

Development of Chinese telecom equipment industry and indigenous innovation ecosystem

A study with patent analysis

Kaidong Feng

Tingting Zhao

Li Zhang

Zhenyu Fu

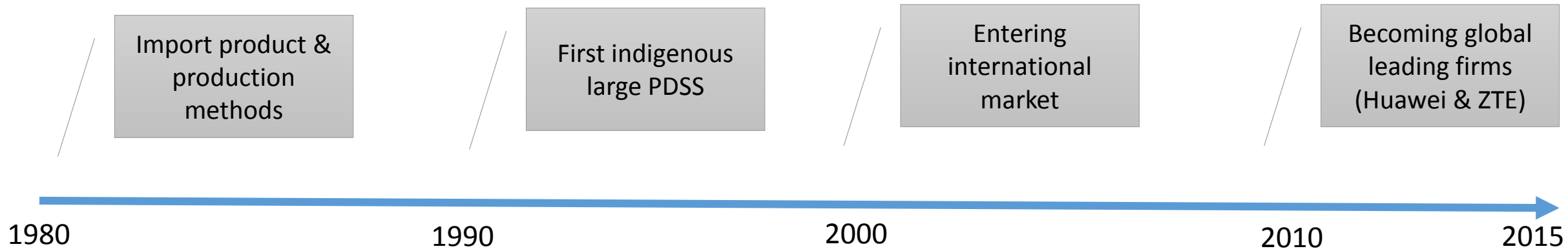
Peking University, China

Peking University, China

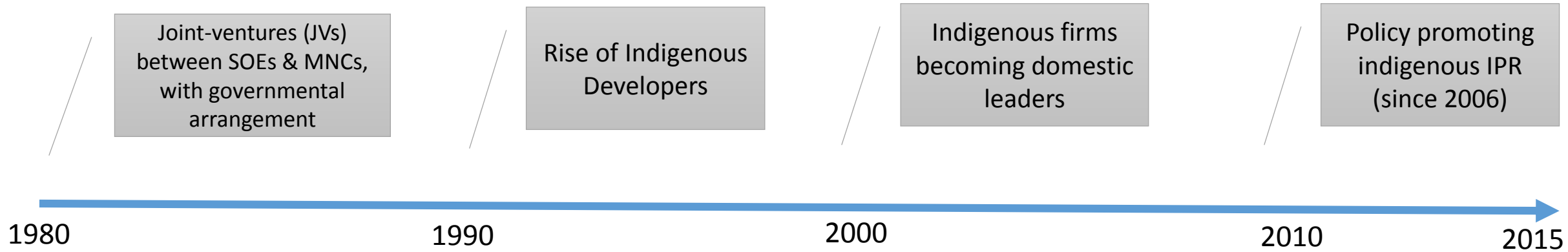
SIPO, China

Cambridge University, UK

Development of Chinese Telecom Equipment Industry



Rise of Chinese indigenous innovation: Great Dragon, Datang, ZTE, Huawei, WRI



Chinese government “Trading market for technology” policy in this sector

Central planning sector/government

Mobilizing resources in traditional telephony and radio sector

- JVs
- Governmental S&T projects

Redirecting technological trajectory

Corporatization of research institutes & ministry-owned factories

- Datang, WRI
- (Great Dragon) Luoyang Telephony
- Eastom (Hangzhou Telephony)

1980 1990 2000 2010 2015

Non-planning sector

Computer technology application (Great Dragon)

- S&T force of computer & semiconductor entering telecom domain

Intensively attracting S&T force from the governmental sector (Huawei & ZTE)

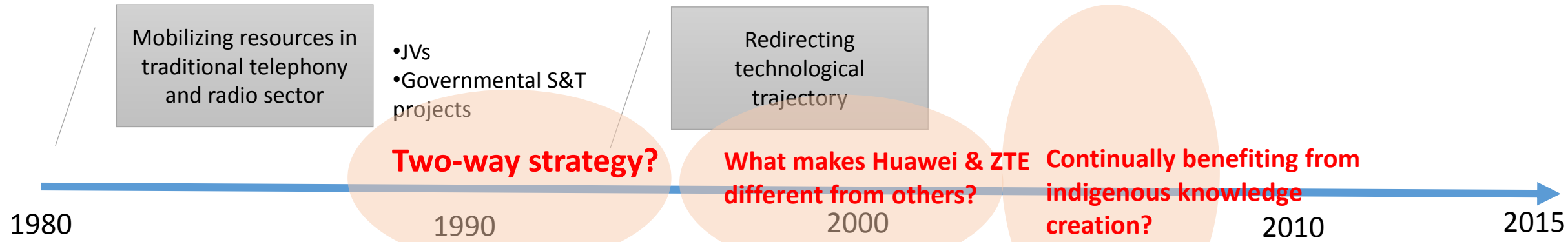
- S&T personnel from research institutes, universities
- Personnel from SOEs & JVs
- University graduates (after 1998)
- Cooperative research

Multiple-mechanism of knowledge generation

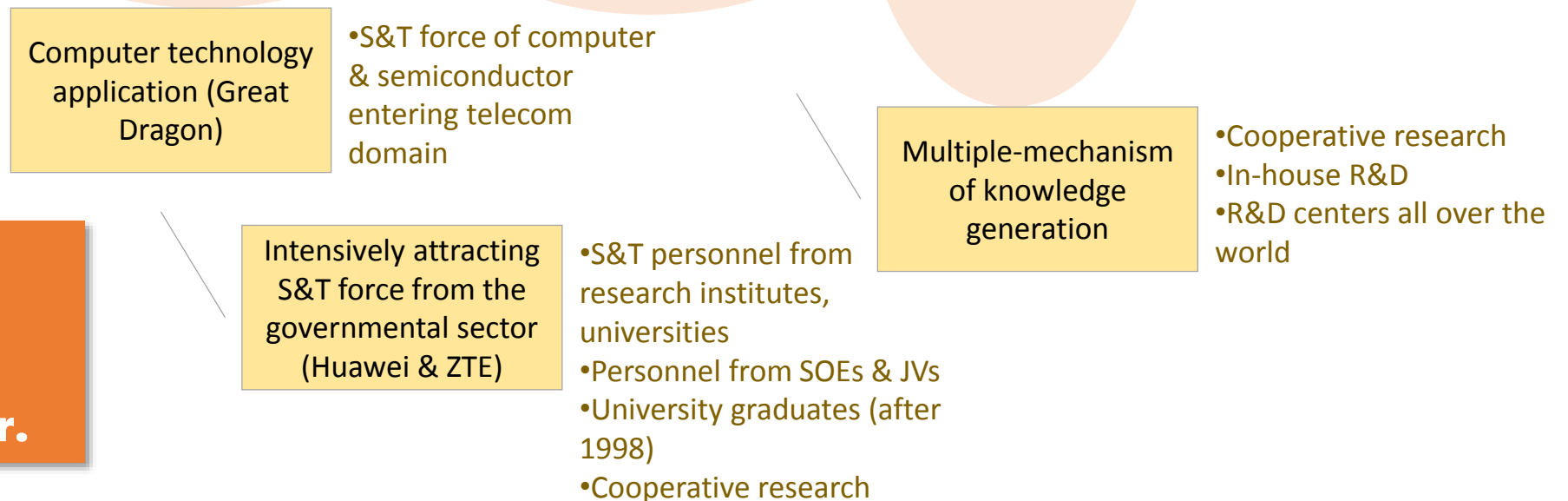
- Cooperative research
- In-house R&D
- R&D centers all over the world

- Three questions are critical:
- (1) *Did Chinese government implement a “two-way strategy” by encouraging JVs & domestic developer to promote inward technological transfer?*
 - (2) *What did help Huawei & ZTE stand out among indigenous developers?*
 - (3) *Can Huawei continually benefit from local knowledge generation for frontier innovation competition?*

Central planning sector/government

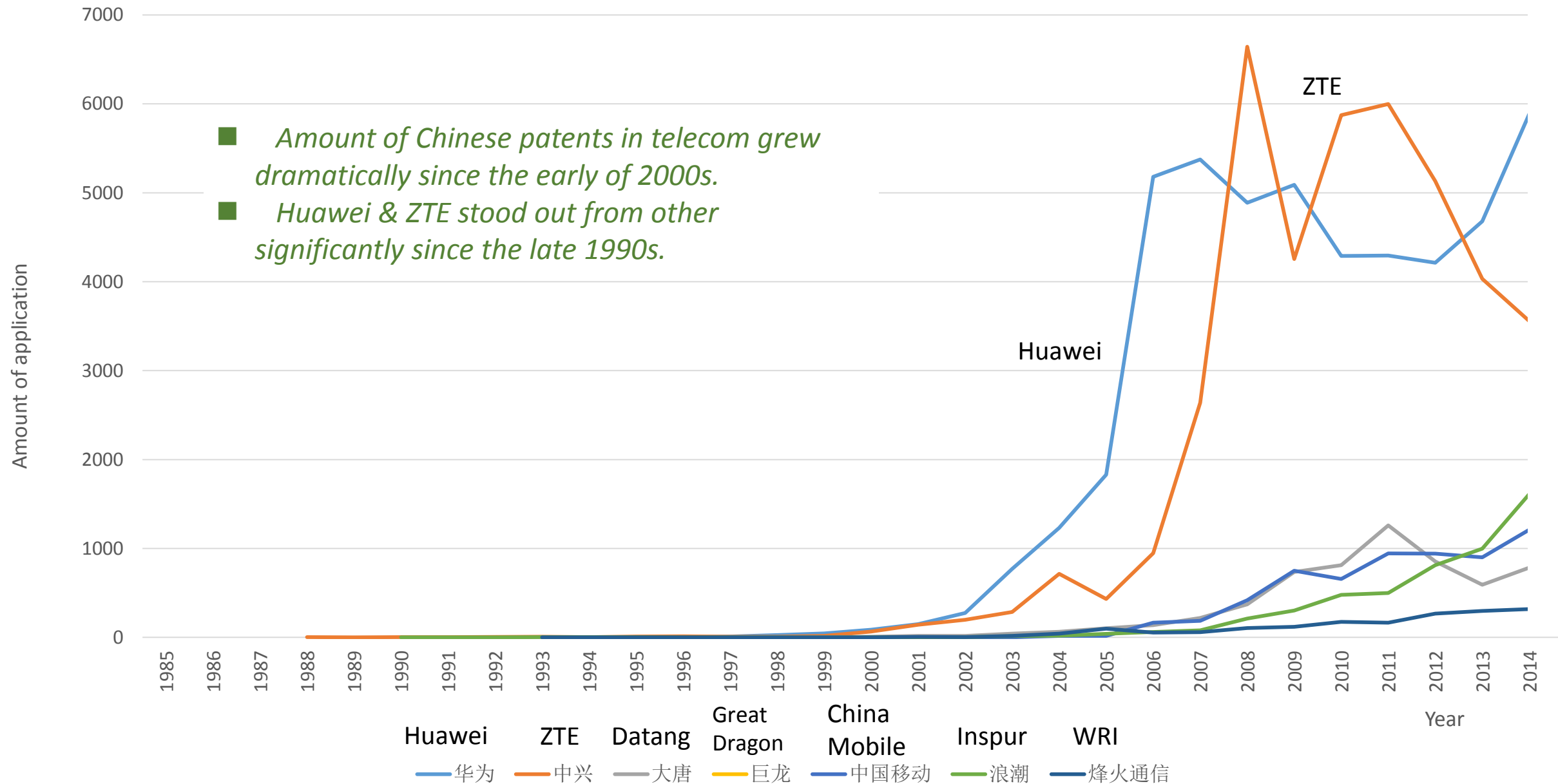


Non-planning sector



At this stage, we are employing patent data analysis to help us to clarify this study further.

Patent application of Chinese indigenous firms 1985-2015



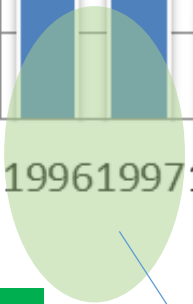
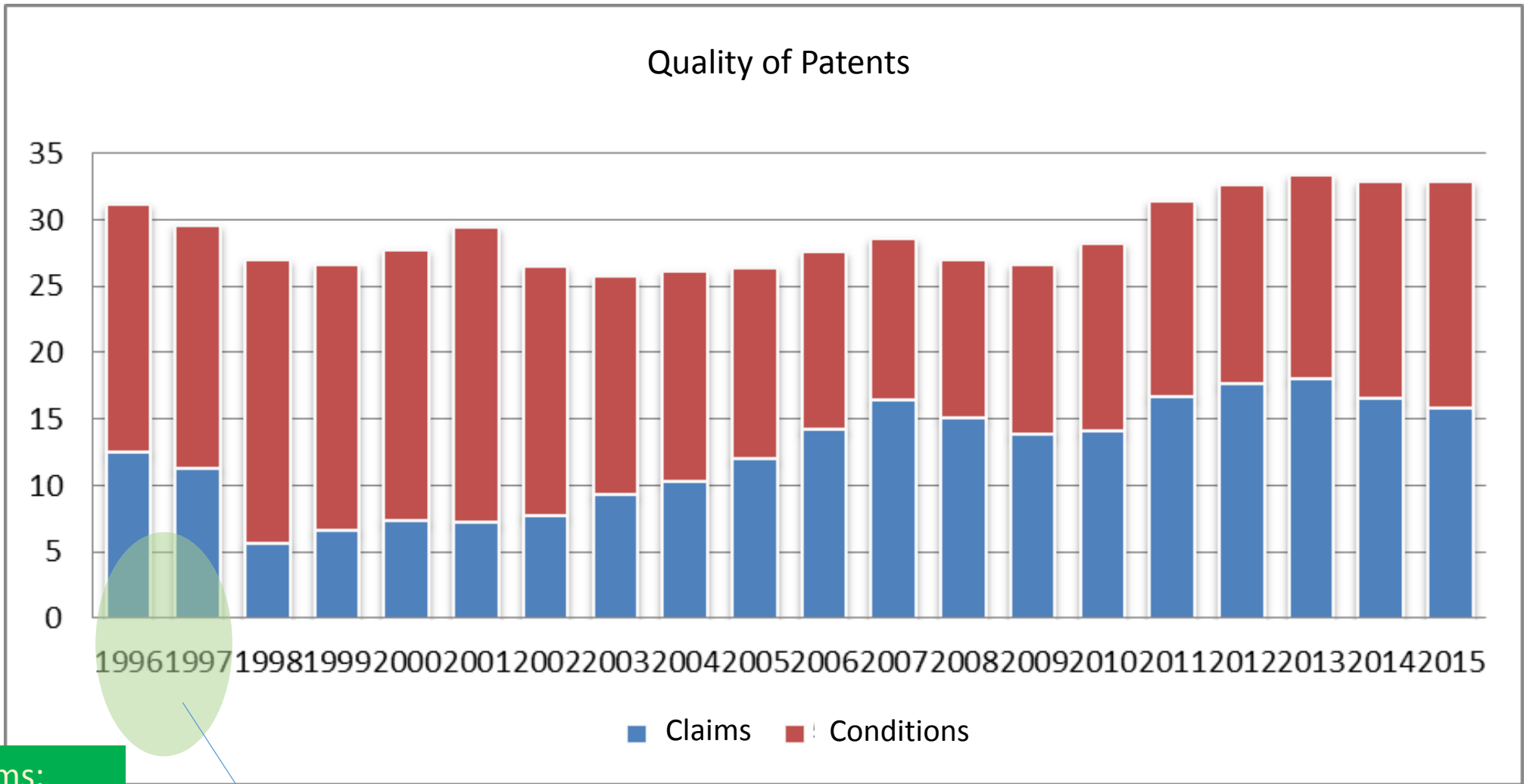
Quality of Huawei patents

Patent Granted in China			Patent Application in China			
	Amount	Claims	Conditions	Amount	Claims	Conditions
1995	4	7.5	38	5	8.8	33.2
1996	11	10.27	20.18	17	12.47	18.64
1997	18	8.38	22.5	33	11.27	18.3
1998	28	5.89	27.5	49	5.59	21.38
1999	89	6.98	25.5	132	6.53	19.91
2000	173	6.89	25.73	231	7.35	20.24
2001	446	6.61	26.66	474	7.15	22.24
2002	947	7.12	24.53	1091	7.74	18.7
2003	1333	7.99	21.76	1576	9.29	16.41
2004	1785	8.71	22.34	2202	10.31	15.71
2005	2784	9.8	23.33	3619	11.97	14.41
2006	4047	12.6	20.44	5928	13.28	13.28
2007	3247	13.63	18.92	4938	15.65	11.69
2008	3239	12.48	19.1	5233	14.99	11.77
2009	2741	11.5	19.37	4320	12.75	11.78
2010	2007	11.97	20.79	3296	13.51	13.48
2011	1913	13.13	20.95	4209	14.72	12.94
2012	996	12.6	21.26	5717	15.15	12.82
2013				5476	15.88	13.51
2014				1561	16.54	16.14

Average amount of claims:
Steadily increasing

Average amount of conditions:
Steadily decreasing

Quality of Huawei patents



Average amount of claims:
Steadily increasing

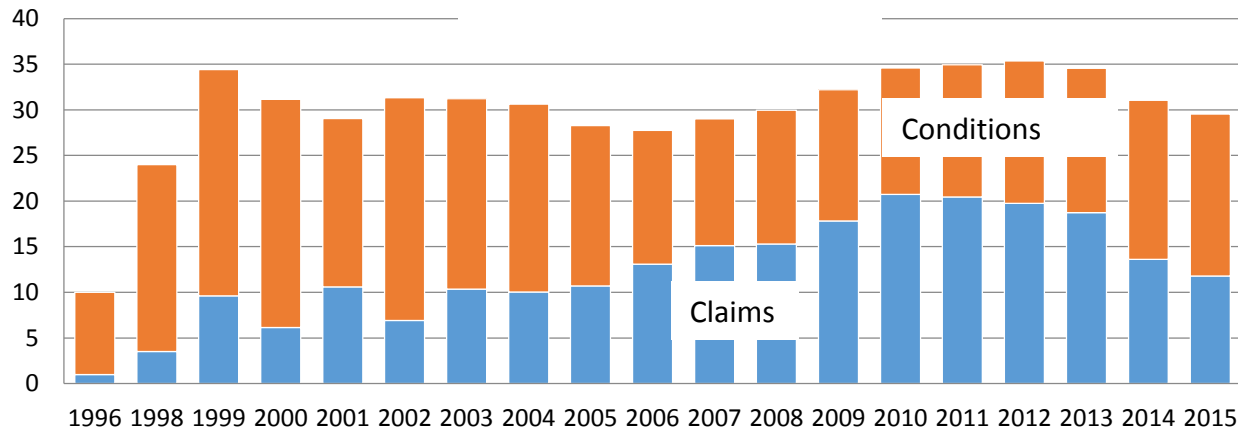
Average amount of conditions:
Steadily decreasing

The amount of patents was still very small.

Quality of Datang patents

Data: Datang patent application in China

Quality of Patents



Datang Patent Application in China

	Amount	Claims	Conditions
1995			
1996	1	1	9
1997	NA	NA	NA
1998	2	3.5	20.5
1999	5	9.6	24.8
2000	13	6.15	25
2001	30	10.6	18.43
2002	30	6.9	24.43
2003	86	10.34	20.86
2004	136	10.04	20.57
2005	172	10.7	17.58
2006	330	13.07	14.66
2007	510	15.12	13.9
2008	676	15.3	14.67
2009	860	17.82	14.38
2010	772	20.73	13.84
2011	779	20.45	14.5
2012	887	19.76	15.58
2013	656	18.73	15.82
2014	367	13.61	17.43

Question 1: JVs and indigenous innovation, a two-way strategy of Chinese government?

- **Negative.**

- My previous study reveals (based on interviews and documents):
 - (1) JVs only transferred production technologies.
 - (2) The technologies employed in indigenous technological exploration of other firms & institutes of Ministry of Post & Telecom (MPT) differed from the technologies of JV significantly.
 - (3) There was no significant technological outcome of these JVs even after more than 10 years practices.
- Now current patent data reveals:
 - (1) very few patent outcome, even considering the best-performing JV.
 - (2) patents of these JVs had little relevance to patents of corresponding MNCs.
 - (3) patents of other firms & institutes of (previous) MPT had insignificant relevance to patents of JVs.

Quality of Shanghai-Bell patents

Note: Shanghai-Bell (a JV between Potevio of MPT) and Belguim BTM was set up in 1984, the first JV in this domain; and it was dominated by Alcatel since 2002 because of ownership change.

Shanghai-Bell was the best-performing JV by any measurement in telecom equipment.

Very poor quality!

	Amount of application	claims	conditions
1990	1	4	12
1991-1996	0	NA	NA
1997	1	7	13
1998	3	4	31.67
1999	11	2.27	31.82

Data: Shanghai-Bell patent application in China

No relevance between Shanghai-Bell patent and patents of Bell (series) or Alcatel. Ironically, there is relevance with patented technologies of its Chinese parent firms.

Note: Belgium BTM (Bell Telecom Manufacturing) was the original foreign partner of Shanghai-Bell, and then Alcatel took it over.

Relevance Analysis of Shanghai-Bell patent application (-2000)

Data: Shanghai-Bell patent application in China, up to 1999

Relevance Analysis:
Logic-semantic analysis based on text of patents, to study the potential competitors of patents when they are designed.

Similarity in challenges, conditions, technological trajectories, etc.

Note: Shanghai-Bell is included in the compared group.

Rank	Firm	Amount of Patents	Rank	Firm	Amount of Patents
1	Shanghai-Bell	7	11	F.P. Kelly	1
2	ZTE	4	12	Wu, F-Zh	1
3	No. 6 Factory of Shanghai Wireless Radio*	3	13	HXD Telecom Tech	1
4	Huawei	1	14	Hu, X-H	1
5	Potevio (SOE owned by MPT) *	1	15	Hu, B	1
6	Qiaoxun, Beijing	1	16	Ericsson	1
7	Beijing Uni. Of Post & Telecom	1	17	BT	1
8	Tailong, Nanning	1	18	Siemens	1
9	South Telecom	1	19	Weinan WeiHua Research Institute of Telecom Tech	1
10	UNIFFIELD SETTLEMENT	1	20	Huang, T	1

No relevance between Datang (aspin-off of MPT S&T division) patents and Shanghai-Bell

Note: Relevance analysis not includes Patents of Datang itself.

Relevance Analysis of Datang patent application (-1999)

Data: Datang patent application in China, up to 1999

Relevance Analysis:
Logic-semantic analysis based on text of patents, to study the potential competitors of patents when they are designed.

Similarity in challenges, conditions, technological trajectories, etc.

Note: Datang is excluded in the compared group.

Rank	Firm	Amount of Patents	Rank	Firm	Amount of Patents
1	ZTE	6	11	Samsung	2
2	Huawei	5	12	Cwill (Datang)	1
3	Ericsson	5	13	Beijing Uni. Of Aeronautics & Astronautics	1
4	Nokia	3	14	Lin, S-Q	1
5	SouthEast Uni.	2	15	Hanli New Tech, Wuhan	1
6	InterDigital Tech	2	16	Haier	1
7	Research Institute of Telecom Transmission, MII	2	17		
8	South China Uni. Of Tech	2	18		
9	Thomson Tech	2	19		
10	Inventec.	2	20		

Question 2: What did help Huawei & ZTE stand out among indigenous developers?

- My previous study reveals (based on interviews and documents): Huawei & ZTE
 - (1) consistently invested in R&D (Huawei over 10% revenue; contrast against JVs).
 - (2) insisted on their own platforms of product (continually learning on systemic level; contrast against JVs).
 - (3) emphasized interaction with users, and implemented rapid adjustment according to users' demand; emphasized collaboration with (or studying) other firms, research institutes or universities (contrast against JVs, traditional SOEs including Great Dragon, Datang & WRI).
- Now current patent data reveals:
 - (1) Patents of Huawei & ZTE are with better quality than patents of JVs and traditional SOEs.
 - A. patent claims – require patented technologies to be more fundamental; and know clearly about rival technologies.
 - B. patent conditions – implies whether a patent is more fundamental or more specific, even just marginal, which can indicate whether a firm has its own systemic product platform.
 - (2). patent relevance – indicates whom a firm intend to compete with in technology, or who targets the applicant; require a firm to know better about commercial application of rival technologies.

Difference between firms

	Beijing Uni. Of Post & Telecom		WRI		Datang		ZTE		Huawei	
	Claims	Conditions	Claims	Conditions	Claims	Conditions	Claims	Conditions	Claims	Conditions
1998	9	35			3	24	5.5	45.75	5.89	27.5
1999	9.4	21.8			9.2	31	5.11	33.58	6.98	25.5
2000	6.33	33	6	13	5.46	29.54	5.61	28.13	6.89	25.73
2001	7	32.46	6	20	9.91	28.52	5.03	34.05	6.61	26.66
2002	6.74	45.26	11.83	41.83	7.9	33.62	4.91	30.71	7.12	24.53
2003	6.5	35.11	8.15	36.24	9.85	26.55	5.95	32.21	7.99	21.76
2004	6.31	42.86	5.19	37.22	8.9	27.53	6.59	30.6	8.71	22.34
2005	7.22	45.33	4.64	41.62	8.5	29.8	7.04	29.75	9.8	23.33
2006	8.41	39.78	5.8	41.54	11.62	21.38	7.84	26.07	12.6	20.44
2007	9.32	37.35	6.53	41.79	13.25	20.47	8.33	23.46	13.63	18.92
2008	8.34	36.58	5.79	39.92	13.34	20.8	8.82	22.38	12.48	19.1
2009	7.87	40.67	4.48	38.44	15.08	21.59	9.85	22.31	11.5	19.37
2010	6.93	41.5	5.68	40.85	16.97	22.45	9.76	23.02	11.97	20.79
2011	6.71	46.61	5.21	40.69	17.59	22.46	9.37	23.25	13.13	20.95
2012	6.06	47.97	8.28	40.64	13.65	23.85	9.36	22.81	12.6	21.26
2013	7.1	48.5	9.13	36.53	11.13	22.88	11.67	18.83	13.1	19.38

bad bad bad bad relative relative relative relative relative relative
 low high good good bad bad good good
 Benchmark

Consistently investing in systemic products

Whom they aimed at in
patent competition?—
pattern of patenting

Data: “invention” patent
application in China not
later than 2001

	Beijing Uni. Of Post & Telecom	Datang	ZTE	Huawei
(1) Firms	73.33% <i>(Huawei & ZTE for 26.67%)</i>	75.68% <i>(Huawei & ZTE for 37.84%)</i>	89.55% <i>(Huawei 22.65%)</i>	91.87% <i>(ZTE 7.34%)</i>
a. International firms	44.44%	24.32%	54.36%	78.17%
b. Domestic Firms	28.89%	51.35%	35.19%	13.69%
(2) University & Research Institutes	26.67%	24.32%	7.31%	6.35%
(3) Not recognizable	0%	0%	3.14%	0.02%

They aimed at in competition?

	Beijing Uni. Of Post & Telecom	Datang	ZTE	Huawei
(1) Firms	33 78.57% (Huawei & ZTE 26.19%)	28 75.68% (Huawei & ZTE 37.84%)	257 89.55% (Huawei 22.65%)	463 91.87% (ZTE 7.34%)
a. International firms	20 47.62%	9 24.32%	156 54.36%	394 78.17%

Up to the end of 1990s, when Huawei, ZTE and Datang were still comparable to each other in terms of size, and when Huawei was still a firm centering Chinese market:

- Datang acted much more like a research institute or a university rather than a firm, in addition to its insufficient R&D investment to generate patented technologies.
 - ❑ *Datang paid considerable attention to compete against universities & research institutes.*
 - ❑ *Datang paid less attention to international firms which also played significant roles in Chinese market.*
- Huawei & ZTE were more aggressive at competing against international rivals, in domestic market and potentially in international market.
 - ❑ *The explorative scope of Huawei R&D was quite comprehensive since its patenting activities covered most international players in various domains of telecom technology.*
 - ❑ *Huawei invested intensively to catch up the global technological frontier.*

Question 3: Can Huawei continually benefit from local knowledge generation for frontier innovation competition?

- My previous study brings about two puzzles: Huawei
 - (1) “We could not benefit from collaborative projects with domestic universities and research institutes after around 2000-2001 since we found they were already behind us.”
 - (2) “Within Huawei, more critical breakthroughs are generated by our overseas R&D centres than by our domestic centres.”
- The current patent analysis cannot provide further evidence:
 - (1) because of the standardization of applicant names in our patent analysis system.

Quality of Huawei patents

Patent Granted in China			Patent Application in USA			
	Amount	Claims	Conditions	Amount	Claims	Conditions
1995	4	7.5	38			
1996	11	10.27	20.18			
1997	18	8.38	22.5			
1998	28	5.89	27.5			
1999	89	6.98	25.5	1	6	29
2000	173	6.89	25.73	3	7.33	27.33
2001	446	6.61	26.66	12	11.8	19.75
2002	947	7.12	24.53	40	11.12	24.35
2003	1333	7.99	21.76	64	10.4	25.45
2004	1785	8.71	22.34	49	14.1	24.36
2005	2784	9.8	23.33	81	14.95	24.38
2006	4047	12.6	20.44	222	15.71	21.34
2007	3247	13.63	18.92	310	17.6	19.6
2008	3239	12.48	19.1	347	15.29	19.34
2009	2741	11.5	19.37	509	14.24	19.15
2010	2007	11.97	20.79	562	14.45	18.47
2011	1913	13.13	20.95	757	15.18	18.71
2012	996	12.6	21.26	805	15.6	18.45

Huawei's patents granted in U.S. are better than its in China, even though it was more difficult for Huawei to patent its technologies in U.S.

Summary: what patent data help us to clarify further...

- ✓ Governmental initiative in 1980s-1990s, namely setting up Sino-foreign JVs through “trading market for technology” did not bring about direct and important transfer of product technologies to indigenous players. Not an effective “two-way strategy” (quantity of patents, patterns of patenting).
- ✓ Huawei & ZTE differed from other indigenous firms because:
 - They invested obviously much more in in-house R&D (quantity of patents).
 - They had their own original knowledge and product platforms (quality of patents).
 - They focused more on the real application and competition, interacted with customers and learned from international rivals (patterns of patenting).
- ✓ The quality of Huawei’s patent in U.S. is better than its in China (quality of patents).

Thank you!

Relevant data is still under processed. Do not quote it at this stage please.

Contact: k.feng@pku.edu.cn