

Report on International Competitiveness of Nanjing City --Technology Innovation Improves Urban Competitiveness Abstract

I. Study Framework of Urban Competitiveness

The global competitiveness makes cities become competitors. Chinese cities feel the pressure of international city competition as they are actively participating in economic globalization and international division of labor, and are establishing preliminary relations with the international urban network system. Worldwide nations and regions are dedicated to examine, cultivate and improve their urban competitiveness; institutions and researchers from some countries also commit themselves to the competitiveness studies of their local cities and propose many conceptual frameworks and index systems. We believe that urban competitiveness is defined as a city's abilities of attracting, contending for, possessing, **controlling** and transforming more resources, fighting for, seizing and controlling more markets, creating more wealth in a faster and better matter, providing more welfare for its residents **than** other cities in the world. The ultimate goal of urban competitiveness is to provide welfare for its residents. Relevant conceptual framework and index system of urban competitiveness is therefore proposed and the technology innovation issues raised during Nanjing urban competitiveness improvement is deeply explored according to this conceptual framework and index system.

1. Conceptual Framework of Urban Competitiveness

Influence factors of urban competitiveness: enterprise **quality**, local element, local demand, internal connection, public institution and global connection work out together to form the comprehensive urban

competitiveness and determine the value earnings of cities. The differences among subject qualities are generally the economic environment, namely basic situations and **actual** background of urban competition. **Subjects of** urban competitiveness are the microcosmic components of a city, and also the players of urban competitiveness; competitiveness objects **that** are contrary to subjects are the elements such as resources and institutions. The supply and demand of elements reflects how competitiveness subjects weigh and select the elements in specific environment. The domestic supply reflects subjects' investment and utilization of existing elements, while the domestic demand reflects subjects' potential need and desire on elements. Local and foreign connection, as the **interaction** between subjects and objects, is actually how the supply and demand of elements are achieved. The public institution defines the **rule of** subject communication. **The** subject quality and the element in global regions (including cities) are quite different.

Industrial operation of urban competitiveness: element environment determines industrial level; differences of element environment cause geographic differences of enterprise business **portfolio** and eventually lead to global distribution differences of industries and industrial links. In regions or cities where high-class and high-quality enterprise operating elements are concentrated, innovation and complicated activities are usually supported, high-end industry sector and hi-tech manufacturing sector of industrial system, and R&D design and brand marketing within industrial links is well developed. **On** the contrary, in regions or cities where low-class and low-quality enterprise operating elements are concentrated, simple labor activities are supported, low-tech sector of industrial system and assembly processing within

industrial links are well developed. In regions or cities where even basic enterprise operating elements are short, the basic industry is impossible to develop. The differences of enterprise business portfolio among cities (i. e. geographic division of labors) determine **that** global industrial system presents a hierarchical, labor-division and cooperative big industrial prospect **that** is composed of regional and differential industrial sub-systems. The whole world constitutes a global big industrial system which is based on cities and has clear hierarchy, division and cooperation of labor.

Dominant characteristics of urban competitiveness: industry level determines city value. **Global** differential distribution of industry levels leads to global differential distribution of urban earning value system. How the influence factors of operation **links** of an urban **enterprise** cluster are composed determines business selection of the enterprise cluster and additional value created by the enterprise cluster, therefore enterprise cluster's operating elements and enterprise cluster's business portfolio make up the wealth creating ability of urban enterprise cluster, namely the wealth creating ability **of a** city, and also determine the value of a city. The differences of enterprise operating condition distribution among global cities determine the differences of the industrial system, and further determine the differences of values created by enterprises among cities, and the differences of additional values created by same industry or industrial links. **So** the global urban value system shows peaks, valleys and bumps.

Determining mechanism of urban competitiveness: element environment system, industrial system and value system are interacted and make up the urban competitiveness; **profit** maximization motive of economic subjects, horizontal differences and liquidity differences of elements cause

global changes of elements, industries and value, and lead to global changes of urban competitiveness. The element environment system of urban enterprise cluster operation is the fundamental of urban competitiveness. Cities cultivates urban industrial structure system and derived urban function system by attracting external elements and maintaining local elements and all of these determine the urban value system; the urban industrial system (i. e. enterprise cluster combination) is the subject of urban competitiveness, affected by operating elements and also a part of operating elements. It creates and determines city value by intensifying or weakening local industries, attracting or repelling nonlocal industries, and it also affects urban operation elements; city value system is the reflection of urban competitiveness, and determined by urban enterprise **operating** elements and industrial system, in return, it intensifies or weakens local elements, attracts or repels nonlocal elements and affects operating conditions and industrial system. The motive to purchase maximized profits (residents **purchase** maximized welfare and enterprises purchase maximized profits) cause **that** residents, enterprises and liquid elements to flow and concentrate into high-yield regions, and result in spatial flow of economic individuals, so it objectively gives rise to competition among regions. This accumulated causality of liquidity and **concentration** results in dynamic change of enterprise operating elements in inlet and outlet regions, and also causes changes of industrial system and value system. Meanwhile, local governments make great efforts to change the overall urban enterprise operating elements, change urban **industrial system** and value system in a further way, **and bring global change of urban competitiveness.**

Technology innovation of urban competitiveness: technology innovation has comprehensive and important effects on scale, **composition**

and change **of the** urban value system, but science technology and knowledge resource are unevenly distributed among cities, so cities are different in their technology competitiveness, and further in urban competitiveness. Urban science technology and knowledge resource participate in production process through two measures, which are: a) attaching and penetrating to labors and production facilities, infrastructure and living environment; b) inputting knowledge information directly into production process to produce knowledge products and non-**knowledge** products. As technology development, innovations and technologies are widely applied into urban production, on one hand, production elements are better used and production technologies and craftsmanship of enterprises are improved, so labor productivity is improved and product cost is reduced; on the other hand, technology applications allow urban enterprises to gain resources and **products** with more monopolistic advantages, so cities **can** get more **industrial** rents, and urban **industrial** products will have a wider market share. Technology applications can expand market share by product quality improvement. The exclusive science technology and knowledge resource, as a production element, are unevenly distributed among cities. Technical differences of industrial levels are resulted from scale economy and scope economy of R&D and technical training, in other words, they are resulted from technology and knowledge resource. **When** a city which has certain technologies **and** knowledge resources is going to develop relevant new technology industry or specific products of the same industry, on one hand, it will have lower product cost, but on the other hand, its products can sell at a higher monopolistic price as hi-tech products have technological monopoly, so its urban industry can gain some industrial rents. The comparative advantages from technology and knowledge resource

make a bigger **component** ratio of the urban value system. Developing hi-tech industries will expand the urban value system, so cities those have technological strength differences will have differences in urban competitiveness.

2. Index System of Urban Competitiveness

Output: the index system of comprehensive competitiveness (value).

From the perspective of display or output, the frameworks to measure global urban competitiveness are: $UC1=F(ES, ED, DL, TI, EG, DA)$. UC1 is the output or performance of urban competitiveness; ES is the economy scale; ED is the economy density; DL is the economy efficiency; TI is the technology innovation; EG is the economy growth; DA is the economy decision. The output index system of global urban competitiveness contains 8 performance indexes.

Input: the index system of element environment. From the perspective of display or output, the frameworks to measure global urban competitiveness are: $UC2=F(EQ, LE, LD, LC, GC, PI)$. UC2 is the input of urban competitiveness; EQ is the enterprise quality; LE is the local element; LD is the local demand; LC is the local connection; GC is the global connection; PI is the public institution. The element environment index system of global urban competitiveness contains 50 indexes in 6 types.

Process: the index system of industrial system. From the perspective of industries, suppose a city has N industries, the frameworks to measure global urban competitiveness are: $UC3=F(IC1, IC2, IC3, \dots, ICN)$. UC3 is the comprehensive industrial competitiveness; IC1, IC2, IC3, ..., ICN represent the competitiveness of different industries respectively. Theoretically $UC1=UC2=UC3$, but they are totally unmatched in fact due to statistic data and other reasons. UC1 reflects the current short-term competitiveness, UC2 reflects the future long-term competitiveness, and

UC3 reflects the future medium-term competitiveness. The industrial chain index system of global urban competitiveness contains 19 industrial indexes.

II. Technology Innovation in Nanjing Urban Competitiveness

1. Improvement of Nanjing Urban Competitiveness

The global comprehensive urban competitiveness of Nanjing city is significantly improved. According to the *Global Urban Competitiveness Report*, Nanjing ranked 247 in top 500 global cities in terms of global comprehensive urban competitiveness, 16 places ahead of 263th position in 2005.

The domestic comprehensive urban competitiveness of Nanjing city is fundamentally stable, and its development cost competitiveness increases very fast. According to the *Annual Report on China's Urban Competitiveness* issued by CASS, the comprehensive urban competitiveness of Nanjing city ranked 21 in nationwide 294 cities in 2008, almost the same position as it ranked 20 in 2005. In terms of subitem competitiveness, Nanjing decreased its ranks of comprehensive improvement competitiveness, economic efficiency competitiveness, economic scale competitiveness and life quality competitiveness, but its development cost competitiveness increased from 106th in 2005 to 76th, and its industrial level competitiveness increased from 28th to 21st. Nevertheless, compared with some developing medium- and large-sized cities, Nanjing urban competitiveness has substantially improvement, for example, from 2005 to 2009, its annual growth of **local** GDP reached 14.9%, much higher than 13.8% of Shenzhen, 11.0% of Shanghai and 12.57% of Hangzhou, especially its development cost competitiveness grew very rapidly, and its industrial level competitiveness grew sharply. All are promoting the future urban competitiveness of Nanjing city.

2.Improvement of Nanjing Technology Competitiveness

Scientific research institute competitiveness and enterprise innovation ability is increased, but the **concentration** competitiveness of technology resource is slightly decreased. According to the *Annual Report on China's Urban Competitiveness* issued by CASS, in 2008 the scientific research institute competitiveness of Nanjing city increased from 35th to 29th in nationwide 52 medium- and large-sized cities, its enterprise innovation ability increased from 31st to 22nd, but its technology resource concentration competitiveness decreased to 20th in 2008.

As far as scientific research institute competitiveness is concerned, R&D input-output efficiency is significantly increased. The R&D input-output efficiency of Nanjing city increased from 47th to 22nd in 2008. R&D level and environment competitiveness is slightly decreased.

As far as enterprise innovation ability is concerned, the enterprise R&D **ability** and efficiency competitiveness of Nanjing is increased. Its enterprise R&D ability increased from 19th to 15th in 2008, while its enterprise R&D efficiency increased from 34th to 29th.

3.Effect of Nanjing Technology Innovation

Technology innovation has increasing importance to the improvement of Nanjing urban competitiveness. Technology innovation is the fundamental driving force for Nanjing to change its growth pattern and achieve great-leap-forward development; technology innovation is the decisive factor for Nanjing to improve its regional competitiveness and enhance its central city position; technology innovation is the important method for Nanjing to break **territory** limit and construct a beautiful ancient capital to achieve green and sustainable development; technology innovation is the key for Nanjing to change its "more inheritance but

less innovation" situation and cultivate innovative culture; technology innovation is the demand-end driving force for Nanjing to guide its science and education resources and play its potential to the most extent to **improve** its science and education competitiveness.

III. Status Quo and Achievement of Nanjing Technology Innovation

1. Quality of Technology Innovation Subject: innovative enterprises are fast developing and high-end industrial enterprises are further concentrated.

Enterprise quality is enhanced, innovative enterprises are fast developing, and high-end industrial enterprises are further concentrated. The amount of industrial enterprises in Nanjing increases very fast, especially the amount of small-sized industrial enterprises, but medium- and large-sized industrial enterprises are still the operation **subject**; hi-tech enterprises have a huge growth, and their performance is much better; high-end industry has good fundamental and great innovative potential.

The service quality of public departments is improved, but their function transformation still needs to be promoted. Nanjing fiscal **expenditure** is increasingly rising, but its proportion in GDP is slightly reduced; Nanjing government is efficient in its operation, but it needs to enhance its function of serving economy.

Home education quality is **continuously** improved, and innovative spirit is increasingly intensified. The gross enrollment ratio of high education in 2008 was 57.9%, 2.6 percent higher than that in 2002. Per capita education years is at least 14 years, 3 years longer than **that** in 2002. Innovative spirit is not enough, but the value is changing. **Diversified**

exploration and selection is emerging, and innovative spirit is gradually strengthened.

2. Technology Innovation Output: innovation carriers are increasingly perfecting, technology achievements are fast increasing, and technology trade are more vigorously.

Human capital amount is rapidly growing, but its structure still needs adjustment; talent environment is gradually improved. The amount of technology participants and R&D crew has a huge growth, but its proportion in professional technicians is slightly decreased; Nanjing has abundant education resources, and its education capability is fast increased; Nanjing has good healthcare environment but its service level needs to improve, per capita expected life in Nanjing was 76.6 in 2009; Nanjing has gradually improved life environment, its on-position staff salary in 2008 increased to 3609.0 yuan. But "rigid expenses" are increasing fast, the life cost is then increasing fast either.

Financing environment is increasingly improved, and equity investment is rapidly developing. The financial industry in Nanjing is fast developing. In 2008 the gross **value** added of financial industry reached 30.2 billion yuan, **accounting** for 8% of GDP; financial services are diversified, the amount of banks and insurance institutions increase very fast, and financial supporting services are increasingly perfecting; venture capital firms and private **equities** become the financing channels for **more** and more technology enterprises.

Technology carriers are diversified, technical achievements are plentiful, and technology activities are more active. Scientific research institutions, development zones and hi-tech enterprises in Nanjing are numerous, technology incubators and public technology

platforms **increase**, and the **University Park** is developed fast; patent applications increase, up to 11,692 pieces in 2008, including 5,019 invention patent applications, accounting for 42.9% of annual patent applications; higher education institutions are still the main carrier of technology achievements, in 2007 patent applications made by higher education institutions reached 1984, and the proportion of total patent applications from independent R&D centers, higher education institutions and medium- and large-sized **industrial** enterprises was **increased** from 53.4% to 55.5%; the transaction volume of scientific and technology contracts in Nanjing has steady growth, the technology transaction amount in 2007 reached 5.559 billion yuan; but the technology transferring in higher education institutions in Nanjing is not optimistic, in 2007 the contract amount and transaction amount of technology transferring of **higher** education institutions and the actual income had a sharp drop compared to **that** in 2004.

3. Technology Innovation Input: technology input is fast increasing, and R&D expenditure of medium- and large-sized enterprises are sharply increasing.

As population and economy is fast increased, fiscal **expenditure on science** and **education** rises. In 2008, the permanent population in Nanjing was 7.5889 million, **increasing** 18.0% than **that** in 2003; its local GDP reached 377.5 billion yuan in 2008, 1.5 times over **that** in 2002, and the structure of three industries became 2.5:47.5:50; in 2008 the municipal fiscal **expenditure** on education was 5.803 billion yuan, 1.9 times over that in 2002, and per capita education **expenditure** was 764.7 yuan, 1.16 times more; science and technology **expenditure** was 946 million yuan, 2.3 times more, and per capita **expenditure** was 124.7yuan, 1.45 times more.

Science and technology funds are rapidly increasing, and the per capita fund of R&D personnel in industrial enterprises takes the lead. In 2007, Nanjing technology institutions received 15.766 billion yuan of science and technology funds, 1.26 times over **that** in 2002; in 2007 the total social R&D funds account for 2.64% of local GDP, 0.78 percent increased than that in 2002; **the** average R&D fund of each R&D person in technology institutions is almost the same, but medium- and large-sized industrial enterprises have a rapid growth and already take the lead; the proportion of experiment funds is increased very rapidly.

4. Technology Innovation Region Connection:

Industry-University-Research collaboration network is initially shaped, and local transformation efficiency of technical achievements is significantly increased.

Local environment is very good, but the layout of innovation subjects still need adjustment. The fast developing industries in surrounding areas of Nanjing have large demands on technology, which is favorable for Nanjing to **utilize** its rich science and education resources; but Nanjing technology innovation subjects are not **close** enough in their locations, neither are science and education resource and hi-tech development zone.

Science and technology **resource** has some industrial bases, but the industrial structure still needs adjustment. The technology innovation resources and relevant industries in Nanjing are mutually supported and promoted; industrial structure adjustment and upgrading should be finished before the advantages of science and technology resources in Nanjing can be **optimized**, **and** technology-intensive industries in Nanjing is still underdeveloped; the existing industrial parks in Nanjing have small scales, industrial **additional** value per land is very low, and the

industrial intensification level is too low. All of these issues have some restrictions on emerging industry development and technology innovation capability.

Local transformation efficiency of technology achievements is increased, and industry-university-research collaboration promotes rational allocation of resources. In Nanjing **there** are 27 incubators and 107 engineering technology centers above municipal level, and the local transformation of application technology achievements of higher education institutions and scientific research institutions in Nanjing is up to 41%; Nanjing has established politics-industry-**university**-research-finance joint conference system for over 80 units in terms of politics, industry, university, **research and** finance, and districts, counties and development parks have also established industry-university-research collaborative leadership in different forms; the resource allocation mechanism of **industry**-university-research collaboration and innovation is further improved, and the technology research advantages of Nanjing-headquartered universities and scientific research institutions including Nanjing **University**, Southeast University and 14th Research Center of CETC should be paid attention to utilize; districts and counties dedicate themselves to promote major **industry**-university-research technology innovation projects and research center construction.

5. Foreign Connection of Technology Innovation: technology

becomes more export-oriented and overseas talents are more attractive.

The position of transportation hub is enhanced and the logistics **center is** more functional. Nanjing is the intersection of the Yangtze River from west to east and the Beijing-Shanghai Railway from north to south,

its logistics bases of both Longtan port and Lukou airport, approved by the State, need to intensify the foreign connections of Nanjing; the modern logistics business in Nanjing is developed very fast.

Technology is more export-oriented, and foreign investment is stably increased. In 2007 hi-tech export was 4.04 billion dollars, 1.02 times as against 2004; export income of new products was 19.9 billion dollars, 3.46 times as against 2004; export amount of hi-tech products accounted for 19.6% of gross export value, 0.39 percent increased than 2004; in 2008 Nanjing used 2.373 billion dollars of foreign investment, 1.17 percent increased than 2003.

Talent introduction policies are more encouraged, and more and more talents who study abroad come back to China. By 2009 Nanjing had introduced almost 10,000 overseas talents; only in 2007 Nanjing had up to 362 technology projects in which overseas high-level talents or technicians who have overseas study background are involved.

Technology transformation system is increasingly perfected and technology transformation **amount** is greatly increased. Nanjing has established complete international technology transformation system, and utilizes global technology resources to actively explore the international technology transformation network.

International exchanges are increasingly frequent and the Youth Olympic Games is **promoting** international cooperation. Nanjing becomes the international sister city of 12 cities in 12 nations including Nagoya in Japan and St. Louis in USA, and its inbound tourist arrivals are increased fast; in 2010 it gained the right to host 2nd Youth Olympic Games in the summer of 2014, which enhanced the communication and **cooperation** between Nanjing and the world.

6. Public Institution of Technology Innovation: property right protection, environment improvement and government service function are further enhanced.

Law enforcement of property right protection is enhanced, but property loss still exists. Nanjing has established cross-department and cross-industry law enforcement mechanisms to enhance enterprises' intellectual property, jointly investigate and punish infringement and counterfeit, clean-up and rectify audio-visual product market, and intensify the supervision on network and **information** broadcasting fields; but enterprise technicians bring the key technologies or secrets of their former employer to the new employer when they are mobilizing among enterprises, and enterprises have no **consciousness** of intellectual property protection and ignore intellectual property value assessment, so intellectual property losses still exist.

Market supervision ability is improved and market environment is improved. Nanjing makes great efforts to improve the market **supervision** system involving government supervision, industry self-regulation, supervision by public opinions and public participating, enhance the market **supervision**, punish unfair competition and anti-competitive practices **according** to laws, establish and improve the market admission and franchise mechanisms for municipal public utilities, enhance and normalize the market **supervision involving various** elements like capital, **equity** transaction, real estate, construction, technology and human resource, normalize behaviors of all market players like employment, transaction and tax payment, and intensify the effective administration of natural monopoly industries.

Government management: its service functions are enhanced and its administrative **legislation** is increasingly improved. Nanjing municipality further transforms its government function to a public service government, implements "six openness", attempts to normalize "parallel approval", promotes the reform on administrative approval system, and reduces lots

of administrative approval affairs; Nanjing municipality intensifies legislative system reform, perfects legislative procedure, and enhances legislative democracy and transparency from the administrative legislation source, and also solves the problem of department interest tendency during legislation and improves overall legislation level from the entity and procedure.

IV. Six Experiences of Nanjing Technology Innovation

1. Scientific development: use technology to promote industrial leap, and use innovation to promote urban **transition**

“Three development” specifically embodies **that** Nanjing adheres to scientific development as its transition development mode; innovation development featured of technology innovation is the core content of “three development”; the proposal of “three development” injects continuous **demands** on Nanjing technology innovation.

2. Target concentration: constitute strategic plans as guidance, and seek critical links to break through

The construction of “Smart Nanjing” needs technology innovation as the impetus; **the** strategy of “science and education makes city prosperous” is implemented, and the direction of innovation city is persisted; “4+8+8” industrial development plan is made, and technology innovation resources are guided to concentrated; several R&D centers, competitive industries and cluster products are outstanding, and critical **breakthrough** of technology innovation is made.

3. Systematic guidance: follow the basic market laws, and establish the position of enterprise innovation subject

The policies of the position of enhancing enterprise innovation subject are constituted; enterprises are encouraged to establish

technology centers; technological standards and brand strategies are implemented; the protection of proprietary intellectual property rights is enhanced; technological breakthrough is reinforced and new **product** application is promoted; government investment on enterprise innovation is increased; government purchase policy **that is supportive** to enterprise innovation is implemented; preferential tax policies are implemented to encourage enterprises' technology innovation.

4. **Higher education promoting hi-tech: intensify environment resource strengths, and strive for concentrating high-end resources**

Rich science and education resources are used to try to get approved as the sole pilot city where comprehensive reforms on the technology system are carried out; the existing high-end technology research bases are utilized to try to get important R&D center located in Nanjing; international and domestic cooperation and exchange is attached great importance to, so as to **promote** technology elements to **concentrate** in Nanjing; hi-tech parks and higher education universities and colleges are **relied** on to attract technology resources to concentrate in Nanjing; encouragement plans are made to attract high-level talents to concentrate in Nanjing.

5. **Vertical and horizontal alliance: integrate industrial regional resources and construct the government-industry-university-research collaboration network**

The existing resources are integrated, resource sharing mechanisms are innovated, the mechanism of joint conference of politics, industry, university, research and finance is established, and the regional technology resource sharing mechanism is established; market orientation and **innovation** technology transformation mechanism are persisted, industrial technical **research** and development institutes are established,

and a series of industry-university-research technology **innovation** strategic alliance is established to **accelerate** the cultivation of technology agency service system; universities and enterprises are cooperated to establish technology achievement transformation platforms, "Nanjing Technology Square" is the priority project, technology achievement industrial bases are continuously constructed, **including** Ningnan Technology Town, Xianlin University Town, and 4 national (provincial) university technology parks in Nanjing, "second business starting" within Nanjing Hi-tech Development Zone is promoted, park management institutions and institution reforms are promoted, and comprehensive service level and ability is **improved**; preferential politics are made to give aid to the encouragement of technology achievement transformation in Nanjing.

6. Project promotion: construct technology resource carriers, and build innovation activity platforms

More labs and technology research centers are constructed; more technology parks are constructed, more hi-tech development zones (one zone has several parks) are constructed, and more university technology parks and more technology innovation park-in-park are constructed; more incubators and more technology achievement transformation service platforms are constructed, **and** establishing technology achievement transformation platform **promotes** the cooperation between universities and enterprises; **more** concentrated **industrial** bases are constructed, great attentions are paid to the **combination** of industrial concentration and technology achievement transformation, innovation achievement **industrial** bases are constructed, and great importance is attached to the construction of five technology **innovation** projects; **innovation** platforms

are actively constructed and more talents are **concentrated**, more and better development opportunities are created for high-level talents to start technology **innovation** business, and constructions of **innovation** and **enterprise** bases for high-level talents are actively promoted.

V. Technology Innovation: Improve Nanjing's Position in Global Urban Competitiveness Ranking

1. **Global urban competitiveness output:** its comprehensive urban competitiveness is at the midstream of global 500 cities.

Among global 500 cities, Nanjing ranks 247 in terms of comprehensive urban competitiveness, higher than Wuhan and Xi'an, but lower than Vienna, Barcelona, Stockholm, Boston, Munich, Beijing, Shenzhen, Hangzhou and Wuxi.

For economy scale, it ranks 74 among global 500 cities, an upstream level; for economy growth, it ranks 38 among global 500 cities, a leading level; for development level, it ranks 292 among global 500 cities, a midstream level; for economy concentration, it ranks 389 among global 500 cities, worse than the average; for technology innovation, it ranks 240 among global 500 cities, a midstream level; for international influence of economy, it ranks 199 among global 500 cities, better than the average.

2. **Global urban competitiveness input:** its urban competitiveness is better than the average level among global 500 cities.

To measure from the perspective of element or input, the urban competitiveness of Nanjing is better than the average level among global 500 cities. The total scores of its element environment rank 175 among global 500 cities.

Enterprise Quality: it ranks 101 among global 500 cities, approximately a leading level. Compared with benchmark cities, Nanjing score of enterprise quality is much lower than Beijing, **Barcelona**, Vienna, Munich, Stockholm, Shenzhen and **Boston**, but a little higher than Wuhan, Xi'an, Hangzhou and Wuxi. For global high-end enterprise, Nanjing ranks 136; for enterprise development, Nanjing ranks 60; for global enterprise brands, Nanjing has none, the same as Hangzhou and Wuhan; for financial institution, Nanjing ranks 66; for technology enterprise, Nanjing ranks 100; for culture enterprise, Nanjing ranks 198.

Local Element Supply: it ranks 96 among global 500 cities, a leading level. Compared with benchmark cities, Nanjing is higher than Barcelona, Xi'an and Wuxi, but lower than any **other** cities. For education index, Nanjing ranks 250; for minimum **salary**, Nanjing ranks 146; for university index, Nanjing ranks 59; for bank index, Nanjing ranks 108; for patent index, Nanjing ranks 108; for R&D center amount, Nanjing ranks 181; for road **convenience**, Nanjing ranks 371; for hotel price benchmark, Nanjing ranks 166; for hospital bed amount, Nanjing ranks 309; for house rental benchmark, Nanjing ranks 70.

Local Demand: it ranks 204 among global 500 cities, a midstream level. Compared with benchmark cities, it's higher than Hangzhou, Shenzhen, Xi'an and Wuxi, but lower than Munich, Barcelona, Boston, Vienna, Stockholm, **Beijing** and Wuhan.

For total population, it ranks 38; for population growth potential, it ranks 253; for GDP of big cities within 1-hour **flight**, it ranks 143; for population of big cities within 1-hour flight, it ranks 62; for GDP of cities within 3-hour flight, it ranks 139; for population of cities within 3-hour flight, it ranks 80; for national per capita income, it ranks 347; for national economic growth, it ranks 4.

Internal Connection: it ranks 123 among global 500 cities, **better** than the average level. Compared with benchmark cities, it's lower than any **other** cities except for Wuhan, Xi'an and Wuxi. For labor intensity, Nanjing ranks 21; for industrial concentration, it ranks 342; for hi-tech park, it **ranks** 104; for inflation rate, it ranks 338; for unemployment rate, it ranks 178; for political stability, it ranks 186; for crime rate, it ranks 252 (backward); for climate index, it ranks 160; for per capita carbon emission, it ranks 330(backward); for history culture, it ranks 22; for multilingual, it ranks 178.

Global Connection: it ranks 98 among global 500 cities, an upstream level. Compared with benchmark cities, it's higher than Hangzhou, Wuhan, Xi'an and Wuxi, but lower than any **other** cities. For multinational corporation connectivity, it ranks 98; for financial company connectivity, it ranks 66; for technology company connectivity, it **ranks** 100; for international organization index, it ranks 118; for culture company connectivity, it ranks 198; for city's international popularity, it ranks 82; for sea distance, it ranks 331 (backward); for airline flight, it ranks 117; for road amount, it ranks 58; for internet server, it ranks 87; for international convention, it ranks 199.

Public Institution: it ranks 261 among global 500 cities, a midstream level. It's lower than all international benchmark cities and **Beijing**, but higher than any **other** domestic benchmark cities. For business convenience, it ranks 267; for freedom index, it ranks 368; for local initiative, it ranks at a midstream level, for finance and taxation proportion between the central government and the local government, it ranks 202; for government public governance index, it ranks 270.

3. **Global urban competitiveness process:** its industrial chain competitiveness is at the midstream level among global 500 cities.

Nanjing's industrial chain competitiveness ranks 228 among global 500 cities. Compared with benchmark cities, it's higher than Hangzhou, Wuhan, Xi'an and Wuxi, but lower than **other** 5 international benchmark cities, and Beijing and Shenzhen.

As Nanjing's bank sector takes the high end of industrial chain, its industrial value index ranks 19; as the chemistry sector is at the pre-high end of industrial chain, its industrial value index ranks 93; as the retail sector has a higher value, its industrial value index ranks 67; as semiconductor sector is well performed, its industrial value index ranks 70; as the telecom sector is well performed, its industrial value index ranks 78; for commercial service sector, its industrial value index ranks 178; for financial capital sector, its industrial value index ranks 169, exactly the same as Hangzhou; as the durable consumer goods sector is at the middle of industrial chain, its industrial value index ranks 130; as the multifunctional financial sector is at the middle of industrial chain, its industrial value index ranks 181; as the biopharmaceutical sector is at the middle of industrial chain, its industrial value index ranks 146; as the insurance sector is at the middle of industrial chain, its industrial value index ranks 178; as the news media sector is at the middle of industrial chain, its industrial value index ranks 198; as the hardware equipment manufacturing sector is at the middle of industrial chain, its industrial value index ranks 126; as the national defense aviation sector is at the low end of industrial chain, its industrial value index ranks 497; as the healthcare instrument sector is at the low end of industrial chain, its industrial value index ranks 487; as the trade sector is at the low end of industrial chain, its industrial value index ranks 364.

4. Improvement potential of global urban competitiveness:
Nanjing has great potential for its urban competitiveness improvement.

For the competitiveness improvement potential, Nanjing ranks 72, and the second place among all benchmark cities, just next to Xi'an. It has great potential for urban competitiveness improvement.

VI. Technology Innovation: Improve SWOT Analysis of Nanjing's Global Urban Competitiveness

1. Seven strengths to construct the technology innovation system for Nanjing

(1) **Good economic development foundation**, strong urban **comprehensive** strength

(2) **A major city in metropolitan area of Yangtze River Delta**, important strategic position

(3) **Abundant science and education resources**, competitive talent strength

(4) **Rich humanistic** connotation, very inclusive culture

(5) **Continuously improved technology infrastructure**, gradually forming the technology innovation system

(6) **Famous with military technology**, cutting-edge technology strength

(7) **Clear strategic thinking**, forward-looking policy guidance

2. Four weaknesses to construct the technology innovation system for Nanjing

(1) **Not** enough innovative enterprises, less prominent entrepreneurship

(2) **Over-decentralized** innovation resources, no innovation join forces

(3) **No** contact bond for government-industry-university-research, underdeveloped venture finance

(4) **Public administration** framework to support technology innovation is not perfect, government implementation and **property** right protection need to be reinforced

3. **Four opportunities** to construct the technology innovation system for Nanjing

(1) **The** global economy pattern is under the deepgoing adjustment

(2) **Innovation** nation is under construction and China economy is under transition

(3) **New** technology innovation revolution is emerging

(4) Yangtze River Delta development strategy is promoted and the city cluster in Yangtze River Delta is rising

4. **Four threats** to construct the technology innovation system for Nanjing

(1) **The** double-edged effect of economic globalization causes fierce competition among high-end resources.

(2) **The** increasing cost and the slow growth of external demands cause great pressure on transition.

(3) **The** strategy of overall development among the Middle and the West brings great pressure to Nanjing in terms of resource and market.

(4) Its surrounding cities compete intensely for innovation resources.

5. SWOT strategy to construct the technology innovation system for Nanjing

SO strategy: science and education resources should be utilized to raise payment to attract and keep talents; regional integration should be intensified; privatization of military technology should be promoted; guidance and promotion of government should be played.

WO strategy: technology business **should** be encouraged, entrepreneurship should be cultivated; innovation resources should be concentrated; government-industry-university-**research** bridge **should** be established; public **management** system for technology innovation **should** be constructed.

ST strategy: good technology resources, cultural environment and generous payment should be utilized to attract and keep high-end talents and resources.

WT strategy: accurate position should be made, innovation resources **should** be concentrated, and local transformation ability of technology achievements **should** be improved.

VII. Technology Innovation: Improve both Global and Domestic Experiences of Nanjing's Urban Competitiveness

1. Munich: the government takes the lead to integrate innovation resources, while the agencies **establish the** innovation platform.

Key experiences: make accurate positioning and the best use of the circumstances; application education is oriented, and education mechanism is innovated; outgoing culture is advocated, and city influence

is radiated; a **unique** public innovation mode ---- “Fraunhofer Mode” is established; NGO network effect builds three-power spiral agency platform.

Key inspiration: the government should take the move when it's necessary **and** take the lead to select the path of “politics-industry-university-research”; talent resource **strengths** of schools should be utilized to cultivate effective science and education resources; the one should practice its own ability to go out and take initiative move to introduce outside strengths; preferential policies and industrial linkage can bring the spring for small- and medium-sized enterprises; **strengths** of industrial associations and commerce chambers should be explored to establish its own unique agency service mode.

2. Shenzhen: it changes the comparative advantage into competitive advantage and uses institutional innovation to promote technology innovation.

Key experiences: it's always the first one in the world to make attempts and it utilizes institutional innovation to implement technology innovation development strategies; it considers the situations and changes its comparative advantage to competitive advantage; it makes overall plans and coordinates all factors, and uses cluster to promote the development of hi-tech industry; it makes use of its strengths and avoids its weaknesses, and utilizes the **external** resources for its own development; it cultivates **atmosphere** to **foster** independent and innovative urban culture.

Key inspiration: the government should be a good “parent” and as well as “babysitter”; it should establish fund **platform** firstly and protect intellectual property; it should make good use of talents to boost technology innovation; it should create innovative culture and make innovation concept deep into people's minds.

3. Beijing: the capital of humanity culture and science technology takes the lead of China innovation.

Key experiences: its politics, industry, university and **research** are integrated and builds innovation environment and ambient; it takes **the** lead to make **innovations** and is the first one to try reforms; it intensifies patent protection and criteria establishment; it consummates technology and finance institutions and improves capability of independent innovation; it lays **emphasis** on cultural accumulation and advocates **competition**, cooperation and endeavor.

Key inspiration: it should rely on its local resources and look for global resources; it has good **entrepreneurial** environment and fair competition ambient; it should intensify patent consciousness and be the first one to implement industrial criteria; it should make clear definition on government role; it should make innovative exploration of industry-university-research **cooperation** mode and play the support effect of finance to its most extent.

4. Helsinki: it achieves great-leap-forward **development** with concentrated targets and technology globalization with huge technology import and export.

Key experiences: it formulates great-leap-forward **development** strategies and occupies the high-point of technology; it integrates technology resources and takes the path of internationalization; it establishes high welfare institutions and motivates innovation vitality; it increases investment and promotes the integration of industry, university and **research**; it explores innovative mode of "Living Lab" according to its own circumstances.

Key inspiration: it should look far ahead and make long-term plans; it **should** blend into the world and take the lead of high-end sector; it

should consummate law system and establish good technology innovation environment; it should consummate government functions; it should free its mind and move forward with the times.

5. Dublin: it shifts from a European village into the “Celtic Tiger”.

Key experiences: it attaches importance to enhance coordination, and the government enhances the management of itself; it improves law environment to convoy innovation industries; its policies are clear and directional, promoting technology innovation; it implements preferential tax policies to attract foreign investment; it works hard to improve its infrastructure and lay solid **foundation** for future development; it pays high attention to education, so talent bonus is emerging; it inputs many R&D funds to use capitals to support innovation.

Key inspiration: it **should** establish special institutes to manage innovation ability and innovation industry development; it **should** encourage technology innovation enterprises to grow bigger and stronger, and guide enterprises to **develop** in **different** levels, so small-scaled vicious competition can be avoided and the **industrial** chain can be perfected; the management committees of all development zones should improve the service ancillary facilities of software parks; more funds should be invested; the municipal government should lead multiple channels to expand international **publicity** of industries and enterprises; products and enterprises should go out while **more** talents should be attracted.

6. Austin: it explores a unique development path and receives the good reputation as “**silicon valley**”.

Key experiences: based on the complete industry policies and law protection systems of USA, it formulates preferential policies to guide innovation; the government invites targeted investment to form **an**

electronic industry cluster; it **integrates** all technology resources and establishes technology incubators to promote technology innovation; it improves urban environment to attract global talents; enterprises establish perfect talent **management** mechanisms to inspire talents' potential; it establishes developed financial systems to attract venture investment.

Key inspiration: the government should follow the guidance of national technology policies and formulate specific policies, regulations and measures for the implementation; it should intensify the "politics-industry-university-research" cooperation mode and give play to the leading role of the government; it should spare no effort in inviting investment to build industry clusters; it should utilize local technology resources and accelerate the construction of technology incubators; it should improve urban life quality and help enterprises to establish perfect talent **management** mechanisms, so as to attract talents from multiple angles; it should promote the development of local **finance** system and attract more venture investment.

7. Vienna: it composes the music of "sustainable prosperity and harmony" and plays the music of "international technology city".

Key experiences: it takes the initiative move and repositions **itself**; it uses music to attract the world and uses the art to promote its transition; it develops first-rate education and builds top living environment; it implements technology encouragement policies and sets up international R&D centers; it establishes **advanced** connection network.

Key inspiration: it **should** clearly define the city positioning; it should exert its strength resources; it should **make** use of technology and education to promote its development.

8. Wuxi: it dares to be the first and is brave to make exploration.

Key experiences: it positions itself after all situations are considered and moves forward with the times; it develops its own style to get industry-university-research alliance; its "530" talent introduction plan achieves **that** a **group** of talents lead the city; the government has good executive ability and **efficiently** serves the innovation activities; it has rich innovation culture, and takes the lead in "four respects and four creation" (i.e. respecting labor, knowledge, talent and creation and starting business, innovation, creating excellence and creation).

Key inspiration: it should expand the view, reposition itself, "activates the inventory" and "introduces high-end talents"; it should make carriers bigger and stronger, and promote the integration of industry, university **and research**; it should be good at inspiration and nesting for talents; it **should** reinforce executive force of the government and **create** a service-oriented government; it should build innovative culture and urban spirit.

9. Boston: its tradition and innovation are simultaneously emphasized, and its technology and economy are simultaneously developed.

Key experiences: it makes scientific positioning and achieves industrial transition; it improves innovation environment and enhances the integration of industry, university **and research**; it makes use of finance and venture **capitals** to **promote** hi-tech industry development; it constructs incubators for technology enterprises and creates favorable conditions to accelerate the development of technology enterprises; its

128th road is revitalized and MIT returns in an all-around way and reconstructs the cultural system for starting business; it develops underground spaceship and improves urban environment.

Key inspiration: it **should** accelerate industry transition and give full play to the government's leading role; it **should** intensify the "Five-in-One" strategy and construct platforms for technology achievement transformation; it **should** promote finance development and explore new financing modes for technology; it **should** promote the development of hi-tech industries with the help of experiences learnt from 128th road industry band; it should pinpoint the target **position** and find a unique **path** of technology innovation.

VIII. Strategic Measures of Nanjing Technology Innovation

1. Functional Orientation of Nanjing: the important center of the world's top metropolitan area, and the world's **important** science and education center

The vision and goal of Nanjing is to be a world's important city; its functional orientation of development is to be an important center of the world's top metropolitan area; a metropolis which has important international **conventions**, logistics, technology, information, finance and high-end manufacturing sectors; the "best city" of Yangtze River Delta; a technology innovation center in Yangtze River Delta, a nationwide technology innovation center, and even a world's important science and education center.

2. Goals to Achieve: it aims at catching up Suzhou in short term, Shenzhen and Beijing in medium term, and Boston and Munich in long term.

Short-term goal: a technology innovation center in Yangtze River Delta. Its development goals include that per capita GDP reaches 10,000 dollars and the contribution rate of science progress is 55%; it intends to catch up Suzhou and consolidate its position of technology innovation center in Yangtze River Delta.

Medium-term goal: a nationwide technology innovation center. Its development goals include **that** per capita GDP reaches 16,000 dollars and the contribution rate of science progress is 60%; it intends to catch up Shenzhen and Beijing, and become a nationwide technology innovation center.

Long-term goal: a world's important science and education center. Its development goals include **that** per capita GDP reaches 24,000 dollars and the contribution rate of science progress is 70%; it intends to catch up Boston and Munich, and become a world's important technology innovation center.

3. Industry System: it focuses on key industries **and** fields.

The key industries and fields include the **research** and development of IT sector, communication equipment, photoelectron, computer, biomedical sector, vehicles and ships, equipment manufacturing sector, metallurgy material, electronic and electrical sector; and productive service industries like technology service sector, information service sector and logistics.

4. Service Range: it focuses on Yangtze River Delta and expects for the whole world.

No doubt the technology innovation achievements of Nanjing have to serve the development of all industries in Nanjing, but it's expected **that** they will serve Yangtze River Delta, the whole nation, even East Asia and Southeast Asia, and eventually be able to take a place of the world.

5. Implement Approach: seven strategies

The strategy of **"education leading, science and education integrated"**: innovate in education mechanisms; enhance vocational education; intensify fundamental **research** and education; make use of Nanjing's industrial strengths and development trend to train talents; utilize the existing resources, and attract enough overseas and domestic high-end talents.

The strategy of **"open, leading, carrot and stick"**: keep open to both inside and outside; insist on expanding amount and **utilizing** structure; adhere to inviting investment and **improving** investment environment at the same time; adhere to the combination of **"import"** and **"export"**; concentrate high quality talent resources; make high standard plans and constructions of infrastructure and **services**.

The strategy of **"invigorating small enterprises while relaxing control over large ones, and promoting clusters"**: cultivate and develop small- and medium-sized enterprises; support the development of local hi-tech enterprises, and promote the transition of private enterprises; give aid to critical enterprises and **accelerate** developing local and private hi-tech enterprises; optimize industrial structure and promote cluster **development**.

The strategy of **"finance command and integration"**: cultivate finance subjects for technology innovation, and consummate the supporting conditions for technology finance cooperation; consummate multi-layer

finance supporting system for independent innovation; establish perfect fiscal taxation policies and guide financial institutions to be independent and innovative.

The strategy of “expanding network and promoting connectivity”: the government institutes should initiatively go out and **establish** the global network; give full play to private forces to promote the network construction; carry out the army-civilian combination **strategy to** promote technology innovation ability.

The strategy of “displaying personality and building brands”: form unique urban style; reinforce core strengths and build urban brands; construct “harmonious Nanjing”; construct the interactive multi-culture pattern; protect and explore historical and cultural **heritage**, actively develop **modern** urban culture, and forge a “modern, humanity and green capital”; take the opportunity of the Youth **Olympic Games** to develop urban marketing, build urban brands and improve the international image of Nanjing city.

The strategy of “making performance assessment and improving efficiency”: on one hand, it should make performance assessment on government employees, and give awards or **punishments** according to the performance assessment, so as to improve the governmental executive forces; on the **other** hand, the government should establish the index system for technology innovation evaluation and update the index system regularly, conduct assessment on the independent innovation of enterprises to promote their technology **innovation**.

6. Implement Measures: six measures

Stimulating the impetus and vitality of technology innovation subjects: further integrate technology resources, share integration

achievements, and allow enterprises to exert their dominant role of technology innovation; support the development and innovation of small- and medium-sized enterprises, and inject technology innovation **vigor**; concentrate high quality talent resources to keep bringing fresh energy for technology innovation.

Promoting the development of technology service industry: develop state-operated and private-operated technology agencies; focus on **foster** incubators for technology parks, and improve the transformation ratio of technology innovation achievements and promote the sustainable development of technology parks; develop technology finance, and create good environment for business starting and innovation financing; establish technology information exchange **network**, provide PTP services, and consummate public service platform functions; scientifically plan the development of technology service industry, which should let market dominating and keep high-end and concentrated; establish standard technology criteria, and formulate technology service quality insurance strategies; the **government** should take the initiative to go out and create international economic network environment, enhance business connection and marketing Nanjing.

Improving industrial core competitiveness: make high standard industrial development plans, and determine the urban development strategies for Nanjing; make development plans of the development zones, and promote concentrated development of industries; intensively use lands and promote **industrial** clusters; enhance technology achievement transformation **and** industrial base construction.

Consummating public institutions: create service-oriented government, and intensify governmental executive forces; reinforce intellectual property right protection mechanisms to convoy technology innovation; **encourage establishing** NGO like industrial associations and

commerce **chambers**, and give full play to industrial associations; keep exploring new **innovation** modes, such as "Fraunhofer Mode".

Building innovation culture: actively promote vocational education on in-service techniques, improve service level and explore innovation potential; implement BBS (**Berufsbildenden Schule**) and cultivate down-to-earth talents; cultivate hi-tech innovation entrepreneurs, and build favorable cultural ambient for starting business; strengthen innovation cultural experience, and promote the formation of innovation culture system based on traditional **culture**.

Improving urban ancillary facilities: improve urban infrastructure; improve communication ancillary measures; improve cultural and recreational facilities and the social service system.