Indian Journal of Economics & Business, Special Issue China & India (2006) : 1-...

HIGH TECHNOLOGY CLUSTERS IN INDIA AND CHINA: DIVERGENT PATHS

SUSAN M. WALCOTT
Georgia State University, Atlanta
and
JAMES HEITZMAN
University of California, Davis

The economic giants of Asia, India and China, encourage clusters of high technology companies to fuel their national economic development drives, but the paths of these neighbors follow divergent trajectories due to different interconnections between government policy and business strategy. Based on field research, economic data and targeted case studies, this article explores the impact of regional political agency, technology infrastructure (unconnected versus integrated), the central government (hands-off versus highly involved), private capital (large versus negligible), and foreign direct investment. The picture emerging from each country's profile allows assessment of short and long-term change for these urban clusters.

1. THE TECHNOPOLE AND ASIAN URBANIZATION

A growing body of multi-disciplinary scholarship focuses on technopoles: dynamic clusters of research and production organizations generating rapid employment growth within innovative sectors, forming an important component of public policy. The "technopole effect" - encompassing spin-offs from co-located science or business parks, the segregated enclaves of privileged employees, attractive recreational amenities, and enabling infrastructure - produces a characteristic urban morphology within an emerging category of technology-based world cities. The transformed environments where the technopole effect occurs, often defined as corridors, signify a major component in urban policy that aims at the stimulation of services on the borders of former urban cores.

A clear need exists for examining such spaces of human interaction, based on case studies of new urban developments offering possibilities for global application (Grant and Nijman 2002). This study concentrates on processes involved in the establishment of parks within corridors adjoining four urban regions: Bangalore and Hyderabad (Haidarabad) in India, Chongqing and Chengdu in China. Examination of public policies specifically designed to promote clusters in these metropolitan regions traces the technopole effect as a problem of institutional expansion or organizational change. An underlying question concerns whether the political and economic dynamics of India or China best responds to the challenge of producing such cities.

Scholars and managers interested in regional planning frequently examine economic clusters where competitive advantages emerge when closely related groups of firms, interacting with research and development organizations, establish nearby facilities. The cluster approach resonates with city planning, which focuses on the problems of rapid demographic growth, infrastructure and service delivery, and the differentiated spatial distribution of human activities. The concept of technopoles evolved within cluster analysis from the older notion of "growth poles" that traced the stimulation effects of concentrated investment extending into surrounding areas (Perroux 1955). Former "industrial parks" have become "science and technology parks", or "business parks". These terms reflect the shift from an earlier interest in heavy industry and factory production toward "knowledge" industries and "high and new" technology, consisting largely of information and computer technology (ICT) and biotechnology, with the race on to develop nanotechnology and new materials. Castells and Hall (1994) utilized a comparative framework to analyze the policy and institutional frameworks allowing the construction of the "milieu of innovation," leading to Castell's conceptualization (1996) of a network model embedding a "space of flows" within global capitalism as a new mode of development. In a later study, Markusen *et al.* (1999) suggested that "global Fordism" (the accumulation of branch plants of transnational corporations with government infrastructure support) drives most examples of expansion around technopoles.

Regional geographers use the concept of the corridor to describe contiguous conurbations or multi-regional concentrations of population, such as the belt of cities stretching from Boston to Washington, D.C. (the "Boswash Megalopolis"). The corridor, in that context, resembles other geometric figures used to describe extensive urbanization, such as the "Ring City" or Randstadt of the Netherlands or the "Research Triangle" of North Carolina. Insertion of a technological basis for multi-city geometries brings forth the examples of Silicon Valley southeast of San Francisco or the Route 128 complex of ICT firms west of Boston (Saxenian 1994). The impressive growth of the economy based on ICT within these corridors has stimulated an entire sub-specialty within urban planning oriented toward the replication of the institutional conditions supporting the genesis and expansion of the technology cluster.

As second-tier cities become components within polycentric urban regions with science and technology projected explicitly as the dynamo for growth, the older concept of the park becomes incorporated within a more ambitious model of the corridor. This unprecedented scale of spatial concentration lures investment for scientific activity by building corporate campuses, constructing housing and services for tens of thousands of employees, and zoning thousands of hectares within a comprehensive public policy strategy. Development corridors create the framework for polycentric urbanization (Storper and Walker 1989) that quickly absorbs dozens of suburban villages, propagates a transitional market model, and establishes extensions linking multiple metropolises into multi-regional complexes (Zhou and Ma 2000; Deng 2003).

In Asia, exploding technology-led economic activity is reshaping major city regions experiencing very rapid demographic growth and attracting many companies exploiting markets in cutting-edge fields (Heeks 1996, Huang and Khanna 2003). This is a phenomenon of global significance attracting considerable scholarly attention, but rarely

yielding studies that adopt an explicitly comparative, multi-regional perspective. Our research moves toward a new understanding of metropolitan patterns within rapidly developing nations by examining the impact of science and technology policy on urbanization and the significance of emerging innovative clusters within Asia's two largest nations, India and China.

Cities in India and China manifest growth patterns that superficially resemble those in North America, Europe, or Japan and in fact respond to them (Fen and Zhou 2005, Wu 2005). As ring roads and arterial highways extend residential and economic activity outside old urban cores, familiar patterns of suburbanization and transport-oriented development emerge. These patterns reflect the impact of economic liberalization and also the historical specifics of regional economic change, interacting with provincial- or state-level policy initiatives for science and technology alongside urban planning (Fan *et al.* 2001; Garver and Prime 2002; Lalkaka 2002). The cities we portray exemplify the importance of political intervention into processes typically described within a globalized economy, contrasting a bottom-up approach in India with a more top-down approach in China (Park and Markusen 1995; Jong 2002; Huang and Khanna 2003).

2. A TALE OF TWO COUNTRIES

In India, after the establishment during the 1950s of center-state relations and the physical definition of the Indian states, the 1960s witnessed the passage of fundamental legislation by state governments that defined urban areas and delegated to state-level agencies the ability to determine the authorities and direction of urban planning. Although local urban governance became standard practice, and in some cities retained considerable vitality, state governments remained the legal arbiters of urban affairs. This led by the 1970s to the passage of acts that vested a wide range of urban planning functions in the hands of "parastatal" organizations that managed infrastructure issues, such as power generation and distribution, water and sewerage, and transportation (to name a few). The states delegated urban planning and land use management to Urban Development Authorities that accepted the parameters of the long-range Master Plan model pioneered originally in 1940s Britain. This model placed the metropolitan corporation at the center of the planning arena, surrounded by territory that was undergoing or could undergo urbanization within a future horizon of about 20 years (the whole labeled the "urban agglomeration" by the Census of India). Surrounding the agglomeration was a "green belt" where the state would attempt to suppress urbanization. Outside the green belt would be alternative growth poles or new towns; within the urbanized or urbanizing area the development authority would regulate development according to zones (e.g. industrial, residential, commercial). By the 1980s, state governments were establishing Metropolitan Region Development Authorities to regulate the territories lying beyond the green belts through "structure" planning. From a long-range perspective, one could expect the metropolitan region to become the most important planning arena once urbanization had filled or spread beyond the green belt. The acquisition of land and assembly of resources for industrial zones, typically on the fringe of the green belt or even within it, rested in the hands of Industrial Development Authorities that benefited from legislation allowing the rapid expropriation and compensation of previous landowners and the establishment of basic infrastructure.

For India, where the suburban industrial zone or the independent industrial township served as the dominant models for urban employment generation during most of the twentieth century, the shift toward technopole thinking became increasingly important during the late 1980s as the microcomputer revolution became a reality. With the preliminary installation of civilian digital networks and the demonstrated feasibility of transnational networking for software production teams, the central government moved forward with a project called Software Technology Parks of India (STPI). Ground stations provided connectivity to satellites that transmitted digital messages between Indian outsourcing firms and foreign clients, mostly in the United States, seeking relatively cheap programming services. Here is where Bangalore took on the image of India's Silicon Valley, although in fact other Indian cities were major sites for offshore software production—including Delhi, Mumbai, Hyderabad and Chennai. With the onset of liberalization in 1991, the technopole discourse began to move into the planning language of bureaucrats and corporate interests, and began to affect the allocation of public and private investment. The software industry became the symbol of transnational competitiveness, export-oriented policy, and the importance of high technology and knowledge industries as growth engines for a new liberalized economy. The entrepreneurs and well-paid programmers of firms specializing in ICTs became the symbols of a burgeoning, urban middle class that was demanding "world class" housing and services.

Post-1949 China continued the traditional form of top-down centralized governance. Differential regional development played an integral part in central government planning throughout the twentieth century. Mao Zedong sought to develop targeted inner China cities in the western region as a fall back position relative to the more advanced east coast, dumping intellectuals and materiel there during the "Hundred Flowers," "Third Front," and Cultural Revolution campaigns. Deng Xiaoping reversed this flow in 1978 under the "Opening and Reform" policy, which favored rapid growth in major eastern and southern Chinese cities such as Beijing, Shanghai, and Guangzhou. These policies produced some of the world's largest concentrations of urban population, with industrial firms increasingly oriented around market forces and export.

Deng's successor, Jiang Zemin, tilted central government development funds westward again, while encouraging continued rapid economic growth in the eastern centers. Proclamation of the central government's "Great Western Development" policy (*Xi Bu Da Kaifa*) in June 1999 signaled a major escalation in resources and attention focused on decreasing the development gap between the east coast powerhouses and the twelve provinces of an increasingly lagging western China. The ratio gap of gross domestic product between the eastern and western provinces increased steadily from 1980-2000 (2.98% to 4.33%), a clear indication of the yawning divide (Yeung 2004). The Chinese model of direction from the center remained intact for political reasons; certain key cities received designation as national level urban areas (e.g., Beijing, Shanghai, and most recently Chongqing), giving them greater autonomy in economic planning, but they remained tied to national goals and subject to national Party directives both in policy and personnel. Provincial level governments were likewise the recipients of policy and fiscal flows from the top, able for example to start their own development parks but acting only within the parameters and subject to the permission of national policy.

Recent studies assessing the effects of proclaimed self-responsibility measures for sub-national units find few to no functional changes (Marton 2000, Tang and Chung 2000).

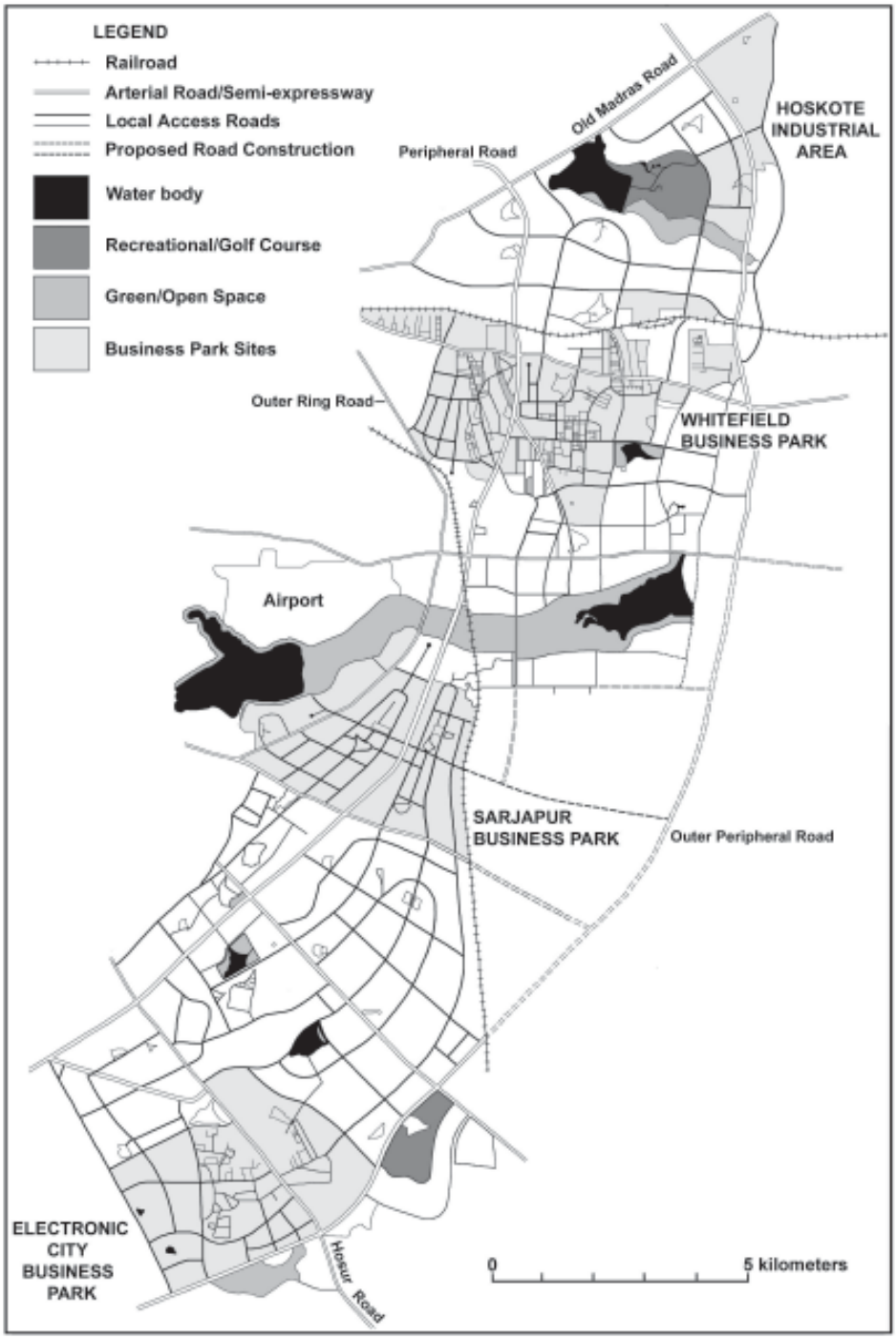
The west China cities of Xi'an, Chongqing, Chengdu, and its suburb "Technology City" Mianyang (a recipient of transformative amounts of central government funds) remain the most advanced research bases in western China for products with high technology inputs (Mianyang 2004). Plans for these cities include greatly improving transportation links between them so that they can complement each other as tent poles raising the level of western development by linking to air, water, and surface transportation routes (Yeung *et al.* 2004). Although it is less than an hour away from Chengdu by car on a major highway, Mianyang sports its own airport with a non-stop connection to Beijing–convenient for the authorities who created it as a technology center with the highest percentage of PhD's per capita in the country. Internally each city (particularly less well-developed Chongqing) is designated for upgrades in their logistics infrastructure, public services, and roads. Areas along the major transportation arteries are also designated for expanded medical and health service provision, anticipating the needs of an increased settlement population. Although the effects of urban growth are felt locally, directives come from central authorities.

3. A TALE OF FOUR CITIES

Located on a relatively flat plain on the southern part of the Deccan plateau, Bangalore (population 6.53 million in 2005) is a textbook example of science and technology policy linked with urban planning (see Figure 1). After Independence, Bangalore attracted to its suburbs the industrial townships of giant public sector enterprises operated by the central government, while simultaneously becoming the capital of the state of Karnataka and experiencing a rapid growth of administrative employees. In order to build on Bangalore's emerging reputation as an electronics production center, the state government set up an industrial park called Electronic City in the southeastern suburbs, which experienced only slow growth until STPI installed its first earth station in 1992 and began to attract clients including private-sector companies that were beginning to tap U.S. markets for cheap software production. This stimulated a Singapore-based consortium to begin construction in 1995 of the International Technology Park, a multi-tower, steel-and-glass campus located in the northeastern suburb of Whitefield, designed to support clients requiring transnational digital telecommunications. The state government assembled nearby the Export Promotion Industrial Park, which began to attract branch plants of transnational corporations specializing in software production during the late 1990s. These initiatives produced two business park complexes, in the northeastern and southeastern suburbs, which combined with a rapidly proliferating series of corporate offices scattered throughout central and southern Bangalore to support the city's growing reputation as India's "Silicon Valley."

The configuration of higher education in Bangalore contributed to its attractiveness as a technology magnet. The Indian Institute of Science (IISc) had been established in 1911 in what were then the northwestern suburbs of the city, and gained a reputation as India's premier site for fundamental research in the physical sciences. Although its relationship with regional business formation had long remained ambiguous, its reputation for excellence along with some outreach programs created an ambience that

Figure 1
The Bangalore IT Corridor in 2003



allowed IISc to regularly feature among the rationales cited by technology firms for their location in Bangalore. The city's strength, however, was engineering. In 2000, Bangalore was home to 21 out of 82 engineering colleges in the state of Karnataka (enrolling, as a whole, 17,000 students), where information technology was the hottest field. In combination with private training institutes, the educational system was supplying personnel for an ICT workforce reputed to top 100,000. During the 1990s, the assembly of a new, high technology cluster transformed the mature industrial structure of the metropolitan region. These changes culminated in the foundation of the Indian Institute of Information Technology in Bangalore (IIIT-B) in 1999 (Heitzman 2004: 222-29).

The Government of India was observing these developments with great interest, for they dovetailed with a national export/import strategy that projected a continuing, rapid increase of earnings by offshore software service firms. Following the advice of a special task force, in 1999 the Government of India announced the creation of a national Ministry for Information Technology, which began to work with state governments to set up goals for a national programming workforce and infrastructure that would support continued domestic and transnational corporate investment. The Government of Karnataka followed suit with the establishment of a Department for IT and Biotechnology, and the following year rolled out the concept of an "IT Corridor" on the eastern and southern sides of the city, as a means to connect the complexes in Whitefield and Electronic City (Heitzman 2004: 165-217). Jurong Township Consultants (India), which had worked on the International Technology Park, prepared a structure plan for the corridor by January 2003. The goal of the consultants' planning exercise (See Map One) was to provide a "showcase environment for IT professionals to live, work, play and strike deal." At a conceptual level, this meant a transition from the older "industrial" park idea to a "business" park idea, attracting firms engaged in "high-technology, research and development, high value-added and knowledge-intensive activities." One of the recurring principals guiding the planners was attention to the characteristics of "quality parks of international standards that would cater to international companies," in order to "reflect the high-tech image of international style."

The IT Corridor of Jurong Consultants was a stretch of land about 25 kilometers in length and 7.5 kilometers in width, amounting to an area of about 139 square kilometers. Outside the space in and around three major lakes with associated wetlands, 80 water bodies, and land already developed, 62 percent of the land area within the corridor would be available for new development. Business park lands would be concentrated within four areas: the two around Whitefield and Electronic City (already underway), a third in the north along the main road leading to Hoskote, and a fourth in the Ring Road-Sarjapur Road vicinity. About 21 percent of the land within the corridor was set aside for business parks, which would provide employment to 773,000 IT professionals, including 15 percent support staff, by 2021. At the residential level, outside the 50 villages and pocket developments already lying within the corridor, constituting "untidy urban streetscapes," the planners envisioned six residential townships, or New Towns, accommodating a total population of approximately 936,000 by the year 2021. Located in the areas between the three business parks, two regional commercial centers would each serve a population of about 500,000 persons, becoming the "Life Exchange hub of

the entire IT community of Bangalore." Two regional parks, six town parks, neighborhood parks, six community centers, six swimming complexes, and two golf courses (one at either end of the corridor) would provide open spaces and facilities for sports. In practice, the first project begun within the framework of the IT Corridor plan was the southern golf course near Electronic City. According to the planners, the estimated cost for the IT Corridor—outside land acquisition and landscaping—would be US $ 1.07 billion (Jurong Consultants 2003).

Undoubtedly it was the seemingly impossible cost of the mega-project that motivated the Bangalore Development Authority to produce a Comprehensive Development Plan in 2005 that ignored the consultants' report while preserving the idea of a new residential township around Sarjapur Road. Meanwhile, a high-level committee established by the state government was busy allocating extensive lands throughout the erstwhile IT corridor to corporations specializing in software and services and to private land developers who were building residential colonies for the middle class and the well-to-do.

The city of Hyderabad (population 6.15 million in 2005), located on the eastern side of the Deccan Plateau in peninsular India, is in a sense Bangalore's twin in the state of Andhra Pradesh, for which it serves as the capital. As in the case of Bangalore, the big break in the evolution of the ICT industry in Hyderabad was the 1992 establishment of an office of STPI. By 2003-04, STPI-H had 1,060 companies on its client list, and the total number of persons officially described as working in the local ICT industry had risen to over 75,000 with an additional 10,000 support staff. The consolidation of Hyderabad's high-technology profile coincided with the establishment of an "integrated techno-township" named Hyderabad Information Technology Engineering Consultancy (Hitec or Hi-Tech) City, which came up in 1997 on a 64-hectare site on the north side of the city. The showpiece of the project, completed after only 15 months, was the ten-story Cyber Towers, the heart of a planned township with 500,000 square feet of office space, showrooms, cafeteria, health club, banks, shopping malls and auditoriums. Tenants of Cyber Towers included Microsoft (establishing there its first offshore research facility), Oracle, GE Capital, Hongkong & Shanghai Banking Corporation, and Keane. Stage two saw the erection of a companion structure named Cyber Gateway with 866,000 square feet of office space, opening in 2001, with tenants including Microsoft, GE Capital, Oracle, Dell, and ICICI Bank. Stage three saw the construction of the seven-story Cyber Pearl, a project featuring the participation of Singapore-based Ascendas Private Limited. Additional projects in the neighborhood included a 13-hectare development for a "modern multi-dimensional residential township" at nearby Gachibowli.

Simultaneous initiatives were assembling in the vicinity two prestigious institutions of higher education, both inaugurated by Prime Minister Atal Behari Vajpayee in December 2001. The first to open was the Indian (later International) Institute of Information Technology (IIIT-H), originating in 1998 with support from the state government and private corporations including IBM, Keane, Motorola, Oracle and Satyam. Its mission was to educate engineers who would assume management positions in ICT organizations, conduct continuing education programs, and carry out research on the technical and societal problems of information technology. The second was the Indian School of Business, established with state assistance through the efforts of

academics and corporate leaders envisioning "an internationally top-ranked, research-driven, independent management institution" where "knowledge is a source of competitive advantage." Its publicity highlighted affiliations with the Wharton School of the University of Pennsylvania, the Kellogg School of Management at Northwestern University, and the London Business School.

Hyderabad's IT zone had its educational nucleus; the success of Hitec City gave it an engine. Now it required the legal status that would allow its growth, and a pun provided the key. As early as the initiation of Hitec City, people had begun using the term "Cyberabad" to reflect Hyderabad's new IT image. This led, in fact, to a scramble for domain names on the World Wide Web, resulting in the registration of Cyberabad.com by private interests in December 1997. Cyberabad achieved official recognition when the government of Andhra Pradesh created the Cyberabad Development Authority (CBA), a spin-off from the Hyderabad Urban Development Authority (HUDA), in November 2001. The draft Master Plan of the enclave, prepared by Vastu Shilpa Consultants, called for a total extent of 52 square kilometers (5,170 hectares), including 1,692 hectares (33 percent) allocated for public and semi-public use including computer software units, and 1,376 hectares (27 percent) allocated for residential zoning. Simultaneously, the state government moved forward to legitimize the second cell for biotechnology and medical sciences in the east. Borrowing terminology already used in strategic studies within the United Kingdom (Government of the United Kingdom 1999), the government of Andhra Pradesh bestowed the name of Genome Valley on an area of approximately 600 square kilometers stretching from the northern to the eastern sides of Hyderabad. The policy goal was to attract more private firms to locate around Hyderabad within the Genome Valley administrative area, contributing to the city's self-definition as the "biotechnology capital" of India. Among the variety of concessions offered to firms locating in Genome Valley were rebates on land purchased from the government for every job created, exemption from power cuts, labor concessions allowing flexibility in work shifts, and exemption from provisions of labor laws.

Interviews with employees in both Bangalore and Hyderabad's high tech complexes underlined the importance of labor attraction and retention factors. Despite billboards touting subdivisions under construction, Genome Valley in 2004 was a "concept park" under construction, surrounded by lightly inhabited suburban land, trying to create a "reality on the ground" that would compel linking transportation and other supporting infrastructure. Employees in the more established high technology complexes featured a notable number with overseas education and experience who returned to an India offering middle class living amenities, from shiny shopping malls to Silicon Valley campus-like features. Monetary and fiscal incentives appealed to companies, but footloose knowledge workers wanted a complete lifestyle package to elicit their participation.

Evidence from two of the major cities in western China underlines the contrast between an area with larger fiscal incentives, and one with better human networks: Chongqing, since March 1997 a national-level municipality with the largest area and population in China, and Chengdu, the historic capital of Sichuan province and close neighbor to the west of Chongqing. Within the western region these two cities ranked first and second (respectively) in GDP in 1999, or eighth and twelfth for urban areas within China (Gu *et al.* 2004). The two urban regions of Chongqing and Chengdu form

the leading edge of China's "Go West" campaign for enticing investment to the interior (Lai 2003; Walcott 2003). They clearly illustrate the contrast with India's pattern of entrepreneurial, bottom-up corporate initiated growth compared to China's centrally planned, state-directed investment of transformative amounts of capital to policy targeted high technology industries and urban areas in favored regions.

Chongqing's topography earned it the nickname of "Mountain City", recommending it as the relatively bomb-resistant capital of the Kuomintang–led capital of the Republic of China during World War II. Mao capitalized on its strategic location combining mountainous fastness with a Yangtze river port surrounded by the agricultural lushness of the Sichuan plain, to locate a large number of military-industrial production and technology-infused industries during the Third Front period. Separated from Sichuan province in connection with the world's most massive damming project on the Yangtze River, Greater Chongqing now comprises the largest urban region in western China. The national government signaled a major policy change in the city's profile in 1997 when it raised Chongqing to the level of a provincial municipality (like Beijing and Shanghai) and later proclaimed the "Great Western Development Project" (*Xibu Da Kaifa*) in 1999. With a population of 4.8 million in 2003, wedged largely into high rise buildings reminiscent of vertical Hong Kong-Kowloon developments, central Chongqing has little room to expand and great need for infrastructure connections within and around the city. Development zones consist of land leveled from surrounding hilly areas reclaimed from agricultural production. Fiscal support flowing from the city's designation as a municipal level metropolis balances the more spontaneous and self-generated growth of rival Chengdu, matching the prominence of Sichuan province's capital with heightened monetary infusions and policy persuasions from the central government.

This newly elevated (administratively) municipality remains primarily a manufacturing town, building on its base as a "Third Front" military-industrial site, now producing "dual use" products such as motor vehicles and electronics (Naughton 1988, Frankenstein 1997). Pharmaceutical chemical products form the third leg of Chongqing's principal industries. Newly encouraged "pillar industries" include IT, bioengineering, and environmental protection, along with less technology-intensive foodstuffs, construction materials and tourism (Chen, et. al., 2004, Chongqing 2004). Ambitious urban development projects within Chongqing's Economic Urban Region (see Figure 2) include the Economic Technology Development Zone (since 1992) on the southern edge of the city, the High and New Technology Development Zone (approved in 1991)–which includes 3 other technology development designated areas - to the core city's west, and a massive high technology corridor known as the Northern New District, projected to encompass 130 square kms. (Chen 2004). Industries for principal development in this zone include IT, software, optical electronics, environment protection, bioengineering, pharmaceuticals, new materials, and automobile and components production elements–many linked to the large remaining state-owned enterprises. Ford Motors' production facilities for a "Festa" Chinese model car constitute a major (and rare) foreign investment anchoring the district.

As the capital of Sichuan province, Chengdu (city population 3.4 million, metropolitan population 10 million in 2003) complements the Yangtze Basin-oriented role of Chongqing by looking toward other regions in southwestern China (Han and Yong 2001, Webster

et al. 2003). The hub of a province with 43 universities and 1.2 million scientists and engineers, and home of Sichuan University with 60,000 students, Chengdu attracts transnational corporations specializing in high technology projects into the West High-Tech Zone. Alcatel, Intel, D-Link, Ericsson, Mitsui & Company, Motorola, Siemens, Fuji Heavy Industries of Japan, and more than 200 other firms maintain facilities in the area's special technology districts (Liu and Shiu 2004, Fishman 2004). Chengdu ranks third in China's technology-related sales revenue from its technology and business parks (CSB 2003). The city of Chengdu includes three provincial development zones close to central Chengdu, a High-tech Development Zone near the traditional downtown, and the Wenjiang District's "Across-Straits Science and Technology Industrial Park some 23 kilometers distant. The Singapore Industrial Park and Southern Railway Processing and Trade Zone add to the picture of multiple parks. The stated target bases are electronics and IT (representing 36% of the output value of the Chengdu High Technology Development Zone in 2001), biomedical engineering, and a combination of light machinery, medical instruments, new materials, and food enterprises. Both Chinese and developed world companies–principally automobiles, computer, pharmaceutical and steel companies-line the busy Ching Guan Expressway corridor approaching Chengdu from Chongqing.

The two municipalities offer contrasts in the relationship between intractable features of physical geography and the expansion of a space of flows. New urban boundaries containing technology districts extend old developed areas in different sections of each city. In Chongqing, where two major rivers intersect amid a hilly topography, the "Northern New District" forms the most striking extension, given the paucity of flat land and the intensity of agricultural development in its vicinity. Although planners declared that the land was empty, and required flattening by machinery for construction of business zones and high-rise residences, other studies belie this assertion with tales of hardships for dislocated farmers in the area (Fishman 2004). Finding agricultural land for the flood of new peasants resettled from the Three Gorges inundation of their previous property is especially problematic given the competition for scarce land. Chengdu, on the other hand, lies on the eastern side of an extensive plain, with greater potential for symmetrical growth around its original quadrilateral hub rimmed by several rivers (See Figure Two). Zones of industrial production in Chengdu, hitherto concentrated in the eastern suburbs, are now complemented by business parks on the southern side (where Sichuan University lies), and rapidly expanding business and warehousing zones on the western side, where there is unlimited potential for conversion of agricultural land.

Overall, Chengdu's historical development edge marks it for continued success as the innovation leader over neighboring Chongqing. Despite the far larger size of Chongqing (which, given the extent of its municipal boundaries, includes proportionally far more non-urban dwellers than does Chengdu's metropolitan area population), it effectively falls behind the historic provincial capital in a variety of important markers (see Table 1). Chengdu, whose population is approximately half of that of Chongqing, generates relatively higher development measurements. Per capita gross domestic product is 68% greater in Chengdu than in Chongqing, new fixed assets per capita is 42% greater, and foreign direct investment per capita is 64% higher. The number of

Figure 2
Infrastructure and Economic Activity Locations in Chengdu, China

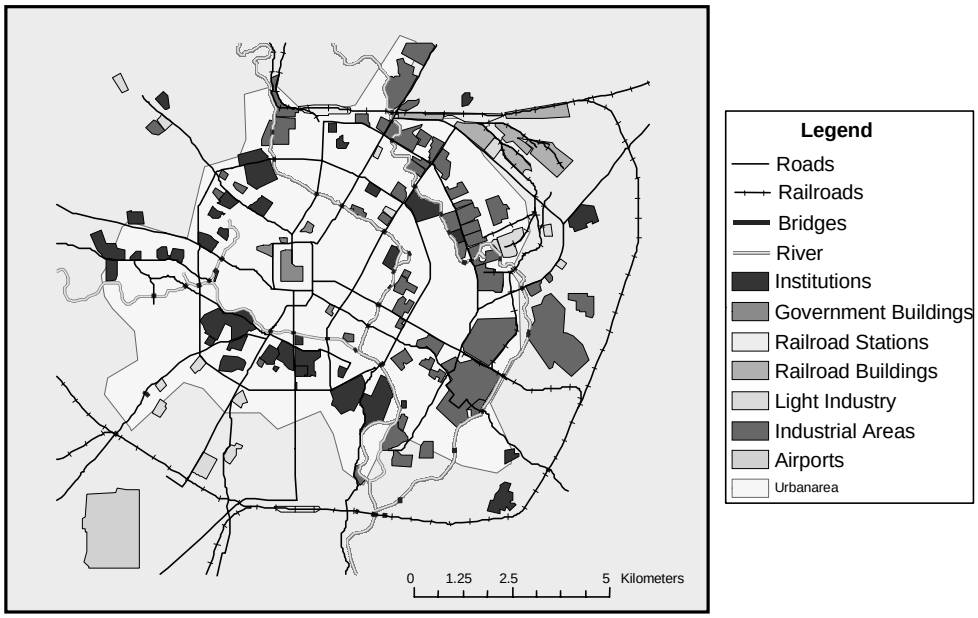


Table 1
Characteristics of Chengdu and Chongqing

Feature	*Chengdu**	*Chongqing***
City Size (sq. km.)/ Population (1 million)	2,176 / 4.39	16,291 / 9.99[***]
Metropolitan region (sq. km.)/ Population (1 million)	12,390 /10.28	82,403 /31.14
Gross Domestic Product (1 billion yuan)	166.32	197.13
Newly Increased Fixed Assets (1 billion yuan)	70.22	99.57
Foreign Direct Investment used (US$ 1 million)	367.13	450.34
Research scientists (1,000 persons)	N.A.	16.12
College graduates (1,000 persons)	33.30	32.33
+Undergraduates/Graduates (10,000 persons)	18.8/ 17	17/ 8.4
+Number of State owned enterprises	1,318	2,054
+Number of nationally recognized academicians	30+ (local resident)	3 (nonlocal)
Amount of new land developed (sq. km.)	761.00[****]	491.89

[*]Source: *Chengdu Yearbook 2003*, *http://www.cd.3000.gov.cn/sjck/cdnj/nj_main02.asp?Select=2002*, accessed on 7/26/04.

[**]Source: *Chongqing Yearbook 2003*, *http://www.rctj.gov.cn/2003cqtjnj/yearbook/indexw.htm*, accessed on 7/26/04.

[***] Chongqing is a province-level jurisdiction, composed of 15 urban districts, 21 rural counties, and 4 county-level cities. Here, the city only consists of its 15 urban districts. Other data in this column refer to the whole province-level jurisdiction.

[****] These data are obtained by subtracting the city size of Chengdu in 2002 by the size in 2001. It may be over-estimated, because the increase in city size can be caused not only by the new land development activities but also changes in jurisdictions.

\+ Webster *et al*. 2002.

undergraduates and college graduates is also higher in Chengdu. Sichuan University, the largest and leading research institution in that city, is heavily involved with innovative business incubators in the area and with companies utilizing high technology for domestic and foreign markets. Its graduates and affiliated professors follow the university's encouragement to form entrepreneurial companies for marketing innovative products. In the crucial category of land development, Chengdu far outstrips its regional rival. According to informants in Chongqing, when the people's money is at stake, decisions tend to be cautiously conservative. Reflecting its importance as a Third Front site, Chongqing remains a place with a high degree of military influence; the major hospital connected with medical device and biopharmaceutical products is managed by the military.

In both Chinese cities, interviews with company and development zone representatives found that they sought ways to disseminate information from a knowledgeable source to the corporate receivers. Receptivity of bureaucrats to outside inquiries varies markedly between the two cities, in the experience of several recent researchers (Chen 2004; Gelb and Chen 2004). Development zone representatives in Chongqing expressed doubt as to the feasibility of university science and technology parks, given the academic connection that they saw as impractical. Chongqing's University Science Park joined 22 other national level entities in June 2001, followed the next year by Chongqing Beipei University Science Park and a National University science Park, the Xinyang New Science World, the Binjiang Scientific and Technological Town, and the university-affiliated Jiazhou Science Park. Unlike in Chengdu, however, these areas produced few cooperative ventures, successful graduates, or other tangible measures of success.

Sichuan University's leadership in Chengdu, and the demonstrated success of several professor-led commercial ventures such as a new radar guidance system for planes approaching and leaving Capitol Airport in Beijing, shows that such technology transfer bench-to-market moves are possible. Several major mergers consolidated a number of leading higher education entities under one administration, including the former Chengdu University of Science and Technology and West China University of Medical Science. Sichuan University currently contains over 100 research institutes, 41 "key laboratories", nine "advanced research bases" and five province-affiliate research organizations. Sichuan University Hospital boasts a top research as well as clinical reputation. The university's "National Technology Transfer Center" is one of only six in China. Joint and subcontracted projects with businesses include corporate partners Boeing, Motorola, Dupont, and numerous Japanese firms (Sichuan University 2002).

The central government's concern with opening Chongqing, "the mountain city," to more fast-paced and globally integrated ways of operating prompted the recent transfer of a deputy mayor from Shanghai to Chongqing in order to bring more innovative and large-scale ideas to municipal governance. Chongqing is favorably situated as a river shipping port tied to the east through the tamed Yangtze and as the "tail of the dragon" military-industrial base trading on its transferable technology and related market-responsive products. Given the difficulty of new breakthroughs in Western "chemical pharmaceuticals", Chinese traditional herbal products constitute an important segment of medical products. The city's unique profile may end up defining Chongqing's position,

however, while Chengdu's intellectual edge perhaps provides a better fit for the New Economy.

4. REGIONAL LAUNCH PADS FOR THE MIDDLE CLASS

This preliminary study indicates that major changes in land use in the suburbs of large "second-tier" cities are taking place within the terms of a context that privileges specific intellectual and business fields collectively known as ICT and biotechnology. The terms of this discourse make possible a strategic alliance between bureaucrats, the leadership of private corporations, and real estate developers. The alliance removes land from the control of village farming communities and transfers it into the hands of corporate administrators and the urban middle class. Although growing rapidly, ICT and biotech employment account for a relatively small percentage of jobs within these metropolitan regions; nonetheless, the establishment of the spatial and infrastructure environment enabling their growth now constitutes the legitimating framework for an astonishing spatial transformation. By assuming overall "structural" direction for land use planning and service delivery within suburban corridors, the state maintains its legal hegemony over the urban economy while allocating responsibility for middle-class employment generation, and its assumed multiplier effects, to increasingly influential corporate managers.

The similarity in the schemes propounded for technology corridors in Bangalore and Hyderabad goes beyond the incessant visual presentation of gleaming corporate offices studding the landscape. First, the institutional components of the planning process are identical: the urban development authorities and the development boards of the state governments, the alliance of construction firms and national-level real estate developers, the transnational consultants from Southeast Asia. Second, the corridors always contain the same juxtaposition of physical elements: the successful "park" project is the anchor; new highways and high-speed telecommunication lines provide connectivity for campuses of business and educational organizations along with residential complexes. Third, the environment of the corridor displays a striking discontinuity with the socio-economic reality it attempts to replace. The previous owners of the land, typically poor cultivators, having alienated their rights through equitable sale, disappear completely or remain within the "untidy" enclaves of village sites as a new service proletariat. The erasure of the metropolitan green belt results in the marketing of miniature green belts within the business park, used now for recreational contemplation of nature.

The Chinese case study, based on the unfolding development of two major growth centers in and proximate to the interior western province of Sichuan, illustrates the effect of China's centrally directed economic initiative. Major infrastructure improvements and massive infusions of capital coalesced to kick at least the physical transformations into high gear. The effects of local history and culture remain, however. Attitudes fostered by geographic isolation linger in Chongqing, but the urban expansion containing districts designated for new technology-infused developments on the periphery of the traditional settlement areas looks similar to those in other cities examined, from offices to restaurants, recreation facilities and amenity housing. The scale of the plans envisioned in Chongqing and Chengdu could only happen with the support of the national government, however. The "city-leading-county" system

reinvigorated in 1982 attempted to encourage entrepreneurial local activities by moving administrative control from the provincial to prefecture level, with the effect of increasing the number and size of urbanized areas. The overall direction of control remains with central government guidance due to both funding and political reasons. Unlike in India, where the state level remains strong, China creates large metropolitan units for funneling centrally dispersed funds in response to national initiatives. The scarcity of both private capital and foreign investment in the interior cities, even in comparison to east coast urban areas, reinforces this pattern. Though the urban landscape looks similar, development processes sharply contrast between the two countries (Table 2).

Table 2
Comparison of Chinese and Indian High-tech Clusters

Category	*China*	*India*
1. Government Role	National level: establish Parks, tax breaks, incubators, r&d	State level: establish Parks, tax breaks, r&d
2. Labor Considerations: (a) cost (b) education (c) availability	Inexpensive, High quality, Plentiful labor	Inexpensive, Software maintenance, some basic writing, Limited # of high skill labor
3. Relation to Foreign Companies	Welcoming, but careful re ownership, staffing	Hesitant, restrictive; allow foreign ownership
4. Company location relative to each other	Within Parks, several in same town	Tightly clustered
5. Assistance programs within Park	Interpret regulations, incubators, info and networking opportunities	Technology incubator
6. Location of main customers	Abroad and domestic	Abroad and domestic
7. Location of main suppliers	Abroad and domestic	Abroad
8. Competitive advantage	Labor and huge potential domestic market	English fluency; Ties to U.S., management skills
9. Major problems	Shortage of private capital, Inadequate IP protection, Many other Parks,Underdeveloped legal infrastructure	Gov't over-regulation, Overdependent on outside due to export bias,NRI brain drain,Low literacy impedes domestic market formation, Underdeveloped physical infrastructure

Chinese urban planners clearly recognize the need to configure amenity-rich spaces in order to attract and employ young, highly skilled and internationally-aware workers along with transnational investment. The appearance of special districts on the periphery of old cores indicates the scarcity of land in previously developed central urban districts, although some popular redevelopment schemes include pedestrian retail along a traditional shopping street. Chengdu's broad pedestrian mall in the new deputy center includes eateries, movie houses, bowling allies, major department stores, and coffee and tea shops with international names. A large restaurant complex adjacent to the technology center on the south side, its towers of new apartments and latest (third)

extension of Sichuan University, also attest to the new prosperity fed by technology related growth. Outlying suburbs and development zones in all cities examined incorporate a more total, integrated picture of up scale development in their expensive mall shops and residential enclaves.

With the transformation of urban space in China and India, we are witnessing the creation of the Asian middle class under different political systems: a state-centric democracy in India and an authoritarian central government in China devolving increasing powers to strong municipalities. The political form seems to matter less than the economic functions; while both are transitioning, metropolitan landscape patterns seem to be converging in corridor extensions absorbing new political-economic functions on the urban fringe. Some have posited that the Indian example indicates the existence of opportunities for private entrepreneurial activity due to looser (but still prominent) central control, but that nevertheless have weaknesses from a lack of the kind of networking seen in the West (Fromhold-Eisebith 1999). In China, the central government inserts infrastructure and infuses large amounts of capital into urban centers in order to raise them as functional globalizing nodes (Lin 2002, 2004; Wu 2003). Underlining the insufficiency of economic policy incentives, differences lie in the level of human networking ties fostered by specifically designed campus facilities encouraging Western-style interactions (e.g. banks, laundromats and gyms in Bangalore; restaurants in Chengdu; convenient "villa" residential developments in both) within corridors of isolated affluence.

The national technopoles examined in this research currently constitute peninsulas of privilege created to connect work, residence, and amenity landscapes large enough to attract a core of cosmopolites. Intriguing similarities between the two countries flow from their attempts to follow an international pattern attracting highly desirable native talent who can live in more developed lands but prefer to remain in their cultural hearths. The newly sculpted landscapes that are the goal of these projects—though hardly visible today in the mostly barren suburbs—embody "international" standards, projecting an impression of global fashion that modernizes. This is not simply the imposition of globalization on the liberalized nation, but the result of a conscious attempt by a state-corporate nexus to appropriate elements of the transnational within a national developmental project—in the name of foreign exchange. The implementation of the technopole and corridor concepts suggests that regional actors are seeking solutions to the problematic of late capitalism through a shared language of space. This transcendence of the past is the occasion for celebration of the knowledge-based society that the regions have joined.

REFERENCES

Castells, M. (1996), *The Rise of the Network Society. The Information Age: Economy, Society, and Culture,* Blackwell, Cambridge, MA.

Castells, M. and P. Hall (1994), *Technopoles of the World: The Making of 21st Century Industrial Complexes,* Routledge, London.

Chen, J. (2004), *Investment Focus in the Chongqing*, Chongqing People's Municipal Government, Chongqing.

Chen, Y., C. Chen and H. Lin (2004), "Chongqing", In Y. M. Yeung and J. Shen, eds., *Developing China's West: A Critical Path to Balanced National Development,* The Chinese University Press, Hong Kong, 435-462.

Chongqing Hi-Tech Industry Development Zone (2004), *Chongqing Hi-Tech Zone*, Chongqing Hi-Tech Industry Development Zone, Chongqing.

CSB (2003), *High-Technology Industry Statistical Yearbook, 2003*, China Statistical Bureau Publishing House, Beijing.

Deng, F. (2003), "Development Zones and Urban Land Reform in China", Asian *Geographer* Vol.22, 5-25.

Fan, J., Z. X. Cao, W. Z. Zhang, and Y. D. Xu (2001), "The Consideration of Strategic Innovation of Western Development Based on Theories of Economic Geography", *Acta Geographica Sinica,* Vol. 56, 720-728.

Feng, J. and Y. Zhou (2005), "Suburbanization and the Changes of Urban Internal Spatial Structure in Hangzhou, China", *Urban Geography*, Vol. 26, 107-136,

Fishman, T. (2004), "The Chinese Century", *New York Times Magazine,* 24-31, 46, 50-1.

Frankenstein, J. (1997), "China's Defense Industry Conversion: A Strategic Overview", In J. Brommelhorster and J. Frankenstein, eds., *Mixed Motives, Uncertain Outcomes: Defense Conversion in China*, Lynne Reinner Publishers, Inc, Boulder, CO, 3-34.

Fromhold-Eisebith, M. (1999), "Bangalore: A Network Model for Innovation-Oriented Regional Development in NICs?" In E. Malecki and P. Oinas, eds. *Making Connections: Technological Learning and Regional Economic Change,* Ashgate Publishing, Aldershot, 231-260.

Garver, J., and P. Prime (2002), "China Wins the Race: A Comparison of Chinese and Indian Economic Development", Coles College of Business Working Paper 02-19, Kennesaw State University, Kennesaw, GA.

Gelb, C., and D. Chen (2004), "Going West: A Progress Report", *China Business Review,* Vol. 31, No. 2, 8-12, 19-23.

Government of the United Kingdom, Department of Trade and Industry (1999), *Genome Valley: The Economic Potential and Strategic Importance of Biotechnology in the UK* (*http://www.dti.gov.uk/genomevalley*).

Grant, R. and Nijman, J. (2002), "Globalization and the Corporate Geography of Cities in the Less-developed World", *Annals of the Association of American Geographers*, Vol. 92, 320-342.

Gu, C., J. Shen, and T. Yu (2004), "Urban and regional development", In Y. M. Yeung and J. Shen, eds., *Developing China's West: A Critical Path to Balanced National Development,* The Chinese University Press, Hong Kong, 177-212.

Han, S. and W. Yong (2001), "City profile: Chongqing", *Cities,* Vol. 18, 115-125.

Heitzman, J. (2004), *Network City: Planning the Information Society in Bangalore*, Oxford University Press, New Delhi.

Huang, Y., and T. Khanna (8/8/2003), "Can India overtake China?" *Foreign Policy* July-August. *www.foreignpolicy.com*. Accessed Dec. 2003.

Jong, H. (2002), "The Two Giants of Asia: Trade and Development in China and India", *Journal of Developing Societies,* Vol. 18, 64-81.

Jurong Consultants (2003), *IT Corridor Bangalore, India: Structure Plan Final Report*, Jurong Township Consultants (India) Pvt. Ltd., Bangalore.

Lai, H. H. (2003), "China's Western Development Program: Its Rationale, Implementation, and Prospects", *Modern China,* Vol. 28, 432-466.

Lalkaka, R. (2002), "Technology Business Incubators to Help Build an Innovation-Based Economy", *Journal of Change Management,* Vol. 3, 167-176.

Lin, G.C.S. (2002), "The Growth and Structural Change of Chinese Cities: A Contextual and Geographic Analysis", *Cities,* Vol. 19, No. 5, 299-316.

Lin, G.C.S. (2004), "The Chinese Globalizing Cities: National Centers of Globalization and Urban Transformation", *Progress in Planning,* Vol. 61, 143-157.

Liu, X. and G. Shiu (2004), "Sichuan", In Y. M. Yeung and J. Shen, eds., *Developing China's West: A Critical Path to Balanced National Development,* The Chinese University Press, Hong Kong, 410-433.

Malecki, E. and Oinas, P. (1999), *Making Connections: Technological Learning and Regional Economic Change,* Ashgate, Aldershot, UK.

Markusen, A., Y-S. Lee, S. DiGiovanna, eds. (1999), *Second Tier Cities: Rapid Growth Beyond the Metropolis,* University of Minnesota Press, Minneapolis.

Marton, A. (2000), *China's Spatial Economic Development: Restless Landscape in the Lower Yangzi Delta,* Routledge, London.

Mianyang (2004), *Mianyang State High-Tech Industrial Park*, Mianyang.

Naughton, B. (1988), "The Third Front: Defense Industrialization in the Chinese Interior", *The China Quarterly,* Vol. 115, 351-386.

Park, S. O., and A. Markusen (1995), "Generalizing New Industrial Districts: A Theoretical Agenda and an Application from a Non-Western Economy", *Environment and Planning A,* Vol. 27, 1-104.

Perroux, G. (1955), "Note sur le Notion de Pole de Croissance (Note on the idea of growth poles)", *Economie Appliquee*, Vol.8, 307-320 (translation in I. Livingstone, ed. *Economic Policy for Development*, Penguin, Harmondsworth, UK, 278-289).

Phelps, N. and T. Ozawa (2003), "Contrasts in Agglomeration: Proto-industrial, Industrial and Post-industrial Forms Compared", *Progress in Human Geography,* Vol. 27, 583-604.

Saxenian, A. (1994), *Regional Advantage: Culture and Competition in Silicon Valley and Route 128,* Harvard University Press, Cambridge, MA.

Science and Technology Commission (2004), *Introduction to Chongqing Science & Technology*, Science and Technology Commission, Department of International Cooperation, Chongqing.

State Statistical Bureau (2000-2002), *China Statistical Yearbook*, China Statistical Publishing House, Beijing.

Stephan, P.E., A.J. Sumell, G. Black, and J. Adams (2004), "Doctoral education and economic development: The flow of new PhDs to industry", *Economic Development Quarterly,* Vol. 18, No. 2, 151-167.

Storper, M., and R. Walker (1989), *The Capitalist Imperative: Territory, Technology and Industrial Growth,* Oxford University Press, Oxford.

Tang, W.S. and H. Chung (2000), "Urban-rural transition in China: Beyond the Desakota model", in S.M. Li and W.S. Tang, eds., *China's Regions, Politic and Economy: A Study of Spatial Transformation in the Post-reform Era*, University of Hong Kong Press, Hong Kong, 275-308.

Walcott, S. (2003), "Xi'an as an Inner China Development Model", *Eurasian Geography and Economics,* Vol. 44, 623-640.

Webster, D., J. Cai, L. Muller, and B. Luo (2003), *Peri-urbanization in Chengdu, Western China: From "Third Line" to Market Dynamics*, Asia-Pacific Research Center, Stanford.

Wu, F. (2003), "Commentary: Transitional Cities", *Environment and Planning A*, Vol. 35, 1331-1338.

Wu, F. (2005), "Guest Editorial – The City of Transition and the Transition of Cities", *Urban Geography*, Vol. 26, 100-106.

Yeung, Y. M., F. Jin and G. Zeng (2004), "Infrastructure and The New Economy", In Y. M. Yeung and J. Shen, eds., *Developing China's West: A Critical Path to Balanced National Development,* The Chinese University Press, Hong Kong.

Zhou, Y., and Ma, L. (2000), "Economic Restructuring and Suburbanization in China", Urban *Geography,* Vol. 21, No. 3, 205-236.