granted two, rather than three licenses, to the SKT and KT consortia with W-CDMA. It publicized a plan to set aside an additional license in early 2001, and it hoped that LG would apply for a CDMA2000 license. LG was reluctant, having spent several years concentrating resources on developing W-CDMA technologies, but in the end, MIC convinced them to apply for a CDMA2000 license, but with a significantly lower licensing fee than SKT or KT.[81]

Shaping Competition

SKT's takeover of Shinsegi brought about some of the most extreme market interventions by the Korean government. Both the MIC and FTC were concerned that SKT, already the dominant carrier, would dominate the market so completely as to render it uncompetitive. They gave their approval with the condition that SKT actually lower its market share to less than 50% within six months of the merger.[82] This shows perhaps most clearly that the government's priority in liberalization was to facilitate competition rather than pull back and let markets run their course.

V. Conclusion

Thus, we have examined how the two countries chose their standards and undertook liberalization. It is now time to compare our findings with the initial expectations.

First, we found that the initial structure of the overall telecommunications sector influenced the politics of *choosing a digital standard*. While Japan's NTT had considerable R&D resources, dominating a set of "family" firms, Korea's equipment manufacturers undertook R&D in cooperation with the government and carriers. While NTT's R&D resources enabled it to create its own domestic analog cellular standard, Korea's carriers relied on imported equipment, with a US standard.

Therefore, in the political process of choosing a digital standard, Korea's government spearheaded strategic R&D efforts to build the capacities of domestic actors in cellular technology. Yet, the government was not a monolithic, unitary actor, as bureaucratic conflicts over jurisdiction and a political scandal determined the scope and exact timing of the new standard's deployment. In Japan, on the other hand, the digital standard was chosen after two competitors had been introduced into the market after a complicated battle, and MPT wanted to avoid a political struggle over redistributing spectrum. This gave it the strong incentive to agree to use NTT's standard, with domestic equipment firms already capable of dominating the domestic market. These choices of digital standards greatly affected the fortunes of each

[80] Jho 332-337
[81] ibid 339-348
[82] ibid 322

country in global handset markets, but MPT was a primarily domestic-oriented Ministry, unlike MITI, and its primary concern was not facilitating exports.

Second, in *liberalizing the market* by introducing competitors and changing regulations, both governments used spectrum allocation as a strong policy tool to orchestrate the entry of new competitors. In Japan, however, in contrast to our expectations, the bureaucracy was not actually able to manage the initial entry of competition effectively, as the process became a bilateral market access issue with the US. In the second round of introducing competitors, however, the government did succeed in orchestrating the entry of a set of consortia, and in addition, it was able to use industrial policy R&D measures to create a new technological competitor to cellular services. The classic pattern of intense domestic competition leading to spillover exports did not materialize, however, despite rapid improvements in the domestic market, since the standards were domestic and proprietary.

In contrast, Korea's experience with the introduction of competition did not precipitate bilateral pressure, since it occurred later, the US equipment firm was experiencing difficulties worldwide and was in a weak position with the US government, and because Korea's digital standard entailed paying license fees to a different American firm. The Korean government was successfully able to facilitate the creation of consortia carriers, limit foreign and chaebol influence, and nurture domestic equipment firms, and make its domestic market a platform for exports. In Korea, the classic pattern for exports did work.

In governing competition in cellular markets, the two countries used similar policy tools of licensing and broad discretionary authority, as expected. Despite the recent challenge to Japan's spectrum allocation process by a newcomer, its policy regime remained largely intact save some deregulation of prices – unlike in its landline policymaking regime.

Korea, as expected used its policy tools more aggressively than Japan to influence market actors, going so far as to stipulating market shares of the dominant carrier in exchange for approving its merger. However, the surprise in Korea's case was the conflicting bureaucratic jurisdictions and agendas regarding subsidies, leading to a series of confused policy reversals.

The two governments actively promoted 3G network and service deployment, choosing to allocate licenses cheaply rather than burden carriers and invite uncertainty by engaging in auctions. In Japan, by limiting the number of licenses, the government effectively consolidated the industry into national carriers more likely to be able to afford to invest in national networks. In Korea, export markets were clearly part of the agenda in allocating spectrum to both 3G standards, despite the duplicated investment in the short term. Export markets were on the agenda in Japan as well, but since it already had a mix of technologies, it did not become an explicit issue in the manner of Korea.

This study also clearly shows that hardware whose function requires a *services infrastructure*, such as cellular telecom, cannot be exported in the manner of automobiles or semiconductors. Interestingly enough, Japanese handset component makers, such as batteries, LCDs, CCD cameras, and condenser chips, are flourishing in global markets. Since their products do not require carriers to offer particular services to function, the contrast is clear with handsets as final products.[83]

[83] Sony and Sharp have over 90 percent of the CCD camera global market share, Fujinon has over 80 percent of glass lenses, Murata over 50 percent of condensers, Sanyo and Sony with over fifty percent of batteries in 2005, according to market research firm IDC. (Shuukan Diamondo 2007.)

Appendix

The Development of Cellular Internet Services

Origins of Cellular Internet Services: the Logic of Competition

NTT DoCoMo is often credited for the innovative business model in its *i-mode* service.[84] However, most analyses undervalue the role played by the dynamics of competition that focused all actors on commercializing cellular Internet services. In addition, the lack of a direct policy support to facilitate exports is largely due to MIC's domestic orientation.

The rapid growth of Japan's cellular subscribers in the mid-1990s drove the market towards saturation. In addition, DoCoMo's competitors using the PDC standard were at a significant competitive disadvantage, since DoCoMo was the only carrier with the resources to upgrade the standard. Though the upgrades were formally approved by the Association of Radio Industries and Businesses (ARIB) and made public, DoCoMo privileged "family" firms with specifications and information before the were publically disclosed. As a result, "family" firms could roll out new handsets for DoCoMo's service before other manufacturers developed their new handsets for competing carriers. In exchange for early information, "family" firms were forced to delay shipping their new handsets to competitors for several months, though these practices drew a warning from Japan's Fair Trade Commission.[85]

With the playing field tilted in favor of DoCoMo, the desperate competitors were pushed to look for alternative strategies. PHS services, their carriers increasingly driven into financial difficulties, first to market with messaging services, revealed a significant latent demand for such services.[86] This played into the general expectation shared in Europe and the US that cellular services would eventually connect to the Internet. Combined with Japan's carrier-led R&D regime, from around 1996 these expectations led the carriers to begin a race to commercialize Internet connection services.

The underappreciated aspect of Japan's cellular Internet services is that each carrier took an independent path to develop their technology and business model, and that DoCoMo actually lagged behind for much of the time.[87] DoCoMo's famous *i-mode* service, with its

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[84] For example, see Beck and Wade (2003), Murase (2003), Ratliff, John M. 2002. NTT DoCoMo and Its i-mode Success: origins and implications. *California Management Review* 44 (3):55-71.

[85] Funk 2002, Yuasa, Izumi. 2000. *NTT Docomo no chousen [The Challenge of NTT DoCoMo]*. Tokyo: Kou Shobou.

[86] (Kontentsu kakumei no kishu tachi: "kokusaikijun" de dokomo ni taikou. 2003. *Nihon Keizai Shimbun*, October 8, 5.; Kontentsu kakumei no kishu tachi: shanai benchaa, nankan toppa. 2003. *Nihon Keizai Shimbun*, October 9, 5.; Kontentsu kakumei no kishu tachi: shameru de onnagokoro tsukamu. 2003. *Nihon Keizai Shimbun*, October 10, 5.)

[87] Tokyo Digital Phone (later J-Phone, and then Vodafone) went to a research lab in Keio University known for its work on Internet-related technologies, IDO (later KDDI) joined the WAP forum assembled by the American firm Unwired Planet, and DoCoMo strengthened ties to Access, a Japanese startup company. J-Phone's first cellular information service, "Sky-walker," in late 1997, took DoCoMo by surprise. DoCoMo's president at the time, Ohboshi Koji, was reportedly furious about being behind the game. When J-Phone rolled out an early text-only version of its cellular Internet service in December 1998, DoCoMo was again behind in the race (Kontentsu kakumei no kishu tachi: "kokusaikijun" de dokomo ni taikou. 2003. *Nihon Keizai Shimbun*, October 8, 5.; Kontentsu kakumei no kishu tachi: shanai benchaa, nankan toppa. 2003. *Nihon Keizai Shimbun*, October 9, 5.; Kontentsu kakumei no kishu tachi: shameru de onnagokoro tsukamu. 2003. *Nihon Keizai Shimbun*, October 10, 5.)

innovative business model, was rolled out in early 1999.[88] Yet, few observers recognize the significance of the fact that, later that year, all major Japanese carriers rolled out competing services with similar features, but different underlying technologies and networks.[89] While DoCoMo used it considerable financial resources to build an entirely new, nationwide packet-switched network, its competitor KDDI used a CDMA-based network built with Motorola equipment, and J-Phone used a circuit switched PDC network.

Rather than simply being the success story of a single innovative firm, Japan's cellular Internet services were the product of competitive dynamics of the entire Japanese cellular market shifting toward the commercialization of cellular Internet services.

Commercialization was, of course, aided by the close carrier-manufacturer R&D regimes, since implementation needed to occur in handsets as well as infrastructure. In DoCoMo's case, its powerful R&D labs could essentially hand specifications to "family" handset manufacturers, who would reliably implement and deliver the new models. The other carriers lacked DoCoMo's extensive R&D capabilities, but were able to work closely with manufacturers, sometimes receiving feedback from "non-NTT family" manufacturers, such as Sanyo.[90] The retail structure, in which carriers purchased handsets outright from manufacturers, allowed them to guarantee minimum demand for the new Internet-enabled handsets, and subsidies to retails allowed consumers to purchase handsets easily.[91]

Once the cellular Internet services took off in commercial popularity, new services by DoCoMo, such as IC chip embedded handsets acting a debit cards, tend to receive the most attention, but its competitors were actually responsible for several service innovations as well. J-Phone was first to market with camera-embedded phones, with a service that allowed users to email the pictures. It took DoCoMo approximately a year to offer similar services. KDDI commercialized downloadable songs, "chaku-uta," which recorded 5 million downloads 16 months after its introduction in late 2004, closing in on the number of CD singles sold in early to mid-2006.[92]

The Spread of Cellular Internet Services Abroad

The unexpected spread of cellular Internet services abroad mainly through foreign carriers rather than domestic carriers has several explanations, which need to be understood in a political economy framework.

First, the deregulation of foreign direct investment into facilities-owning carriers, a result of the 1998 WTO agreement, opened the door for Vodafone to enter Japan. They had become a minor shareholder when PacBell of the US was sold to SBC.[93] Though the J-Phone management was not eager to for Vodafone to increase its share, Vodafone went to Japan Railroad, the main shareholder in need of cash, to buy J-Phone's parent company, Japan

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[88] In DoCoMo's business model, *i-mode* was a portal, modeled loosely on AOL, rather than a channel for providing in-house content (Natsuno 2001). The main innovation was that, for websites officially approved by DoCoMo, DoCoMo offered revenue sharing with content providers and billing services integrated with DoCoMo's own billing service (Funk 2001).

[89] After Docomo began *i-mode* services in February of 1999, KDDI introduced its *EZWeb* service in April, and J-Phone its *J-Sky* service in December.

[90] For examples, see an illuminating series of Nikkei articles analyzing the development of Japan's Internet connection services though interviews with key participants, titled "Kontentsu Kakumei no Kishu tachi (flagholders of the contents revolution)" (Kontentsu kakumei no kishu tachi: shameru de onnagokoro tsukamu. 2003. *Nihon Keizai Shimbun*, October 10, 5.)

[91] For details on how the distribution system worked, see (Kushida 2002:58).

[92] Masuno 2006 p. 30, Shukan Daiyamondo 2006, p.34

[93] I would like to express my gratitude to Professor Shigehiko Naoe for explaining this point to me.

Telecom. Though Vodafone promised it would not immediately sell off the landline division to get its hands on J-Phone, it did just that, selling the landline business of Japan Telecom to Ripplewood, and American investment fund. While expanding into Japan's lucrative market was part of Vodafone's aggressive global expansionist policy, they were also interested in J-Phone camera-embedded handset-enabled picture mailing technology.[94] Thus, it was the deregulation in 1998 that allowed Vodafone to become one of the three nationwide carriers in Japan.

Second, DoCoMo's corporate strategy for global expansion was simply unsuccessful. Rather than expanding directly as a carrier (like Vodafone), it chose to purchase minority stakes in mostly small carriers across the world in an attempt to transplant its i-mode service. However, aside from massive capital losses it incurred when the technology bubble burst in 2001, it was unsuccessful in convincing some of its larger partners to adopt i-mode – AT&T Wireless being the most prominent example. Without its cadre of "family" firms unavailable to provide handsets abroad, exacerbated by the low presence of Japanese handset manufacturers abroad, carriers that did offer i-mode faced a small number of i-mode enabled handsets available in their domestic markets. Local carriers had also already moved in the direction of WAP.[95]

Third, we see a difference between exporting hardware and services, especially when the services are enabled by particular types of hardware. As Funk puts it, had difficulty in transferring its domestic network content providers, sophisticated lead users, and phone manufacturers abroad.[96] The contrast is with Vodafone, which opted for a more closed model for content.

Finally, to an observer of Japan's successful exports in other sectors, or in comparison to Korea's government, which was clearly focused on handset exports, it is striking that Japan's government was not more pro-active in supporting exports. The answer is that MPT (carried over to MIC in the government reorganization of 1999), unlike MITI, was historically a domestic-oriented Ministry. Its initial task was to build up Japan's domestic infrastructure, and its focus remains on domestic competition issues. Only recently has MIC convened a study group to examine and strategize about the international competitiveness of its ICT sector.[97]

[94] See Kushida 2006.
[95] Funk 2004 33. Funk also argues that DoCoMo was not a strong negotiator – it took KPN 18 months to introduce i-mode in Holland after the alliance was formed. Even then, only two i-mode capable handsets were available.
[96] Funk 2004 p. 201
[97] The "ICT International Competitiveness Study Group"

Table 11: Prepaid subscribers

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Canada	0	1	3	19	28	30	31	33	38
Denmark	–	–	10	12	15	14	11	10	10
Finland	–	–	–	–	–	–	1	2	4
France	–	–	73	130	181	171	171	171	176
Germany	–	21	55	263	314	313	332	361	402
Italy	56	152	255	371	458	490	515	570	656
Japan	–	–	–	–	–	21	26	29	27
Korea (Rep. of)	–	–	–	–	–	–	–	–	–
United Kingdom	–	44	150	274	310	333	366	407	–
United States	–	–	52	120	128	99	95	109	156

Source: ITU World Telecommunication Indicators Database 2006

Table12: Average Revenue per Mobile User, G-8 (minus Russia), plus Finland, Denmark, 1994-2003 (USD)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Canada	703	642	610	499	553	466	431	388	381	432
France	875	1487	1329	818	391	310	241	242	288	358
Germany	1129	1829	1571	1234	896	701	319	274	298	353
Italy	886	726	724	564	380	292	222	243	271	331
Japan	3132	2160	1388	1140	966	1056	1122	1008	921	932
Korea	1232	1351	1338	506	272	311	407	372	369	396
UK	551	465	571	602	467	328	245	256	275	319
US	630	593	588	597	535	583	578	581	547	554
Finland	2995	2952	2765	2533	455	485	447	430	473	533
Denmark	462	380	507	528	429	378	292	262	285	371
OECD Total	926	982	882	771	586	537	459	426	421	454

Source: OECD Telecommunications Database 2005

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