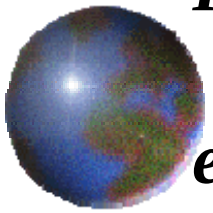

From underdogs to tigers? The rise of the SW industry in some emerging economies

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Heinz School

Carnegie Mellon University

Outline

- Software: Activity or Industry?
- Two paths of the emerging SW industries
  - Export led development or Development led exports
- How did the “underdogs” become “tigers”?
  - Understanding software activity
  - A macro perspective
  - A firm capability perspective
- What are the major lessons?
  - Role of MNC
  - Diaspora and human capital
  - Govt. policy
  - Domestic market
- What should governments in other countries do?

Software is Ubiquitous:
SW Employment as % of Total Employment by State, 2001

Source: BLS, 2001

Software is both a technology and an industry

66% of US software jobs are outside the IT Sector

Industry	SW Employment
Computer Equipment	72,000
Computer and Software Services	977,000
All Other Industries	2,816,000
Total	3,865,000

Source: BLS, 2001

Indian SW exports target the in-house SW activities of user firms:

($ billion)	2002-03	2003-04
Banking, Financial Services & Insurance (BFSI)	39%	40%
Manufacturing	12%	12%
Telecom equipment	9%	9%
Retail	5%	5%
Telecom service providers	4%	4%
Healthcare	5%	5%
Total	100%	100%

- **Standardization and modularization of "support" functions inside large organization, which reduced need for local presence**
  - **Demand-Supply mismatch in 1990s**
  - **Telecommunication advances**
- **Much of SW globalization is**
  - **directed at "in-house" software systems,**
  - **through *outsourcing*, increasingly through longer term partnerships**
  - **US vendors are starting to increase offshore capabilities**

The international SW industry (2002)

Countries	Sales ($ B)	Empl ('000)	Sales/ Empl	Sales/ GDP (%)
Brazil *	7.7	160 **	45.5 **	1.5
China	13.3	190 **	37.6 **	1.1
India	12.5	250	50	2.5
Ireland (MNE)	12.3	15.3	803.9	11.0
Ireland (Dom)	1.6	12.6	127	1.3
Israel *	4.1	15	273.3	3.7
US	200	1024	195.3	2.0
Japan **	85	534	159.2	2.0
Germany *	39.8	300	132.7	2.2
Argentina**	1.35	15	89.3	0.5

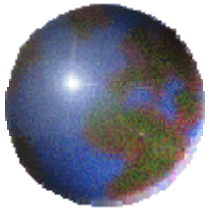
Estimates of SW industry in developed countries under count in-house SW

Arora and Gambardella, 2005, from various sources. * = 2001; ** = 2000;

The global SW industry, $billion

	2002	2003	2004
China	13.3	19.3	27.8
Korea	16.8	20.1	20.7
India	12.2	16	20
USA	280	297	311
Japan	71	79	83
Europe	216	225	238

Source: Chinese SW industry association

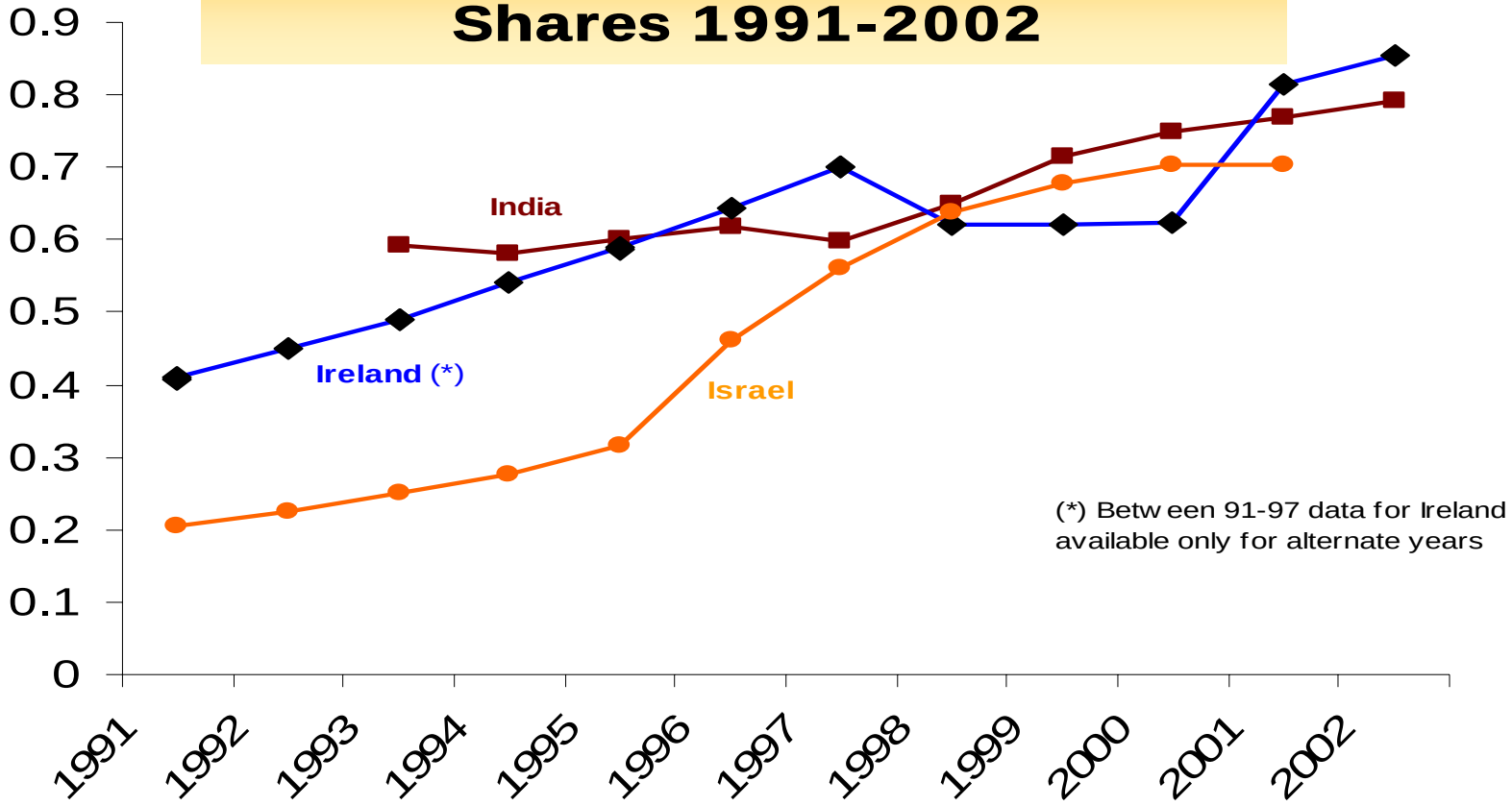


Export led growth

The “eyes” of the tiger:

India, Ireland, Israel

India, Ireland, Israel: SW Export Shares 1991-2002



Source: Arora and Gambardella (2005)

The SW industry in India

Indian IT Industry-Sector-wise break-up

USD billion	FY 2004	FY 2005	FY 2006E
IT Services	**10.4**	**13.5**	**17.5**
-Exports	7.3	10.0	13.2
-Domestic	3.1	3.5	4.3
ITES-BPO	**3.4**	**5.2**	**7.2**
-Exports	3.1	4.6	6.3
-Domestic	0.3	0.6	0.9
Eng Serv, R&D, Products	**2.9**	**3.9**	**4.8**
-Exports	2.5	3.1	3.9
-Domestic	0.4	0.7	0.9
Total Software and Services Revenues	**16.7**	**22.6**	**29.5**
Of which, exports are	*12.9*	*17.7*	*23.4*
Hardware	**5.0**	**5.9**	**6.9**
Total IT Industry (including HW)	**21.6**	**28.4**	**36.3**

Source: Nasscom (IT factsheet), www.nasscom.org (accessed 18 Sept 2006)

- **Starts in mid 1980s. Liberalization of 1991 critical**
  - IBM departure in 1977 → need for integration services for other platforms such as Wang, Burroughs
  - Some MNCs (e.g., TI, Motorola, Citibank) spot opportunity to do SW development.
- **After experimentation, domestic firms settle on service exports**
  - body shopping -> onsite -> global delivery
  - Over time, increasing complexity and size of projects ($100m+, multi-year).
  - Leading service firms expanding geographically and in terms of business knowledge
- **Entrants focused**
  - technology (e.g., telecom; semiconductor)
  - vertical sector (e.g., banking, retail).
- **Policy mostly one of benign neglect initially.**
- **With success, SW industry molded policy to its own needs (e.g., ease foreign exchange and capital market controls)**

Ireland & Israel

Ireland

- First indigenous "hi tech" industry for Ireland – mid 1980s
- Byproduct of attracting MNCs, (e.g., DEC, Gateway) through tax concessions and access to EU.
- MNCs typically use Ireland for "localization", packaging and distribution.
  - More recently, open SW development centers for more sophisticated work as well, for embedded SW and telecom.
- Domestic firms small, focused, very slow growth consultancies organized around a small niche product
  - pharmacy management in a hospital
- A handful of high tech firms, from universities or spinoffs out of original spinoffs (e.g. Iona, Trintech).
  - Many high tech startups have been sold to MNCs
- State policies facilitated and moderately important
  - Invite MNCs to create jobs
  - Invest in education
  - Support exports from domestic SW.

Israel

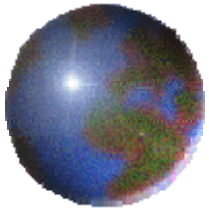
- R&D Lab of the World?
  - Comparative advantage in innovation
  - Electronics and hardware; medical devices
  - SW industry is "hi tech" – networking; security
  - Strong links with HW and semiconductors
- SW growth levered domestic research and sophisticated local defence demand.
  - Exports exceed domestic sales on in 1997
  - Many products are aimed at IT sector itself
- Military service forms social network of engineers and entrepreneurs.
- Silicon valley model
  - Technology and product oriented
  - VC and NASDAQ listing (~ 70 SW firms on NASDAQ)
  - Top 4 firms have sales ~ $ 3 Bn
- Policy helps
  - State investments in R&D and higher education
  - State → VC, incubators and tech parks

Israel's Top SW Companies by Sales ($ mill) 2002-2001

Name	Primary subsector	Sales 2002	Sales 2001
Amdocs	Telecom billing, CRM, automated directories	1613.60	1533.90
Comverse	Voice mail	1270.20	1225.10
Checkpoint	Security	427.00	527.60
Mercury	SW Systems Optimization	400.10	361.00
NDS	Security	368.70	304.80
Formula Systems	HC and SW house	283.30	376.90
Nice Systems	Monitoring	162.50	127.10
Verinet	Telecommunication	120.60	141.70
Precise SW	Optimization	76.00	55.60
Sapiens	Conversion	64.80	63.40
Magic	RAD	60.00	76.60
TTI	Telecommunication	58.30	60.80
Ulticom	Telecommunication	58.20	47.40
DSSI	SW House	55.90	45.90
Aladdin	Security	49.50	46.60
Radvision	Telecommunication	49.10	46.20

The "I" Countries: A SW comparison

	India	Ireland	Israel
Domestic firms	Services; maintenance, solutions	Niche mkt consulting; Some product	R&D based products: telecom, network security
Sector Focus	Limited	High	High
Growth	Export based	MNC and export based	Leverages domestic requirements for export success
MNC	Prod devp; Services	Localization	R&D
Industry Business Model	Large service firms; retained earnings based	Business solutions – products and small consultancies	Silicon Valley – VC finance, NASADQ listing



Development led exports?

China and Brazil

Brazil

Company	Millions of USD	Origin
'Pure' non-government SW Firms		
Microsoft	362	US
Computer Associates	260	US
Oracle Brazil	182	US
SAP Brazil	124	GER
Consist	77	US
Microsiga	*72*	***BR***
CPQD	*64*	***BR***
Datasul	*41*	***BR***
Novell	25	US
Consulting / SW Services Firms		
EDS	240	US
Accenture	194	US
DBA	*62*	***BR***
CTIS Informatica	*57*	***BR***
Proceda	*52*	***BR***

- **Domestic market = 98% of total SW sales**
  - **Balanced product and services**
  - **MNCs have significant share**
  - **Federal and state demand is significant**
- **Grew out of HW industry**
  - **Older firms emerge from HW, or as in-house SW units of large users**
  - **1990s, new SW only firms emerge**
- **Informatics policy 1970s → protect domestic HW**
- **HW policy failed but**
  - **Sophisticated telecom and banking demand**
  - **Growing IT workforce. 18,000 IT engineers, plus 22,000 non eng IT grads (mid 1990s)**
- **1992 – liberalization + IT R&D tax credits + economic stability**
  - **SW ~ $10 B in 2001**
  - **SW/GDP increase from 0.5% to 1.5%, 1991-2001**
  - **SW exports $1 m to $100 m**
- **De facto protection remains**
  - **Language and cultural barriers**
  - **Regional govt procurement has local bias**

China

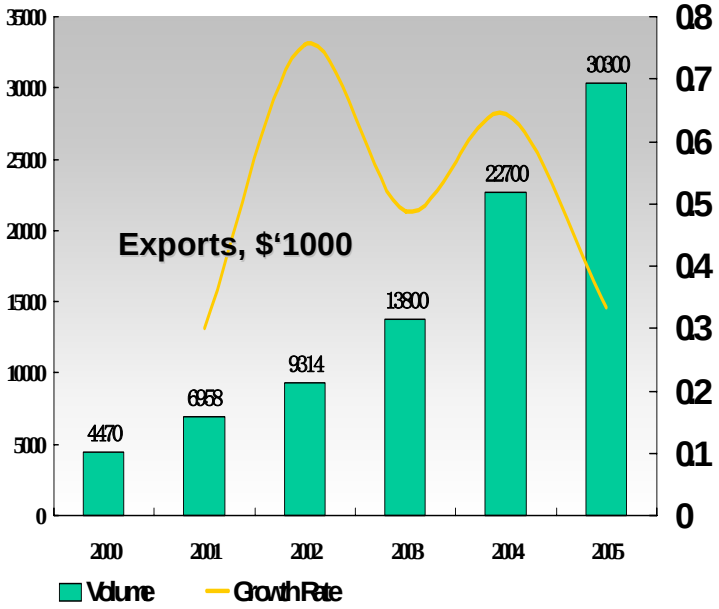
- Domestic market = 90 % of total SW sales
  - Large market in banking, media, manufacturing & govt.
  - Some outsourcing by Japanese firms
  - Balanced product-service mix; Chinese firms have 33 % of product mkt.
- Established firms evolve from HW assembly & systems integration.
  - Wide range of activities – HW, sys. integ, SW, products,
  - Wide range of sectors – telecom, tax, finance, security,
- Newer firms (e.g., Kingdee, USoft, Red Flag): SW focused
  - Started by academics and CAS spinoffs
  - Embedded SW to support growing HW (PC; handheld; cell-phone)
- 19 out of 6500 firms have sales greater than $120 million
- De facto protection remains due to language and procurement
- Govt. Policy
  - investments in R&D, including development of Chinese OS
  - SW technology parks

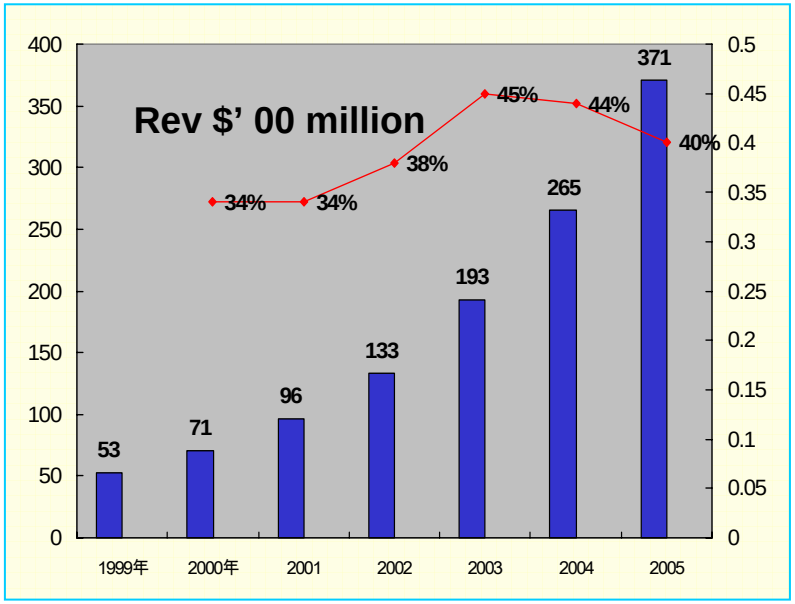
Leading Chinese SW firms: Small and diversified

Name	Software Products and Services	Sectors	Size
Founder	Software products: Electronic publishing, word processing, fingerprint technology, digital media. Customized industry solutions for various sectors ; Other activities: (PC hardware and peripherals, rare earth materials)	Government, insurance, postal, banking, security	>1000 S/W engineers
Legend	IT services: system and security, system operation services, IT consulting.; Customized applications for: finance, telecom, government, insurance. Other activities: (PC hardware and peripherals, rare earth materials)	Government, insurance, telecom, finance	12000
Neusoft	Developed application systems, public platforms, middleware products and consulting, and embedded software and system products, etc. Other activities: training, medical imaging equipment etc.	Telecom, power, finance, insurance, govt, hospitals	> 5000 empl
CS & S	software product development, systems integration, software outsourcing; Technology and products: Operating systems, machine translation software, information security products, ERP, supply chain management (SCM), finance, e-commerce, misc business (office automation), middleware	Various	2020
Pansky	Products and solutions	Banking, securities, aviation, govt.	700
Yan Tai	Integrates R&D, manufacturing and support for electric power automation.	Electric power	
CVIC	Software development and systems integration: 40 copyrighted products including industry application software, infrastructure software, and other digital products	Banking, transport, government, TV stations, retail	>600 **
Sichuan TOP Group	Application software and complete solutions for major industries Products: Middleware, database application systems, embedded Linux operating systems, ERP software, e-tax information systems, OA software Services: networking, technical support, IT management consulting. Systems Integration. Other activities: computer hardware, LED display systems, digital precision technology, IT education, IT	Government, finance and securities, various	788 SW in 2001

Source: Tschang and Xue, 2005

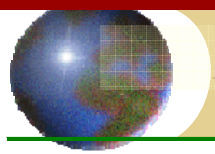
China Software Revenue and Export





	Rev ($ B)	*Est. VA (@15k per empl.)*	Empl., '000s	% export	Jap %	US %
2001	8	*3.2*	210	7.5%	67%	14%
2002	11	*4.3*	290	11.3%	67%	9.3%
2003	16	*8.2*	550	10.3%	69%	10.8%
2004	24	*9.3*	620	9.7%	54%	18.7%
2005	30	*10.8*	720	11.0%	57%	17.5%

Source: Beijing Software Park



The BIC countries: A software comparison

	Brazil	China	India
% exports (2002)	2	11	75
Firms Number	5400	8,000-10,000	1000
Empl top 3 firms	1-2K	3– 10K	50-80K
Leading firms	• Diversified • Regional focus • Broad range of activities • Products: Business apps (e..g, telecom; ERP)	• Diversified firms • Regional bias • Broad range of activities, • Product: Business and user applications (ERP; office suite), OS for PC and hand-held	• Services • Number of verticals • Products: embedded SW • BPO • Contract engineering
MNC role	• Serve domestic market, with products and solutions • Compete with domestic firms in product market	• Sell products in domestic market • Compete with domestic firms	• SW development & R&D platform • Export base (e.g., IBM, Mastech, Cognizant)
Origins	• HW firms; • In-house SW dept of large users • MNCs (IBM; Siemens)	• Academia (incl CAS) • Startups	• Related firms (consulting) • Spinoffs (from Patni, Wipro, Infosys, TCS; TI) • Startups • diaspora
Capability	Technology oriented; consulting and system integration	System integration; consulting for domestic client; technology	Project management and delivery; Industry vertical knowledge

The promise and reality of development led exports

The Promise

- In Brazil: HW capabilities provide technical edge over peers in Latin America, China, India
  - Sophisticated banking, telecommunication SW capabilities
- In China: Opportunity to enter markets at all levels, and room to learn and innovate (e.g., in embedded SW, and OS for handheld devices)
- China: cater to idiosyncratic needs of domestic users

The Current Reality

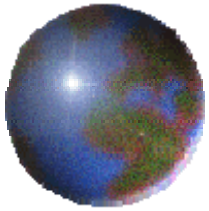
- Low end trap: MNCs occupy high end of SW, leaving domestic firms to fight for low end.
- Domestic firms focus on client specific needs,
- breadth instead of depth
  - Regional fragmentation
  - Small firm size
  - Insufficient specialization in activities
  - Insufficient specialization in sectors and technology

Learning and the domestic market? India

"… (Our parent firm) … was the first firm to use IBM mainframes in India for a very long time … We have the most qualified experts on IBM mainframes. … (But) technology is not such a critical factor as compared to understanding business practices."… Domestic expertise may be useful in gaining technical expertise such as in coding and project management. However domestic and export projects are two different ball games."

(Interviewed by the author in Bombay, 1997, quote extracted from Arora et al., 2001. Emphasis added.).

- Not important
  - Exports were different in nature – technical sophistication was of limited value
  - Brazil has a very sophisticated domestic banking and telecom sector, served by domestic software industry but very little by way of exports.
  - HW had ample protection and very little success
- Israel has been more successful in network security
- i-flex did succeed in leveraging domestic experience for exports



Explaining the rise of the software tigers

Firm capabilities at play with a backdrop of comparative advantage

How did the underdogs turn into tigers? *Traditional Explanations*

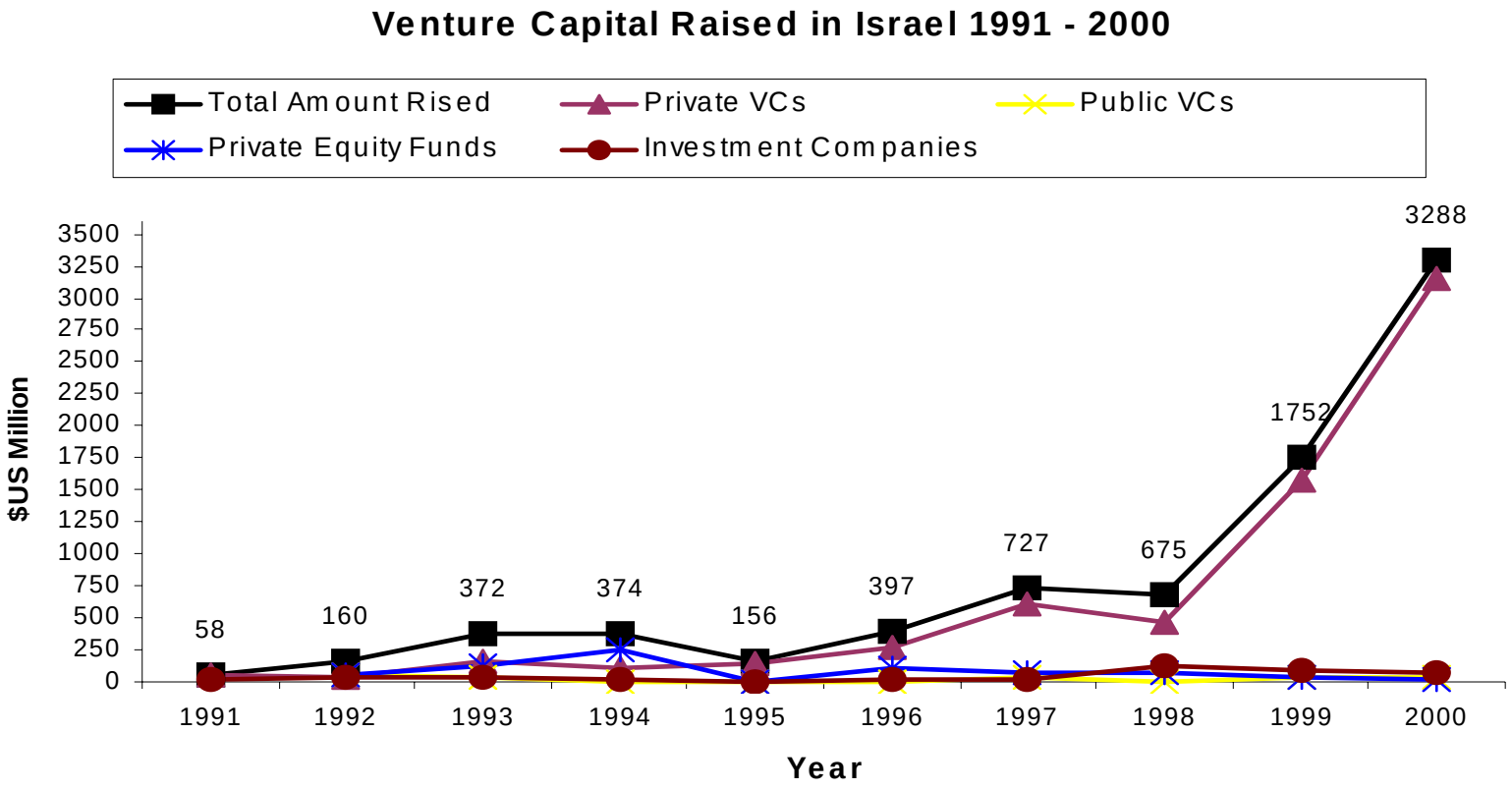
- Agglomeration economies relatively unimportant
  - Bangalore is *not* like Silicon Valley (at least, not yet)
  - Localized knowledge spillovers have modest role
  - Domestic market learning important only for Israeli firms
- Capital (incl VC) is also not big part of the explanation
  - Indian & Irish SW firms mostly self financed
  - Israeli firms use govt. financing, but US VC firms are quick to get into the act.

AFFIRMATIVE GOVT. POLICIES

- India: Unimportant
  - Benign Neglect
  - Communication infrastructure helpful
- Ireland: Moderately important
  - Invite MNCs – help connect to markets and managerial talent
  - Not conscious policy – "jobs for the boys"
  - NDS, IDA-Ireland, FSA played some role afterwards
  - Seed capital, markting links
- Israel: Direct policies unimportant
  - But indirect encouragement of R&D
  - Defense Needs (demand; training; networking)

VC follows rather than causes the growth of Israeli SW Industry

- By 1998, SW industry has already taken off
- Most of the VC is private, American
- Public VC is a very small fraction



Sources of location advantage in Ireland: Relative importance by firm type

Domestic Firms

	Customers	Partners	Business services	phys infrastruc	communicat infrast	Skills	Universities
Mean	2.68	2.32	2.96	3.54	3.74	4.54	2.93
Mode	1	2	3	4	4	5	3
SD	1.33	1.16	1.14	0.92	1.21	0.69	1.12

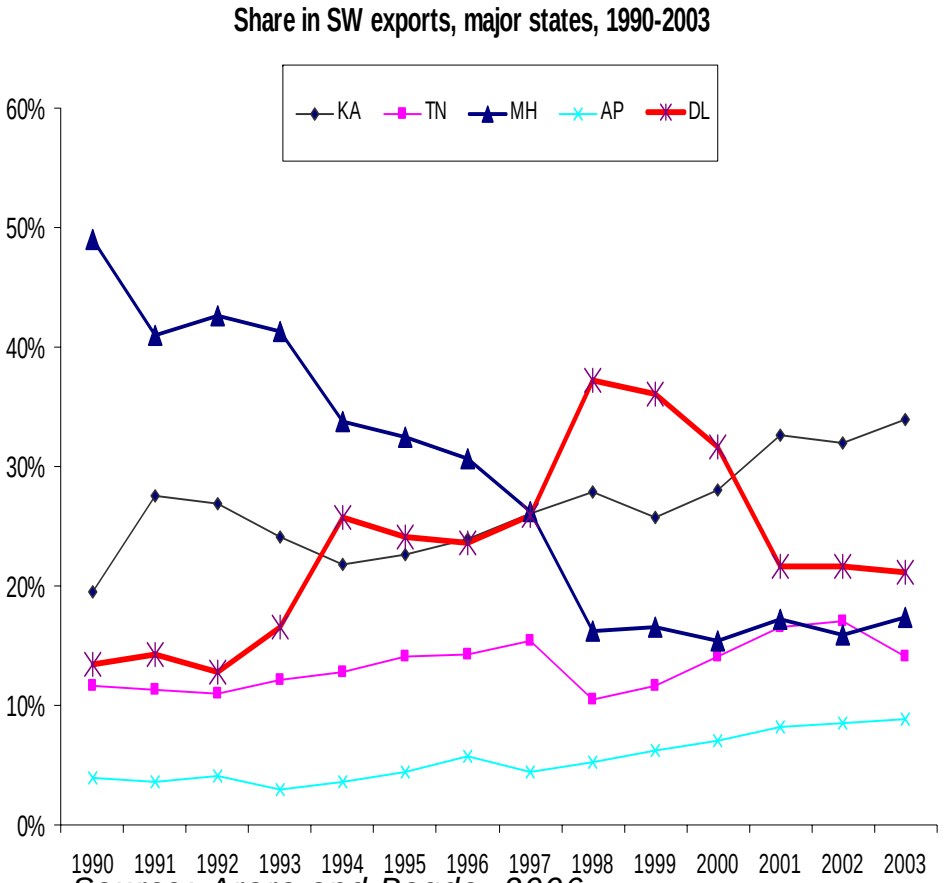
Foreign Firms

	Competitors	Partners	Busin. Serv.	Phys. Infrastru	Comm. Infrastru	Skills	Labour cost	Subsid & Tax
Avg	2.54	2.54	2.54	3.54	3.77	4.54	3.33	3.67
Mode	3	3	3	5	5	5	3	5
SD	1.13	1.20	1.33	1.61	1.54	1.13	1.37	1.30

Source: (Arora, Gambardella, Torrisi, 2003)

Software in Ireland is not a typical agglomeration story

Bangalore was not the past of the Indian SW industry, though it may be the future



Source: Arora and Bagde, 2006

Entry dates and the regional location of firms, 2001

Location	Pre-1980	1981-84	1985-91	1992-99	2000-01
Bangalore	3	3	19	50	15
Mumbai/Pune (Pune)	9 (1)	11 (0)	32 (8)	63 (17)	8 (2)
Chennai	3	5	9	34	6
Delhi: of which (Noida) (Gurgaon)	5	4 (1)	25 (6) (1)	63 (18) (9)	17 (4) (2)
Hyderabad /Secundrabad		1	6	29	8

Source: Athreye, 2005

Little merit in claims that Public Sector R&D labs (in Bangalore) explain the growth of the Indian SW industry

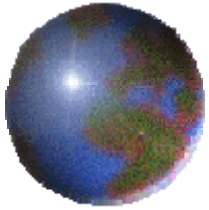
SW in the tigers

The Story

- IT revolution opens a window of opportunity in the 1980s
  - Big increase in demand for IT and inelastic short run supply in rich countries
  - De-coupling of HW and SW
  - Communication revolution
  - Globalization
- India, Ireland, and Israel follow different paths to export success.
  - Exports drive growth in India and Ireland whereas domestic market more important in Israel initially
- Brazil and China emerge later.
- Key differences in sources of advantage, government role, MNCs.

The I countries have several commonalities:

- A "reserve army of the underemployed" engineers and scientists,
  - from public investment in higher education
  - a weak industrial base
  - responsive education institutes (esp India and Ireland)
  - Some migrate to form overseas diaspora
- Openness and connection to major markets
  - Diaspora connects to major markets
  - English speaking
  - SW markets not protected



Human Capital

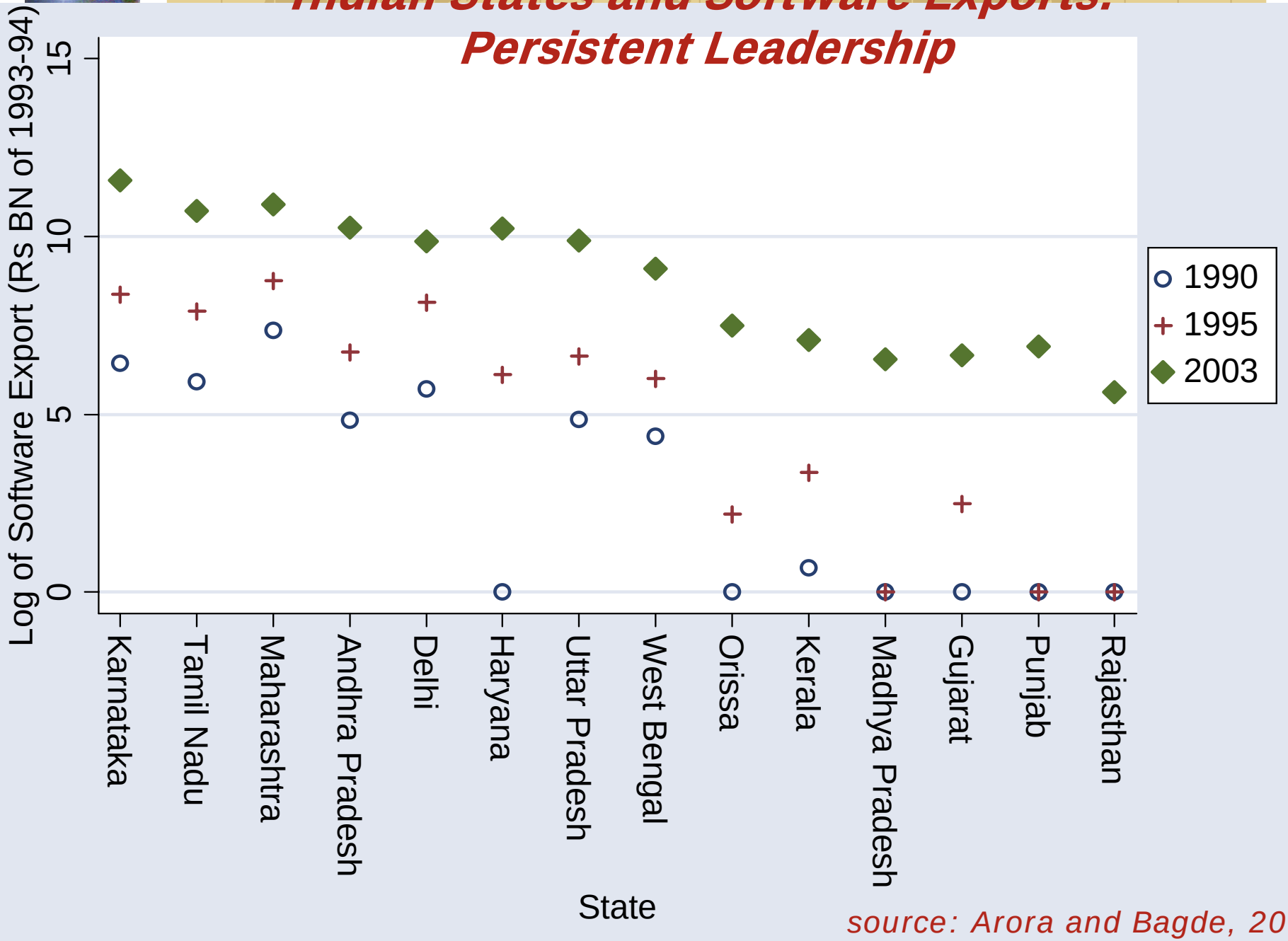
Irish state used EU funds to invest in human capital: Ireland is now the richest country in the EU

Distributions of EU Structural Funds 1989-1993 and 1994-1999 (%)

Country	Human Resources		Infrastructure	
	1989-1993	1994-1999	1989-1993	1994-1999
Greece	25.6	24.6	40.9	45.9
Spain	24.2	28.4	54.0	40.4
Ireland	38.0	43.9	27.7	19.7
Portugal	26.1	29.4	29.2	29.7
Italy	21.6	21.4	38.7	29.8
Average EU11	29.6	29.8	35.2	29.5

Source: First Report on Economic & Social Cohesion 1996 DG XVI EC Brussels (From Sands, 2005)

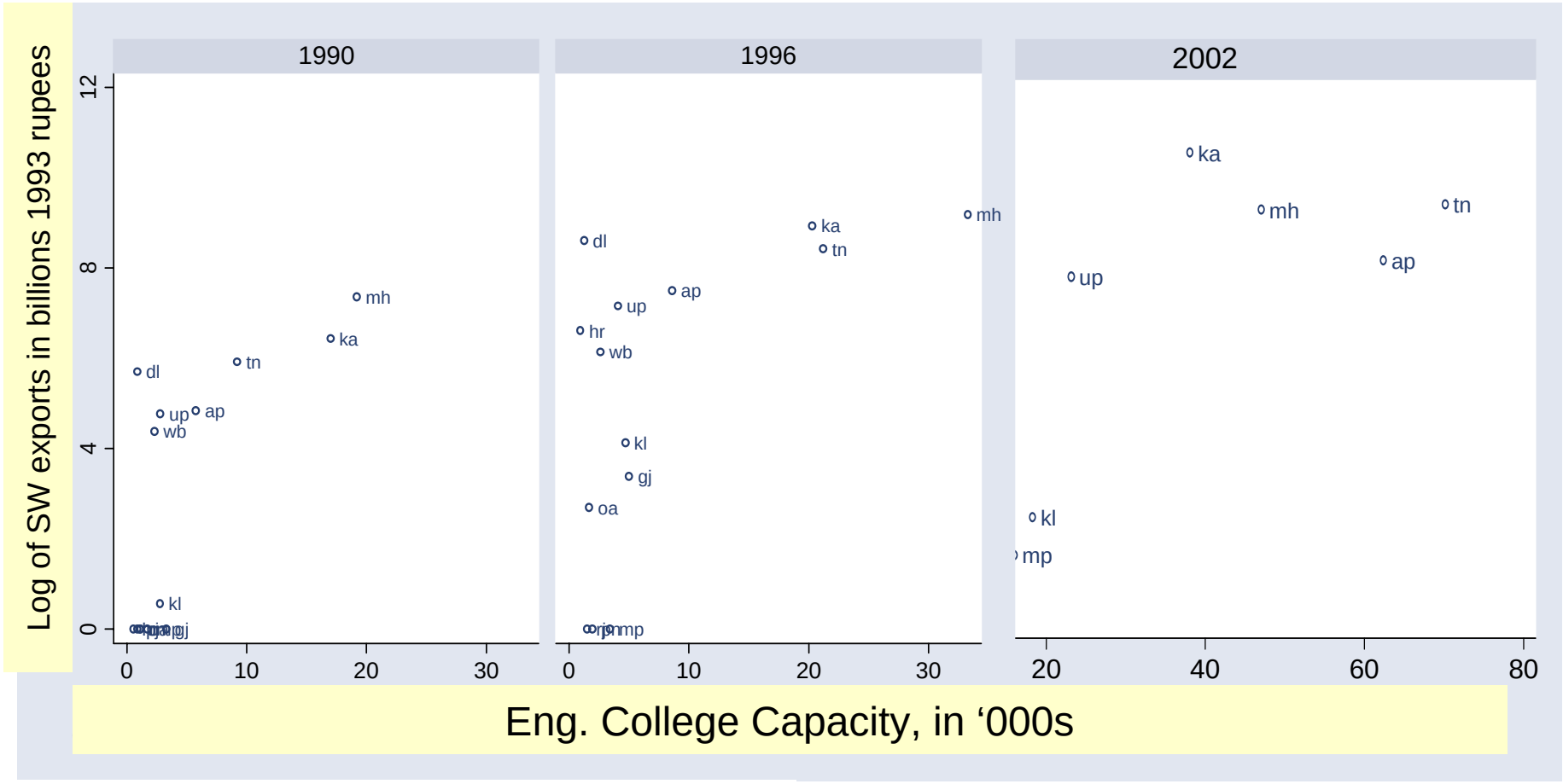
Indian States and Software Exports: Persistent Leadership



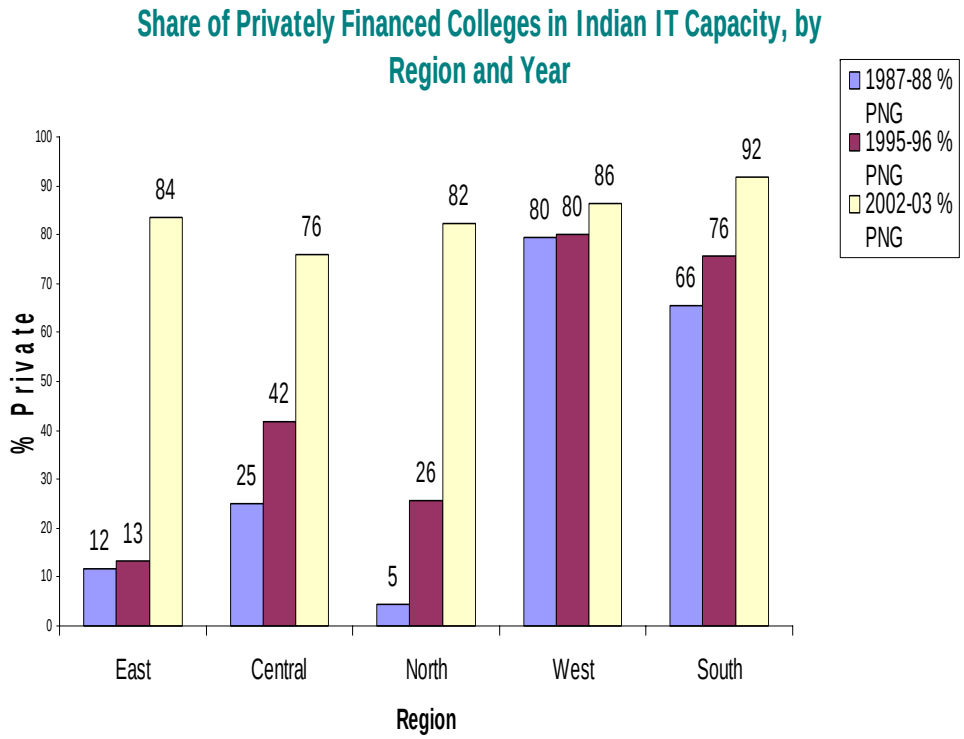
source: Arora and Bagde, 2005

Indian SW exports: Human capital is the key

- **Engineers are the key input for software services**
- **Undergraduate engineering capacity has grown seven-fold between 1990 and 2003**
- **Large inter-state variation in intake capacity**
- **Up to late '1970s most of colleges in public sector**
- **Now very large share of private self-financed institutions**



1. Differences in engineering college capacity predates the rise of Indian SW Exports.
States that allowed private engineering colleges early have larger eng college capacity and more likely to emerge as SW hubs.



Source: My calculations based on AICTE data on sanctioned capacity

Avg. Engineering College Capacity

	Early Adopters	Late Adopters
1991	9,258	1,889
2003	42,144	12647
Diff	32,886	10,758

Avg. Software Exports
in millions of Rupees, 1993-94 prices

1991	602	102
2003	39,682	9,874
Diff	39,080	9,772

Source: Arora & Bagde, 2006

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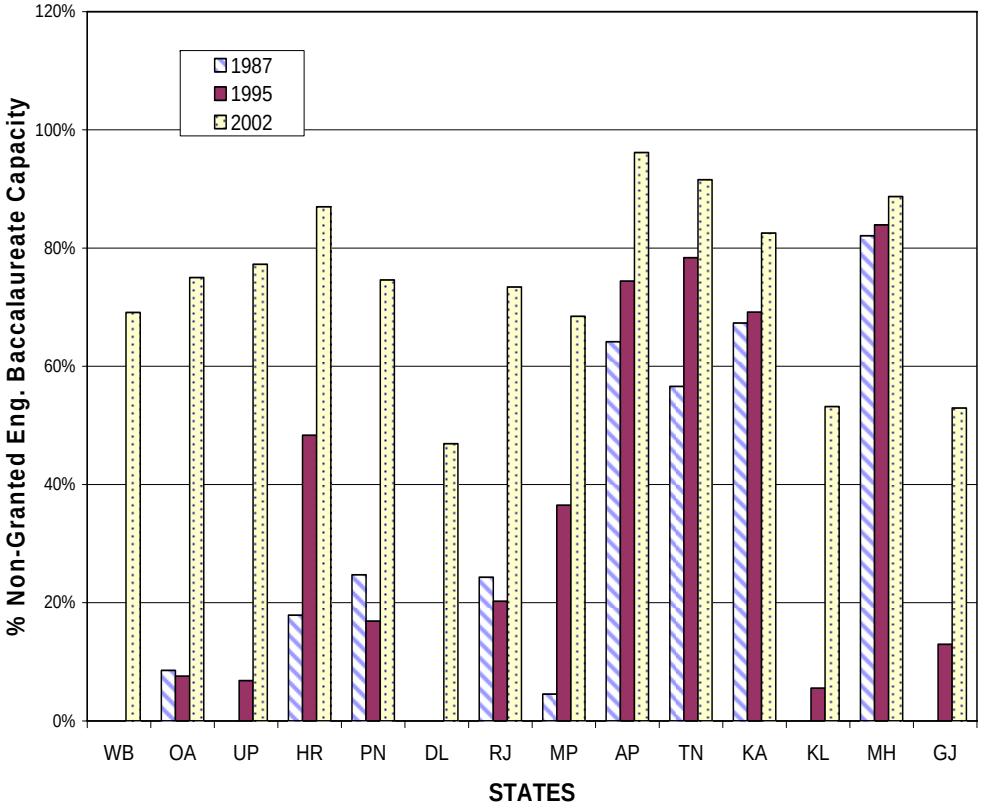
State Share of Private Non Granted College in Sanctioned Engineering Baccalaureate Capability



Dependent variable: SW exports 2003 – SW exports 1990

Eng. College Capacity 1987	5.96 (1.00)
Electronics Production 1990	0.97 (0.50)
Lagged Industrial Output 1987	-0.56 (0.15)
Constant	6096 (4956)
R^2	0.90
N= 14.	

Source: My calculations based on AICTE data on sanctioned capacity

Indian states that allowed private engineering colleges early have larger eng college capacity and more likely to emerge as SW hubs

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Constant	6096 (4956)
R^2	0.90
N= 14.	

Dependent variable: Annual change in SW exports (1993 million Rs)

Eng. college capacity (-4 yr)	**0.34** (0.1)	**0.20** (0.07)
electronics production (-1 yr)		0.40 (0.24)
industrial output (-1 yr)		0.007 (0.023)
per capita income (-1 yr)		-0.55 (0.61)
Population		-0.28 (0.16)
Constant	-371 (1308)	22981 (11914)
State fixed effects	Yes	Yes
Year effects	Yes	Yes
R^2	0.49	0.54

Note: Cluster corrected std. errors in parenthesis. N=182.

Source: Arora and Bagde, 2006

Results survive controlling for reverse causality and state and year fixed effects

	Δ SW exports OLS	Δ SW exports 2SLS	Δ SW exports 2SLS
Eng. College Capacity (-4)	0.20 (0.07)	0.62 (0.36)	0.74 (0.50)
Electronics Production (-1)	0.40 (0.24)		0.21 (0.23)
Industrial Output (-1)	0.007 (0.023)		-0.03 (0.05)
Per Capita Income (-1)	-0.55 (0.61)		-0.67 (0.67)
Population (-1)	-0.28 (0.16)		-0.15 (0.14)
Constant	22981 (11914)	-4773 (4489)	9397 (11527)
State-fixed effects	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
R^2	0.54	0.45	0.44

Note: Cluster corrected std. errors in parenthesis. No. of obs. 182.

Instrument for eng. college capacity

Mean of neighboring states' education policy

- education policy for a state is dummy variable = 1 when first self-financing college starts and stays 1 thereafter
- In 1991 only 6 out of 14 states had self-financing colleges
- By 1998, all 14 states allow

Shows the benefits of political decentralization

Human capital also results in a diaspora in major market

Selected Foreign Born Populations in the United States Aged 25 and Over

	1990	2000	% Chng	% of 2000 population entering post 1990	Educational Attainment (2000)		
					Primary %	Second. %	Tertiary %
India	304	837	175	55	5	15	80
Brazil	54	154	186	49	9	36	55
China	405	847	109	66	20	26	54

Selected Foreign-Born Populations in the United States by Year of Entry (2001 March CPS)

	Indian-Born	Irish-Born	Israeli-Born
Before-1960	1%	32%	4%
1960-1969	3%	19%	1%
1970-1979	14%	8%	28%
1980-1989	24%	23%	35%
1990-1995	23%	13%	18%
1996-2001	36%	5%	14%

Source: Kapur and McHale,2005 based on Census 2000

The Diaspora provide valuable export links, entrepreneurship and financing.

- Link to major markets
  - VC – Israel;
  - Reputation intermediary – India, Ireland and Israel; also China
- Returnees – significant in Ireland
  - SW skills
  - Entrepreneurs
- Many "Indian" SW firms are in US, run by Indo-Americans
- Represents a net loss of human capital to the economy but beneficial to the software industry

Irish SW firm founders by previous occupation, 1981-2002.

Former Employer of Founder	Number of founders
Irish SW company	41 (21%)
Multinational company	63 (33%)
Worked abroad	51 (27%)
Studied abroad	15 (8%)
NA	22 (11%)
Total	192 (100%)

Source: Sands, 2005

Openness and Entrepreneurship in India

NASSCOM Top 20 SW Exporters

Name of firm	Year Est.	Origin/type of firm	Notes
TCS	1968	Business house	Founder US educated
Wipro	1980	Business house	
Infosys	1981	Spin-off (Patni)	
Satyam	1987	Business house	Founder US educated
HCL	1991	Entrepreneur	
Patni	1978	Entrepreneur	Diaspora
I-flex	1989	Spawn (Citibank)	MNC spawned
Tech Mahindra	1988	Business house	
Perot Systems	1996	MNC	(earlier joint venture with HCL)
L&T Infotech	1996	Business House	
Polaris	1993	Entrepreneurial	
Hexaware	1989	Entrepreneurial	(Venture funded)
Mastek	1982	Entrepreneurial	
Mphasis BFL	1992	Spin-off (Citibank)	Diaspora
Siemens		MNC	
Genpact	1997	Spawn (GE)	MNC - Diaspora
IGate	1993	Entrepreneur (US based)	Diaspora
Flextronics	1991	MNC	(Hughes Software) - Diaspora
NIIT	1981	Entrepreneur	HCL spawned
Covansys India	1985	Entrepreneur (US based)	Diaspora (CBSL)

PLUS
IBM,
- Accenture
- HP
- Syntell
- Inteligroup
- Kanbay

Israel: 40% of managers of listed firms had US degrees

India: 1/3 firms by MNC or diaspora

- Diaspora intermediates
- TI and Citi pioneer offshore model

How did the underdogs turn into tigers? Two Levels of Analysis & Explanation

- Macro: *Economic Development with Unlimited Supplies of Labor*
- Abundant human capital supply
  - relative to domestic need
  - Partly due to poor economic performance
- Openness and links with export markets
  - Falling telecom costs
  - Expatriates ("brain drain")
  - English language
  - MNC contacts (esp. Ireland)
- Good timing and luck
  - liberalization when economic boom and global IT skill shortage

Firm level

- Strong entrepreneurial response and accommodating policy
  - High rates of entry
  - Edu institutions respond
  - experimentation
    - market (geography)
    - market (product or service)
    - business model (e.g., service delivery)
  - learning and capability acquisition
- Economists have neglected the role of firm capabilities
- Comparative advantage is not fine grained enough
  - Actual exports tend to be very concentrated.
  - Hausman and Rodrik – "Industrial success entails concentration in a relatively narrow range of activities" because countries have *learn* what precise product lines and activities at which they are likely to succeed
- Likely reason why other English speaking, human capital abundant countries such as Philippines, Pakistan and Bangladesh did not make it.

Development of firm capability

- Comparative advantage sets the stage but does not provide the script
- Success requires selecting the right set of activities (per Hausman and Rodrik) or the right *business model* but also doing them well
- Once understood, this understanding (which is likely to be very tacit) is amplified through spinoffs and imitation
- Considerable experimentation of the right business model
  - domestic market vs export;
  - product vs process;
  - onsite vs offshore;
  - high end business consulting vs low end programming
- How to execute with 40% turnover of employees, capital constraints, poor brand image outside, need for close client interaction ...
- Indian SW firms have, after considerable experimentation and effort, developed the hybrid delivery model *which uses talented but poorly trained and inexperienced workers.*
  - CFO of Infosys has become the human resource chief!

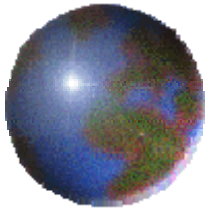
- "When I was out there in 1991, the country was bankrupt. We had three governments in one year, an assassination of a prime minister, and we were hawking our gold. You know, selling overseas was not a piece of cake…. if I have to present ten slides, the first eight had to be to sell India and the ninth one would say we do have an IT industry in India and unless the guy bought those nine slides, your tenth one about your company was meaningless. Because who are you anyway? Fifty people -- its no big deal. So we were building up the (India) brand from day one"

(A founder-member of NASSCOM, interviewed by Suma Athreye, 2005, cited in Athreye and Hobday, 2006)

Examples of large contracts obtained by Indian SW firms

Date	Indian firm	Client	Contract type	Value (million) (period)
2006	Mahindra	BT	SW and service	$1000 +
2006	Wipro	GM		$27-$300
Sep 2005	TCS	ABN	SW Dev	$260
Sep 2005	Infosys	ABN	SW Dev, maintenance	$140
Aug 2003	L&T	Motorola		$70-90 (3-5 yrs)
Aug 2003	Satyam	Certain Teed (USA)	Implement supply chain solution.	$15 (9 months)
Jun 2003	HCL	Airbus	Embedded SW	-
April 2003	HCL	B T group (UK)	Business telemarketing, billing conferencing	$ 160 (5 years)
April 2003	Infosys	BT group (UK)	Second service provider for BPO services	- (5years)
Mar 2003	Patni r	Guardian Life (US)	Gap analysis and implementation.	$35 (7 years)
Mar 2003	Ramco-Boeing	Aloha Airlines (US)	Technical services with main marketing by Boeing (50% of revenues for each)	-
Nov 2002	TCS & Wipro	Lehmann Bros.	IT outsourcing	$50-70
Jan 2002	TCS	GE medical	'Take or pay' model,	$100-120 (2 yrs)
July 2001	Wipro	Lattice Group (US)	Outsourcing	$70 (3 years)

Indian firms are moving up the value chain,
but not necessarily the technology ladder, AND this is OK.



What does this mean for other countries wishing to develop a SW industry?

Economic Impact of SW in the 3Is

Direct

- Ireland: High
  - 11% of GDP** and 10% of Exports
  - 1.7% of employment (~30,000)
- Israel: Moderate.
  - Hardware is much bigger
  - 55K employed vs 30K in SW
  - $12.5 B vs $3.5 B in SW (35,000)
- India: Modest
  - 2.3 % of GDP, 20% of exports
  - Small % of employment (but rapidly growing for English speaking) ~ 300,000 to 400,000

Indirect

- India: Significant as catalyst and exemplar
  - 10% of GDP growth in last decade
  - Catalyzed progress in capital markets, corporate governance
  - “Made in India” brand – Helps BPO (call centers, transcription services…)
- Ireland: Large impact – catalyst and exemplar
  - First *indigenous* success story
  - Exemplar for univ-industry links
- Israel: Moderate
  - Important for success in HW, telecom

Origins of leading BPO firms: (Domestic SW origins highlighted)

Dataquest top BPO firms, 2005

	Empl	Start Year	SW	Origin
Genpact	26000	1997		Spin-off (GE)
IBM Daksh	18000	2000	Yes	
Wipro	16000	2000	Yes	(Acquired Spectramind, a startup)
WNS	10000	1996		Start up – Diaspora
Convergys	10000	?		MNC
HCL BPO	10000	2001	Yes	
Intelnet	9500	2000		Startup – HDFC
Mphasis	8300	1999	Yes	Spin-off (Citibank)
Aegis	8000	2004		Business House (Essar)
Sutherland	8000	1986		MNC
Hinduja TMT	7500	2001		Business House
ICIC One-Source	7300	2001		
EYesL	7300	1999		Start up – Diaspora
Progeon (infosys)	7000	2002	Yes	
24/7	7000	2000		Startup – Diaspora
TCS	5000	?	Yes	
Efore	3200	1999		Startup-Diaspora
Vcustomer	3000	1999		Start up – Diaspora
Sitel India	3000	2000		MNC
Transworks	2235	1999		Business House (Birla)
GTL	1700	1999		
Datamatics	1125	1991	Yes	
Techbooks		1988		
Efunds				MNC

Impact in India

"Software was virtually the first instance where wealth was created honestly and legally, and more important, visibly so. Before this, wealth came from breaking laws or at least bending them to one's convenience, using existing political and economic power. Hitherto commercial success had invited envy, cynicism and even outright hostility, and only rarely, admiration. While envy and hostility are by no means gone, there is much more of admiration, and more importantly, a desire for imitation."

Conclusion: From Underdogs to Tigers 2005

Exportable Lessons

Relearning Old Lessons

- Human capital investments
  - Primary education still a better bet?
  - Need international agreements to sustain
- Openness ("Export optimism")
  - Export led
  - English
  - Diaspora
- Comparative advantage
  - The dangerous lure of "hi-tech"
- Do not make good the enemy of best

New Lessons?

- Leverage temporary advantage
  - Success breeds success
  - Policy must adapt
- Trust in entrepreneurs
  - Pessimism unjustified
  - Policy should not try to control
  - Need space for experimentation
    - Indian firms experiment with domestic markets
    - Experiment with business model
- What do MNCs bring to the table?
  - Not tech as much as contacts, business skills?
  - Breeding ground for future entrepreneurs