China's Development Model: An Alternative Strategy for Technological Catch-up

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- 3.New environment for China's catch-up
- 4.China's alternative catch-up model
- 5.The case of mobile phone handset industry
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1.Theory of catching up

- There are two different approaches to explain the process of catching or lag behind.
- In early neoclassical growth models, technology can freely spill across countries and this will lead to certain convergence (Solow, 1956).
- By contrast, research in more historical, institutional and evolutionary traditions rejects simplifying assumption about technology. They emphasize that technological innovation does not flow freely across countries. The innovation process is closed related to specific firms, networks and economic institutions (Freeman, 1987, Nelson, 1993). Here, technology is the key issue in the catching-up process.
- There are lots of countries who used “window of opportunity” of their time to catch up, such as USA in late nineteenth, Japan in 1960s-1980s, Korea and Finland recently, etc.

Catching up in Asia

- For Asian catch up, most of them take the role of government vs. markets as the most important variable (World Bank,1993; Amsden 1989).
- A different approach is from perspective of technological innovation and national system of innovation (Kim, 1997). For example, Lee and Lim (2001) think that technological regime is very important framework to understand why some industries did catch up and why others not. In Korea, Automobile and IC catched up but PC and consumer electronics failed.

2.Catching up: the Japanese and Korea Model

- Three assumptions of catch-up
- Firstly, it is advantage of late development. Gerschenkron studied the catch-up process in the steel industry by German firms in 19th century. He argued that it was very important for the latecomer to target progressive and dynamic industries to compete globally through investing in the most modern equipment and plants (Gerschenkron, 1962)

- Secondly, technology and its institutional setting are the key factors in catching-up process. This approach emphasizes on the historical context and the institutional framework in the catching up process. Freeman noticed the role of institutions in his research of Japanese experience of catching up with developed countries in 1960-80s (Freeman, 1987), such as making factory as a research lab, job rotation in firms, the role of MITI.

- Thirdly, it is related to product cycle theory (Vernon,1966). The theory holds that, leading companies with dense R&D investment will lead to radical innovation, open a product innovation space. After the industry reaches its mature stage, the leading companies will shift its production to developing countries. If the companies in developing countries had the capability of learning, then, they may find the opportunity of catching up.

The practice of catching up in Japan and Korea

- Three stages from imitation to innovation
- The first stage is to acquire mature technology from developed countries; the companies will learn some production technology from this. In Japan, technology import and reverse engineering are very important for catching up for the first stage. In 1950s and 1960s, Japan imported lots of technology in automobile, machine tools and other industries. Up to 1988, Japan was the largest country in payment to technology importation in major countries (Odagiri and Goto, 1993).
- In the Second stage, process development and product design technologies are acquired.

- Take incremental process innovation as their core competence to win the competition with companies in developed countries. This is a reversed innovation process: Rather product innovation first, process innovation later as told in Abernathy-Utterback model, catching up firms adapted Process innovation first, product innovation later (Kim, 1997).
- In Japan, reversing engineering and in-house R&D are their top priority in industrial enterprises to catch up. Japanese firms had a strong propensity to invest in production processes. (Odagiri and Goto, p.100).
- In the third stage, companies will do R&D work and get the capability to product innovation.

Japan unique model of innovation

- through reverse engineering, Japanese firms created a new style of innovation management with reintegrated R&D with engineering design, procurement, production and marketing even in a largest organization (Freeman, 1988, p.337)".
- On the other hand, Japanese enterprises have developed a new type of R&D: their work was closed related to the work of production engineers and process control. So there is a good integration of R&D, production management and marketing.
- Lastly, Japanese firms made few radical innovation as American firms do, but they have made lots of incremental innovations so that to make the product better and better in quality and function (Freeman, 1988, p. 335).

Paradigm of Japan and Korea's catching up

- Why this model works:

- Product cycle theory: radical product innovation in USA first in early stage, in mature stage, shifted to Japan, based on that, with in-house R&D, introduced lots of process innovations. That is, enter the industry in a late stage.
- Keep FDI away and focus on in-house R&D, more closed way of innovation. In 2001, Japan invests 4.5% of GDP in the form of FDI outside the Japan, but the inward FDI is the lowest in any OECD country and represent only 2% of world inward-FDI flows (Kimura and Schulz, 2004, p.31).
- The industries are integrated, complex manufacturing industries, like machine tools, automobile, house-electronic appliance, shipbuilding. Inter- and intra-industry's collaboration, the seniority system, lean production are good for that.

3.New environment for China's catch-up

- Firstly, information technology has changed the game of rule for catch-up. The life cycle of technology system is more relevant than single product cycles.
- In today's IT industry, lots of firms specialize themselves only on one activity. It makes use of global procurement of good and mobility of human resources possible. It takes advantage network externalities that seem to supersede Japanese closed networking system.

Modularity of manufacturing

- modular production becomes popular in a globally competition context. Modular production has the characteristics of low cost and high product variety. Modularity enables the outsourcing of design and production of components and subsystem within the product system architecture.

Global technology outsourcing

- Global technology outsourcing gives Chinese companies a new ways to make quick product innovations. Chinese firms have used the buy or technology outsourcing strategy more widely than Japanese firms. Leading firms in China take strategy of market-oriented innovation with technology outsourcing.
- The sources of technology can come from different countries, depending they are willing and do have the specific technologies, most of the time, from USA, Japan, European countries, Korea.

4.China's alternative catch-up model

- Market-oriented innovation: not the invention of Chinese firms, American do it first such as Dell, Cisco.
- Because of Chinese companies have limited capability in the in-house technology development, so they relies more international outsourcing, and this makes them to focus more the exploration of new market opportunity and adapted a market-oriented innovation model.
- Haier has offered more than 400 models of the refrigerators to the market.

Figure 2: Haier's market differentiation

Stratification White collar: Separate parts (air condition) Middle size or small size (Wash-machine) Elegance outlook Blue collar: Large and middle size (wash-machine) Luxurious outlook	Overseas Advanced countries USA Germany Japan France Developing countries Argentine Vietnam Iran…..
Style European strict Square door White color Asian elegant arch door color figure American ……	Regions North Large refrigerator Cool only air condition South Cool & warm air condition None-freezing refrigerator Rural twin cylinder(wash-machine) …. Seashore drying wash-machine ---

Table 1 The granted three kinds of patents in China Domestic vs. Foreign owners

	1991	1995	1998	1999	2000	2001	2002
Sum of three patents granted in China	24616	45064	67889	100156	105345	114251	132399
Invention patent	4122	3393	4733	7637	12683	16296	21473
From Domestic owners	1311	1530	1655	3097	6177	5395	5868
Share of domestic owners	**31.8**	**45.1**	**35.0**	**40.6**	**48.7**	**33.1**	**27.3**
From foreign owners	2811	1863	3078	4540	6506	10901	15605
Share of foreign owners	68.2	54.9	65.0	59.4	51.3	66.9	72.7
Utility model patent	17327	30471	33902	56368	54743	54359	57484
From domestic owners	17200	30195	33717	56094	54407	54018	57092
Share of domestic owners	**99.3**	**99.1**	**99.5**	**99.5**	**99.4**	**99.4**	**99.3**
From foreign owner	127	276	185	274	336	341	392
Share of foreign owners	0.7	0.9	0.5	0.5	0.6	0.6	0.7
External design patent	3167	11200	29254	36151	37919	43596	53442
From domestic owners	2667	9523	26006	32910	34652	39865	49143
Share of domestic owners	**84.2**	**85.0**	**88.9**	**91.0**	**91.4**	**91.4**	**92.0**
From foreign owners	500	1677	3248	3241	3267	3731	4299
Share of foreign owners	15.8	15.0	11.1	9.0	8.6	8.6	8.0

Source: China Science and Technology Statistics yearbook, 2003, Beijing.

Learning from technology outsourcing

- Technology import still plays an important role in China.
- International technology allies has become the main way of technology outsourcing.
- Huawei has formed joint laboratories with TI, Motorola, Intel, AGERE, ALTERA, SUN, Microsoft, NEC. It has set a joint venture with 3COM.
- The amount of technology outsourcing can be seen from the following table.

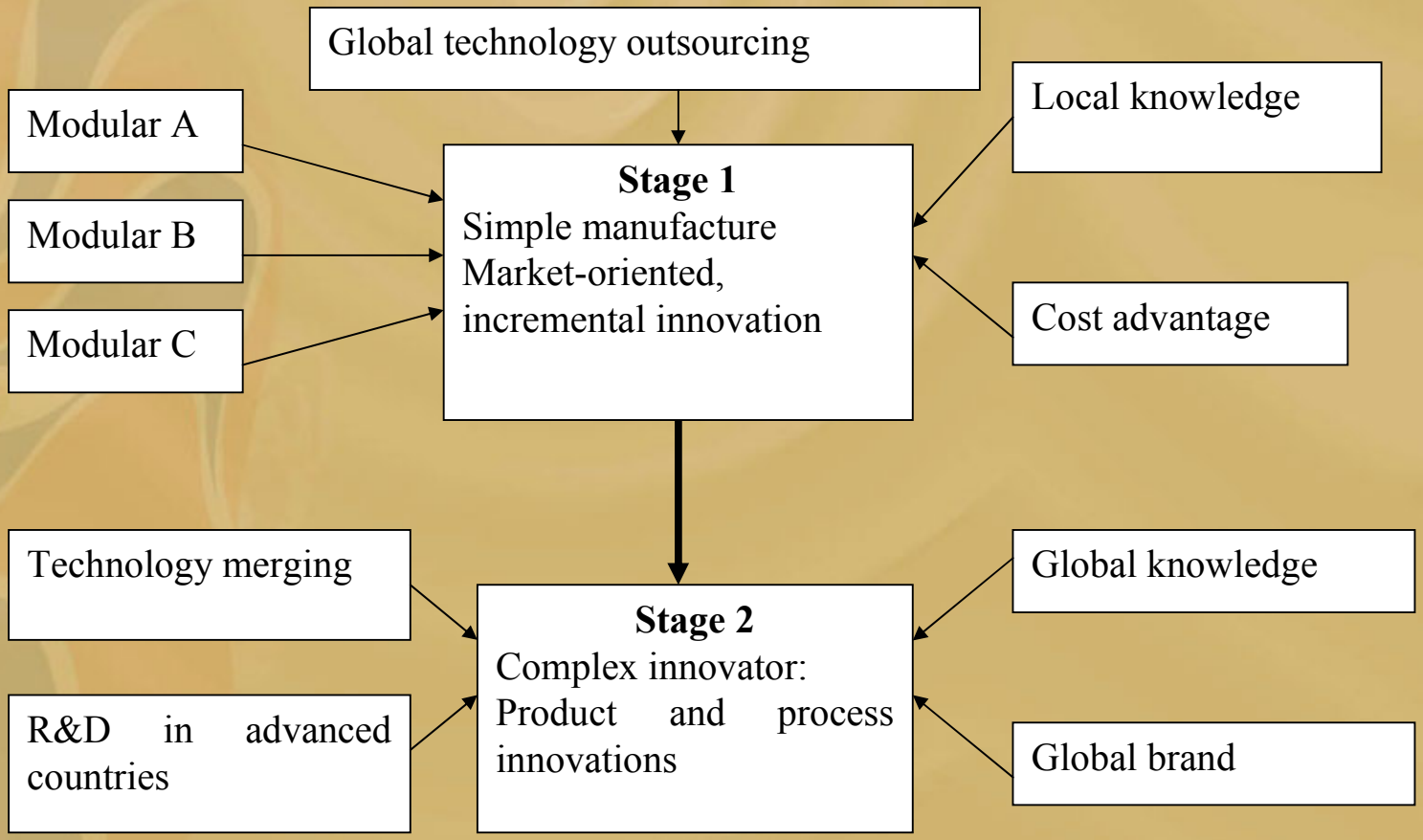
Table 2: The technology-related expenditure of large and medium sized industrial firms of China: million RMB

	1999	2000	2001	2002
Expenditure on R&D	24,993	35,359	44,234	56,017
Expenditure on R&D/sales	**0.60**	**0.71**	**0.76**	**0.83**
Expenditure on technology importation	20,755	24,542	28,587	37,250
Expenditure on technology importation via expenditure on R&D	1:0.83	1:0.69	1:0.65	1:0.66
Government funds	4,967	4,321	4,106	5,371
Government fund/industrial R&D(%)	**19.9**	**12.2**	**9.3**	**9.6**
Expenditure on technology buying from technology market	33,108	45,735	57,363	64,200
Expenditure on R&D via technology buying from technology market	1:1.32	1:1.29	1:1.30	1:1.14
Including				
Expenditure for contract research in universities	5,373	5,545	7,246	8,958
Expenditure for contract research in research institutes	3,455	3,792	2,536	3,627
Contract research to university and research institute/technology buying from technology market(%)	**26.6**	**20.4**	**17.1**	**19.6**

International alliance and merging

- International merging has been more and more important for Chinese companies to get latest technologies .
- in July 29, 2004, sighed an agreement with French company, Thomson to set an joint venture called TTE Corporation. The new venture has the capability of producing 20 million TV sets with revenue of 4 billion USA dollars sales in a year. This will make them the largest TV maker in the world.
- In the end of 2004, another merging shocked the world. Legend, spend 1.75 billion US dollar to merge IBM's PC business. In exchange, IBM will get 18.9% of equity share of Legend. The merging will expand Legend from current business of 3 billion dollars in revenue to a size of 10 billion dollars revenue in a year
- BOE, a CRT maker in Beijing, merged the TFT-LCD business of Korean Hyundai.
- So, Chinese firms follow a two stages catch-up.

Fig. 1 Model of China's two stages catch-up



Modularity and innovation: performance of some industries

- The processing industries, like chemicals and pharmaceuticals, are not easy to be modularized and will have a low degree of labor of division. It is expected to be poor in those industries.
- Electronics industry progresses in modularity and it is expecting that there will be more innovation and rate of growth in this industry.
- In automobile industry, the modularity and division of labor is between chemicals and electronics industries.

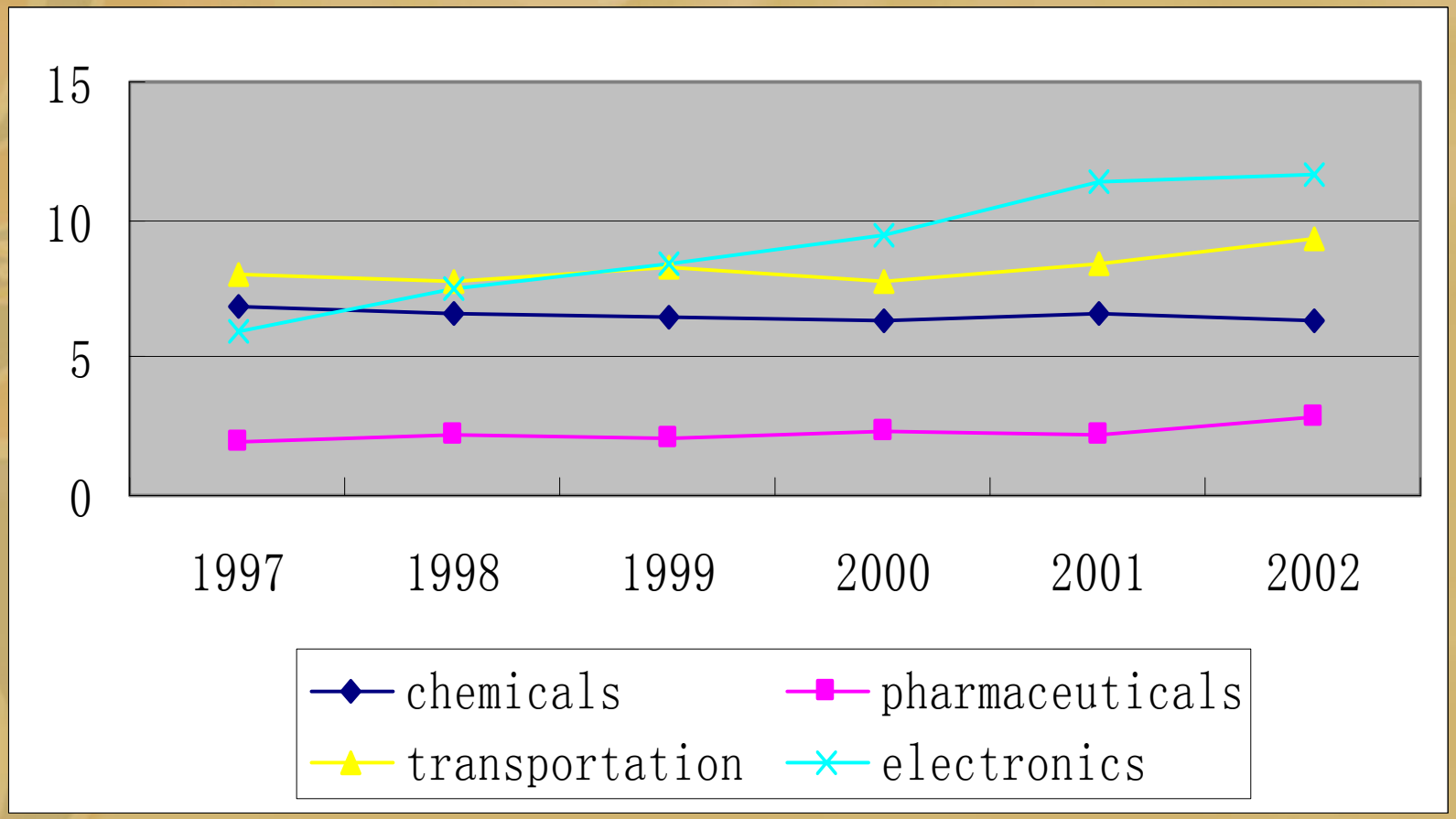
Table 3 Processing industries

	1997	1998	1999	2000	2001	2002
Total of all industries sales	3630	3746	4191	4985	5851	6745
Chemicals：sales	**248**	**249**	**272**	**316**	**388**	**426**
As of total industries%	6.8	6.6	6.5	6.3	6.6	6.3
New products sales	17.0	23.4	27.9	33.2	38.3	49.5
as of sales %	6.8	9.4	10.3	10.5	9.9	11.6
Patent application	210	246	274	767	778	770
Pharmaceuticals: sales	**73**	**82**	**89**	**113**	**128**	**190**
As of total industries%	2.0	2.2	2.1	2.3	2.2	2.8
New product sales	9	10	12	17	20	25
As of sales %	12.3	12.2	13.5	15.0	15.6	13.2
Patent application	257	275	283	547	735	1000

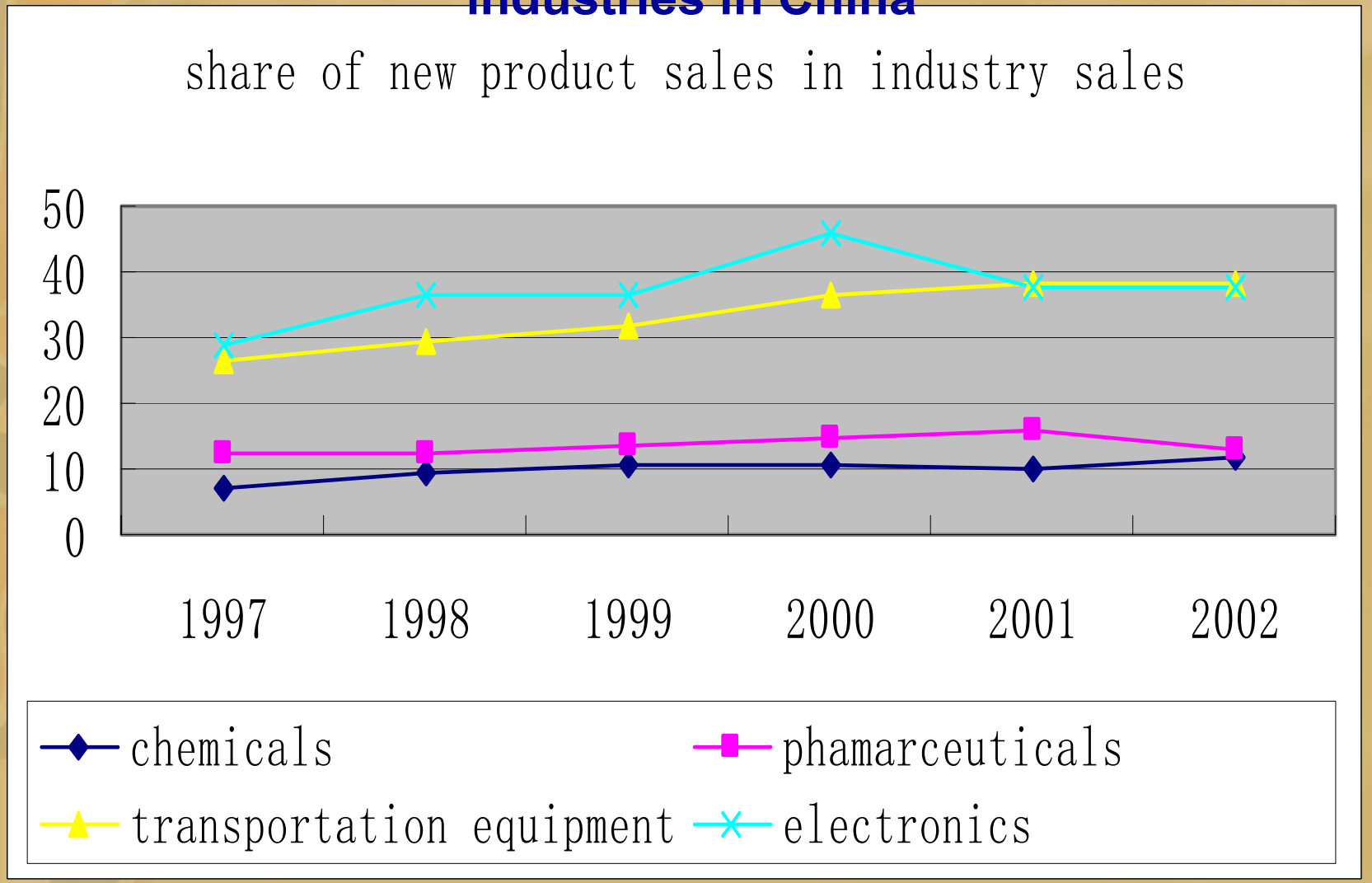
Table 4 Modular industries

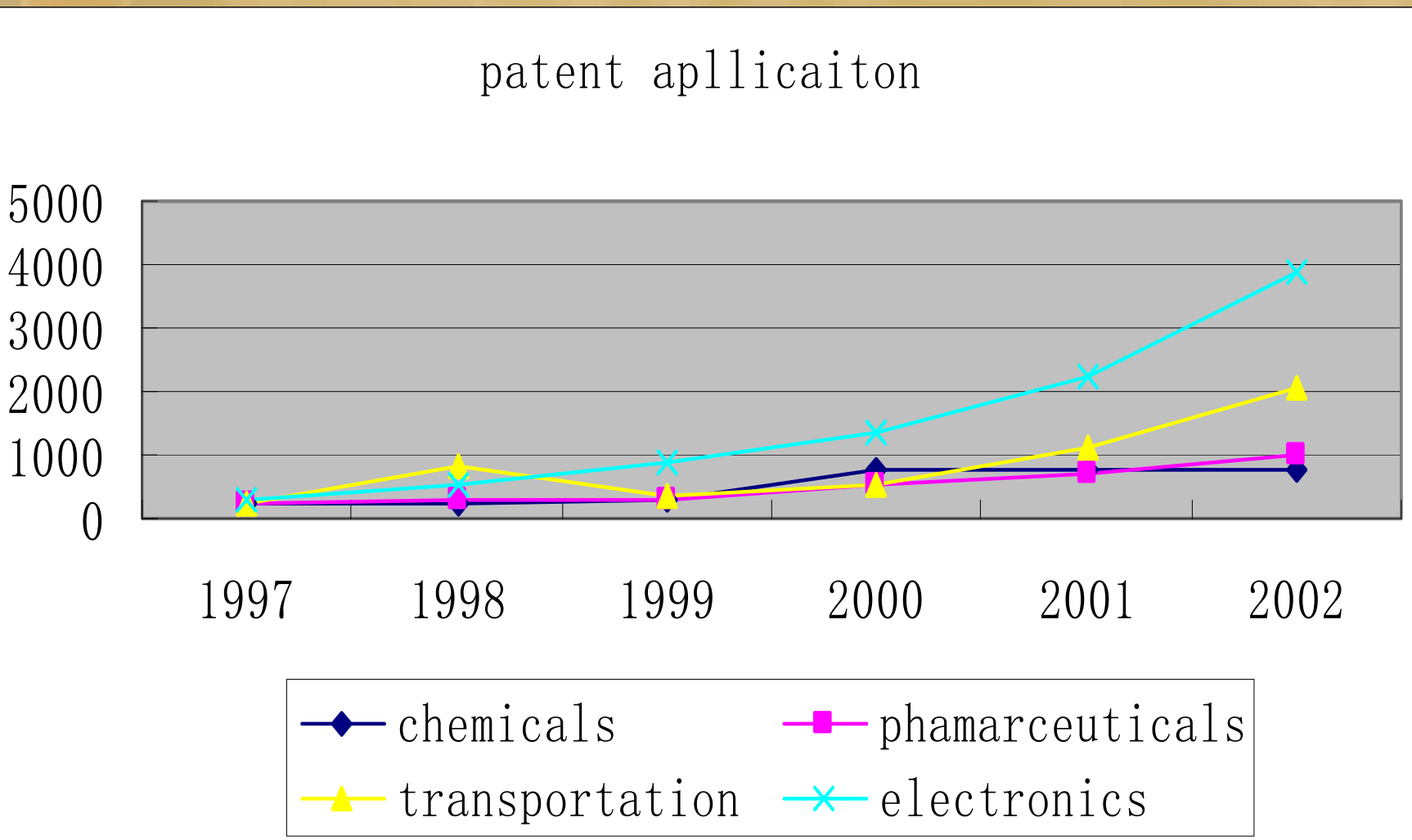
	1997	1998	1999	2000	2001	2002
Transportation equipments: sales	**291**	**293**	**347**	**390**	**489**	**630**
As of total industries%	8.0	7.8	8.3	7.8	8.4	9.3
New product sales	77	87	11	14	18.7	24.3
As of sales %	26.5	29.7	31.9	36.3	38.2	38.5
Patent application	222	806	365	541	1105	2085
electrical machinery: sales	**178**	**180**	**204**	**241**	**286**	**334**
As of total industries%	4.9	4.8	4.9	4.8	4.9	5.0
New product sales	47.4	55.9	75.0	83.1	104.8	122.8
As of sales %	26.6	31.0	36.8	34.5	36.6	36.8
Patent application	1090	1177	1708	2213	2626	4387
Electronics: sales	**215**	**281**	**353**	**471**	**668**	**780**
As of total industries%	5.9	7.5	8.4	9.4	11.4	11.6
New product sales	62.4	102.4	129.1	215.9	250.0	294.9
As of sales %	29.0	36.4	36.6	45.8	37.4	37.8
Patent application	275	556	883	1358	2233	3888

Fig. 3 The share of sales in total industry



Transportation and electronics are the most innovative industries in China

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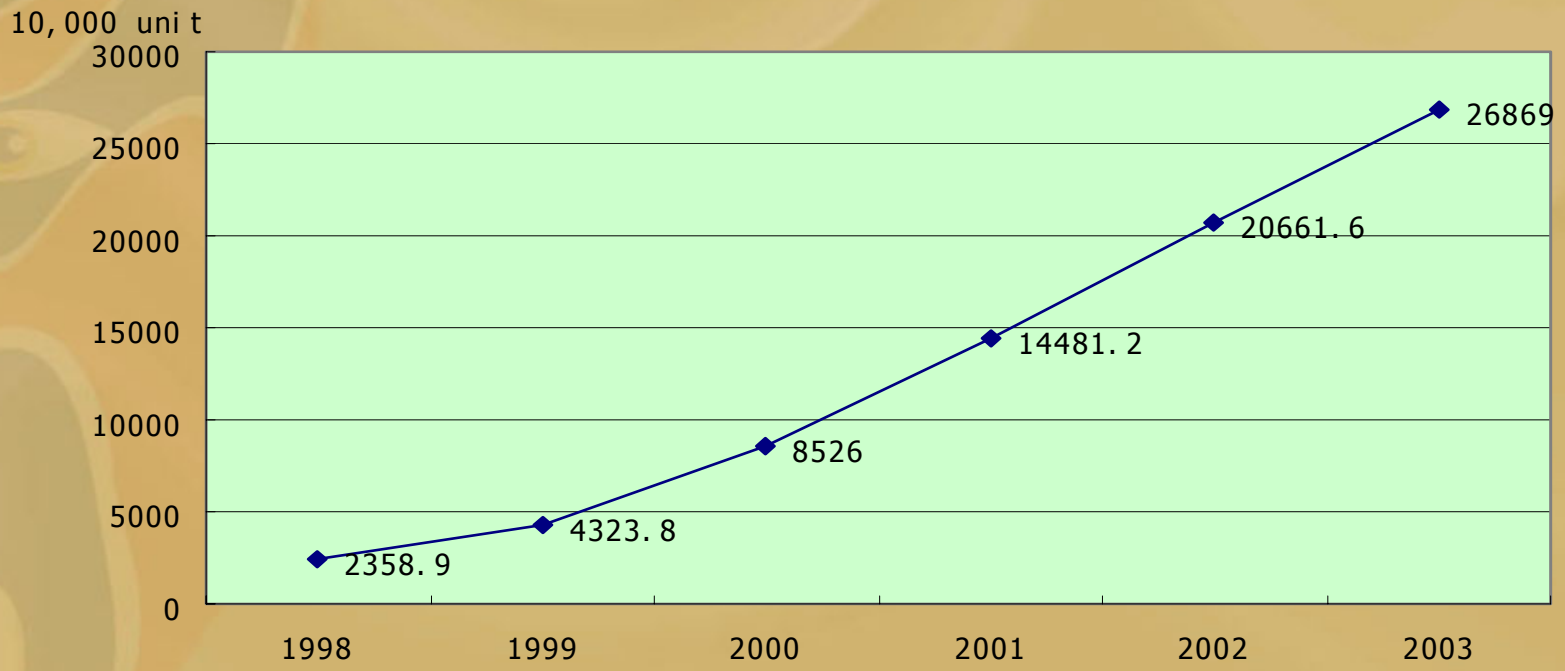
5.The case of mobile phone handset industry

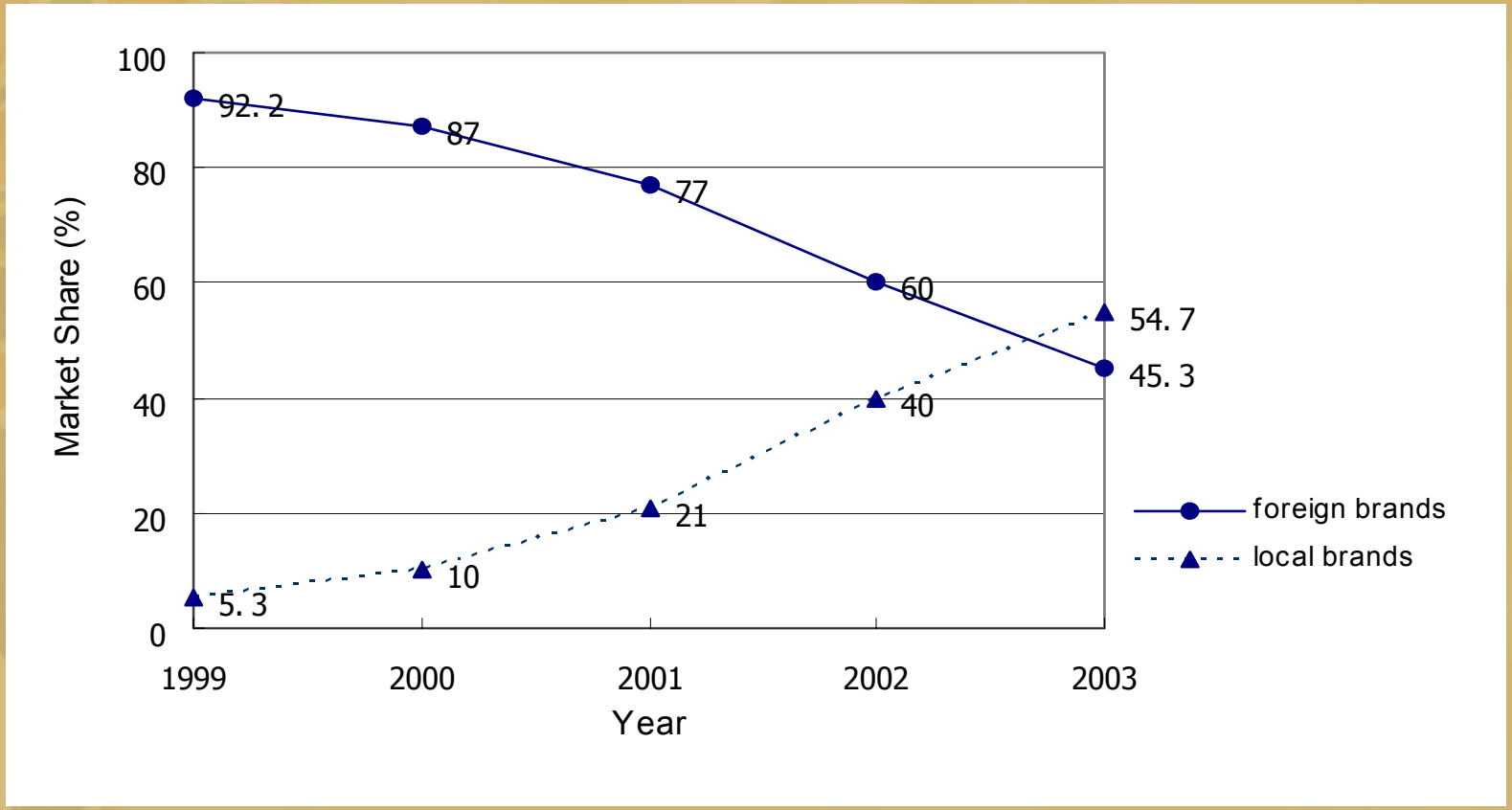
- The mobile handset industry has entered a boom stage since 1998 in China. From 1998-2003, the annual market growth rate reached more than 50%. By the end of 2003, the number of mobile handset users in China has amounted to 270 million, making China the largest country of handsets users in the world (Figure 4). The mobile handset industry is one of the fastest growing industries in China.

Fig.4 The number of handset holders in China



Domestic firms gain market share from the hands of multinationals

Fig.5 the market share of foreign and local brands in handset industry



The evolution of handset industry: from traditionally integrated handset industry to modularized industry

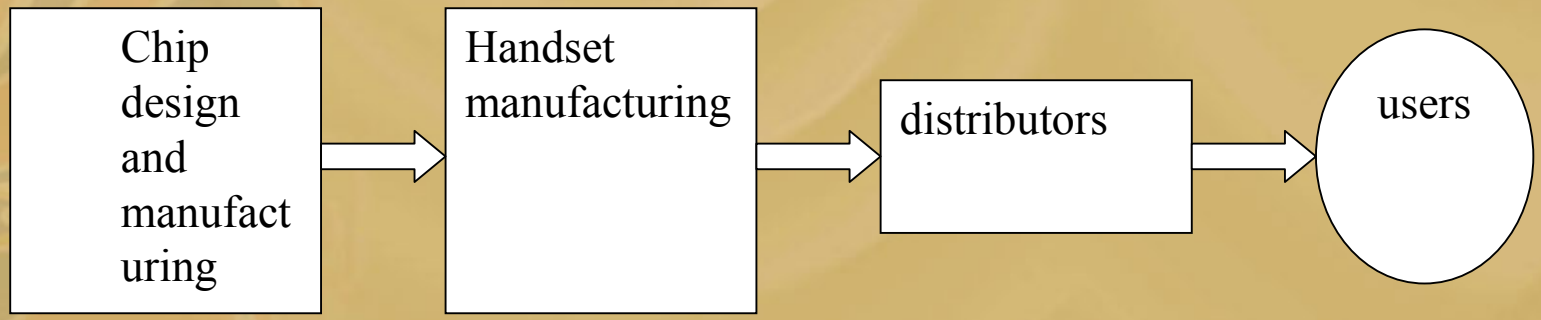
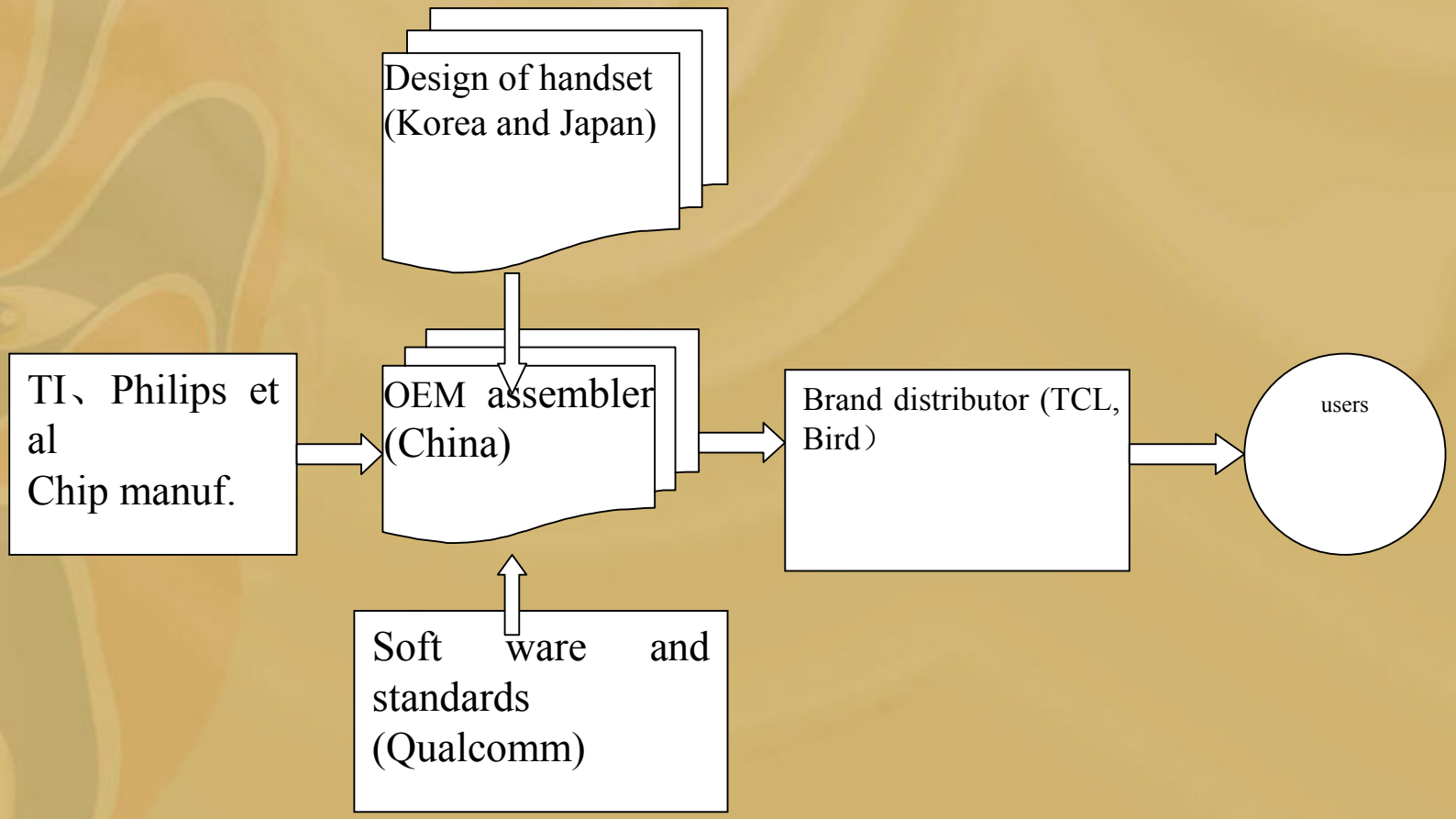


Fig.6 Traditionally integrated handset industry

Fig.7 Modularized handset industry



The case of Bird company: it is the largest handset maker in China

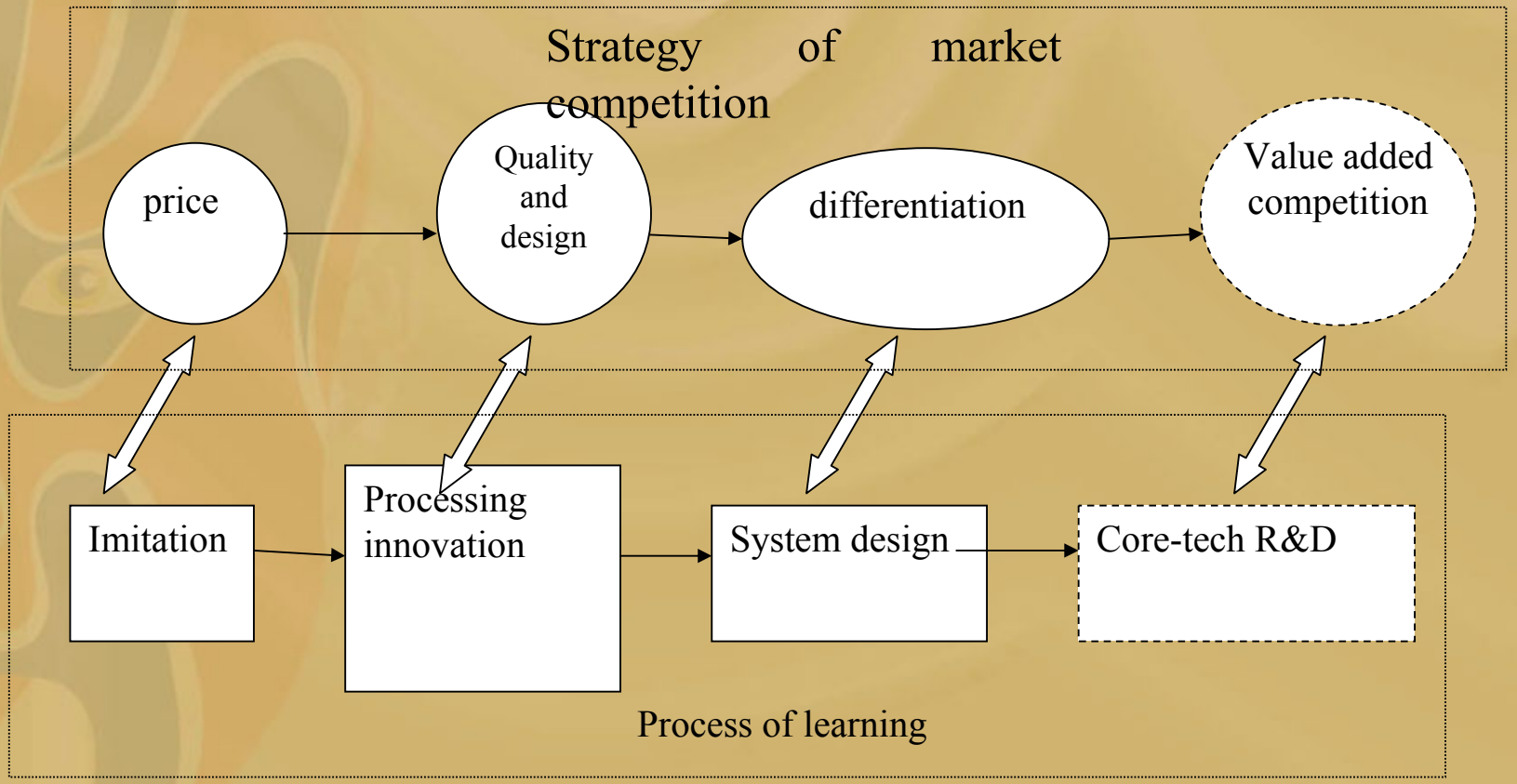
Table 5 The production volume of Bird mobile phone handsets , the largest maker in China (in thousand unit)

Year	1999	2000	2001	2002	2003
Volume	200	700	2,500	7,000	12,000

Stage of catch up of Bird

- 2000-----design collaboration with a UK company, late on, found European company is not good at design, so the collaboration stopped.
- 2001-----cooperation with Korea Sewon, using Sewon's model to produce. The first vintage of product S1000 had a good market records, but later on, Bird found that Sewon also sold its design to other Chinese companies. Bird stopped this trade.
- 2002----cooperation with Korea ATEX until now. They set up a design house in Korea with 20 people.
- In 2003, in order to upgrade Bird's product quality, Bird spend 6 million US dollar to get 30 experts from European countries to do the work of quality control, this make their product quality being greatly improved.
- In the same time, they began their own new product development. They firstly collaborated with Sagem in manufacturing RC 838 and RC818 to learn tacit knowledge of whole design process of mobile phone handset. Based on this new technology, it developed independently its own product---S288. Figure 8 shows the process of catching up in Bird.

Fig.8 The catching up process of Bird



- Lot of technology alliances and cooperators in handset industry, from Korea, European and Japan companies (Table 6).
- In 2002, local handsets companies spend US$ 1 billion on technology from Korean companies.

Table 6 The source of technology for local handset makers.

Company	Source of main technology	Products
Ningbo Bird	Sagem，Philips Sewon, LG, Pantech, Telson Electronis(Korea)	GSM, CDMA
TCL	Sagem Pantech, Standard Telecom(Korea)	GSM, CDMA
Haier	Sewon, Standard Telecom(Korea) Sendo	GSM, CDMA
ZTE	Maxon LG, E-Ron Tech,Giga Telecom(Korea)	GSM, CDMA
Konka	Acer Telson Electronics, Pantech&Curitel(Korea)	GSM, CDMA
Eastcom	Sewon, LG, E-Ron Tech, Giga Telecom(Korea)	GSM, CDMA
Xoceco(Xiahua)	Panasonic Sewon	GSM,CDMA
Kejian	Maxon Samsung(Korea)	GSM, CDMA
CEC	Philips E-Ron, Standard Telecom(Korea)	GSM, CDMA
Capital	Kenwood LG, Pantech&Curitel(Korea)	GSM, CDMA
Soutec	Motorola Pantech, Sewon Telecom,Standard Telecom(Korea)	GSM, CDMA
Datang	LG, Standard Telecom(Korea)	GSM,CDMA

Sources: Keun Lee and Mihnsoo Kim(2004), Yang Jie, An introduction to Mainland Mobile handsets Industry (In Chinese), publisher?.

6.Conclusion

- Chinese catching up is a process market-oriented innovation with global technology outsourcing. A kind of “outsourcing innovation”(Business Week, 3.21,2005), which employs global networks of partners”, to cut costs and reduce the lead time for new product development.
- Modularity, globalization of technology, IT are the three key factors of new development paradigm for Chinese catching up.
- Leading Chinese companies now are more willing to merge technology division of multinationals to strength their R&D function.
- The success of this model is heavily dependent on the structure of a particular industry’s technology system.