How Technology and Knowledge Drive Economic Growth? - Cases of China and India

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Knowledge for Development Program
The World Bank

May 25-27, 2005

"Technology Innovation, Private Sector Development, and Economic Growth" Conference, Hangzhou, China

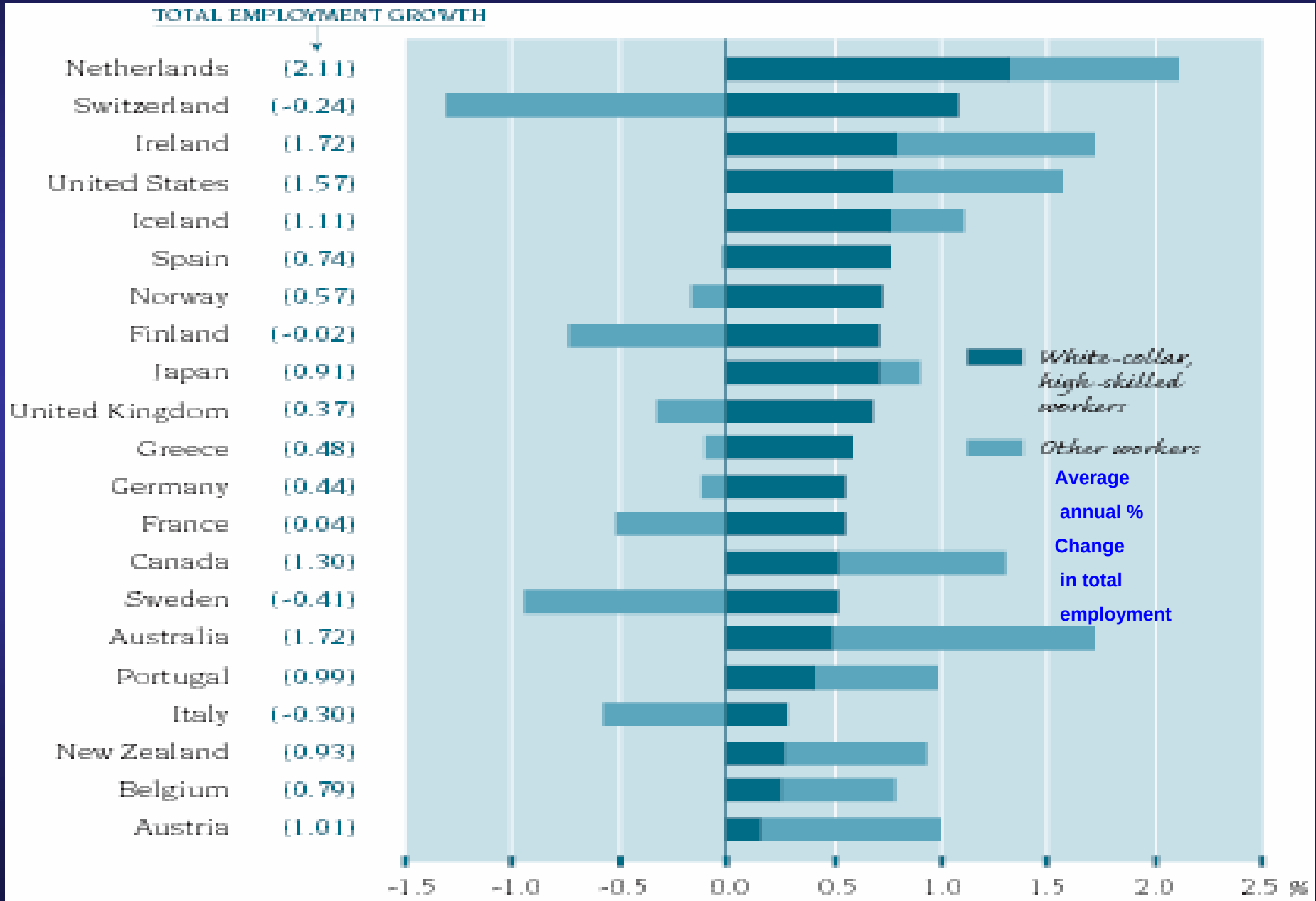
Structure of Presentation

- Knowledge Revolution and Global Trends
- China and India's Knowledge Strategies
- How Knowledge, Technology Drive Economic Growth?
  - Case of China
  - Case of India
- Key Success Factors for China & India
- Future Challenges for China & India
- Towards Continued Success

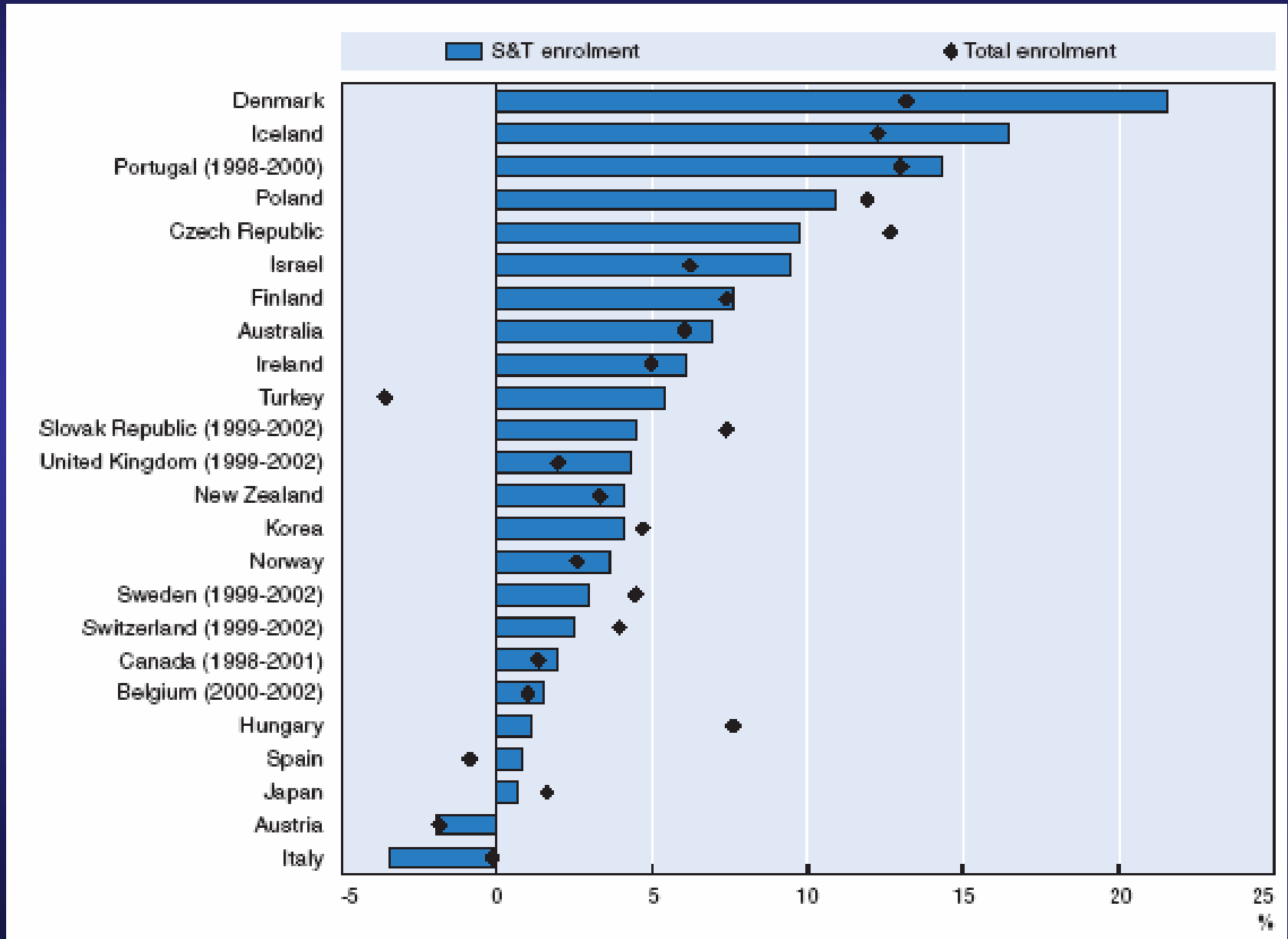
Knowledge Revolution & Global Trends

- Knowledge and Technology have become the key drivers of economic growth and international competitiveness;
- This puts premium on education, skills and technologies, as well as innovation capacities;
- How to create, access and apply knowledge & technology is thus becoming the fundamental determinant of success.

Demand for Knowledge Workers Constantly on Rise 1980-98



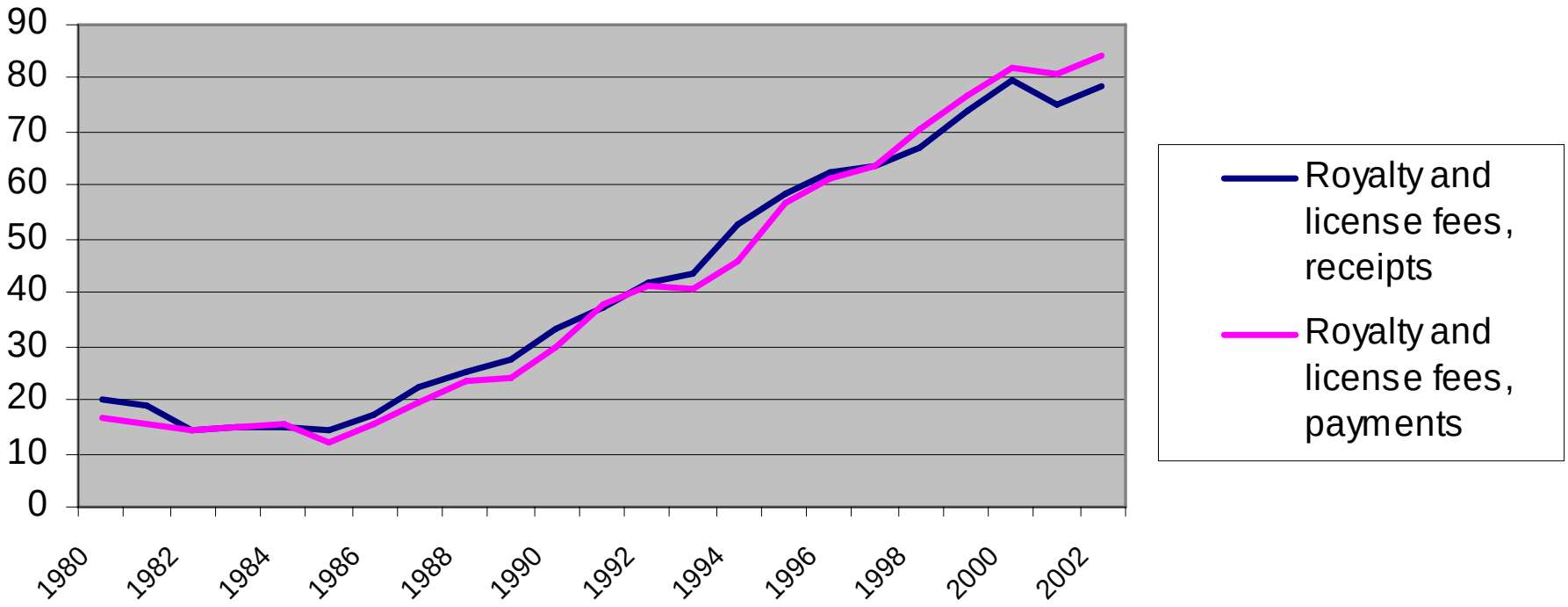
Tertiary Enrollments in Science & Engineering Fields (average annual growth, OECD, 1998-2002)



Source: OECD, 2004

Royalty and License Fees

Worldwide Royalty and License Fees (Payments and Receipts, 1980-2002, bill US$)



Note: The nominal values were converted to 2000 values by the US GDP deflator.

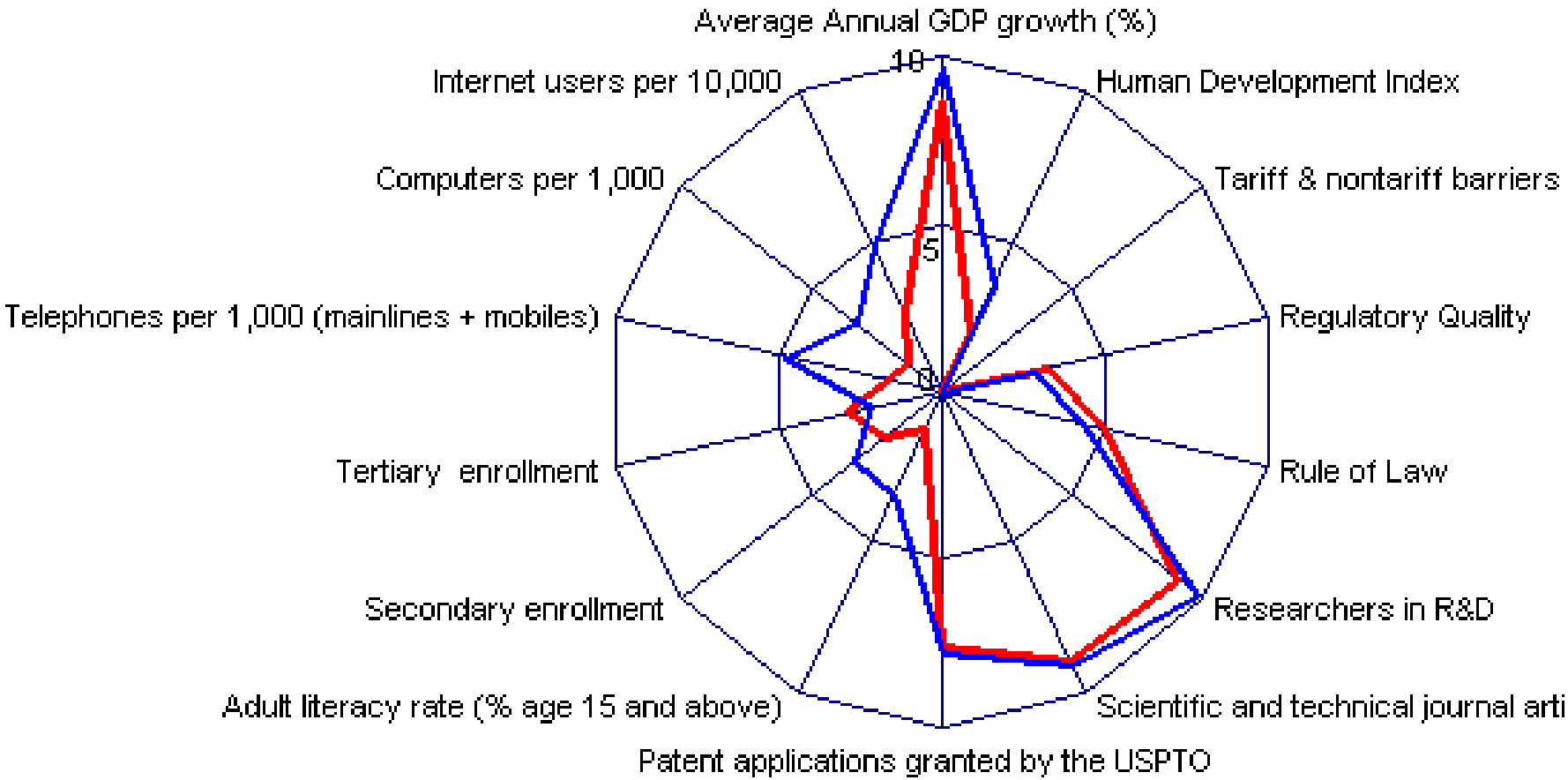
Source: World Bank SIMA database

China and India (Dragon vs. Elephant): Embracing the Knowledge Age

- Together China and India accounts about one third of world population; 5.2% (in US$ term) or 18.5% (in PPP term) of world GDP.
- Since 1980s, China has been growing at an average rate of 8-9%; while India at about 5-6%.
- Both countries have carried out knowledge-oriented reforms to unleashed the potential of knowledge and technologies.

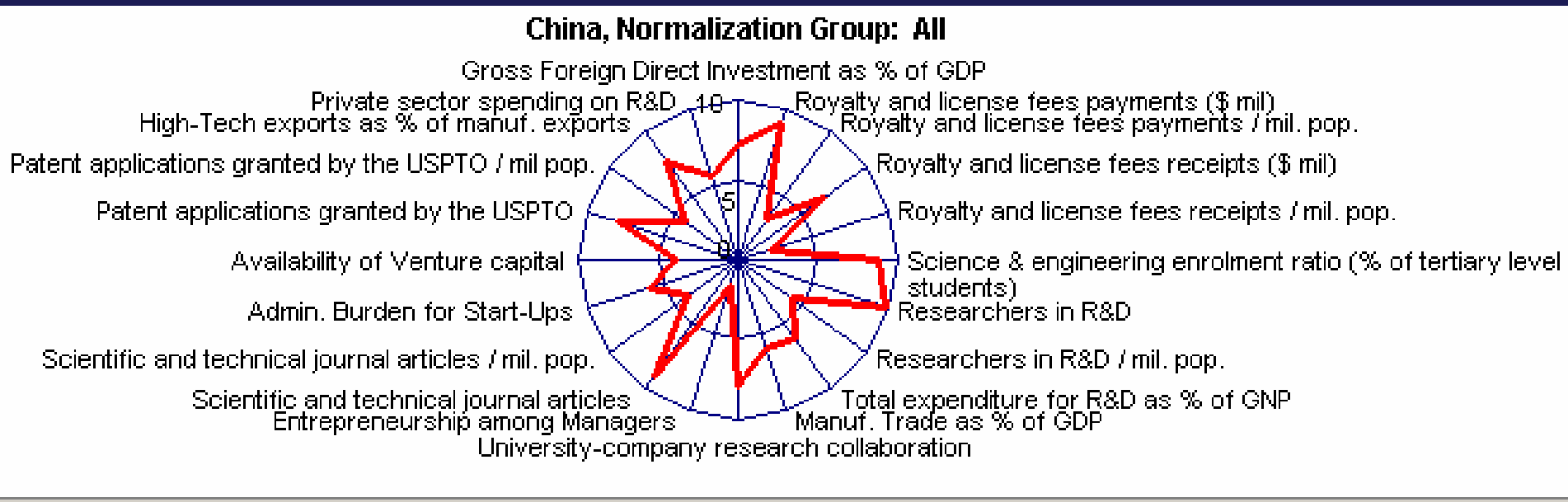
Knowledge Economy Scorecards

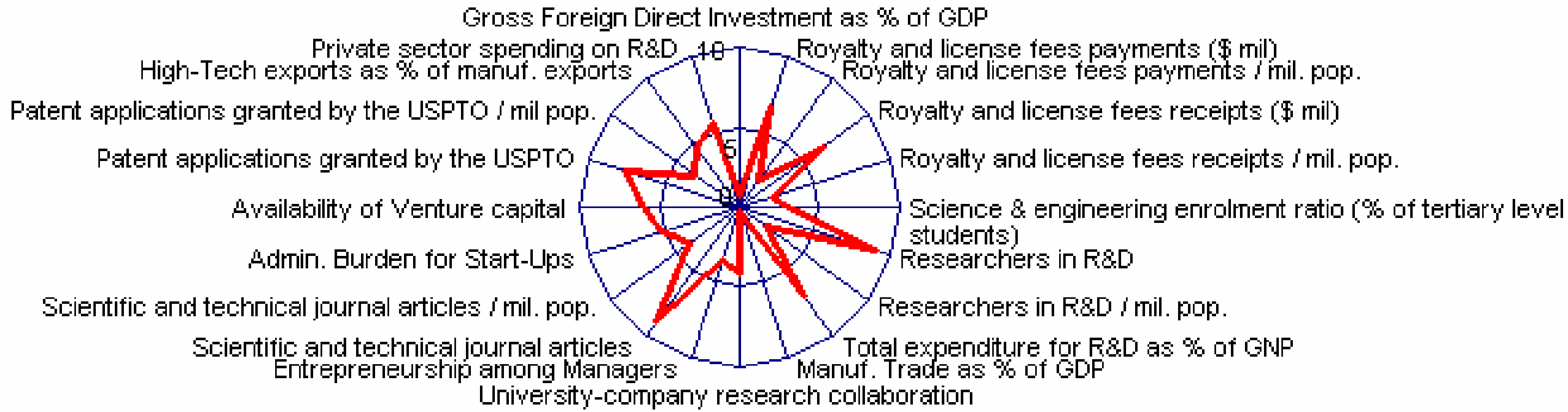
India, China (most recent)



Source: KAM (www.worldbank.org/kam)

Innovation Scorecards





Technology and Innovation: Capacity (2001-02)

	China	India	US	Japan	Germany	Russia
Total R&D expenditure as % of GNP	1.32	1.23	2.69	2.98	2.48	1.00
Total R&D expenditure (bill, PPP)	60	19	253	97	48	12
S&E enrollment ratio (% of tertiary students)	43	25	19	21	47	50
Researchers in R&D (1,000)	742.7	149.3	1114.1	675.9	259.6	505.8
Researchers in R&D (per mill)	584	157	4048	5322	3154	3492

Technology and Innovation: Performance (2001-02)

	China	India	US	Japan	Germany	Russia
S&T Journal articles	11675	9217	163526	47826	37308	15654
Patents granted by USPTO	266	179	98666	34891	11895	239
High-Tech exports as % of manuf. exports	20	6	32	26	18	8
Manuf. Trade as % of GDP	36.8	12.5	15.0	13.9	45.2	18.2

China's Knowledge Strategy

Since 1978, China carried out a series of policy and economic reforms:

- **Property rights change, first from agriculture then expanded into the business sectors;**
- **Attracting FDI through the SEZ and High-tech Zones;**
- **Encouraging trade and exports-led growth, especially in the manufacturing sector;**
- **Restoring the education system, especially the high education;**
- **Reforming the R&D system, and encouraging business-oriented R&D;**
- **Pursing the development strategy of "vitalizing the country through science and technology".**
- **Massively expanding ICT infrastructure.**

FDI – A Key Driver of Economic Growth in China

- **Through SEZs and policy incentives (tax incentives, duty-free for imports, land use rights, etc.).**
- **By 1999, China was third in the world in total FDI stock (by the end of 2004, $562.1 billion).**
- **FDI accounted for about 48% of exports in 2001, and 90% of FDI exports were manuf. Goods; In technology intensive industries, FDI's share of exports rose from 59% in 1996 to 81% in 2000.**
- **Research suggests that technological advances speed up in the 1990s with the opening up and inflow of FDI - averaged 2% annually.**

FDI and High-tech Development in China

FDI share in the value added of various HT sectors

HT sector	‘95	‘96	’97	’98	’99	’00	‘01
Pharmaceuticals	44	35	46	45	52	52	54
Air/space craft	11	NA	14	NA	8	8	9
IT equipment	58	NA	60	60	67	63	66
Computers	67	60	69	56	73	75	82
Medical equipment	28	18	23	30	29	34	32

(source: NBS yearbook on HT industries 2002)

High-tech Parks and ETDZs

- To promote high-tech and exports, China set up 53 technology parks and 49 economic and technology development zones (ETDZs) by 2002.
  - **Attracting FDI and overseas talents.** In ETDZs, 12% of total FDI, 11,600 overseas-funded firms. In parks, among the 2.51 million employees, 1/3rd have a college education or above, over 5,600 overseas talents.
  - **Fostering successful domestic high-tech firms.** Legend, Stone, Founder, Huawei, Zhongxing, Haier...
  - **Incubating new and high tech firms.** 5,293 enterprises are being incubated in 110 incubators; 1,934 have graduated, creating 164,000 jobs.
  - **Creating R&D hubs.** Over 100 R&D centers set up.
  - **Contributing to the economic growth.** The zones reported over 40% annual growth while the parks even higher. In 2000, the parks made up 24% of the national total industrial output, and nearly 20% of national exports. Nearly half of the sedans and 37% of cell phones produced in ETDZs.

Strengthening the Linkages between R&D and Production

- "Jumping into the Sea" strategy to reduce the mismatch between R&D and industry:
  - Gov't funding for GRI decreased by an average of 5% each year from 1986-1993 (from 64% to 28%);
  - GRIs were able to general over 60% of income from non-gov't sources – half from tech services to firms; Similar changes took place in universities.

	Business	GRI	University
China (2001)	61.2	28.7	10.1
India (98-99)	22	75.5	2.5

Upgrading Traditional Industries with New Technologies

- Hybrid Rice by Yuan, Longping in the agricultural sector.
  - Since its inception using genetic technology in 1973, hybrid rice makes up over 60% of China's total rice output;
  - It generates a 20% higher yield than other varieties, which can feed an additional 60 million people per year;
  - The technology is being diffused to Bangladesh, India, Indonesia, Vietnam, etc.
- Many examples in the manufacturing sectors, such as electronics industry.

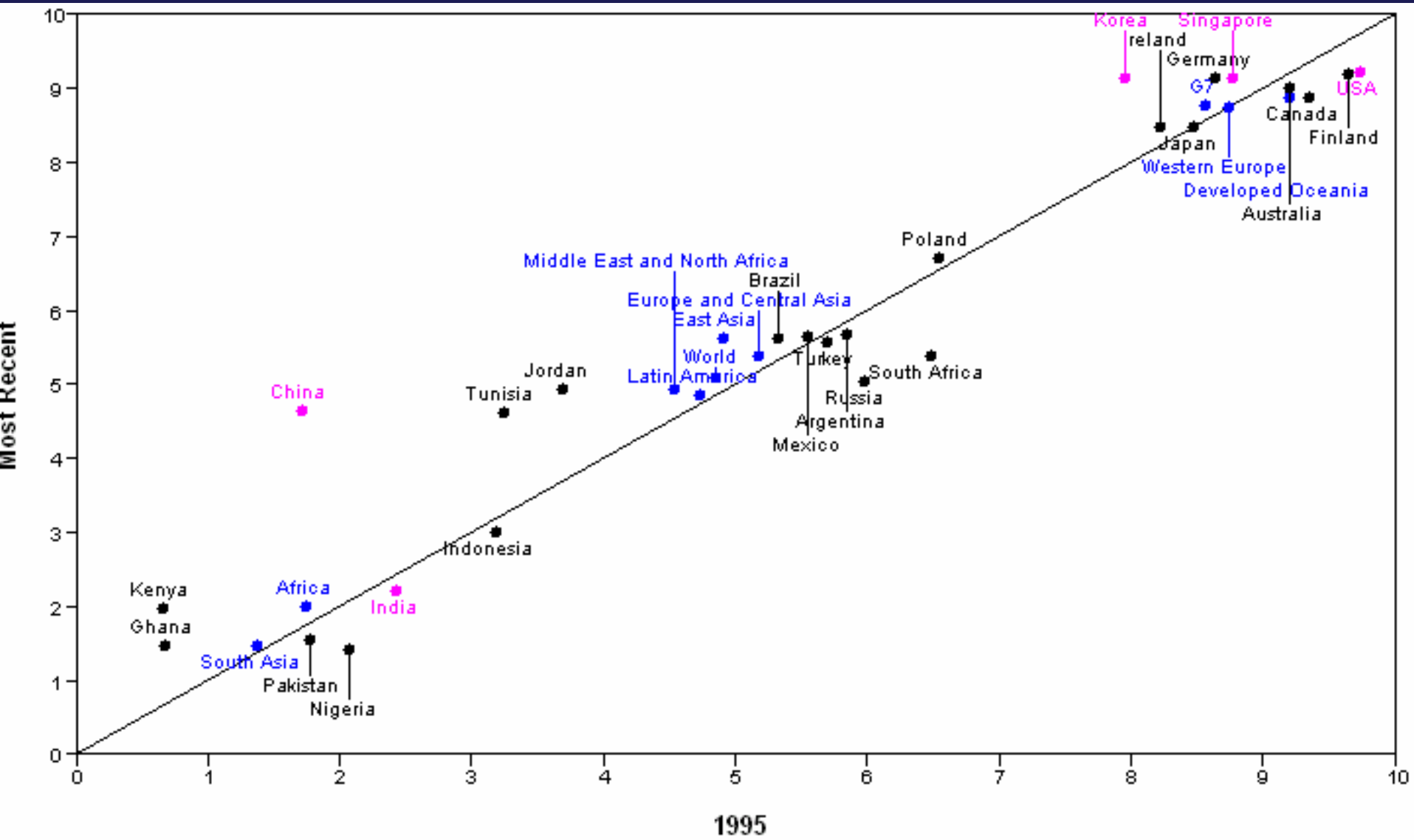
Building a Skillful Labor Force

- 1978-2000, China's adult literacy rate increased from 64% to 91%;
- 1982-2000, the average years of education for the population aged 15 and above increased from 5.33 – 7.85; for the total labor force from 5.81-7.99 (in the secondary industry, 8.05-9.44);
- 1980-2000, the enrollment ration for secondary education increased from 46% to 68%; tertiary from 2% - 13% (around 15% recently).

Expanding the ICT Sector

- Chinese gov't spent $9.2 billion on ICT in 2004, and will increase to $10.9 billion in 2005 (18% increase); average spending grew by 20% in last four years; India spends around $4 billion;
- Since 1997, China's annual revenues in software and IT services have risen by 42% a year, reaching $6.8 billion in 2003, mostly from domestic demand (India $12.7 billion).

ICT



India's Knowledge Strategy

- Opening up more sectors to the private investors, encouraging FDI, further liberalizing trade policy, and reforming capital markets
- Creating structures for biotech development
- Promoting knowledge-based service industries (software and IT)
- Packing and marketing traditional knowledge (e.g., medicine)
- Improving capacity building: HR, R&D, and technology applications.

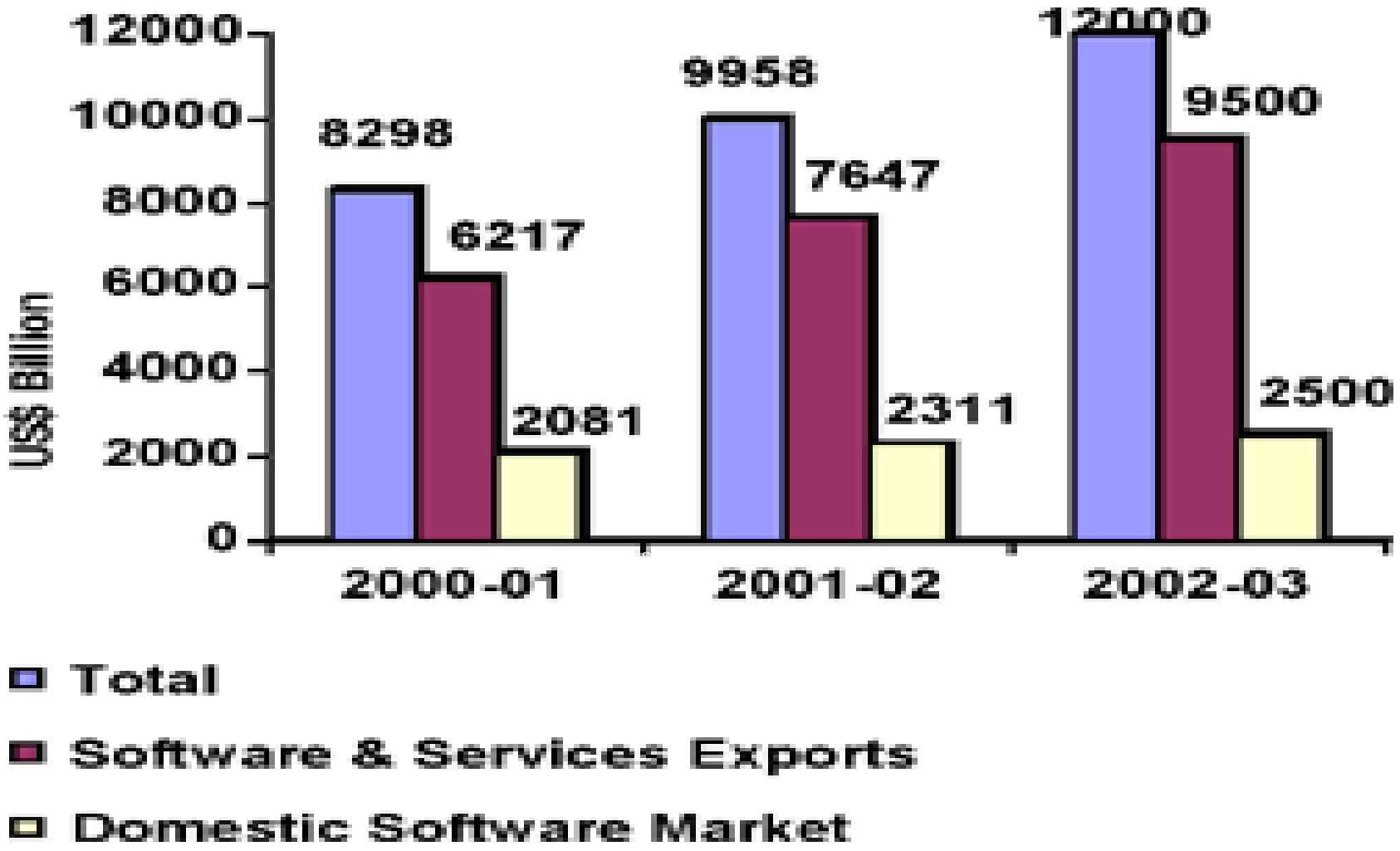
Tapping into the Global Knowledge through Diaspora

- A large and well-educated global Diaspora (about 20 million in 2001): the Indian American community boasts 1.68 million and 62% of them have some college education (compared to just over 20% for the U.S. population)
- Direct investment is rather limited, mostly in the form of knowledge linkages: with foreign markets, helping Indian firms to absorb technical and managerial knowledge.
- According to Saxenien, 77% of Indian in the US had one or more friends who returned to India to start a firm; 52% travel to India on business at least once a year; 33% regularly exchange info on technology.
- The initial impetus for outsourcing to India mostly comes from employees of Indian origin.

IT Software & Service Industries

- Indian IT market has grown from $ 1.73 billion in 1994-95 to $16.5 billion in 2002-03, accounting for 3.8% of India's current GDP.
- The growth in the Indian IT industry has been largely driven by exports.
- The software industry expanded at a compound annual rate of 56% in the late 1990s and early 2000s. Exports share increased from 2% in 94-95 to 21.3% in 03-04.
- In 2004, the software industry alone accounts for 3.3% of global outsourcing market.

Indian Software and Service industry



Source: NASSCOM

Why Successful?

- Cheap talents and highly trained domestic entrepreneurs;
- Global Diaspora provided: tech know-how, networks, entrepreneurship, mentoring, advanced management skills, and outsourcing movement;
- Gov't "hands-off" in early stage allowed market forces to play; Selective support to industry later on in an otherwise constraining environment;
- Restrictive policies towards FDI allowed indigenous firms to grow;
- Early-mover advantages – from "body-shopping" in 1968 to be exposed to the US firms in mid-80s to early 90s.

Software Sector: China vs. India (2001)

	China	India
Software exports	$850 million	$6,200 million
Domestic software sales	$4,300 million	$2,060 million
Growth rate – domestic software sales	+ 55%	+ 31%
Current IT professionals	150,000	522,000
Demand for IT professionals	350,000	400,000
IT professionals graduating each year	50,000	73,218
No. of software firms	6,000	3,000

Can China Compete in IT Services?

- Fragmentation constrains China's IT sector
  - Top 10 IT service firms only have 20% of the market, compared with 45% of India's top 10;
  - About 8,000 software service providers, and almost 3/4 of them have fewer than 50 employees, and only 5 have over 2,000 employees; India has less than 3,000 software service firms, but at least 15 have over 2,000 workers;
  - Fragmentation leads to weak quality controls and product management.
- Needs to consolidate
- Provides more trainings and incentives to IT professionals
- Obtains more international certification/recognition

Emerging Pharmaceutical and Biotech Industries

- In 2004, the Indian Pharmaceutical and Biotech industry boosts the most number of US FDA approved manuf. facilities outside the US, gaining access to high-growth bulk drugs market;
- Increasing spending on R&D by firms: Dr Reddy's and Ranbaxy spends 10% of revenues (Ranbaxy's revenue about $1 billion in 2004);
- Mainly reverse engineering, but also increasing spending on new drugs.

Diaspora and India's Pharmaceutical and Biotech Industry

Company	Total No. of Scientists	Scientist from Abroad	Work Engaged in
Dr. Reddy's Lab	250	20	New Drug Research
Lupin Lab	120	4	Natural Product, chemistry
Nicholas Piramal	80	10	New Drug Research
Torrent Pharma	140	6	Medicinal, Chemistry, clinical research
Wockhardt	160	10	Biotechnology, new drug research, chemistry, pharm

Building a Talented Manpower

- Though still lower compared to China, India has made considerable progress:
  - Literacy rate (aged 7 or older) rose from 52.2% in 1991 to 65.4% in 2001;
  - Secondary and tertiary enrollments have reached 49% and 11% in 2000;

- Early investments in science, engineering and technical education has paid off:
  - Second largest English-speaking scientific manpower second only to the US; 3.5 million technical personnel;
  - Over 1,670 educational institutions including engineering colleges, technical institutes and polytechnics that train over 41,000 people annually.

Promoting Development through Innovation Clusters

- Clusters are drivers of innovation through the adoption of technology, modern systems and practices, and interactions among different players
- India features many innovation clusters in industries such as IT, electronics, rice, textiles (Tiruppur), jewelry processing (Gujarat).
  - Bangalore: A IT cluster characterized by corporate offices, venture capitalists, business startups, and universities and research labs.

Transforming Traditional Sectors through Innovation & Technology

- "Green Revolution" in agriculture: in 1967-68 to 1977-78, using seeds with improved genetics (HYV seeds), and the increased use of fertilizers and irrigation, increased the yield per unit of farmland 20-30%;

- "White Revolution" since late 60s made India the world's largest milk producer (from 17 million tons in 1950-51 to around 88 million tons in 2002-03).
  - Institutional innovation: gov't helped link rural small producers with urban consumers through producers' cooperatives;
  - Technological progress in the production and processing
  - Increased demand with growth of per capita income.

Key Success Factors

- Clear visions and strategies from the top leadership and concerted efforts through public and private partnership;
- Linking to the global knowledge and technology stocks. China - FDI; India - Diaspora;
- Creation of critical mass of innovation and human capital capabilities;
- Applying innovation clusters to promote growth;
- Transforming traditional industries with technology and innovation;
- Encouraging entrepreneurship and pragmatism.

Future Challenges for China and India

- Major improvement in investment climate;
- Major overhaul of education system, especially education quality;
- Strengthening the innovation system, especially the diffusion system;
- Raising productivity of traditional industries, especially farming, with tech and innovation;
- Sustaining growth through environment-friendly and energy-saving technologies and strategies;
- Narrowing the huge income and regional disparities.

Towards Continued Success

- Improving governance and government efficiency;
- Strengthening the overall investment climate;
  - China: rule of law, corporate gover., financial sector, property rights;
  - India: labor regulations, openness, financial sector, infrastructure.
- Strengthening the interactions of major players of innovation system, and linking R&D further to production;
- Further leveraging innovation clusters;
- Further spurring the growth of knowledge-intensive industries (China more on services);
- Enhancing the education quality through curriculum reform and emphasis on core skills;
- Building a lifelong learning system.

Thank you very much!

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