Asia in the Global ICT Innovation Network

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Global innovation network

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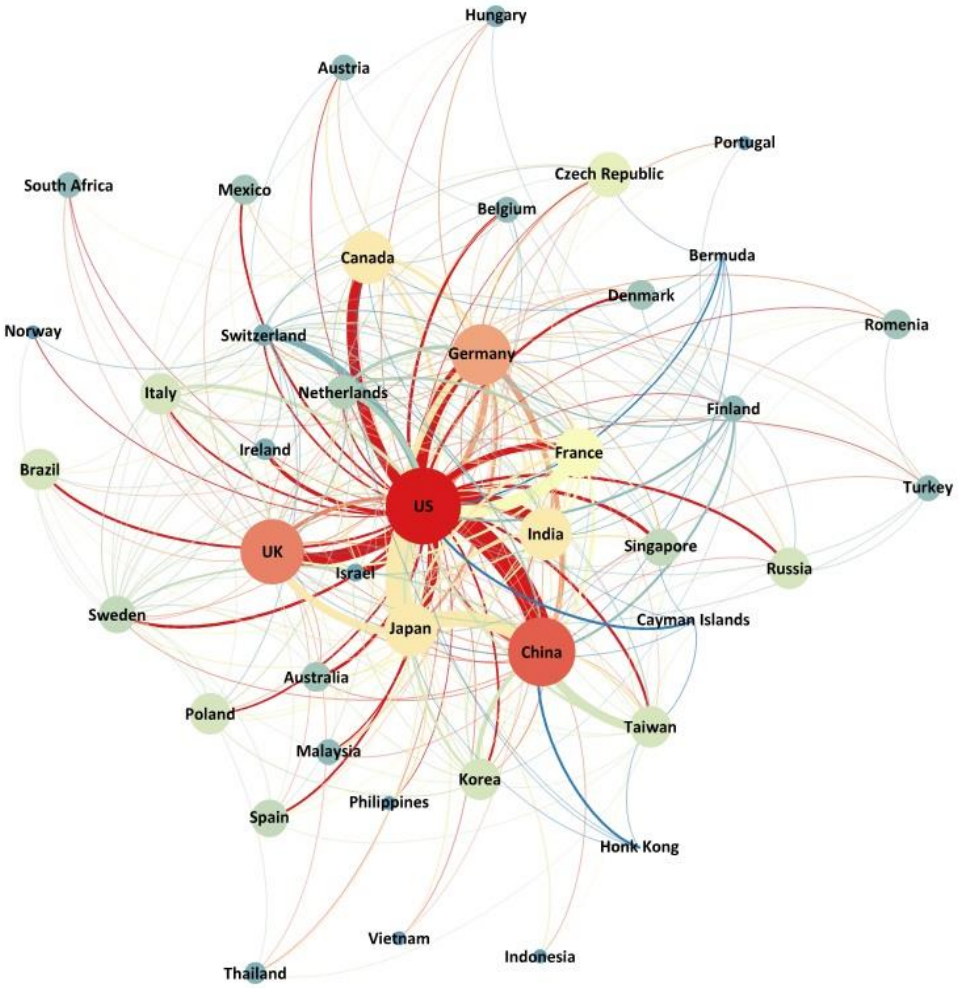
Introduction

Global innovation network



Why do we speak about innovation networks?

- **New locations of innovation**
- **Doing innovation abroad**
- **Nexus of linkages between countries**

-> Global innovation network

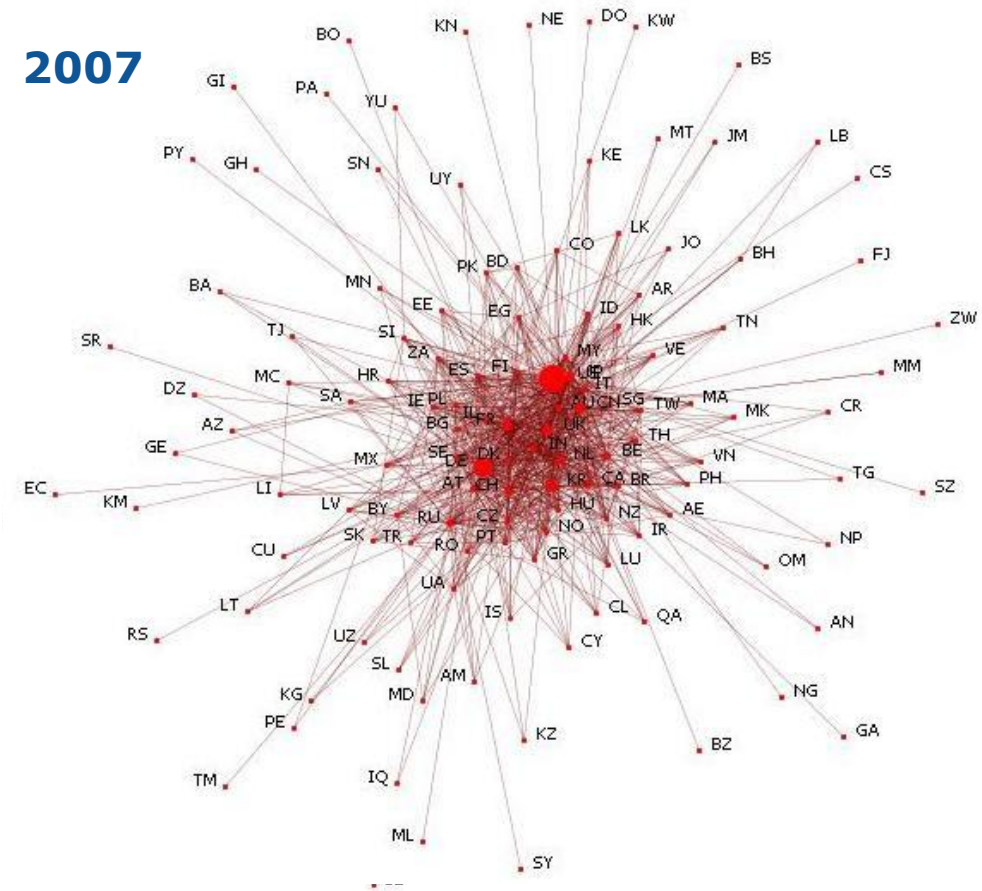
Global innovation network

- **From *one-to-one* to *many-to-many***
- **From *self-reliance* to *mutual dependence***
- **Bridging and absorbing as important as creating and producing**
- **New entrants**

The global innovation network

- The result of the international division of innovation processes
  - in which countries participate
  - and in which firms have a broader capacity to access and combine knowledge from a variety of sources.
- one of the major reasons behind the emergence of the global R&D network is the increasing complexity of technologies and business processes.
  - This requires both firms and countries to specialize.

Global innovation network



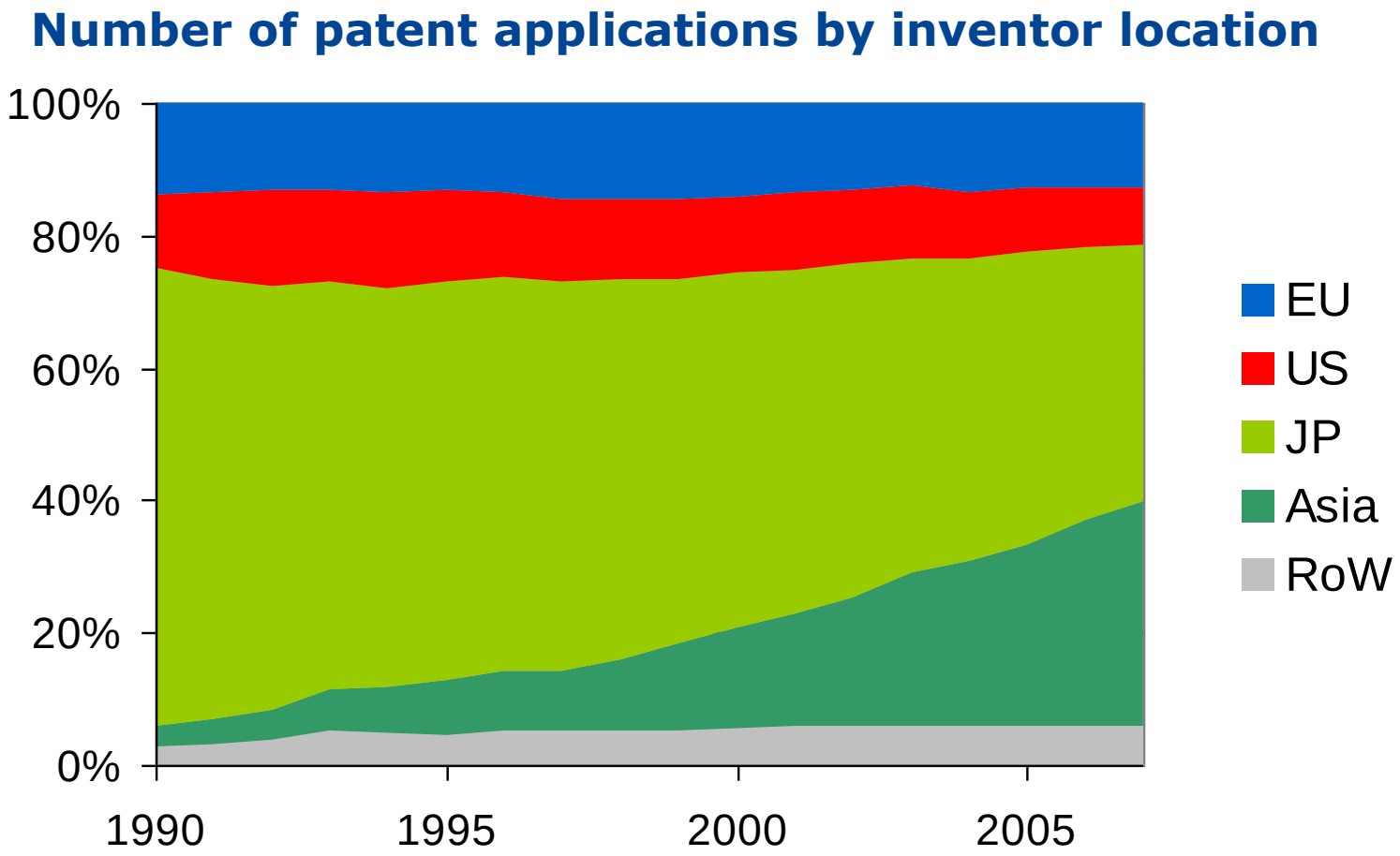
Source: De Prato and Nepelski, 2012

Global innovation network

	Number of connections		Intensity of connections		Gatekeeper index	
			1990			
1	US	60	US	207	US	0,604
2	Germany	35	Germany	126	Germany	0,141
3	UK	25	Japan	62	Poland	0,092
4	Switzerland	22	France	55	UK	0,059
5	France	22	Switzerland	52	Austria	0,056
6	Canada	20	UK	46	India	0,051
7	Japan	19	Canada	39	France	0,040
8	Italy	18	Belgium	21	Switzerland	0,027
9	Netherlands	15	Italy	21	Russia	0,027
10	Austria	15	Netherlands	21	Mexico	0,026
			2007			
1	US	164	US	1313	US	0,262
2	Germany	152	Germany	819	Germany	0,156
3	France	124	S. Korea	419	Russia	0,102
4	UK	110	France	336	France	0,091
5	S. Korea	108	UK	318	S. Korea	0,054
6	Russia	108	Japan	305	Spain	0,049
7	Netherlands	106	China	295	China	0,047
8	Japan	98	Switzerland	262	UK	0,039
9	Australia	90	Canada	197	Italy	0,034
10	China	90	Netherlands	195	Netherlands	0,031

Source: De Prato and Nepelski, 2012

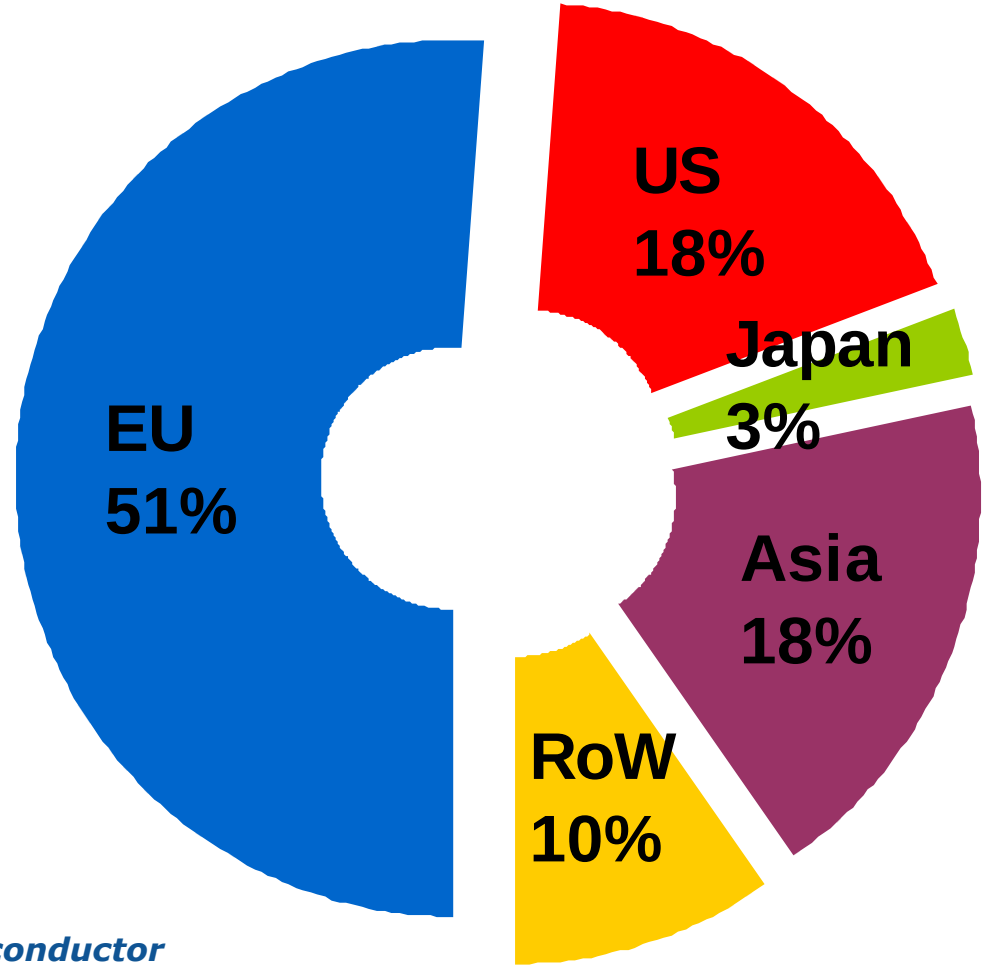
New locations of innovation



Source: De Prato, Nepelski, et al., 2011

Doing innovation abroad

Location of R&D centres of EU high-tech firms* in 2010



**** Based on IHS iSuppli dataset of semiconductor supply chain and industry***

Source: De Prato, Nepelski, et al., 2011

International protection of innovation (foreign patent filings)

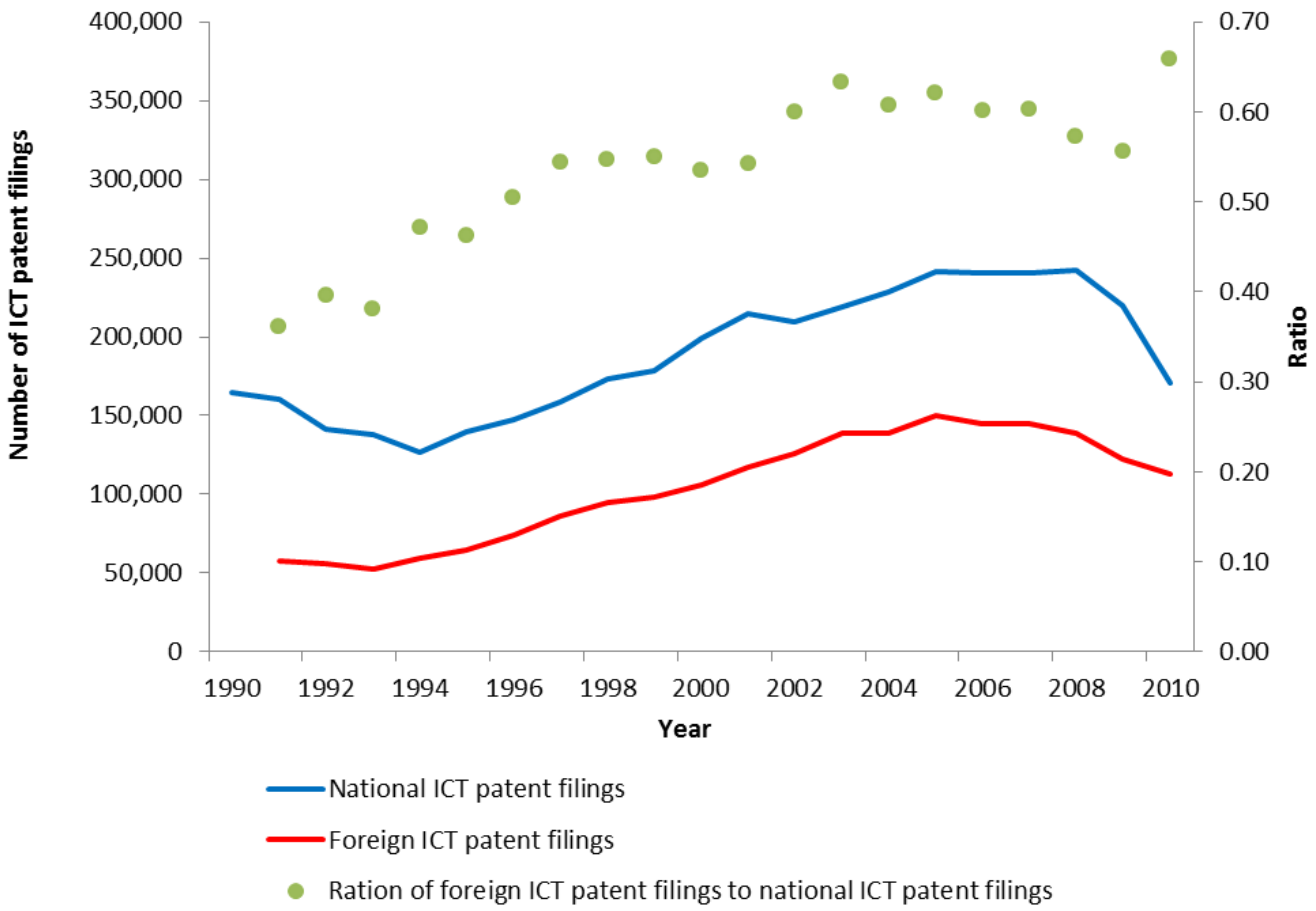
Why patents?

- The top 10 sources of foreign ICT patent filings accounted for over 90% of all the foreign ICT patent applications filed between 1990 and 2011 worldwide.
  - Japan, the US and South Korea are the three biggest origins of foreign patent applications.
- The top 10 patent offices account for 94% of all foreign ICT patent filings worldwide:
  - A very high level of concentration
- The main destinations of international ICT patent filings are the USPTO, EPO and the Chinese Patent Office.

Methodology

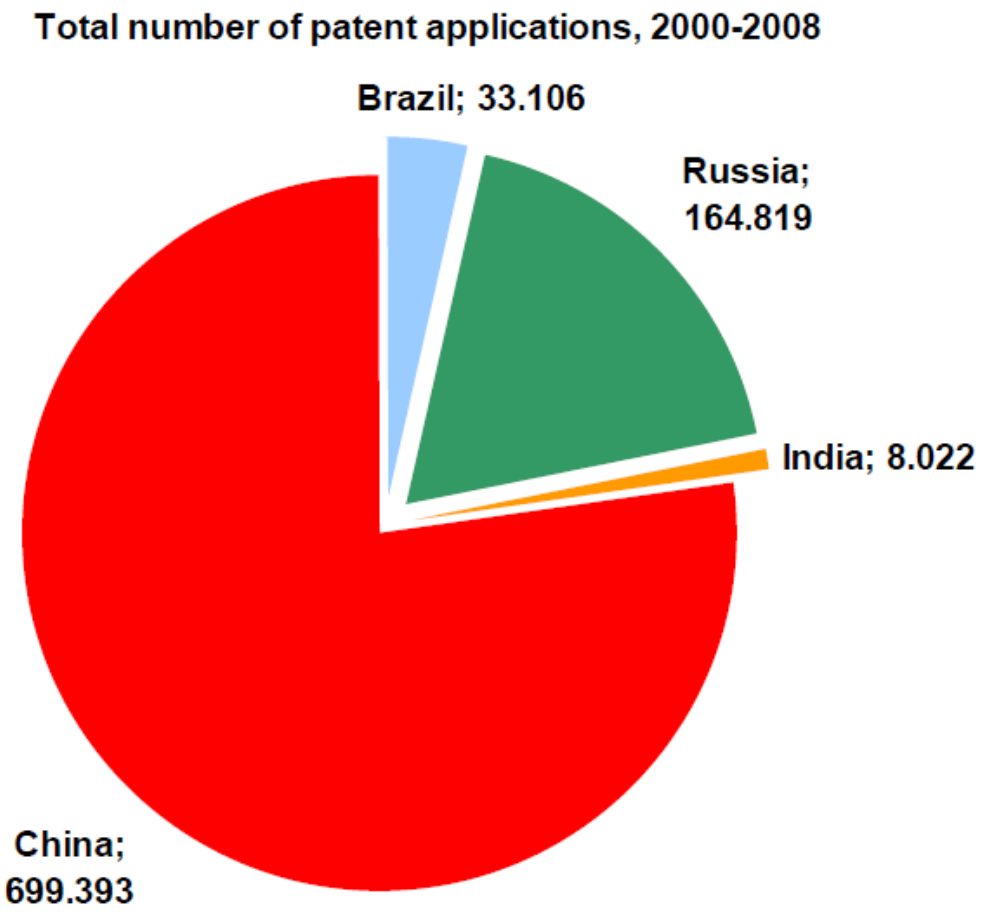
- **Priority patent applications**
- **Fractional counting of patents**
- **Global coverage, i.e. >90 patent offices**
- **Time span: 1990 – 2009**
- **Data source: EPO Patstat**

Number of priority ICT patent filings and subsequent foreign ICT patent filings and the ration between them, 1990 - 2010

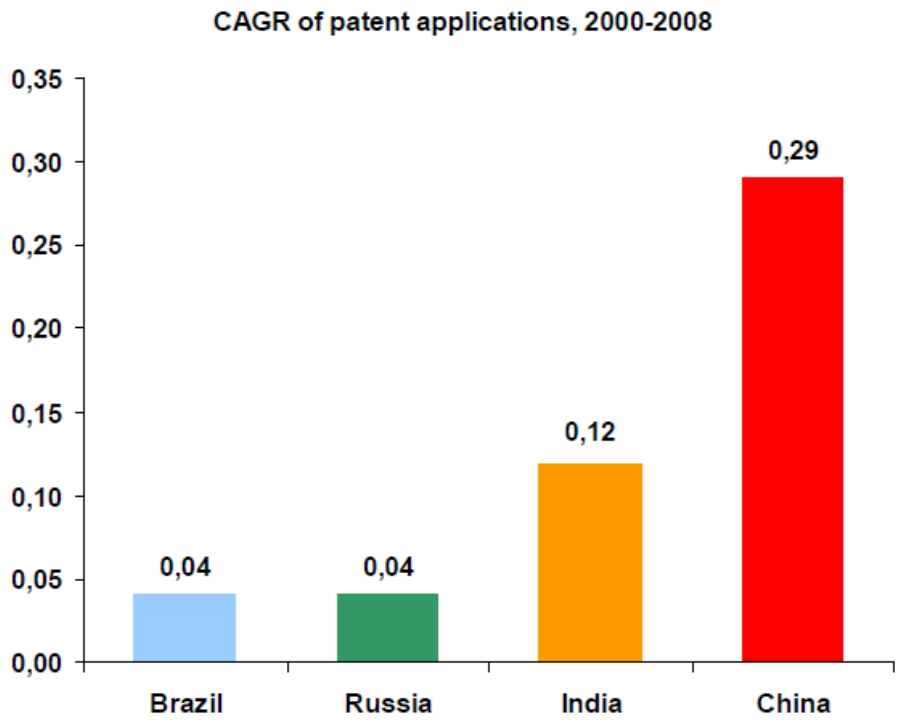


Note: The computation includes all patent filings filed to the EPO, the USPTO and over 80 national patent offices between 1990 and 2011. Invention counts are based on the inventor, the priority date and fractional counts. *Source:* Own calculations based on PATSTAT, 2013.

Total number of priority patent applications with BRIC's inventors



Growth of priority patent applications with BRIC's inventors

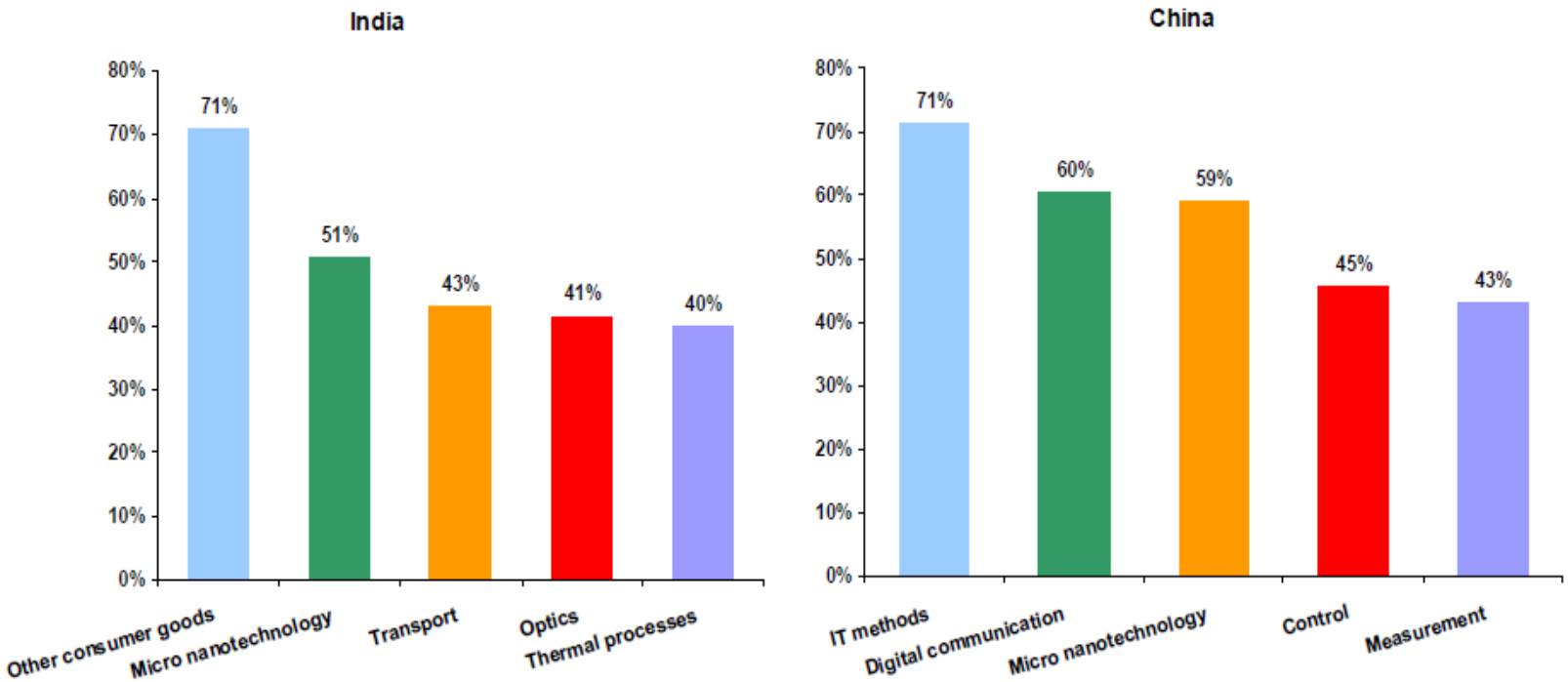


Note: Based on fractional counting of priority patent applications including inventors residing in BRIC countries.

Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012

Distribution and dynamics of patent applications by IPC technology class, 2000-08

Five fastest growing technological classes: CAGR between 2000 and 2008



Note: Based on fractional counting of priority patent applications including inventors residing in BRIC countries.

Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

Part 1. Asia in the Global ICT Network

Changing global production and innovation networks: Asia on the rise

ICT sector at the core

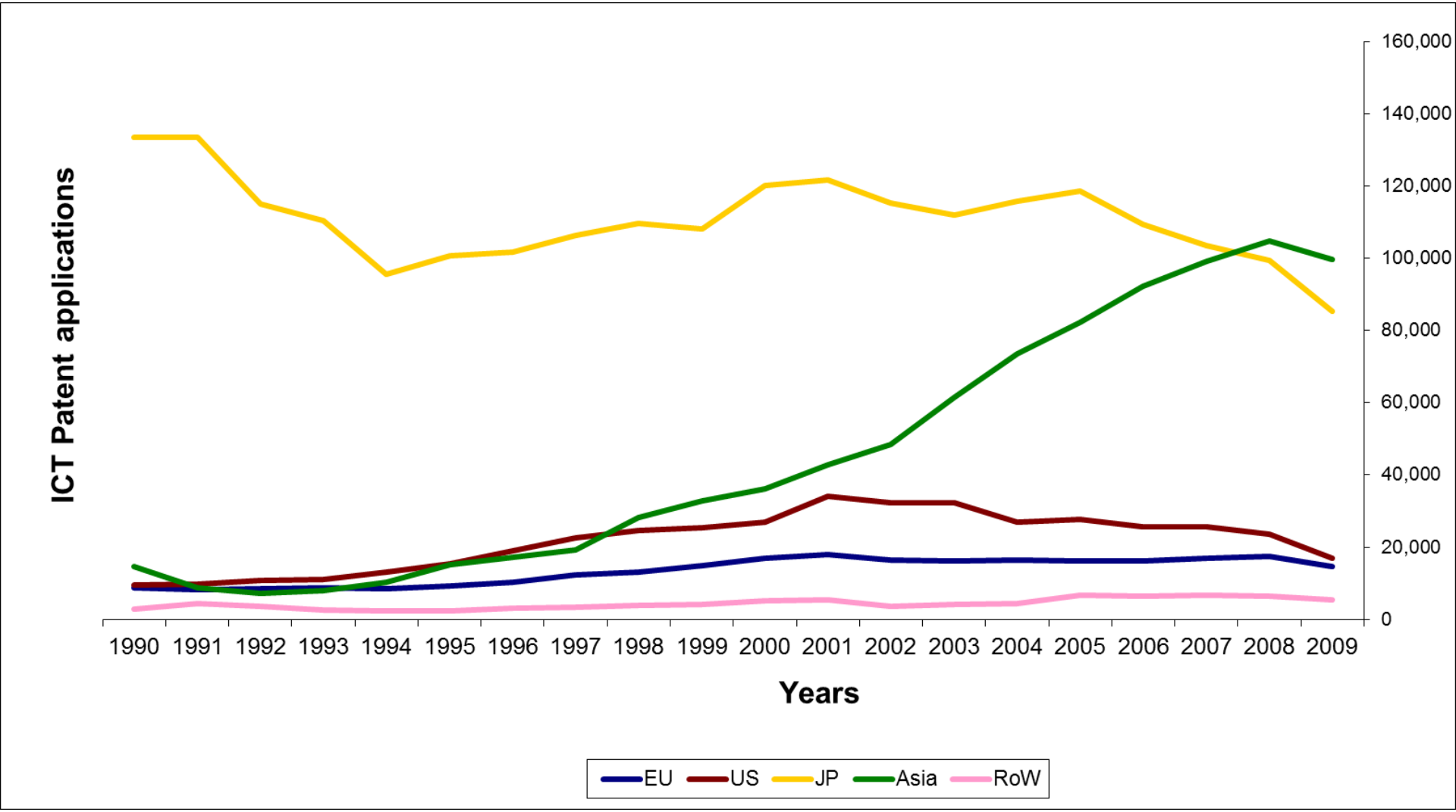
- The two set of countries (China/India, South Korea/ Taiwan) studied in the book offer a different historical profile:
  - with reforms dating back from the nineties for “Chindia”
  - and earlier policies for the “dragons” but different kind of later reforms focusing on IT.
- The four countries have achieved impressive results in terms of economic growth.
- The ICT sector was at the core of the countries economic growth.
  - The ICT was a major contributor to this growth and led a pioneering role for other sectors.
  - The ICT sectors are export-oriented (hardware or software) and born global
- The book documents the size of the IT sector and its role of IT within the countries, focusing on the supply side so as to provide an understanding of the industry.

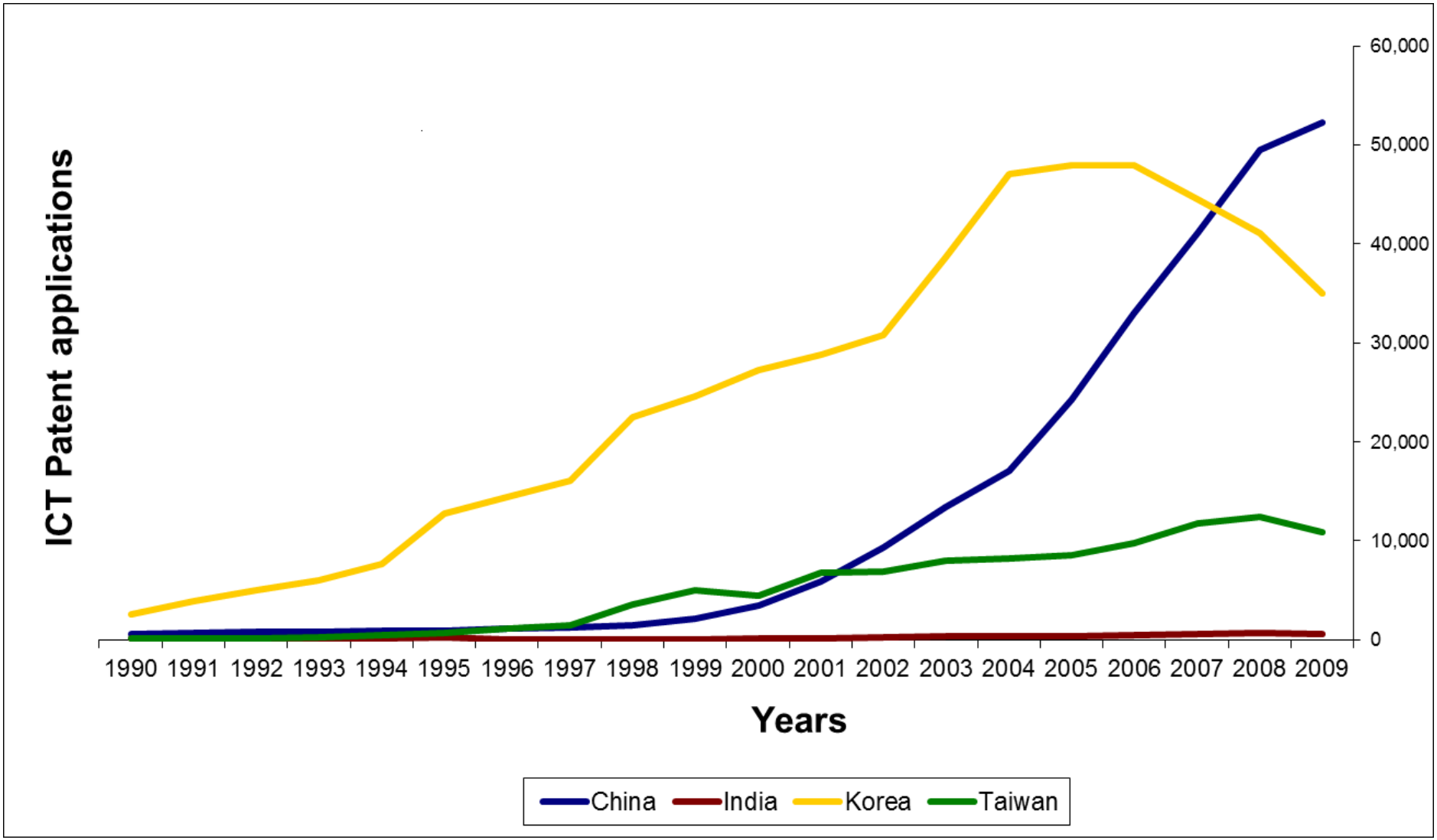
A growth translated into R&D expenditures

- The impressive growth of the ICT market is translated into R&D expenditures and output,
  - for instance, China's invention output overtook that of both the EU and the US, and comprised more than 44% of all Asian patent applications in 2007.
- Innovative capability in Asia has grown; the dynamics in terms of catching up are strong.
- Asian countries are increasingly present in the ICT R&D global landscape.
- However, there is still a gap for Chindia with developed economies and there are local differences.
  - If one takes a look at R&D expenditures (all sectors), these countries are still at the early stages in their investments in R&D.

Growing ICT R&D capacities

- After a long standing cooperation in knowledge intensive activities between developed regions: EU, US and Japan
- The process of ICT R&D internationalization is now marked by an increasing role of Asian countries
- in particular China, India, Taiwan and South Korea
- due to their growing ICT R&D capacities
- The role of Asia as an ICT R&D partner has been rapidly increasing over the last decade
  - Strong ties between the US and Asia


ICT Patent applications
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Years
EU
US
JP
Asia
RoW


ICT Patent applications
60,000
50,000
40,000
30,000
20,000
10,000
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Years
China
India
Korea
Taiwan

Foreign ICT patent filings by country of applicant and the designated patent office, top 20 country pairs, total number of patent filings in 1990-2011

Rank	Country of applicant	Designated patent office	Total number of ICT patent filings	% in total
1	JAPAN	USPTO	378,374	18%
2	SOUTH KOREA	USPTO	110,500	5%
3	JAPAN	EPO	108,783	5%
4	US	EPO	102,823	5%
5	JAPAN	Chinese PO	102,375	5%
6	US	Japanese PO	95,078	4%
7	TAIWAN	USPTO	60,054	3%
8	JAPAN	S. Korean PO	59,408	3%
9	GERMANY	EPO	55,880	3%
10	JAPAN	German PO	55,505	3%
11	US	Chinese PO	52,204	2%
12	GERMANY	USPTO	50,984	2%
13	SOUTH KOREA	Chinese PO	40,651	2%
14	US	German PO	39,854	2%
15	SOUTH OREA	Japanese PO	38,222	2%
16	US	Canadian PO	37,025	2%
17	FRANCE	EPO	32,803	2%
18	JAPAN	Taiwanese PO	32,582	2%
19	FRANCE	USPTO	26,296	1%
20	US	S. Korean PO	24,939	1%
Sum of ICT patent filings for 20 top country pairs			1,504,341	70%
Sum of ICT patent filings for all country pairs (2782)			2,150,992	100%

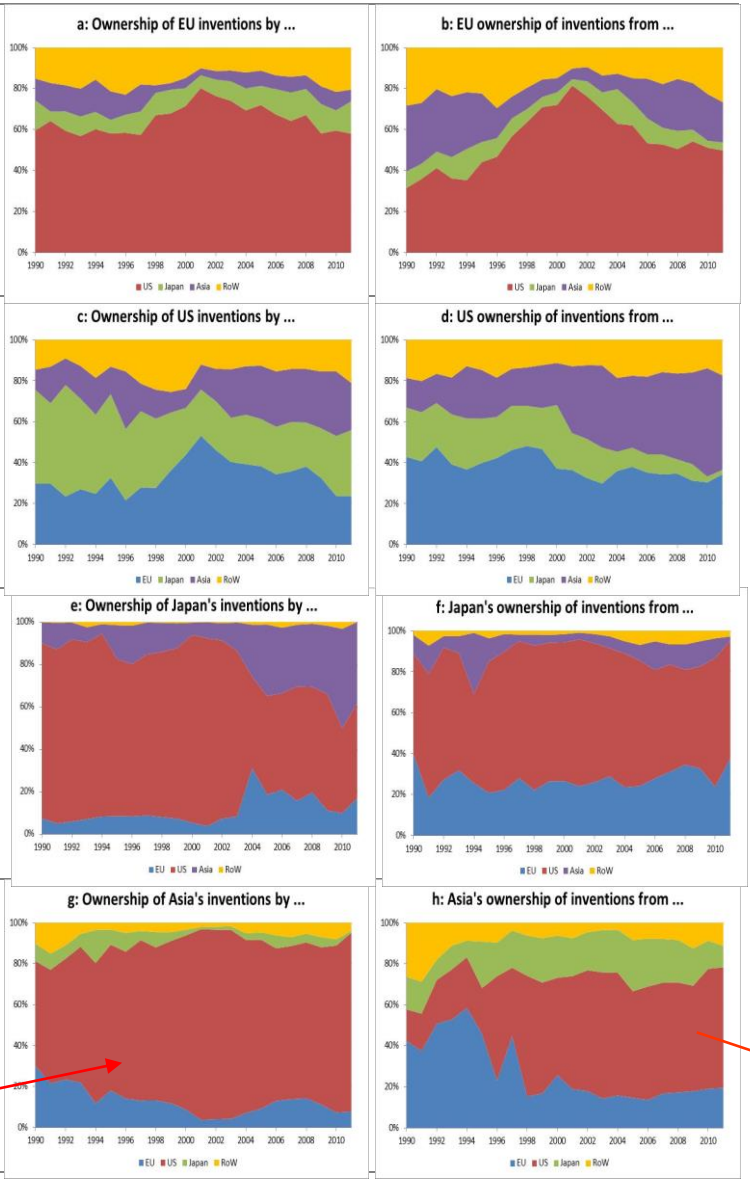
Note: Fractional counting according to the applicant criterion. Sum for 1990-2011. Source: Own calculations based on PATSTAT, 2013.

Collaboration partners of Asia

- In the considered time period (1990-2011), one can observe an increasing importance of R&D joint-ventures between Asian and US and Japanese applicants.
- However, US applicants are the main partners of Asian applicants in joint ownership of ICT patents.
- In 2011, Asian-US co-ownership accounted for 50% of all Asian international co-ownership.
- The remaining portion of Asian international co-ownership is split between the EU (17%), Japan (20%) and the RoW (13%).

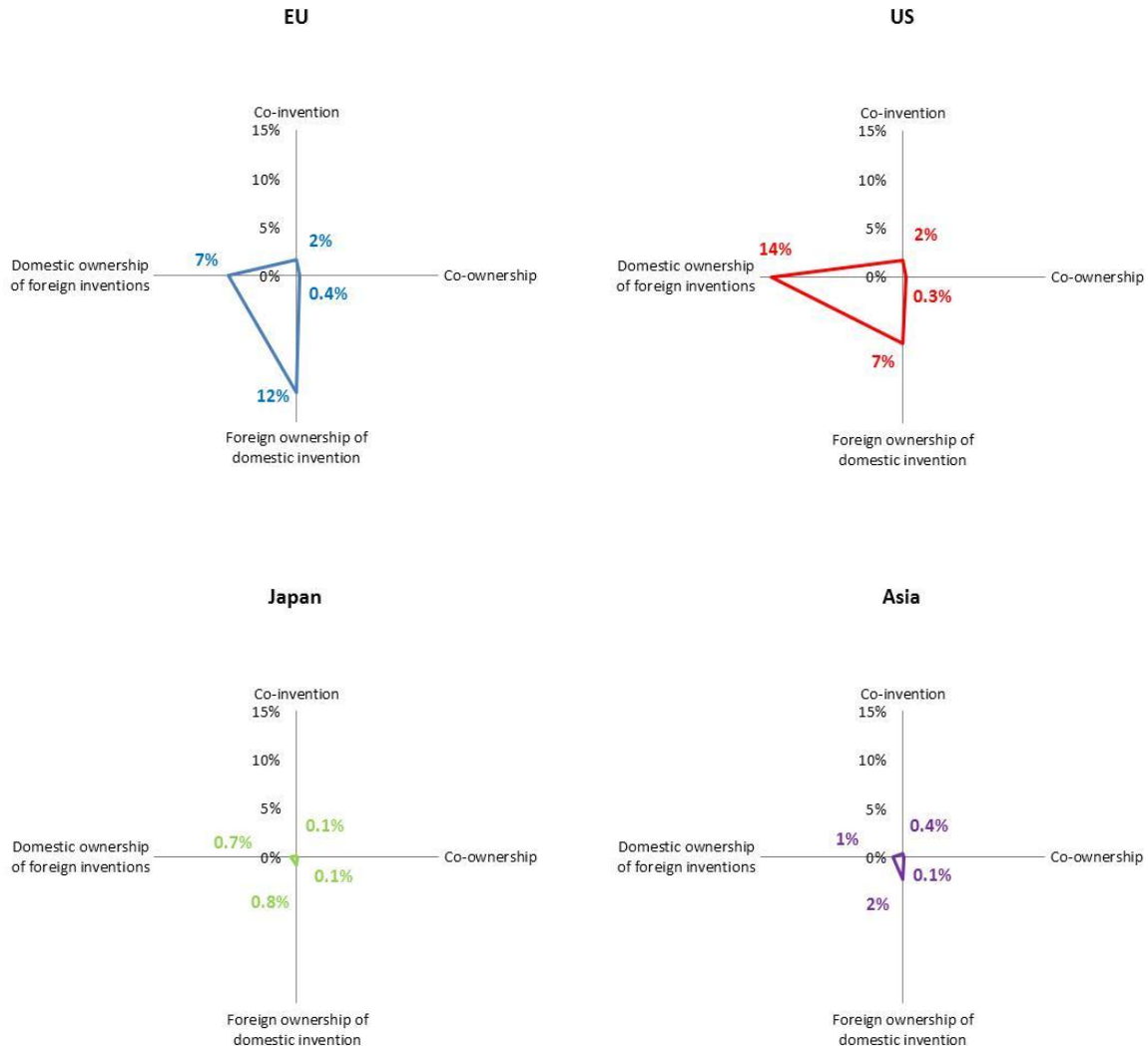
: Cross-border ownership of ICT inventions, in %, 1990-2011

	Foreign ownership of domestic ICT inventions	Domestic ownership of foreign ICT inventions
EU	a: Ownership of EU inventions by ...	b: EU ownership of inventions from ...
US	c: Ownership of US inventions by ...	d: US ownership of inventions from ...
Japan	e: Ownership of Japan's inventions by ...	f: Japan's ownership of inventions from ...
Asia	g: Ownership of Asia's inventions by ...	h: Asia's ownership of inventions from ...



Note: Priority patent applications filed to the EPO, the USPTO and over 80 national patent offices between 1990 and 2011. Invention counts are based on the inventor, the priority date and fractional counts.
Source: IPTS calculations based on PATSTAT, 2013.

A comparison of different levels of ICT R&D internationalisation across the world's regions, % in total for 2000-2011



Note: The figure presents the shares of international co-inventions, co-ownership, cross-border ownership of inventions in the total number of ICT inventions across world's regions. The computation includes all patent applications filed to the EPO, the USPTO and over 80 national patent offices between 1990 and 2011. Invention counts are based on the inventor or applicant criterion, the priority date and fractional counts.
Source: IPTS calculations based on PATSTAT, 2013.

A quick look at the Dragons

Source: Dr. Prof Wang Kung, Director ITRI, Taipei, Taiwan, IPTS EIPE workshop, Mysore, 2013

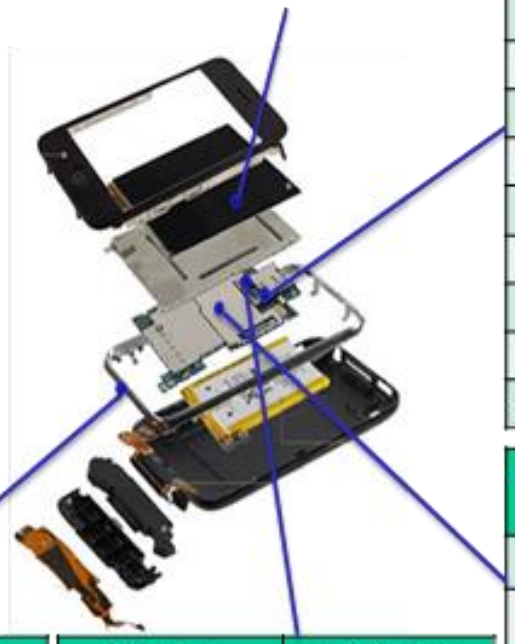
The case of Taiwan (1)

- Taiwan's ICT firms have participated in cross-border supply-chain management, logistics operations, and after-sales services, by forming a fast-response global production and logistics network.
- In terms of domestic production and exports, the role played by Taiwan's ICT industry in the GPN has shifted from a key producer of end products to that of important components and parts (intermediate goods).
- The US being the number one market, the US is also the main partner for cooperation with a high level of networking for instance between Silicon Valley and Hsinchu Science Park.

The case of Taiwan (2)

- Over the years the policies went from “low to high” and from “hard to soft”.
- Taiwan has innovated with the foundry model, design houses are prospering, the most successful companies of the Asian software zone.
- Outsourcing and order-based production adopted by major brand marketers
  - greatly rationalised their global supply chain,
  - hence altered their contractual relationships with their Taiwanese counterparts.
- Exemplified by the Apple case.

The Global Innovation Network of Apple's iPhones and the Role of the Taiwanese ICT Firms



Components	Main Supplier
Display	Sharp, TMD
Touch Panel	Wintek, TPK

Components	Main Supplier
Baseband	Infineon
WCDMA PA	TriQuint
GSM/EDGE PA	Skyworks
Application Processor	Samsung
Mobile DDR DRAM	Samsung
NOR Flash	Numonyx
NAND Flash	Samsung, Toshiba
Bluetooth	CSR
A-GPS	Infineon
SAW Filter	TXC
Power Management IC	Infineon, NXP

Components	Main Supplier
Connector	Foxlink, Advanced Connectek
PCB	Unimicron, Nan Ya PCB, Compeq
FPC	M-Flex, Mektron, Fujikura, Flexium Interconnect, Foxconn Advanced Technology

Components	Main Supplier
Casing	Foxconn Technology
EMS	Hon Hai Precision

Components	Main Supplier
3.2-Megapixel CIS	OmniVision
Camera	Largan Precision

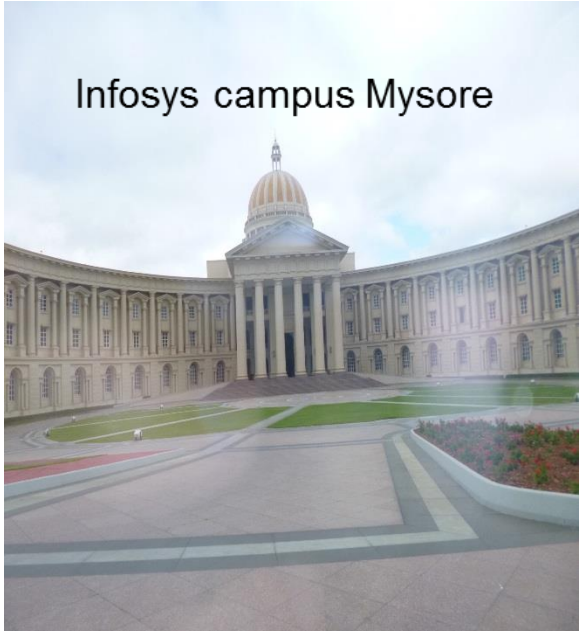
Source: Chen S.H., 2011, IPTS report.

South Korea

- The case of CDMA displays a similar pattern for South Korea
- with a global interaction between US companies such as Qualcom, domestic manufacturers and operators and the public research center ETRI

Part 2. Case studies

2.1 Assessing India as technology and innovation cooperation partner



A framework for assessing innovation collaboration partner: the concepts

1. **Inventive performance:** What is the inventive mass and dynamics of a country's inventive performance?

2. **Technological specialization patterns:** What technology does a country specialize in? Are its technological capacities complementary?

3. **Openness to international collaboration:** Do a country's researches have a record of collaboration with their foreign counterparts?

4. **Economic potential of technology:** Are a country's inventions developed primarily in the domestic or international market?

A framework for assessing innovation collaboration partner: the indicators

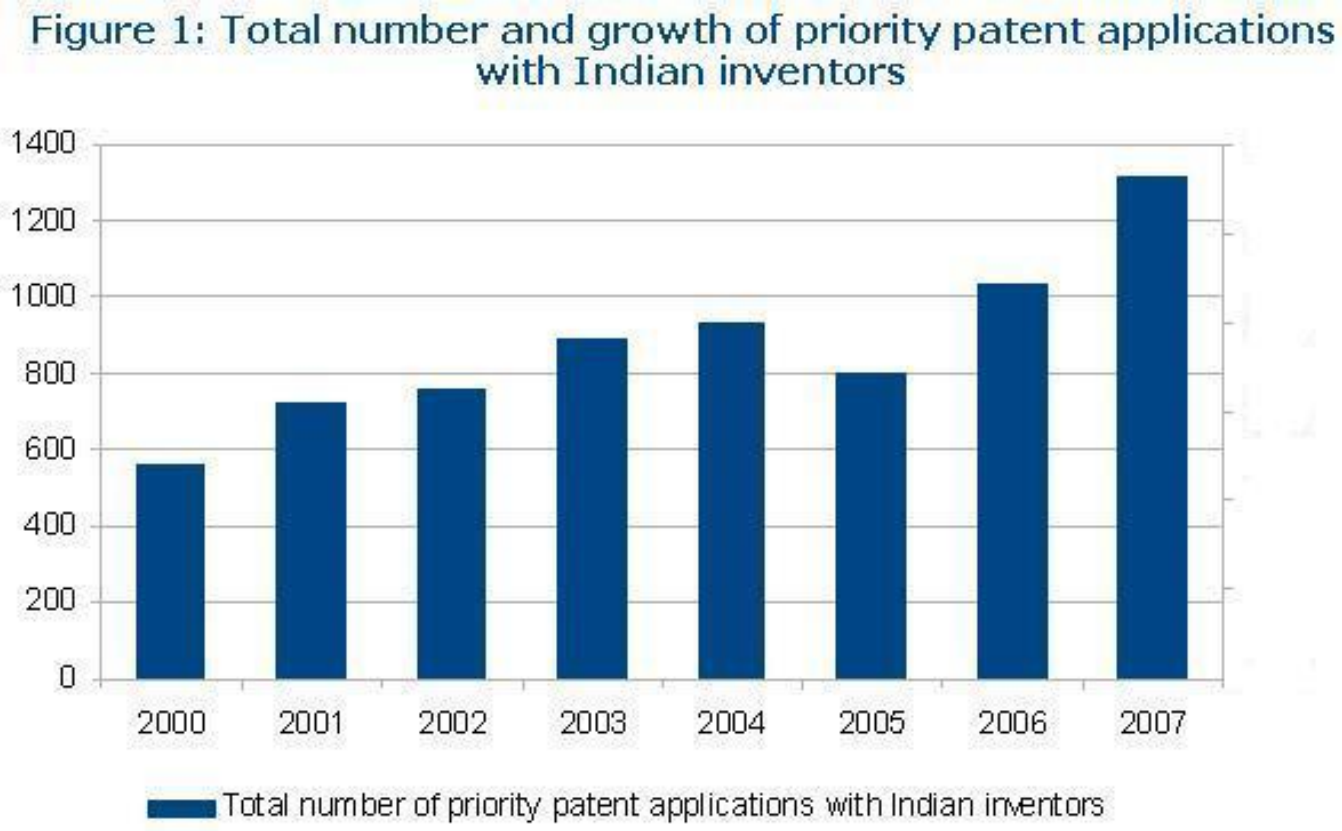
1. **Inventive performance:**
   Fractional counting of patents by inventors from a country

2. **Technological specialization patterns:**
   Shares of each technology field in the total number of patented inventions

3. **Openness to international collaboration:**
   Share of international co-inventions in the total number of a country's patent applications

4. **Economic potential of technology:**
   Share of patent applications filed to international patent offices in the total number of a country's patent applications

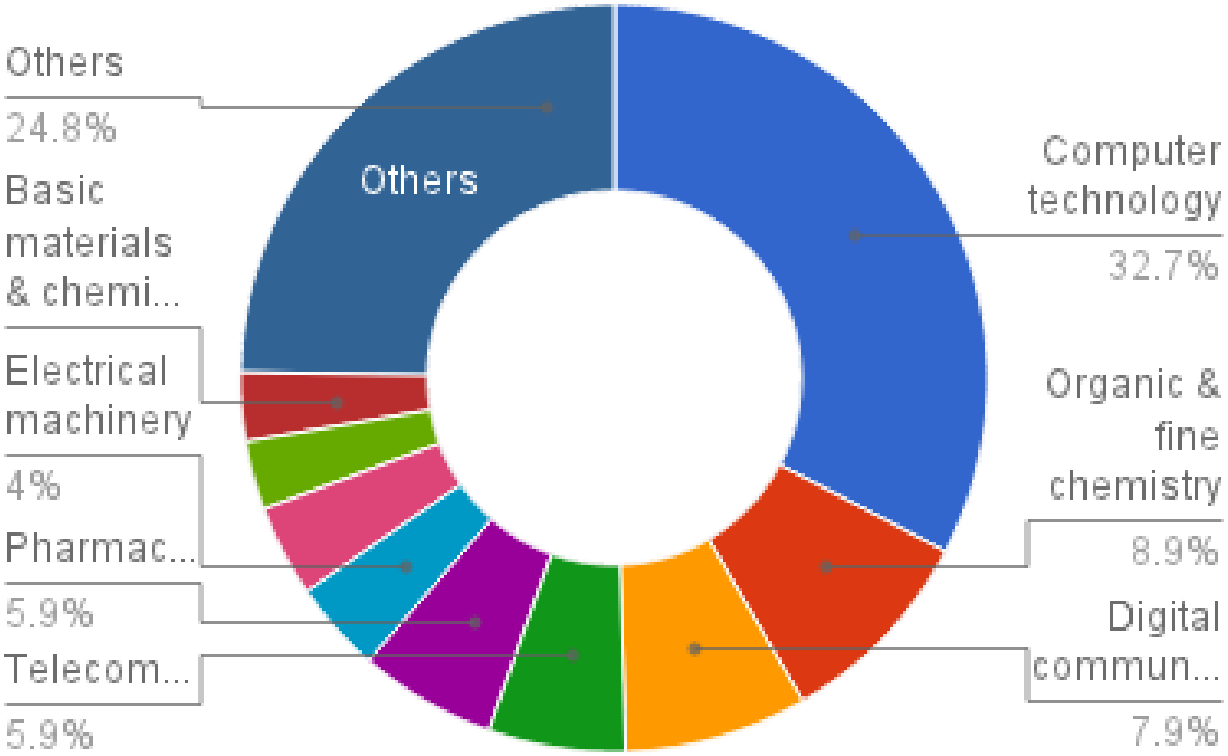
Inventive performance



Note: Priority patent applications including at least one Indian inventor. Own calculations using the inventor criterion based on PATSTAT Database, version 2010

Technological specialization patterns

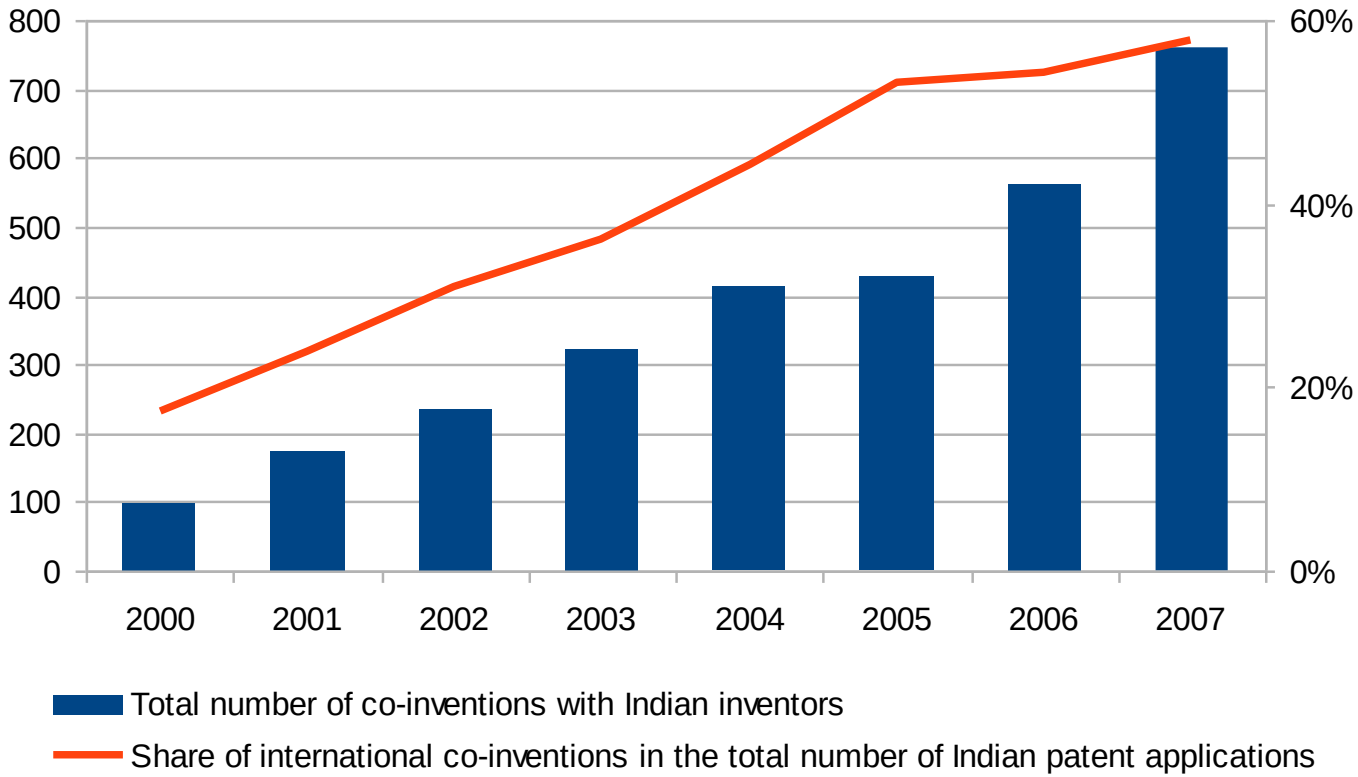
Figure 2: Indian patent applications by IPC technology field, 2000-2007



Note: Priority patent applications including at least one Indian inventor. Technology fields computed by fractional counting. Own calculations using the inventor criterion based on PATSTAT Database, version 2010

Openness to international collaboration

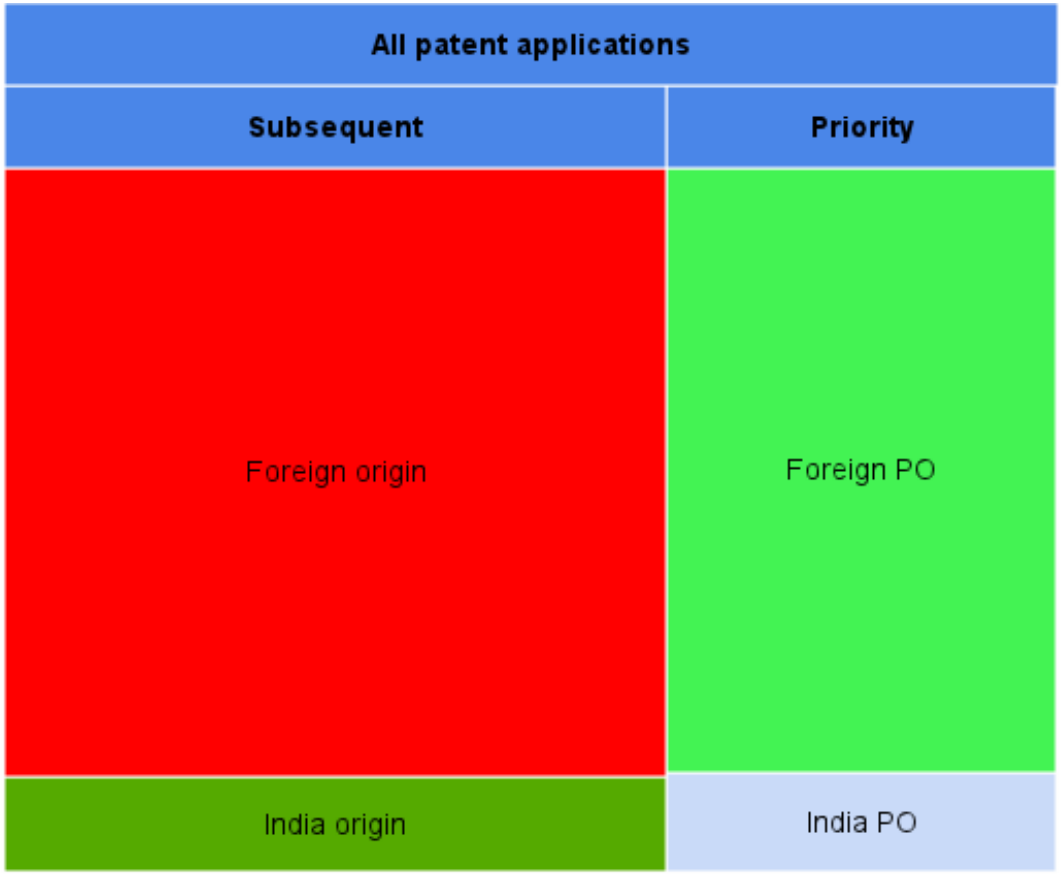
Figure 3: Total number and growth of co-inventions between Indian and non-Indian inventors



Note: Based on fractional counting of priority patent applications including inventors residing in India and at least one inventor residing outside of India. Own calculations using the inventor criterion based on PATSTAT Database, version 2010

Economic potential of technology

Figure 4: Patent applications by filing time and patent office, total number for 2000-2007



Note: Includes all patent applications including at least one inventor residing in India. Own calculations using the inventor criterion based on PATSTAT Database, version 2010

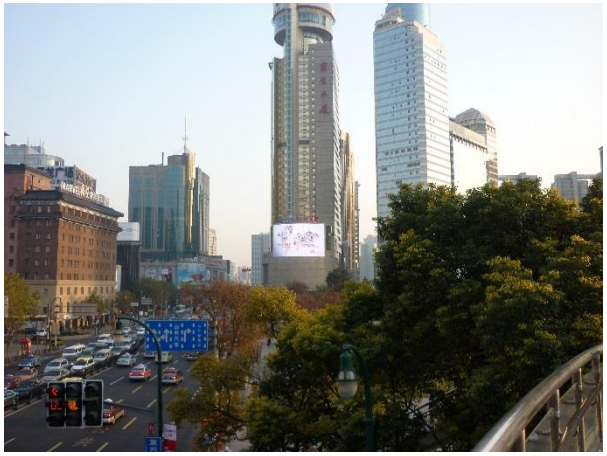
Results 1/2

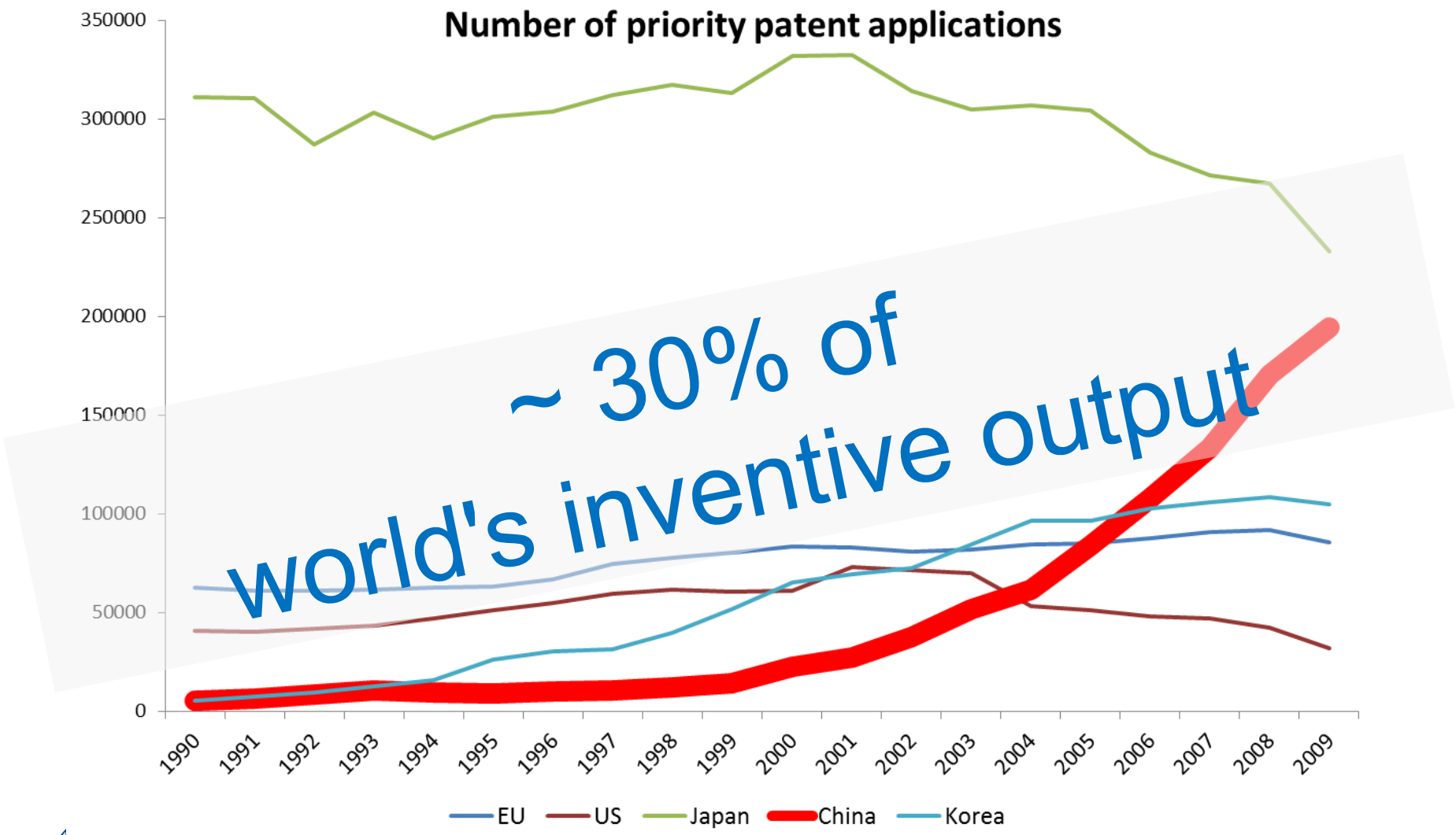
Assessment criteria	Result and description
Inventive performance	• Relatively low inventive performance. • Very high growth in inventive activity.
Technological specialization patterns	• High concentration in two technological fields, i.e. IT and pharmaceuticals. • Dynamic changes in the innovation activity composition. • Sharp increase of activity in such technological fields as nanotechnology. • Decline of activity in pharmaceuticals and biotechnology.

Results 2/2

Assessment criteria	Result and description
Openness to international innovation collaboration	• Extremely high level of international innovation collaboration. • Collaboration limited to few technological fields.
Economic potential of technology	• The overall number of patent applications submitted to foreign patent office is outstanding. • The majority of all priority patent applications are filed to the USPTO. • Only a small fraction of priority patent applications with Indian inventors are filed to the Indian patent office.

2.2 International technology sourcing between China and the rest of the world



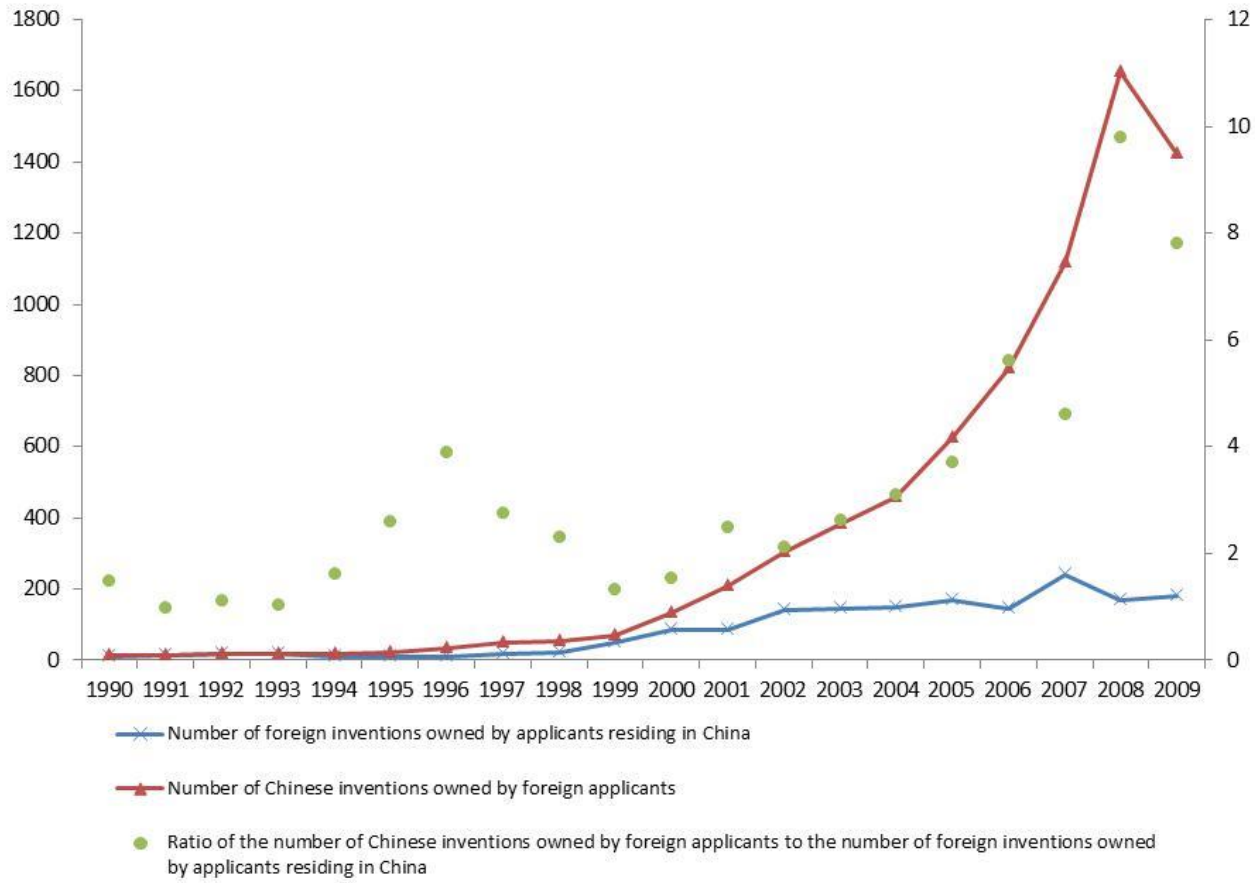

Number of priority patent applications
350000
300000
250000
200000
150000
100000
50000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
EU
US
Japan
China
Korea
~ 30% of
world's inventive output

The questions

- **China is (becoming) the world's technological power-house**
  - It is increasing its demand for technology produced elsewhere
  - It is becoming a source of technology demanded by other countries
- **The questions:**
  - How does the technology sourcing between China and the rest of the world evolve?
  - Who is Chiana's main partners?
  - What flows between China and the RoW?
  - What drives them?

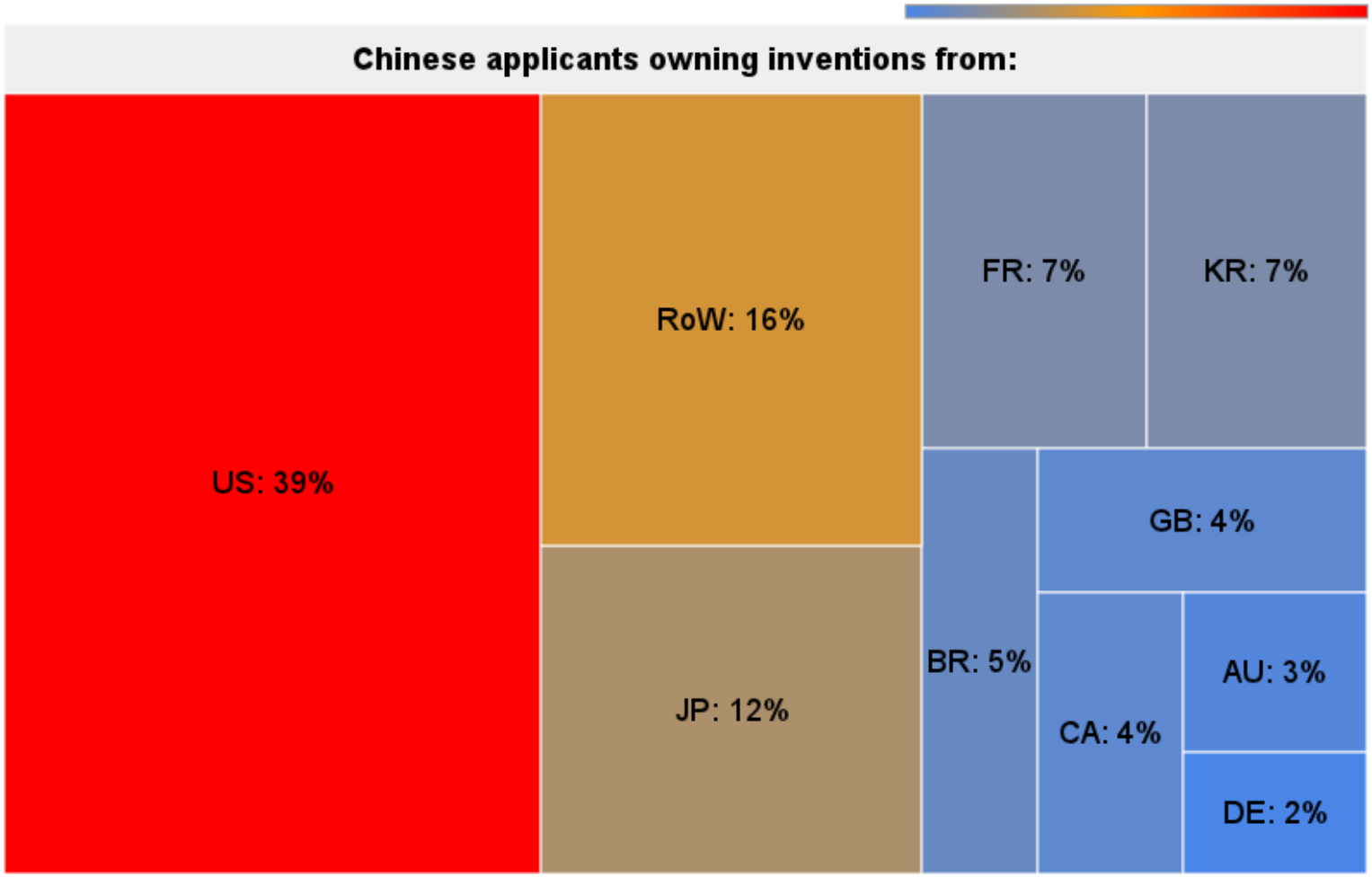
Results

The evolution of technology sourcing between China and the rest of the world



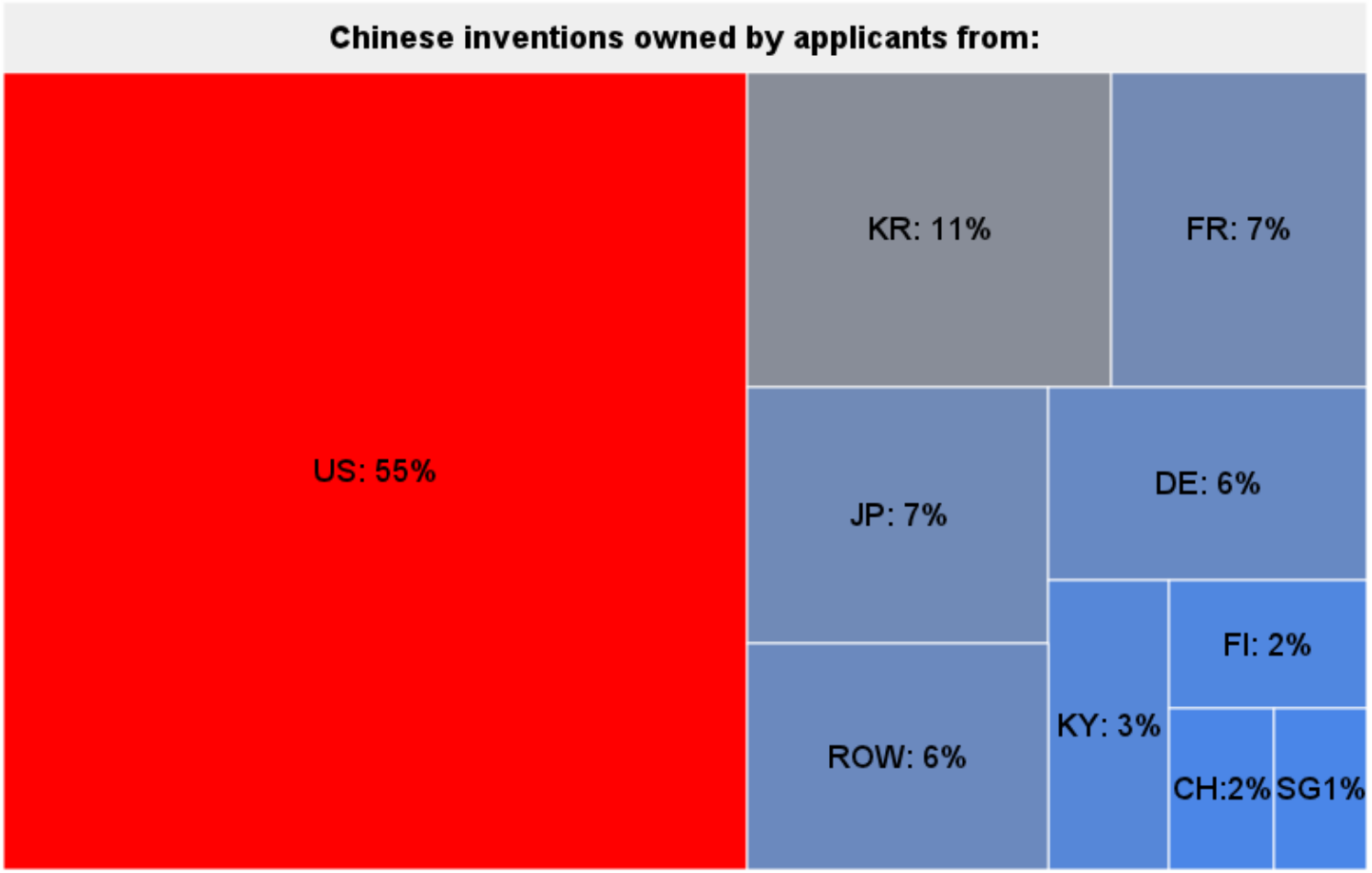
Results

Top sources of technology sourced by China



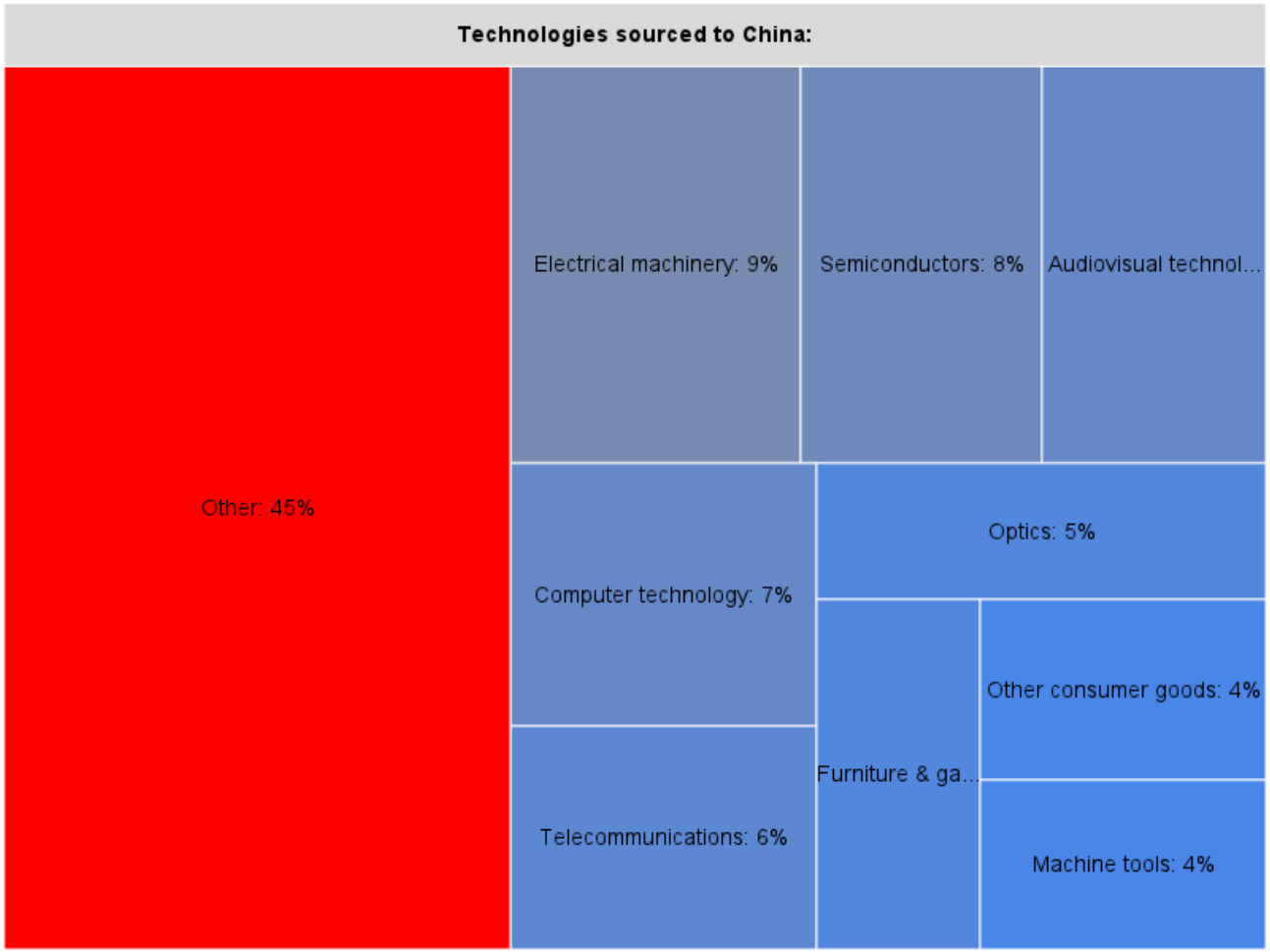
Results

Top destinations of Chinese technology



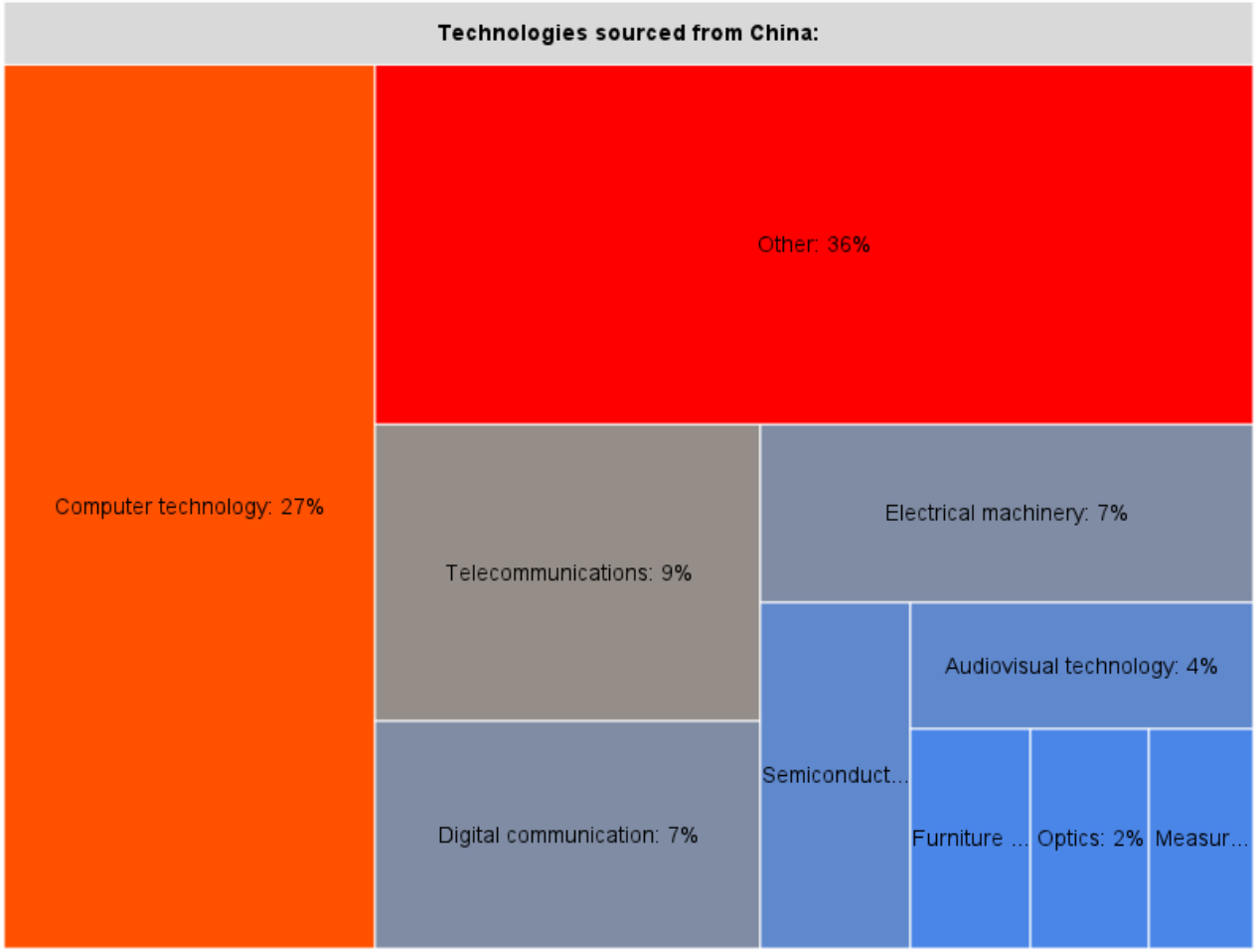
Results

Technologies sourced to China

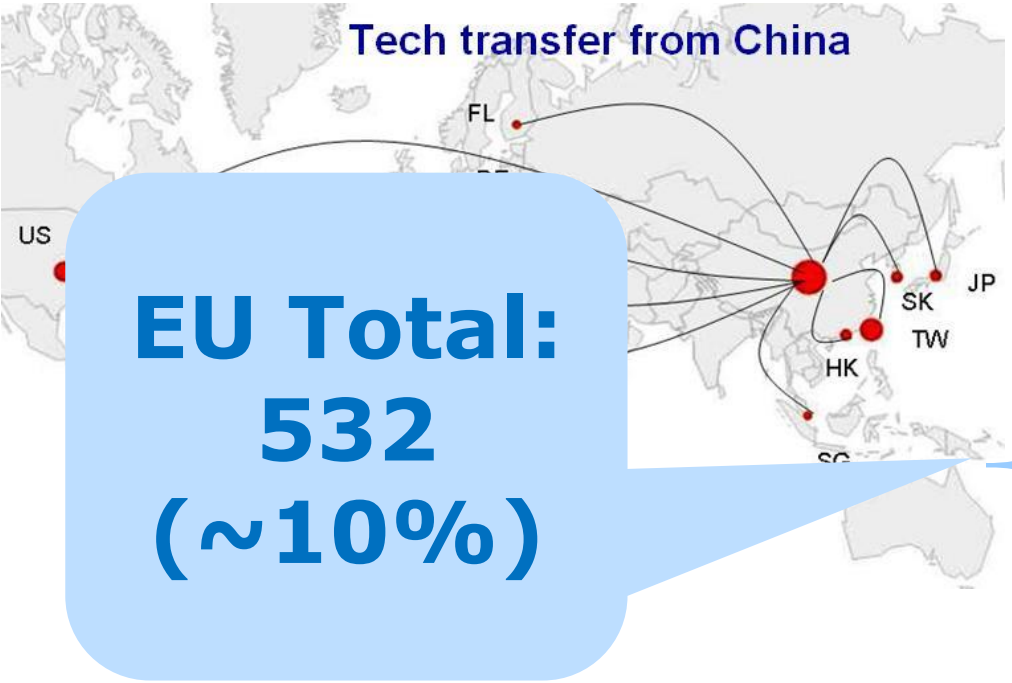


Results

Technologies sourced from China



Accessing technological resources



International technology transfer from China	
to	Nr of patents
Taiwan	2252
US	1674
Korea	441
Japan	291
Hong Kong	285
France	173
Germany	155
Netherlands	136
Finland	68
Singapore	58
Total	**5534**

Fractional counting according to the applicant criterion. Sum for 1990-2007.
Source: Own calculations based on PATSTAT Database, 2010

Source: International technology transfer between China and the rest of the world, De Prato & Nepelski, 2012

Conclusions

Conclusions (1)

- Assessing India as technology and innovation cooperation partner
  - Taking stock of its innovative landscape
  - Putting it into international context
- An increasing role of China as a source and destination of international technology flows
  - China shows a large deficit in technology sourcing
  - Concentration of partners e.g. China - US
  - Concentration in technologies with a strong focus on high-tech
  - Economic capacity and openness among the main drivers of technology sourcing
  - While geographic distance hinders the technology flow from China to other countries, it does not impede Chinese entities to acquire property rights over foreign inventions

Conclusions (2)

- Differences in the levels of R&D internationalisation. might create some imbalance.
- This is clearly visible in the case of Asia, which shows a high participation of foreign companies in shaping its R&D landscape, but exhibits relatively low outward internationalisation of R&D.
- Despite, the achievements of the pioneering firms from India and China which have become global players, the ICT sector is dominated by foreign companies.

Conclusions (3)

- As illustrated by the country case studies several electronics firms have become global players: LG Electronics, Samsung, in South Korea, TSMC, Mediatek, and HTC in Taiwan, Huawei Technologies, Lenovo, and ZTE in China and Tata, Wipro and Infosys in India.
- However, these success stories may be misleading, at least for China, as very few Chinese corporations are among the main R&D investors (there are scarcely a dozen Chinese corporations among the top 1 000 worldwide).
  - Among these 1 000 top corporations, Chinese and Indian firms account for 1% of R&D expenditures (EU firms for 32%, North America for 40%) (EC-JRC –IPTS scoreboard, 2011).

Conclusions (4)

- In order to fully benefit from the participation in the global network of R&D, it is also necessary to seek for knowledge and technology resources outside of the home location.
- By linking up with more advanced countries, Asian countries may reach global technology standards more quickly and at lower cost than through independent expansion.
  - This point is additionally emphasised by Asia's strong orientation towards collaboration with the US.
- This one-dimension approach might reduce the bargaining power of Asian firms and R&D facilities, as it does not leave them a second option.
  - In the long term, this might weaken the position of Asian countries in the global network of knowledge and technology production.

Merci

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Source: Desclozeaux

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Appendix: methodology

Methodology

Cross-border ownership of inventions as measures of international technological flows

- From the rest of the world to China

$$AI_{CNj} = \sum_{p}^{P} A_{CNp} \times I_{jp}$$

- From China to the rest of the world

$$IA_{CNj} = \sum_{p}^{P} I_{CNp} \times A_{jp}$$

Methodology

The intensity of the technological interactions or the *revealed geographic distribution* (RGD)

- What is the role of country *j* as a source of technology for China?

$$RGD\_AI_{CNj} = \frac{AI_{CNj}}{AI_{CN.}} \Big/ \frac{AI_{.j}}{AI_{..}}$$

- What is the role of China as a source of technology for country *j*?

$$RGD\_IA_{CNj} = \frac{IA_{CNj}}{IA_{.j}} \Big/ \frac{IA_{CN.}}{IA_{..}}$$

Methodology

The drivers of technology sourcing from the rest of the world to China:

$$RGD\_AI_{CNjt} = f(Dist_{CNj}, GDP_{CNt}, GDP_{jt}, FDI_{CNt}, FDI_{jt}, IP_{CNt}, IP_{jt}, Rg_j, \alpha, \varepsilon_{ijt})$$

and from China to the rest of the world:

$$RGD\_IA_{CNjt} = f(Dist_{jCN}, GDP_{CNt}, GDP_{jt}, FDI_{CNt}, FDI_{jt}, IP_{CNt}, IP_{jt}, Rg_j, \alpha, \varepsilon_{ijt})$$

where

- $DIST_{CN,j}$: Geographic distance
- GDP_{CN} & GDP_j: Economic size
- FDI_{CN} & FDI_j: Oppenness
- IP_{CN} & IP_j: Inventive Performance
- RG_j: Region of origin of country *j* (EU, US, Japan, Asia, RoW)