China's National Innovation System as an Ecosystem: Investigation through Input and Outcome

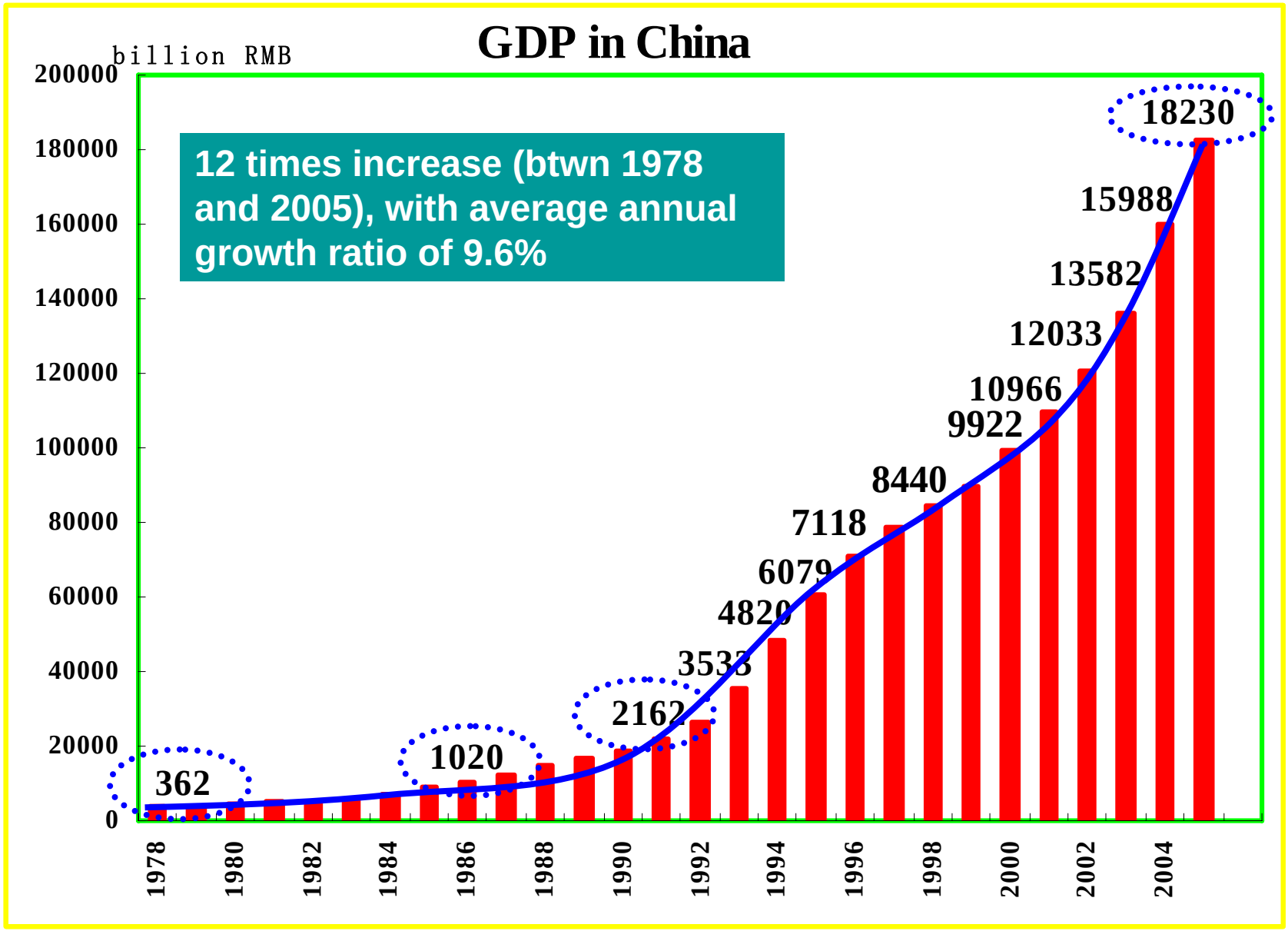
Chen, Xiangdong,
Professor, International Technology Transfer & Innovation Studies
The School of Economics & Management
Beijing University of Aeronautics & Astronautics
Beijing, 100083, P. R. China

National Innovation Ecosystem

- *Sustaining national innovation:*
  - *National and International Innovation Environment*
  - *Through internationalization of innovation*
    - Competition based view: domestic / endogenous innovation;
    - Collaboration based view: international / exogenous innovation

Innovation Environment in China

- National innovation system:
  - Basic research: National support system
  - Sector based R&D institutions: transition stage
  - Firm based innovation activities: highly influenced by FDI
- China’s Economic Growth as innovation background.


GDP in China
billion RMB
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
12 times increase (btwn 1978 and 2005), with average annual growth ratio of 9.6%
362
1020
2162
3533
4820
6079
7118
8440
9922
10966
12033
13582
15988
18230
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004

Rank of GDP in the world

1990 : 11th

2000: 6th （after the US、Japan、Germany、England, France）

2001: 6th

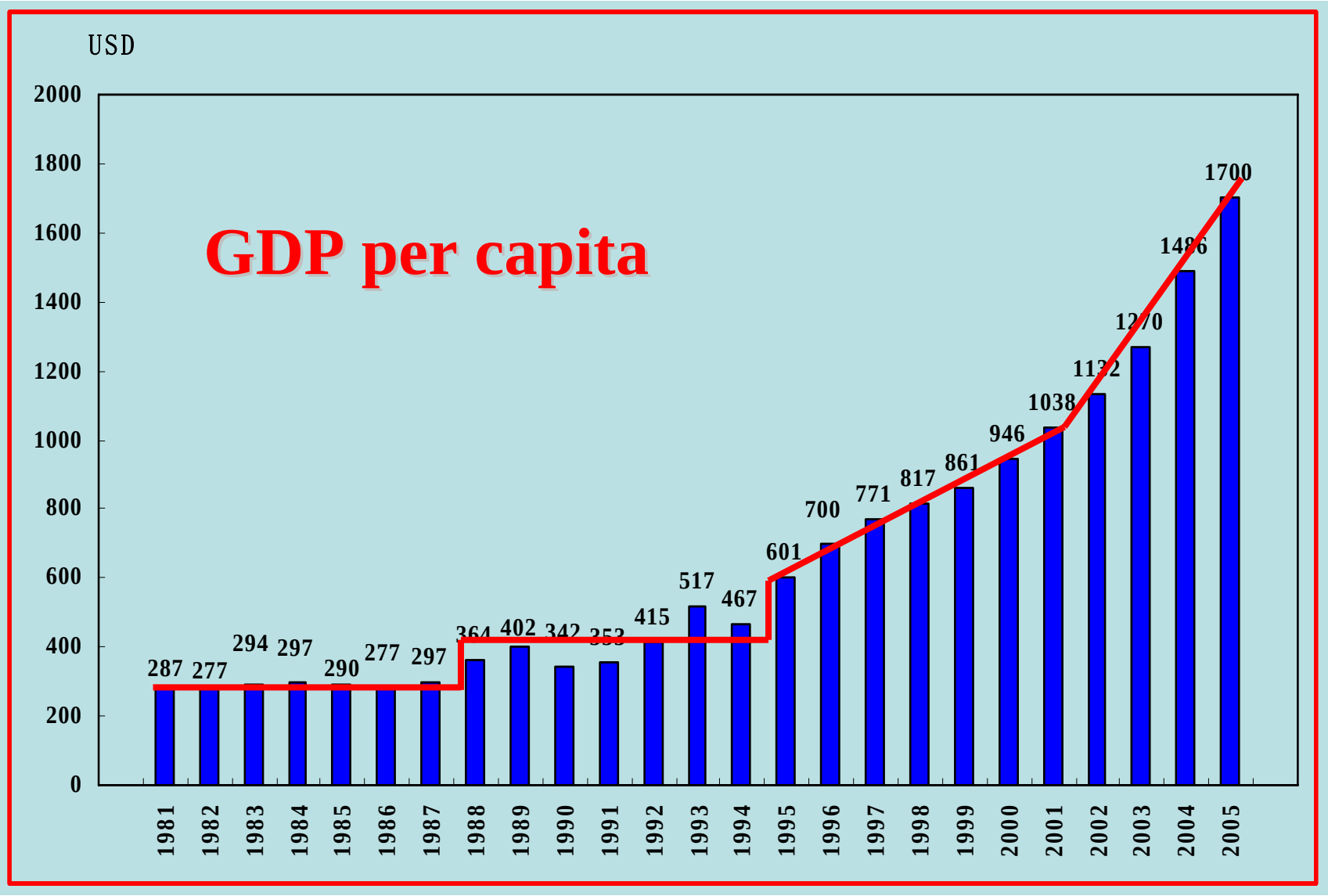
2002: 6th

2003: 6th （before consensus: 7th）

2004: 6th （before consensus: 7th）

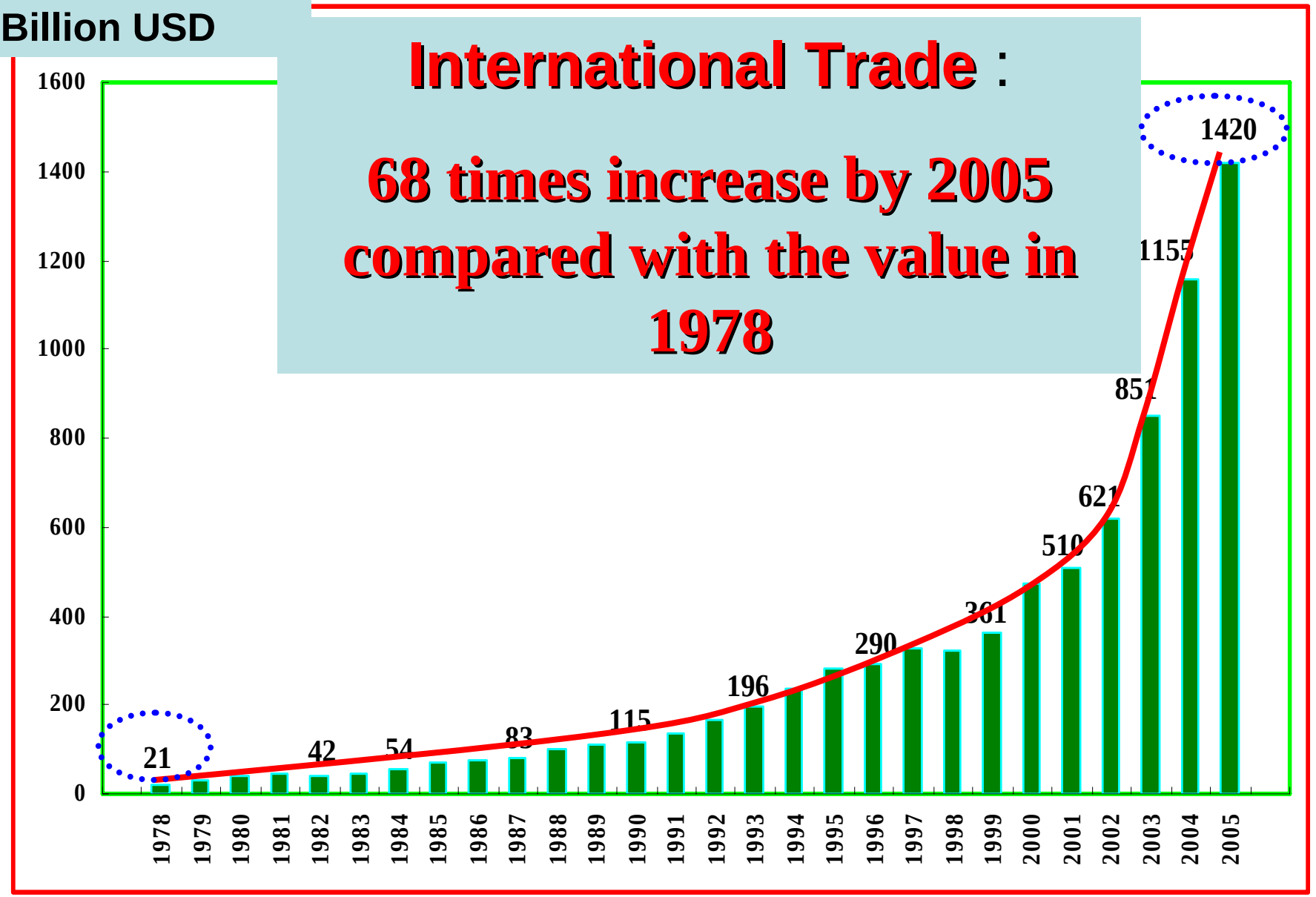
2005: 4th （after the US、Japan、Germany）

—— IMF


USD
GDP per capita
2000
1800
1600
1400
1200
1000
800
600
400
200
0
287 277 294 297 290 277 297 364 402 342 353 415 517 467 601 700 771 817 861 946 1038 1132 1270 1486 1700
1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005

International Trade :

68 times increase by 2005 compared with the value in 1978



Rank in international Trade (Expt + Impt)

1978 : 25th

1989 : 14th

2000: 7th

2001: 6th（after the US、Germany、Japan、France、England）

2003: 4th

2004: 3rd（after the US、Germany）

High tech sectors,
2/3 export value
is contributed by
FDI firms in China

Endogenous vs. Exogenous Innovation

- Domestic based / endogenous innovation
  - Science / technology
    - Science Park / High tech - zone
    - Start-Ups / Entrepreneurship in high tech fields
    - University-Industry relationship …
  - R&D in industries
- Overseas based / exogenous innovation
  - International technology transfer / license
  - FDI (spin-over effects)

I. China's Innovation Environment:

- Autonomous / Indigenous / innovation
  - National Autonomous / Indigenous Innovation :
    - Original innovation / self-owned in terms of IP
    - Integrative innovation;
    - Innovation on imported technology (secondary innovation).
  - Open system
    - International collaboration
    - Strong focus on in-house R&D

Innovation Policy Structure

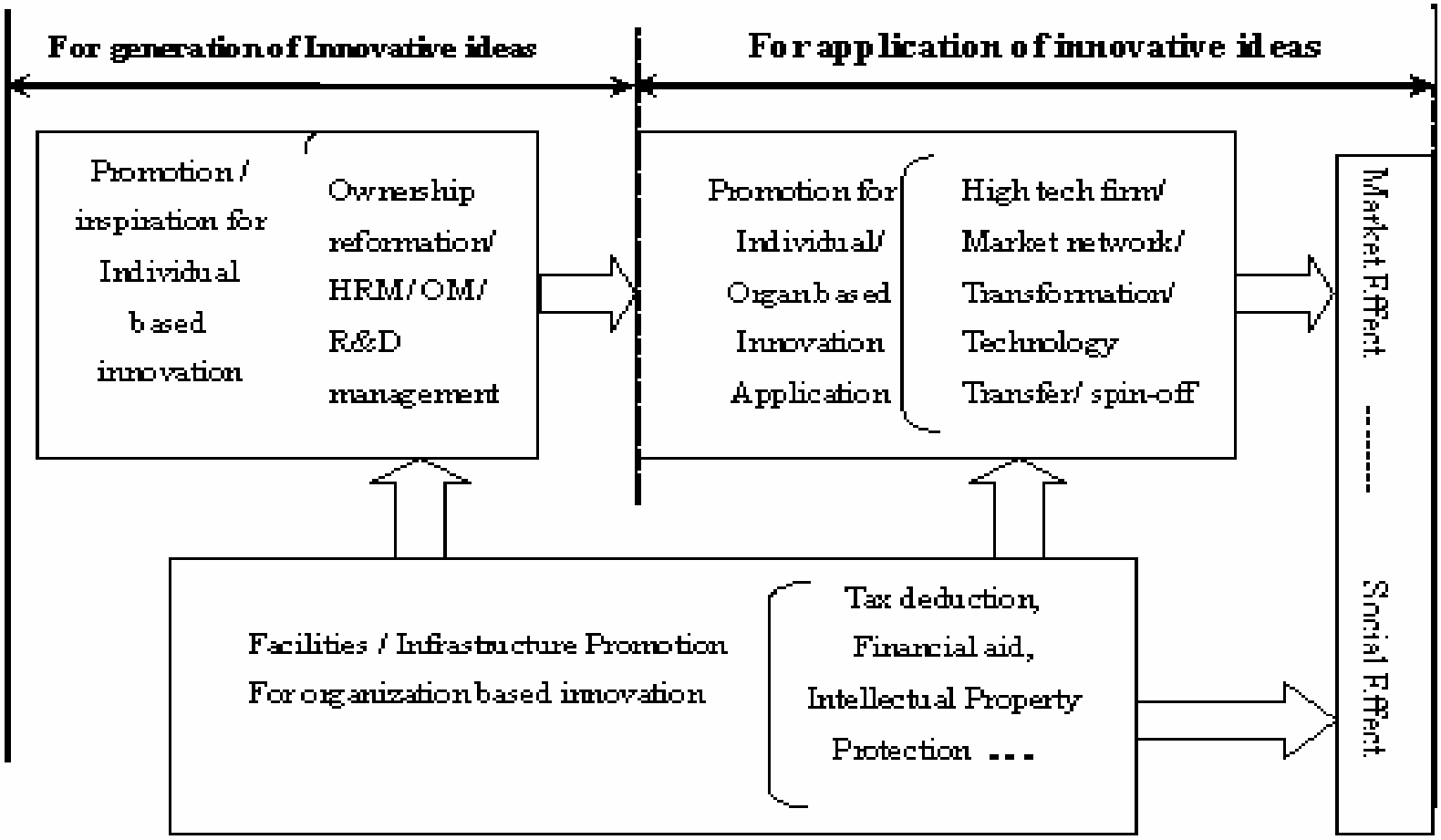
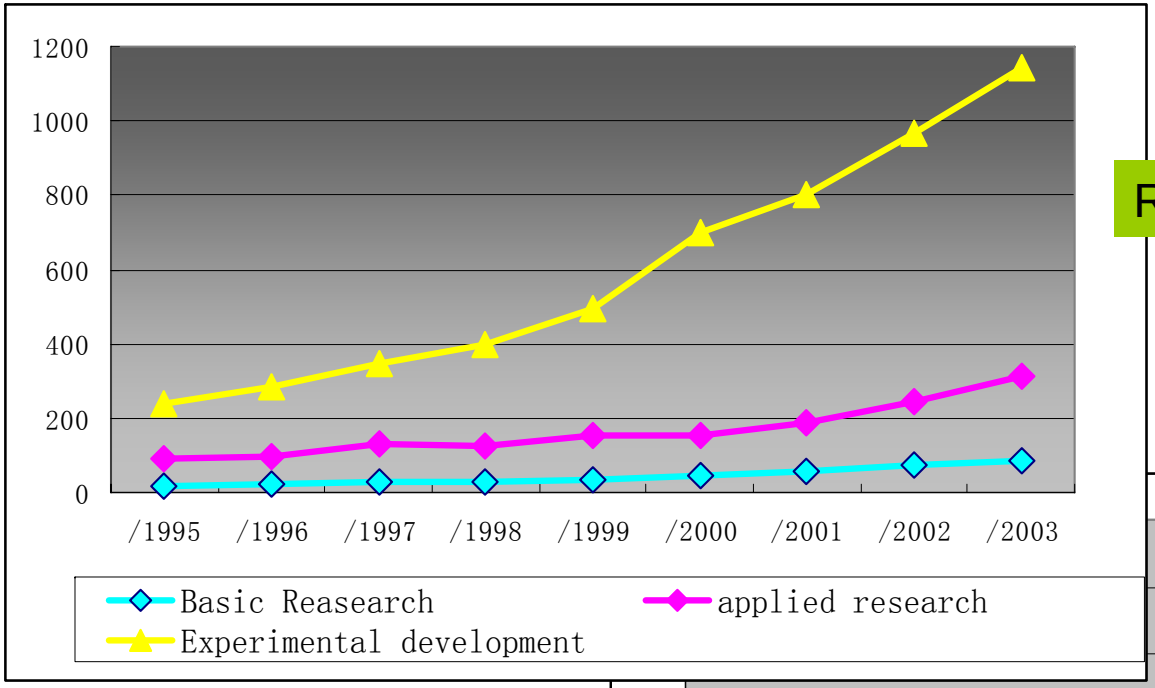
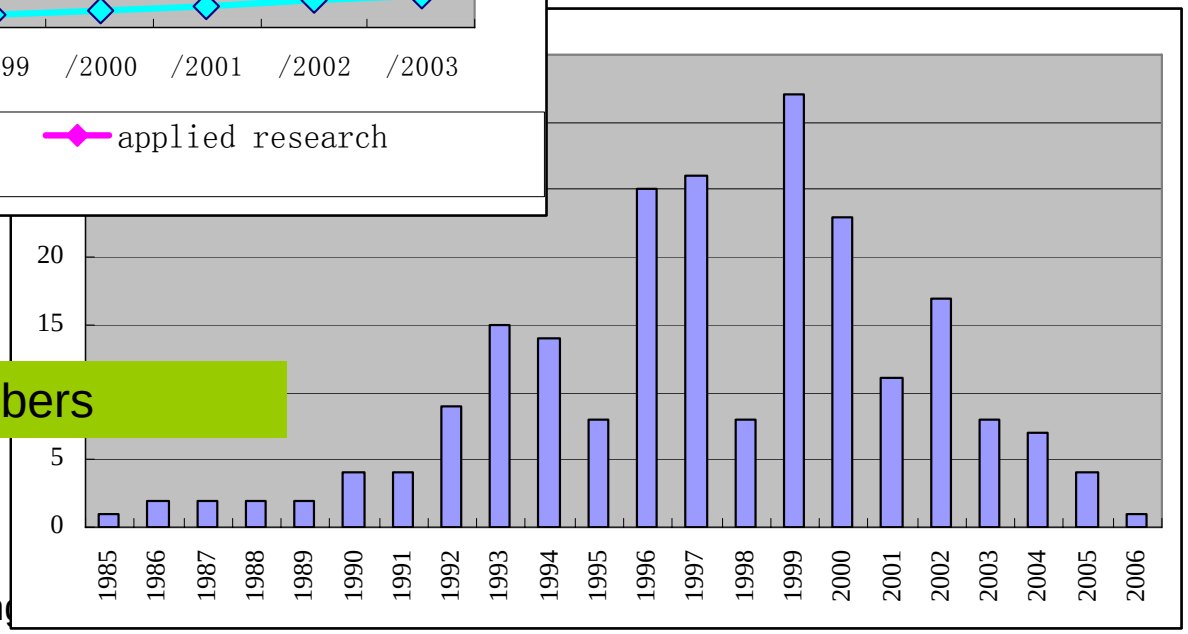


Figure 1. Innovation Policy: Input / Output Structure in China

Innovation Policy



R&D expenditure



Innovation Policy by Numbers

Policy focus

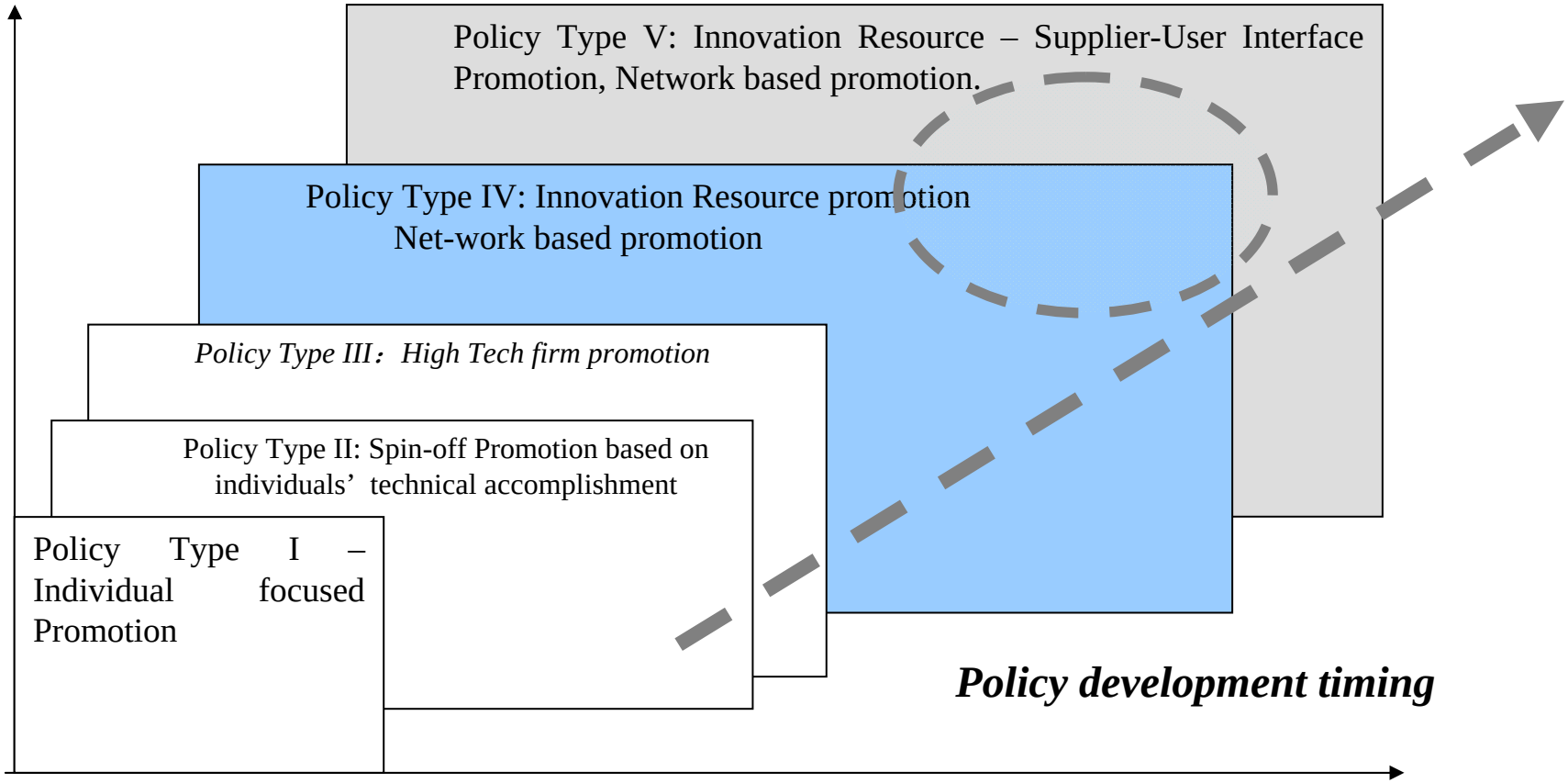
- Policy to encourage new ideas
  - Early time in 1980's
- Policy to improve applications of new science & technology research output.
  - 1990's till present
- Policy to strengthen innovation networks
  - In the near future.

Table 2 China's major innovation policy: distribution pattern.

Policy / Share	Bonus for S&T Accomplishment	Technical Diffusion based promotion	High Tech firm establishment	High Tech firm Tax & Financial support	Knowledge innovation environment		Scientific Research System Reformation	Other	Total
					regulation	Legislation			
%	5.3%	14.7%	18.7%	13.8%	27.1%	5.3%	8%	7.1%	100.

Policy Environment

Policy effect on social / market



Typical Facts

- Torch Scheme: National High Tech Commercialization Plan;
- 53 high tech industrial development zones established since 1991;
- 10 high tech industrial development zones (Beijing, Xi'an, Su-Zhou, He-Fei, Yan-Tai, Wu-Han, Shanghai, Shen-Zhen, Cheng-Du, Yang-Ling) are open for APEC member countries and districts;
- High tech companies established:
  - 1991: 2587
  - 2000: 20796
- High tech firm employees:
  - 1991: 138231
  - 2000: 2509076
- High tech firms output:
  - Till 2000: revenue from technology and trade: 1252 firms with revenue higher than 100 million RMB, 143 firms with revenue higher than 1 billion RMB.
- Patents record in China (April 1985 -- Aug.2006):
  - Grant to domestic owners: 1405172; 85.8% (Invention: 103593, 37.2%; Utility Model: 791464, 99.2%, Industrial Design: 510115; 90.4%)
  - Grant to foreign owners: 233426; 14.2% (Invention: 173301; 62.8%; Utility Model: 6070; 0.8%; Industrial Design: 54055; 9.6%)

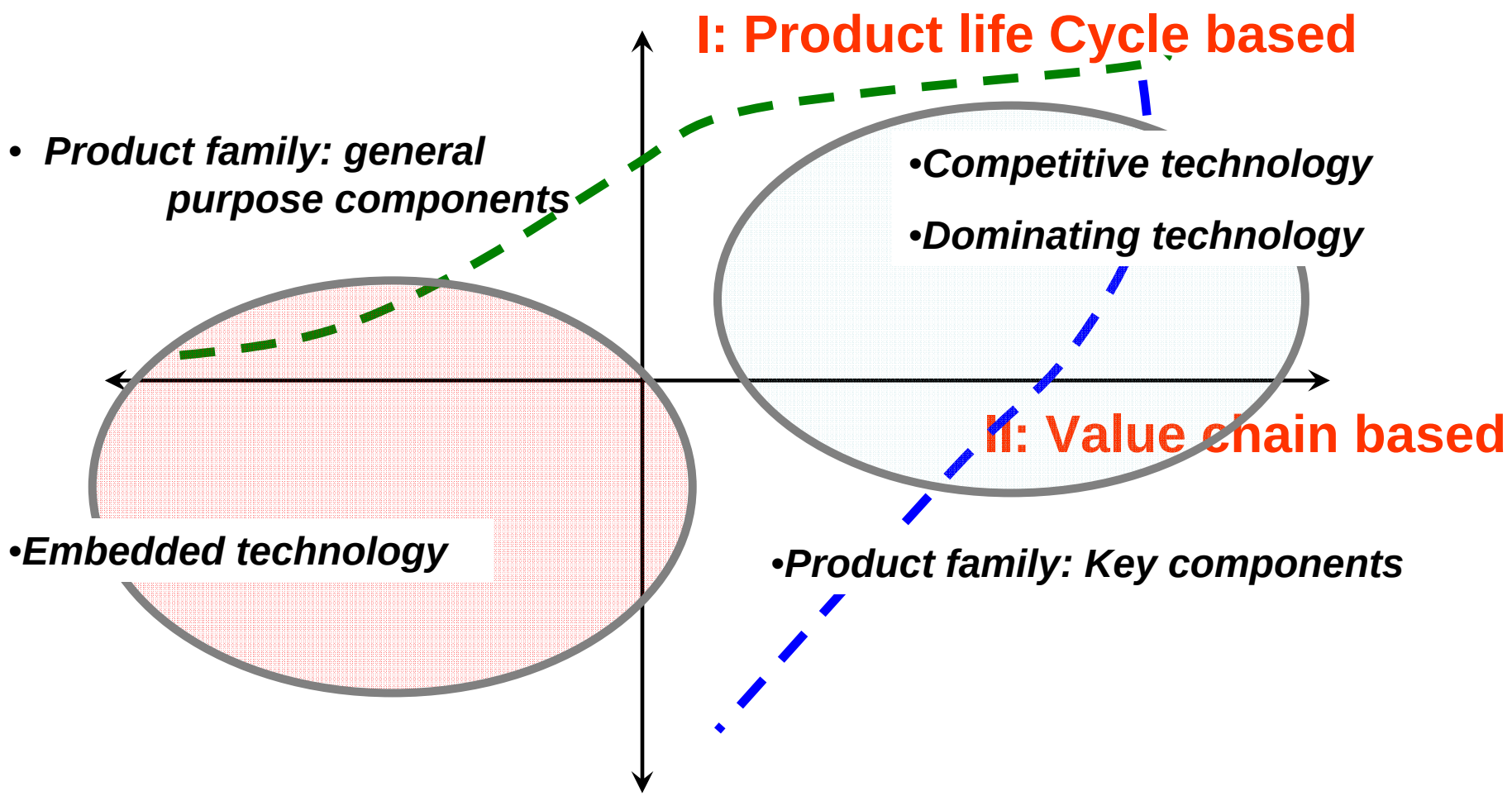
II. Major Driving Force for Innovation in China

- Local innovation base:
  - Local funding capacities
  - Local R&D personnel
  - Local technology and engineering facilities
- FDI
  - Transferring technology into foreign invested firms (product life cycle based view)
  - Supply chain based technology spillover (value chain / modularization based view)

FDI based innovation

- Innovation happens because of other innovations.
  - Technology life cycle. (management based innovation)
    - International export / import of completed goods
    - International capital flows (FDI): local production for local market.
  - Supplier – Customer relationships in terms of technology / possible innovation; (modular / integration based innovation)
    - International export / import of components / intermediate product.
    - International capital flows (FDI): local production for international market / export back

Integrated Market



$$C_{ij} = \frac{JV_{ij} - SO_{ij}}{JV_{ij} + SO_{ij}}$$

Empirical investigation: Exogenous vs. Endogenous Innovation

Comparison of 16 indicators of Innovation activities between FDI firms and local firms. Data selected from 27 geographical regions in China

JVij: the value of the jth innovation measurement of FDI firms in region i，

SOij: the value of the jth innovation measurement of local firms (usually state-owned) in region i.

Apparently, if Cij＞0, FDI firms are dominant in a particular region on certain innovation measurement, and Cij has the value between -1 and +1

$$C_{ij} = \frac{JV_{ij} - SO_{ij}}{JV_{ij} + SO_{ij}}$$

Exogenous vs. Endogenous Innovation

(1) Resource connection with overseas parent companies (Input from parent companies)

- science and technology funding from overseas;
- expenditure for adoption of imported technology

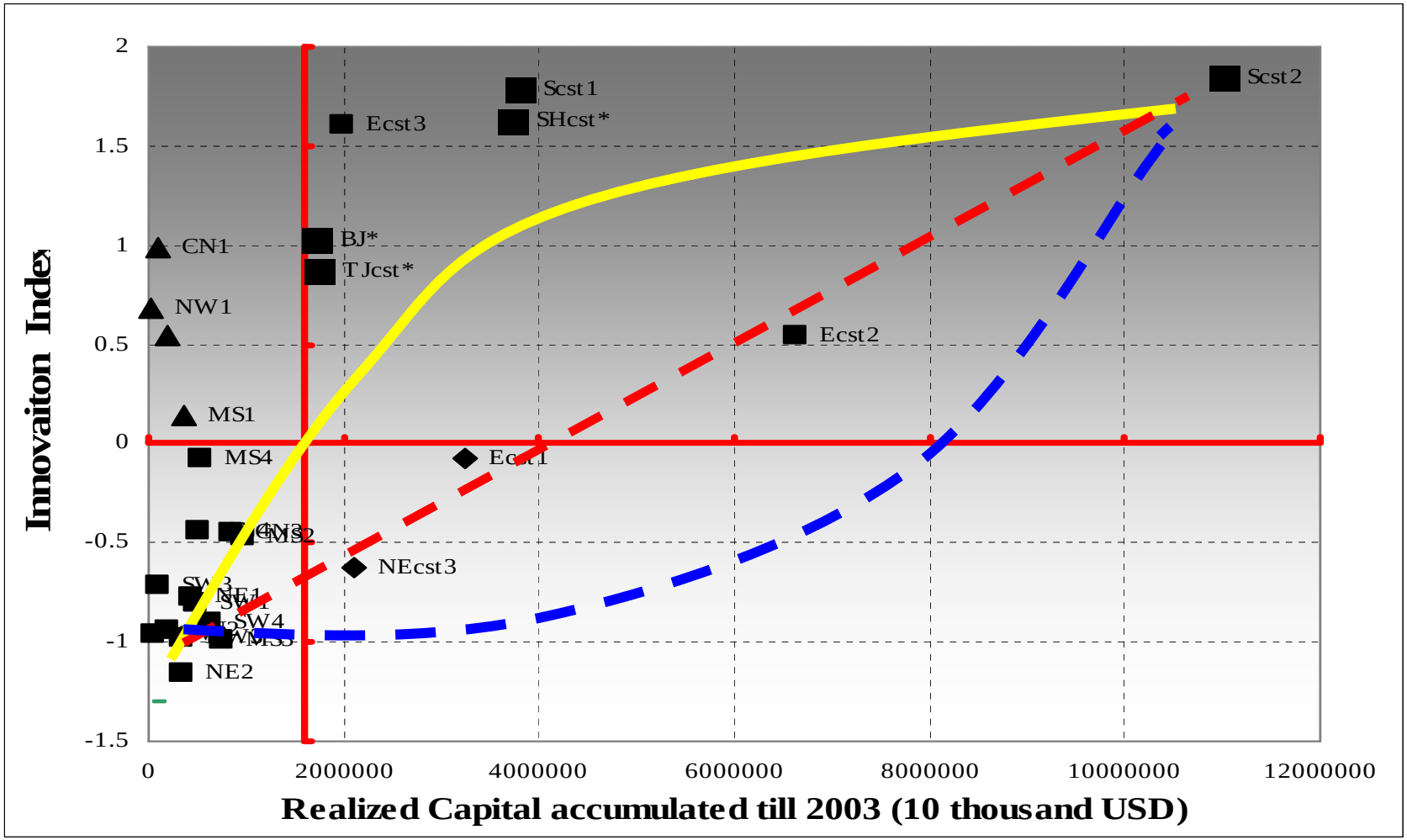
(2) Intra-firm innovation activities: (Input)

- intra-firm expenditure on science and technology activities
- new product development fund
- expenditure for in-house science & technological institution
- expenditure on in-house technology equipment reformation
- expenditure for technology purchase from China's market.
- Total number of technical personnel in foreign invested firms.
- total number of scientific & technological institutions owned by foreign investment
- total number of enterprises that have their own technology development institutions

(3) Intra-firm innovation activities: (Output)

- total production value by new product
- sales revenue generated by new product
- profit level generated by new product
- Numbers of new product development projects
- Numbers of patent application to local Patent House.
- Numbers of invention patent granted by the local Patent House.

Influence from FDI

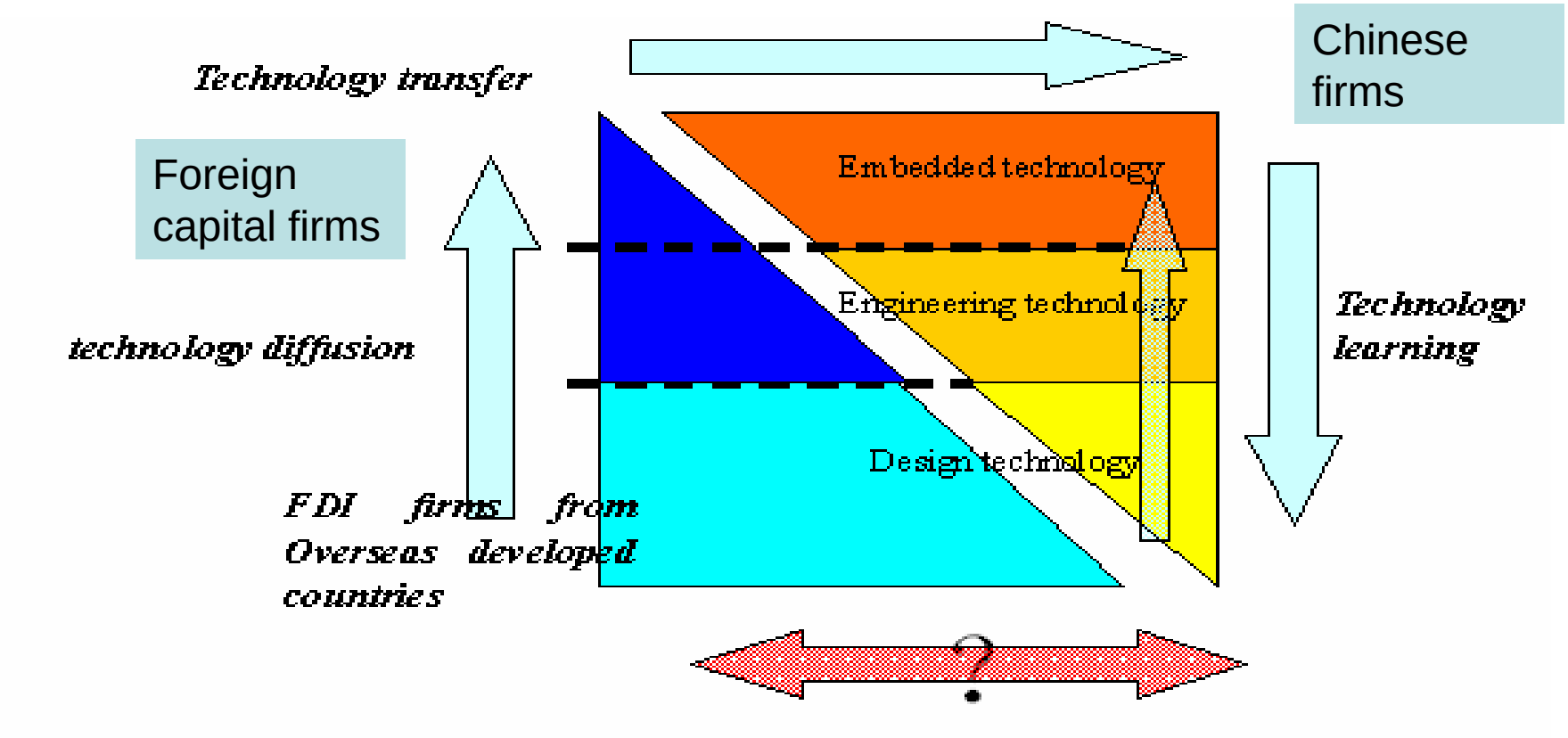


III. Pattern for China's innovation Eco-system

- Input / Outcome
  - Indigenous innovation resource
    - Vertical technology transfer
    - National supported R&D
    - R&D human resources.
  - Exogenous innovation resource
    - Double triangle system
    - FDI and MNE dominated
- International collaboration
  - Research
  - industries

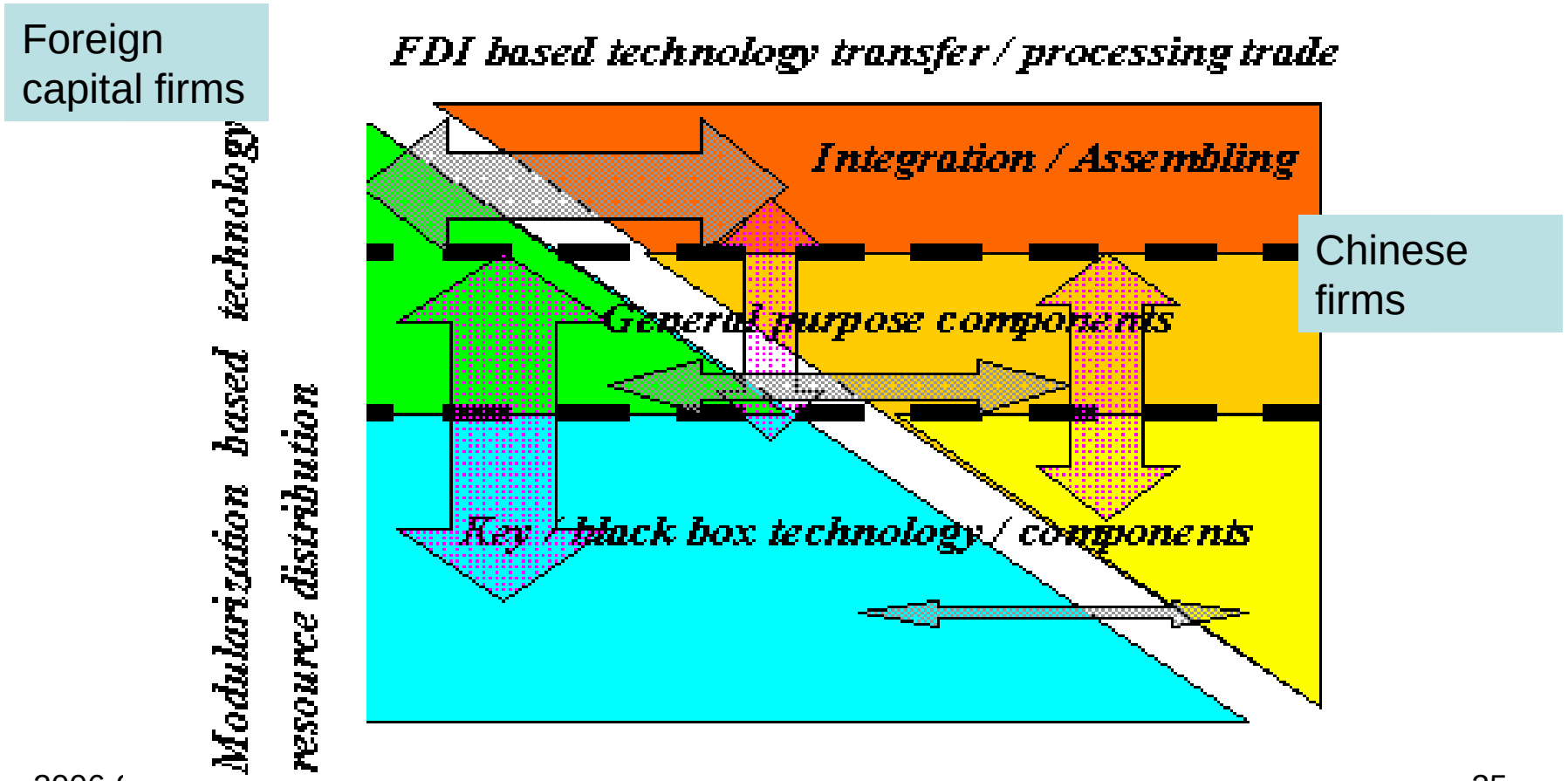
A sustainable development of technology in international background

- Technology life cycle:



A sustainable development of technology in international background

- Supplier – buyer / Modularization based Innovation



Double Triangle Relationships

- I: integrated product: technology life cycle
  - Transferred technology primarily as embedded ones
  - Lower value added section in the cycle.
  - Difficult learning channel from embedded section to design section of the technology system.
- II: Value Chain / Modularization based:
  - Transferred technology primarily as codified ones
  - Lower value section in the chain.
  - Possible but difficult learning channel from lower value part to special purpose modular components

Eco-system from different point of view

- Eco-system from FDI point of view:
  - Product life cycle based technology transfer
  - Value chain / modularization based technology spillover
- Eco-system from indigenous innovation point of view:
  - Local technology transfer from research to industries
  - Upgrading product technology through industrial R&D
  - Local technology resource matched / complementary with foreign technology resource

Conclusion

- Eco-system for developing countries:
  - Technology life cycle in global sense
  - Value chain / Modularization based innovation in global sense
  - Self owned technological innovation / open system to access exogenous innovation resources.
- China's innovation system:
  - University – industry – government relationships (resource for endogenous innovation)
  - Local companies' innovation capability (capability to adopt / capture exogenous innovation)

Strength

- Qualified manufacturing base;
- National supported R&D;
- Human capital in research;
- Active connection with overseas scholars;
- FDI based innovation.

Weakness

- Vertical transfer of technology into industries;
- Technology & innovation based networking;
- R&D in industries;
- Environment for entrepreneurship;
- FDI & MNEs' "technology Lock-in effect"

Thank you for your kind attention, wishing further contacts and collaboration on Global Innovation Ecosystem in the near future!

Professor CHEN, Xiangdong,
International Technology Transfer & Innovation Studies,
The School of Economics & Management,
Beijing University of Aeronautics & Astronautics,
Beijing, 100083, P. R. China
E-mail: chenxdng@buaa.edu.cn,
chenxdng@yahoo.com.cn