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TECHNOLOGY POLICY

The Government attaches great importance to the role of science and technology in the development of the Western Region.¹

Role of technology in regional economic development

A recent study by S. Fan et al.² showed that among the various public investment sectors in rural PRC (R&D, irrigation, roads, education, electricity, and telephone), R&D has been the major contributor to economic growth and poverty reduction (see Chapter 19). The rate of return of public R&D inputs is the highest for total rural GDP, agricultural GDP, nonfarm GDP, and poverty reduction. Even more significantly, the rate of return of public R&D investment is higher in the Western Region than in the Eastern and Central regions. These results imply that R&D should be regarded as the primary target for public investment to increase rural GDP and reduce poverty in the Western Region. This is consistent with the technological policy outlined in the *Circular 2000*.

Technology helped the Eastern Region outpace the Western Region in economic growth. In 1978, per capita GDP in the northwest was higher than that in Fujian (Eastern Region); per capita GDP in Qinghai was higher than in Guangdong. After 20 years, in

1998, per capita GDP in Guangdong and Fujian was 2.5 times higher than the average in the northwest. Among the factors that contributed to the turnaround, the accumulation of physical capital accounted for only 19 percent; the remaining 81 percent was due to the accumulation of human capital, institutional innovation, and technological progress.³

Following standard international practice, it is possible to quantify the lag in technological progress in the Western Region in terms of R&D inputs and R&D output.

R&D INPUTS

All proxy measures of R&D inputs indicate that the Western Region lags far behind the Eastern Region (Table 8-1). The key points are as follows:

- The first proxy, the number of higher-education graduates, is a measure of the potential for technological innovation. By this measure, the Western Region is 27 percent behind the Eastern Region and 9 percent behind the Central Region.
- The second proxy, funds invested in natural sciences and technology projects, is a measure of the actual monetary (capital) inputs in R&D

Table 8-1 Proxy Measures of R&D inputs in the Western Region, 1999

Region	Graduates in Institutes of Higher Education		Investment in Natural Sciences and Technology				Personnel ^a	
	(no.)	(%)	Total Funds		Government Funds		(no.)	(%)
			(million yuan)	(%)	(million yuan)	(%)		
PRC	847,617	100.0	51,432	100.0	32,159	100.0	21,430,140	100.0
Eastern	409,725	48.3	32,569	63.3	19,715	61.3	10,633,235	49.6
Central	257,259	30.4	8,621	16.8	4,923	15.3	5,915,934	27.6
Western	180,633	21.3	10,242	19.9	7,521	23.4	4,880,971	22.8
Chongqing	20,442	11.3	543	5.3	331	4.4	360,515	7.4
Sichuan	35,465	19.6	4,031	39.4	2,905	38.6	1,024,524	21.0
Guizhou	10,568	5.9	271	2.6	169	2.2	444,907	9.1
Yunnan	15,757	8.7	702	6.9	468	6.2	585,409	12.0
Tibet	1,066	0.6	24	0.2	23	0.3	29,868	0.6
Shaanxi	36,328	20.1	2,887	28.2	2,453	32.6	491,367	10.1
Gansu	14,007	7.8	696	6.8	483	6.4	334,964	6.9
Qinghai	2,490	1.4	102	1.0	69	0.9	86,281	1.8
Ningxia	2,680	1.5	92	0.9	51	0.7	108,656	2.2
Xinjiang	11,657	6.5	283	2.8	183	2.4	369,296	7.6
Inner Mongolia	10,911	6.0	264	2.6	205	2.7	408,240	8.4
Guangxi	19,262	10.7	348	3.4	184	2.4	636,944	13.0

Source: *China Statistical Yearbook 2000*.

^a Number of scientific and technical personnel in state-owned enterprises and institutions at the year-end.

Table 8-2 Proxy Measures of R&D Outputs in the Western Region, 1999

Regions	Transaction Value in Technical Markets by Region		Gross Output Value of High-tech Products		Export of High-tech Products	
	(million yuan)	(%)	(million yuan)	(%)	(\$ million)	(%)
PRC	52,341	100.0	594,357	100.0	11,908.2	100.0
Eastern	33,520	64.0	410,143	69.0	10,693.4	89.8
Central	10,430	19.9	110,315	18.6	749.4	6.3
Western	8,392	16.0	73,899	12.4	465.3	3.9
Chongqing	3,253	38.8	9,894	13.4	19.8	4.3
Sichuan	1,259	15.0	27,326	37.0	84.7	18.2
Guizhou	8	0.1	2,685	3.6	9.2	2.0
Yunnan	1,723	20.5	4,340	5.9	95.4	20.5
Tibet	0	0.0	0	0.0	0.0	0.0
Shaanxi	825	9.8	17,658	23.9	139.9	30.1
Gansu	258	3.1	1,856	2.5	5.3	1.1
Qinghai	43	0.5	0	0.0	0.0	0.0
Ningxia	47	0.6	0	0.0	0.0	0.0
Xinjiang	428	5.1	727	1.0	18.9	4.1
Inner Mongolia	294	3.5	2,661	3.6	43.1	9.3
Guangxi	253	3.0	2,824	3.8	20.1	4.3

Source: China Statistical Yearbook 2000.

activities. The Western Region received less than 20 percent of the national total, about 43 percent less than the Eastern Region. Among various sources of research funds, 73.4 percent came from governments, indicating the Western Region's weaker ability to attract funds from other sources, especially research funds from the private sector.

- The third proxy, the number of scientific and technical personnel in SOEs and government institutions, is a measure of human resource inputs into R&D activities. The Western Region attracted only a bit above 20 percent of the PRC's total, 27 percent less than the Eastern Region.
- R&D inputs in the Western Region are also highly concentrated in the capital cities of four provinces and municipalities. Xi'an (Shaanxi) and Chengdu (Sichuan) each contributed 20 percent of higher-education graduates, attracted 28 percent and 39 percent of research funds, and employed 10 percent and 20 percent of science and technology personnel.

R&D OUTPUT

The Western Region contributed even less in terms of R&D output (Table 8-2):

- The first proxy of transaction value in the technical market is a measure of the value of successful projects accepted by the market. The

Western Region contributed 16 percent, proportionally lower than the capital and human resource inputs of 20 percent (Table 8-1).

- The second proxy of gross output value of high-tech products measures total output of final product with imbedded new technological innovations. The Western Region contributed 12 percent, 4 percentage points less than the transaction value of its successful projects; that might indicate weaker ability to commercialize technological innovations.
- The third proxy of export of high-tech products is a measure of the competitiveness of high-tech products in the international market. The Western Region was weak in producing internationally competitive high-tech products.
- As in R&D inputs, R&D output was also concentrated in Xi'an and Chengdu.

In summary, the Western Region lags behind because of less inputs, geographical concentration of inputs, limited sources of funding, and lower productivity and little commercialization of outputs:

- *Less inputs and high concentration.* The Western Region lags behind the Eastern and Central regions in the actual capital and human resource inputs of R&D and potential capability of R&D. The limited resources were highly concentrated in the two cities of Xi'an and Chengdu.

- *Limited sources of funding.* The Western Region relies more on the Government to support R&D activities, and has attracted less funding than the Eastern Region from the private sector.
- *Lower productivity and lack of ability to commercialize output.* R&D output in the Western Region is proportionally lower than R&D input. This indicates there is lower productivity in transferring input to output and a lack of a ability to market technological innovations.

MAJOR CONSTRAINTS ON TECHNOLOGICAL INNOVATION

A successful technological innovation needs the following four factors: (i) high-quality R&D personnel, (ii) incentive mechanism, (iii) information, and (iv) research funds. The Western Region does not have comparative advantage in any of these four areas:

- With the exception of four cities, the Western Region is short of high-quality R&D personnel. Even in the four cities that had sufficient R&D personnel, many of these migrated to the Eastern Region, drawn by its rapid economic reforms and the prospect of a better working environment, creative freedom, higher salaries, and flexible working time.
- Most R&D personnel in the Western Region work for SOEs in which the reward mechanism is rather inflexible. Worse, most SOEs lack incentives to enhance their competitiveness by investing in risky R&D activities; their demand for high-quality R&D personnel is quite low.
- R&D needs information channels to determine the demand for and supply of innovations. R&D personnel also need professional exchanges to stimulate new ideas. The Western Region is isolated by its geographical location and an unwillingness on the part of its institutions to facilitate exchange of information and ideas.
- Most R&D activities are either directly funded by governments or conducted within SOEs. The Western Region does not have a suitable

environment to attract R&D investment from the private sector or venture capital. It lacks both the right “hard environment” (good-quality labor force, communication and transportation facilities, and other living facilities) and the right “soft environment” (regional preferential policies, freedom, appropriate laws and regulations, private property rights, efficient local governments).

Recent institutional reforms and their applicability to the Western Region

The PRC has recently introduced several institutional reforms to stimulate R&D. Although most reforms commenced in the Eastern Region, it is reasonable to expect that all these reforms will extend to the Western Region in due course. The best known of these reforms are the establishment of high-technology industry zones and the promotion of venture capital.

NEW AND HIGH TECHNOLOGY INDUSTRY ZONE

As an institutional innovation, high-tech zones in the PRC have developed rapidly in recent years, with mixed results. Essentially, high-tech zones have the following advantages:

- High-tech zones are institutional enclaves insulated from the surrounding areas.
- Within these enclaves, governments can efficiently and effectively provide support in the areas of infrastructure provision, laws and regulations, and other zone-specific preferential policies.
- High-tech zones shorten the physical distance between R&D enterprises and thereby facilitate information exchange.
- R&D enterprises within the zones have less constraint in designing reward mechanisms to attract high-quality R&D personnel.
- Because these institutional reforms are applicable only to a small enclave, they will encounter less political constraints.

As a result, high-tech zones have attracted significant amounts of investment and R&D personnel in a short time. However, their efficiency indicators are mixed. The sales/profits ratio is higher in the high-tech zones than the national average; that is, in the hi-tech zones, firms appear to need more sales to generate the same amount of profits. This is contradictory to the nature of R&D and international experience (Table 8-3).

Regional analysis further shows that the high-tech zones in the Western Region have lower labor productivity and poorer export performance than the national average (Table 8-4).

As with any other government-supported industry policies, this result is predictable and reflects an inappropriate division of responsibility between the Government and the private sector. More specific explanations for these effects are as follows:

- Initial investment responds to government preferential policies, which are uncertain and short-lived. This increases the risk and uncertainty of investment. Therefore, most investments are short-term and will last only for as long as preferential policies are in effect.
- Local governments control access to the high-tech zones. This provides another rent-seeking opportunity and room for corruption.

Table 8-3 Economic Indicators of High-Tech Zones in the PRC, 1997–1999

Indicator	1997	1998	1999
Number of enterprises (thousands)	136,810	160,790	174,980
Number of employees (thousands)	141	178	220
Total output value (million yuan)	310,950	433,360	594,360
Sales income (million yuan)	275,200	379,310	559,270
Profits and taxes (million yuan)	34,990	47,700	73,730
Sales/profits-and-taxes ratio in high-tech zones	12.7	12.6	13.2
Sales/profits-and-taxes ratio in PRC industry	8.9	9.0	6.7
Export earnings in foreign exchange (\$ million)	6,480	8,530	11,910

Sources: Gao, Zhiqian (2000)

- There is a shortage of subsequent research funds, especially private venture capital.
- Access to information is deficient. Enterprises in the zones are supported by the Government and therefore lack a full understanding of the domestic and international market.
- The enterprises are not competitive enough in the market despite their technical advantages. A questionnaire survey of some export-oriented enterprises in the zones showed that only 18 percent of their products have a domestic market share above 30 percent, and that half of the enterprises do not know the market share of their products.⁴

Table 8-4 Main Economic Indicators of High-Tech Enterprises in Development Areas, 1999

Area	No. of Enterprises	No. of Staff and Workers	Total Income (million yuan)	Exports (\$ million)	Labour Productivity (yuan per person)	Export per Person (\$ per person)
PRC	17,498	2,210,487	677,479	11,908.2	268,880	5,390
Baotou (Inner Mongolia)	158	19,793	2,873	43.1	134,460	2,180
Nanning (Guangxi)	120	15,727	3,758	20.1	179,580	1,280
Guilin (Guangxi)	155	22,670	4,001	28.9	173,230	1,270
Chongqing	195	43,598	9,854	19.8	226,950	450
Chengdu (Sichuan)	223	76,270	13,657	66.7	138,830	870
Mianyang (Sichuan)	64	42,703	13,167	17.9	391,960	420
Guiyang (Guizhou)	57	24,310	2,524	9.2	110,430	380
Kunming (Yunnan)	80	18,955	4,940	95.4	228,980	5,030
Xi'an (Shaanxi)	1,275	80,474	20,167	122.8	177,030	1,530
Baoji (Shaanxi)	88	28,169	3,124	14.7	112,930	520
Yangling (Shaanxi)	32	1,980	377	2.4	116,230	1,210
Lanzhou (Gansu)	322	18,548	2,826	5.2	100,050	290
Urumqi (Xinjiang)	106	7,781	1,268	18.9	93,480	2,430

Source: China Statistical Yearbook 2000.

Table 8-5 Some Venture Capital Enterprises

Enterprise	Year Established	Total Capital (million yuan)	Investors and Share	Department in Charge
Shengzhen High Technology Venture Capital Investment Co.	1998	1,000	Shengzhen municipality: 500 million yuan Others: 500 million yuan	Department of Science, Shengzhen municipality
Guangdong Technology Venture Capital Investment Co.	1997	200	Guangdong municipality: 100 million yuan Guangdong Huaqiao Trust: 50 million yuan Guangdong Yuechai Trust: 50 million yuan	Department of Science, Guangdong municipality
Shengzhen New and High Technology Industry Investment and Services Co.	1995	100	Shengzhen municipal government	Department of Science, Shengzhen municipality
Shanghai Science and Technology Investment Limited Co.	1993	305	Bureau of Science and Technology, Shanghai municipal government	Department of Science, Shanghai municipality
Zhejiang Science and Technology Venture Capital Investment Co.	1993	60	Department of Science: 52% Department of Finance: 48%	Department of Science and Department of Finance, Zhejiang municipality
Shanghai Innovation Technology Group Co.	1993	48	Shanghai municipality	Department of Science, Shanghai municipality
Jiangsu New and High Technology Investment Co.	1992	150	Jiangsu municipality	Department of Finance, Jiangsu municipality

Source: Jiangnan Huang and Jing Wang (eds.) (2001).

Table 8-6 Institutional Shortcomings of Government-Controlled Venture Capital

Activity	Current Institutional Arrangement	International Best Practices	Comments
Selection and evolution of projects	Government	One or some investors with unlimited liabilities (venture capital manager) Independent consulting company	Government does not have sufficient incentives and information
Financing	Out of financial department of governments	Self-financing Partnership Managed trust funds	Single-source funding limits scale and lowers efficiency
Monitoring of the use of venture capital	Government	Venture capitalist Contract between venture capitalist and enterprise manager	Government does not have sufficient incentives and information Without independent consultants, contract is flawed
Exit of venture capital	Government	One or some investors with unlimited liabilities (venture capital manager) Independent consultants	Government does not have sufficient incentives and information to determine the right time to exit

Source: Compiled by consultants.

VENTURE CAPITAL MARKET

The driving force behind the high-tech industry is venture capital, which is characterized by high risk, high return, and high flexibility. Once again,

government controls and involvement dominate. Table 8-5 lists seven major venture capital enterprises and their ownership structure; and Table 8-6 identifies the problems.

Biotechnology

IMPORTANCE OF BIOTECHNOLOGY

Biotechnology provides another opportunity to enhance the competitive advantages and reshape the entire arable and husbandry systems in the Western Region. Because of significant economies of scale and the possible threat to human health and ethics, most biotechnology research in developed countries is done by state-owned scientific laboratories or private laboratories with government subsidy and strict monitoring.⁵ Since the PRC is one of few countries that have achieved significant advances in gene cloning and reproduction, the Government should follow the lead of the Organization for Economic Cooperation and Development (OECD) and set up a high-level commission to coordinate the ethical aspects of biotechnology.

The research and application of biotechnology is not region-specific, and the Western Region does not necessarily have competitive advantage in research and development. However, the Western Region could benefit most from the outcomes of biotechnological R&D and it has several research initiatives in the field that are very significant.

Advances in biological technology can increase crop yields without the side effects associated with the use of chemical fertilizer. A recent study by Huang, Rozelle, Pray, and Wang⁶ shows that the PRC has the largest plant biotechnology capacity outside North America and is far ahead of almost all other developing countries. The pioneering project of the Ministry of Agriculture in 1997 promoting the use of Bt cotton (genetically modified cotton with *Bacillus thuringiensis* inserted) has reduced the use of chemical pesticides from 60.7 kg per hectare to 11.8 kg per hectare. Farmers save significantly on the quantity of pesticide and labor required for pest control. A rough estimate indicates that the adoption of Bt cotton has saved 650 million yuan. The figure would be much larger if the positive effects on the environment were taken into account.

Priority should be given to the following areas of biotechnology research:

- Molecule breeding techniques for trees and crops: improving genes to enable trees and crops to resist diseases and insects and to improve quality
- Animal breeding techniques: defining gene types for poultry and livestock, conducting embryo transfer and mass-producing embryos with improved species, applying vaccines on animal genes, breeding animals that resist diseases and insects and are of high quality, and cloning antibiotics
- New pesticide marking techniques: fast-acting biopesticides, pesticides that promote plant growth and carry informosomes, bionic pesticides, microbial pesticides that help promote plant growth, and farming enzyme lotion

The Chinese Academy of Sciences has conducted some biotechnological research in the Western Region, such as the following:⁷

- Research into the northwestern base of the ecosystem and sustained development
- Research into the southwestern base of biodiversity and biological resources
- Experimental agricultural zones based on advanced biotechnology in areas with highlands, oases, and pastures
- Selection and refinement of 100 types of plants with high scientific and economic potentials

Further R&D needs massive monetary inputs, which may not be forthcoming from the Government, given its other economic development priorities. Using the research capacities of universities and colleges and facilitating scientific exchange is a viable alternative. Moreover, fully utilizing the huge stock of knowledge and R&D human resources of overseas Chinese should be a high priority of technology policy.

Also, bilateral aid projects in biotechnology often lead to international cooperation between research institutions that lasts long beyond the completion of the aid project.

CHINESE TRADITIONAL MEDICINE

Chinese traditional medicine is one area in which the Western Region does have competitive advantages. Chinese traditional medicine, practiced for thousands of years, comprises over 4,000 medicaments. Compared with Western chemistry-based medicine, Chinese traditional medicine has the following advantages:

- It is based on natural ingredients and has little or no side effects.
- It treats the human body as an integrated, complex cause-and-effect system. In addition to the circulation system, Chinese traditional medicine believes that there is another circulation system, roughly based on the reflection of the nerve system, called *jинluo*. The block of *jинluo* is regarded as the main cause of illness and disease. This integrated approach has been shown to be capable of dealing with complex diseases and disorders, such as cancer and AIDS.
- It adopts a preventive or therapeutic approach rather than a curative approach. This approach has blurred the distinction between medicine and food.

Chinese traditional medicine has not been well accepted in the world, despite the advantages identified above and the belief that Chinese traditional medicine and Western medicine will converge at the biotechnological level. The major obstacle is the research behind it, which is based on experience rather than scientific experiments. The Government should encourage research in the following areas:

- Decoding and mapping human gene groups, in order to understand the effects of Chinese medicaments on specific genes and enzymes
- Understanding the active components of each medicament and finding out the best combination and ratio
- Inventing new technology for the manufacture of medicine, such as superfine filter and computer simulation to make medicaments portable and easy to use

The Western Region stocks the best raw materials for making Chinese medicine and has a large number of practitioners and medicaments. Tibet and Qinghai have the best collection of certain precious herbs, and an independent system called "Tibetan medicine." The Tianshan Mountains and other places in Xinjiang have the best collection of food-based herbs and other raw materials. Ningxia is well known for its stocks of top-quality medlar, liquorice, and abace. Gansu has already established its biotechnological base for refining medicaments. Yunnan has a reputation of producing a variety of "green food" and "preventive medicine." Establishing a knowledge database for collecting and analyzing local practitioners' experience and setting up clinics in well-connected cities will help these local practitioners export their services to outside regions and counties.

POLICY IMPLICATIONS FOR BIOTECHNOLOGY DEVELOPMENT

There are several ways in which the Government can support biotechnology development:

- Encouraging networking among research personnel scattered around the country in the universities, colleges, and government research institutes
- Either investing in basic research projects or subsidizing the activities of private research institutions
- Encouraging the establishment of a professional association to standardize the registration and management of professional practitioners
- Initiating a marketing campaign to promote Chinese traditional medicine
- Encouraging the private sector to invest in the manufacture of medicaments and to develop a marketing network to bring these medicines to consumers
- Seeking further bilateral aid from countries with special expertise in biotechnology relevant to the animal husbandry of the Western Region

Information and communication technology

Among the new technologies, ICT stands out for its huge potential to accelerate economic development in the Western Region. There is also, however, a risk that a “digital divide” will emerge, reinforcing existing income and wealth inequalities within and between regions.

ICT represents a new tool for the creation, acquisition, processing, analysis, dissemination, and transmission of information. A properly constructed information infrastructure will have the effect of replacing the physical sphere with a virtual sphere and, therefore, significantly reducing transaction costs in the market. This is the major obstacle to economic development in the Western Region.

However, international experience shows that the success of a country or region in exploiting ICT is dependent on flexible, competitive markets and a well-functioning legal framework that protects the consumer, the security of transactions, the privacy of records, and intellectual property. The Internet may yield smaller benefits in more tightly regulated economies with rigid labor and product markets and inefficient capital markets that prevent shifts in labor and capital in response to new opportunities.⁸ The Western Region lags behind not only in physical information infrastructure but also, and more seriously, in the understanding of the business conventions and legal aspects of ICT applications.

ROLES OF ICT IN THE DEVELOPMENT OF THE WESTERN REGION

The possible benefits of ICT to the Western Region are many. ICT is itself a fast-growing industry that would contribute to GDP, and its applications are everywhere—in health care, education, government administration, tourism, regional planning, and so on.

The specific benefits of ICT to the Western Region are as follows:

- Facilitating movement of resources across regional borders, from areas of abundance to those of scarcity. ICT can thus give the Western Region access to markets, information, and other resources that would otherwise be inaccessible.
- Facilitating access to global markets and increasing trade through e-commerce, making it possible for the Western Region to reap benefits from specialization and economies of scale and scope, and thereby reinforcing the benefits of trade liberalization and the open market.
- Reducing the advantages of vertical integration and the optimal size of firms through Internet use, with its reduced transaction costs. Thus, barriers to entry would fall and the absolute advantages of the incumbent firms (normally SOEs) would vanish. This should have the effect of promoting private sector participation.
- Revitalizing the traditional industries, which currently dominate the Western Region. ICT would decrease energy consumption, improve product quality, reduce production costs, and smooth market transactions.
- Increasing price transparency and competition through the Internet. This should have a positive effect on markets with high margins, which are likely to see the biggest price reductions and efficiency gains.
- Exposing local governments to more intense regional competition through the Internet, forcing them to rethink their old, inefficient habits and to seek new ways to get around or eliminate market rigidities.

STATUS OF ICT DEVELOPMENT IN THE WESTERN REGION

The PRC has achieved significant progress in ICT. The growth of cable networks, optical cable lines, and digital lines and the increase in the number of ICT users are two proxy measures of communication capacity (Table 8-7).

Table 8-7 Growth of Cable Networks and ICT Users, 1991–1999

Year	ICT Users			Communication Capacity	
	Mobile Phone Subscribers	Subscribers of E-mail Services	Subscribers of Internet Services	Optical Cable Lines	Digital Lines
1991	48,000			23,613	n.a.
1992	177,000			51,352	109,300
1993	639,000			162,861	298,045
1994	1,568,000	2,329		330,359	518,915
1995	3,629,000	6,068	7,213	484,231	677,672
1996	6,853,000	10,107	35,652	23,613	n.a.
1997	13,233,000	15,246	160,157	754,143	965,263
1998	23,863,000	20,959	676,755	935,835	1,139,476
1999	43,296,000	19,855	3,014,518	1,351,665	1,560,201

Source: China Statistical Yearbook 2000.

- *Computer hosts.* By the end of 2000, there were about 8.92 million Internet-connected computers. Of these, 1.41 million were connected through leased lines and 7.51 million through dial-up connections.
- *Internet users.* There were 22.5 million Internet users by the end of 2000, including 3.64 million users of leased-line connections, 15.43 million for dial-up connections, and 3.43 million for both methods of connection.

The Western Region, with over 20 percent of the PRC's population, accounted for only 8.5 percent of total domain name registration, 8.1 percent of websites, and 17.5 percent of Internet users at the end of 2000 (Table 8-8).

MAJOR CONSTRAINTS AND OPTIONS FOR ACCELERATING E-COMMERCE IN THE WESTERN REGION

Two major constraints are:

- *Infrastructure constraints.* The Western Region needs to overcome infrastructure constraints in telecommunications, transport, and logistics. While the construction of telecom and Internet infrastructure in developing countries can be left to private investors, official development assistance may be able to leverage private investments.
- *Governance aspects of e-commerce,* including consumer protection, security of transaction, privacy of record, and intellectual property. With respect to legal and regulatory issues, capacity building programs can equip the PRC to participate in negotiations and discussions that are shaping global rules and protocols governing e-commerce.

Relieving infrastructure bottlenecks

A country's readiness for e-commerce depends on its network infrastructure and technology diffusion.

Table 8-8 Internet Usage in the Western Region, 2000

Province	Percentage of Population	Percentage of Domain Name Registration	Percentage of Websites	Percentage of Internet Users
Chongqing		0.94	0.87	2.03
Sichuan		1.75	2.13	5.03
Guizhou		0.31	0.29	0.80
Yunnan		1.40	1.20	1.46
Tibet		0.12	0.02	0.03
Shaanxi		1.29	1.11	1.47
Gansu		0.33	0.39	1.13
Qinghai		0.07	0.05	0.31
Ningxia		0.25	0.21	0.48
Xinjiang		0.86	0.64	2.02
Inner Mongolia		0.46	0.37	1.21
Guangxi		0.69	0.81	1.51
Western Region	20	8.47	8.09	17.48

Source: China Internet Network Information Center (2001).

The growth of e-commerce is fostered by strong growth in infrastructure (including narrow- and broadband access), hardware investment, and Internet use, but it also depends on the growth of mobile applications, price reductions, service improvement, speed, and reliability. A key lesson from international experience is that telecommunications reform is a major determining factor for the emergence of the so-called “new economy.” Faster and more reliable network infrastructure and new ways of pricing, both for consumers and for the leased lines used in business-to-business (B2B) transactions, have led to increased Internet connection in homes and businesses. Low access costs are encouraging uptake, while competition among infrastructure providers and among Internet service providers (ISPs) has led to innovative pricing structures.

A communication network is a key to the development of the Western Region. According to a survey made by the Center for E-Commerce, MoFTEC, the Western Region would experience a “digital divide.” Of the 10 most digital-intensive provinces and municipalities, none is in the Western Region, while the four least digital-intensive provinces are all in the Western Region. Telephone usage per capita is only 50 percent of that in the Eastern Region.⁹

Beyond the physical infrastructure, providing wide Internet access requires the emergence of local ISPs and portals that can arrange a reliable, low-cost connection to the web, develop sites with useful, local language content, and offer a range of other services demanded by local Internet users. Once telephone density is sufficiently high, it should be possible to offer access to most users at local call rates. This presumes that an ISP can lease a high-capacity line from a telecom service provider at a competitive rate.

To encourage private sector provision of ICT infrastructure and Internet services the Government should overcome private sector concerns that may arise from a conflict in objectives, between maximizing revenue and delivering more, better, and

cheaper services to the remote Western Region. To deal with such concerns, the Government should consider:

- Initiating investment in ICT infrastructure but encouraging private sector participation at a later stage via management contracts and other similar methods (see Chapter 1)
- Leapfrogging traditional copper- and fiber-based landlines, and moving directly to leading-edge wireless technologies (such as satellite or microwave) that send voice and data over the same network
- Encouraging Net tearoom and Internet shops in the Western Region to provide affordable Internet access and shared resources for low-income users

Institutional and policy requirements for accelerating e-commerce development

Even assuming that the physical infrastructure bottlenecks to Internet expansion are overcome and access prices become more affordable in the Western Region, there are other significant policy challenges to be met before an environment conducive to e-commerce can be created. E-commerce requires *legal norms and standards* (covering contract enforcement, consumer protection, liability assignment, privacy protection, and intellectual property rights) and *process and technical standards* (in such matters as Internet payments and product delivery to the final user, security, authentication, encryption, digital signatures, and connectivity protocols). The essential challenge facing the Western Region is therefore to create a climate of trust that makes it possible for agents to conduct business online without face-to-face contact. A solution would be a legal and judiciary framework that meets minimum standards of transparency, impartiality, and timeliness.

Besides an enabling policy environment, merchandise e-commerce also requires complementary physical infrastructure, notably a logistics system capable of timely, secure, and

affordable small-batch shipping to multiple destinations (see Chapter 6).

Contribution of international donor agencies

As for micro-level initiatives, a preferred investment objective for international lending agencies is the establishment of electronic community centers. In addition to the normal function of providing Internet access, they can also serve as centers for capacity building, skills enhancement, training, communication, and content development. The private sector and local governments should be encouraged to use these facilities, where they will be assisted in the website creation, digital web management, and the conduct of e-commerce.

POLICY IMPLICATIONS FOR ICT

With the exception of Chengdu, Chongqing, Lanzhou, Xi'an, and their surrounding areas, most cities in the Western Region do not have the capacity to produce ICT products in a competitive way. Priority should therefore be given to encouraging the wider use of ICT rather than its production. Furthermore, unlike a normal city-based information network, the information network in the Western Region should focus mainly on the business sector, that is, ICT should be used to revive and optimize traditional industries and make them more competitive in the national and international markets.

Most policy suggestions in this section are equally applicable to ICT production. The following are important considerations in fine-tuning short-term policies for immediate action in this fast-changing area:

- ICT exhibits strong economies of scale in its basic infrastructure component and significant network externality. Public finance could be justified on the base of natural monopoly and positive externality. Therefore, the Government should invest to improve the communication capacity in the Western Region. Options include pure public finance, public subsidy, public-private

mix, and other forms of PSP in providing public utilities.

- Public investment should be accompanied by a free-access policy that will remove barriers and encourage private sector investment and private ownership. For example, the Government should have policies to let the private sector pay a market competitive price to share the resources (land-based copper line, microwave tower, telephone exchange facilities, satellites, etc.) owned by China Telecom.
- The initial Government investment in ICT infrastructure must be accompanied by subsequent measures to encourage private investment in value-added components, such as ISP services, Internet protocol (IP) telephony, and combined voice and IP services.
- There should be a more liberal policy toward the private sector's use of new technology, such as wireless and broadband communications, cable modems, and asymmetrical digital subscriber lines (ADSLs), in competing with the incumbent firms.
- Deregulating the ICT industry would provide end users with a more flexible and affordable pricing structure.

International practices presented in Table 8-9 shed some light on policy details.

Implications for policies to promote technological innovation

Recognizing the competitive disadvantages in R&D, the Government should *not* try to: (i) invest in the Western Region to establish comprehensive R&D facilities; (ii) graft the high-tech zones model to the Western Region; or (iii) copy the venture capital model to the Western Region. Instead, the Government should emphasize the removal of barriers that prevent the mobility of R&D personnel and research funds. More specifically, it should formulate policies in the

Table 8-9 Sample Country Practices in Promoting the IT Industry

Country	Strategies	Programs/Projects
Canada	<p>Ensure affordable access to essential communication services.</p> <p>Emphasize convenient, less expensive, and just-in-time lifelong learning to improve the ability of the labor force.</p>	<p>National access</p> <p>A Government working group is studying barriers to access, focusing on the influence of social factors (age, disability, ethnicity, education, and income). The Government has increased the budget of the Community Access Program to expand the coverage of the Federal Youth Employee Strategy.</p> <p>Community access</p> <p>Industry Canada's Community Access Program enables people in rural and remote communities to access the Internet. The SchoolNet and LibraryNet programs facilitate the connectivity of Canadians by equipment donation from government, corporations, and individuals.</p> <p>Preferential tariffs for education and health entities</p> <p>There are preferential tariffs for telecommunications services bodies that are provided on a competitive basis to nonprofit education and health services.</p>
Singapore	<p>Extend the use of PCs and the Internet to low-income households.</p> <p>Address language and attitude issues in addition to income and gender issues.</p>	<p>Provision of free used PCs and training to low-income households.</p> <p>Provision of free broadband Internet access at community centers and locally relevant Web content in other Asian languages with the help of the private sector and tax incentives.</p> <p>Development of national Chinese Internet programs for different population segments to bridge the language gap.</p> <p>Extension of the "e-Ambassador" program, using current Internet users to voluntarily teach latecomers.</p>
US	<p>Lower the prices of hardware and software by adapting pro-competition policies.</p> <p>Provide tax incentives to encourage the private sector to donate computers to communities and to stimulate training and education programs.</p> <p>Improve information infrastructure in rural areas.</p> <p>Encourage women to pursue technical education and a technical career.</p>	<p>Government assistance to low-income households for monthly service bills and the installation costs of service connections.</p> <p>US Department of Agriculture's rural service, which provides lending and technical consulting in rural areas.</p> <p>Improvement of the image of women scientists and technologists through female models in the media.</p> <p>Science encouragement programs, which increase female students' interest in technical careers.</p> <p>Mentoring and sponsorship of women in schools and communities by influential colleagues, to develop their interest in IT.</p> <p>Expansion of technical training and job opportunities for women through an alliance between business, government, and education communities.</p>

Source: World Bank (2000).

following five areas. All these policies should be treated as short-term policies requiring immediate attention and action. These policies will have prolonged effects in reshaping the comparative advantages in the Western Region.

- Establishing technology-specific funds to increase public investment in R&D
- Establishing a legal framework to protect intellectual property rights
- Facilitating the exchange of technology

- Encouraging productivity improvements in R&D
- Encouraging R&D activities in areas with competitive advantages

INCREASING PUBLIC INVESTMENT IN R&D

R&D exhibits the nature of a “public good,” and the rate of return of public R&D investment is the highest among all public investment, especially in the Western Region. The Government should therefore treat R&D as the top investment priority for the Western Region, higher in priority than other public investment items, such as infrastructure, education, and telecommunication.

For the effective use of R&D-specific funds, the following methods could be considered:

- The proposed fund(s) should concentrate on projects, rather than regions. A committee comprising experts in relevant areas (such as water conservation technology, specific agriculture technology, environmental protection, mining processing technology) could compile a priority list of R&D projects for the Western Region. Projects should specify the

scope of services, objectives, desired outcomes, and the sharing of risks, while any application must specify the methodology and expected outcomes.

- The research funds should be open to universities and any other qualified research institutes in the PRC as well as abroad, rather than being discriminately injected into R&D institutes in the Western Region. This competitive procedure would ensure the best use of research funds and avoid duplication among research projects.
- There should be a monitoring mechanism to guarantee that the outcomes of a research project meet the objectives. One possible mechanism includes the use of (i) an internationally reorganized publication as a yardstick; (ii) a quality assurance panel comprising international and domestic experts to write an anonymous assessment report; and (iii) a database containing the assessment report for use in evaluating the institutional capability of universities and dedicated research institutes.

Table 8-10 Selected IPR-Related Legislation of the PRC

IPR-related Legislation	Year Passed, Revised
Trademark law	1983 and 1993
Patent law	1984 and 1992
Regulations on the administration of technology introduction contracts	1985
Implementing rules of the Ministry of Foreign Trade and Economic Cooperation for the examination and confirmation of export enterprises and technically advanced enterprises with foreign investment	1987
Rules for the implementation of the regulations on the administration of technology introduction contracts	1988
Copyright law	1990
Implementing regulations of the copyright law	1991
Regulations on computer software protection	1991
Implementing regulations of the patent law	1992
Implementing regulations of the trademark law	1988 and 1993
Decision on copyright infringement punishment	1994

Source: Bosworth and Yang (2000)

PROTECTION OF INTELLECTUAL PROPERTY RIGHTS

From 1949 to 1978, no IPR system was in effect in the PRC. The view was that public property was a socialist priority. Since 1978, the Government has made considerable efforts to improve the IPR regime, introducing new laws (Table 8-10) and signing several international conventions (Table 8-11).

Studies show foreign firms did respond positively to the new regime. They have migrated from using nonaffiliate licensing in the mid-1980s toward greater use of internal affiliate technology transfers in the middle to late 1990s. However, the prospect of attracting greater inflows of technology remains modest, certainly in value terms. This is mainly because foreign firms still hesitate to transfer advanced technologies to a country whose historic record on the protection and enforcement of IPR is seen as being patchy at best.¹⁰ This poses a big threat

to the sustainability of economic growth, which needs continuous inflows of new technologies and innovations.

The PRC, it would appear, still has some way to go in improving the environment for technology sales in both domestic and international markets. Further enhancement of the IPR system, particularly in policing and judicial enforcement, will play an essential role in this regard.

POLICIES FACILITATING THE EXCHANGE OF INNOVATIONS

New policy directions that the Government might consider for the Western Region include the following:

- Establishing a regular exchange market to facilitate the spread of innovations. The Government should use its advantages in coordinating the participation of a large number of R&D enterprises and personnel to facilitate such a market.
- Formulating policies to encourage PRC enterprises to engage in high-technology development overseas or to establish strategic alliances with foreign technological corporations
- Abolishing the quota that limits foreign investment in projects with high R&D content
- Providing infrastructure and regulatory support for hi-tech zones, but simplifying or even abolishing the approval procedure of the Government and the entry control rights of local governments, and encouraging the private sector to mutually develop hi-tech zones
- Leaving it up to the private sector to provide venture capital and to guide the direction of venture capital movement. The Government should limit itself to establishing a fair and transparent legislative framework to protect the interests of private venture capitalists and facilitate the listing of R&D enterprises in the forthcoming second-board stock market.

Table 8-11 IPR-Related International Treaties Signed by the PRC

International Convention	Year Signed
Convention establishing the World Intellectual Property Organization and a contracting country of WIPO	1980
Paris convention for the protection of industrial property (signatory country)	1985
Treaty on intellectual property in respect of integrated circuits	1989
Madrid agreement concerning the international registration of marks	1989
Berne convention for the protection of literary and artistic works	1992
Universal copyright convention	1992
Geneva convention for the protection of producers of phonograms against unauthorized depilation of their phonograms	1993
Patent cooperation treaty	1994
Budapest treaty on the international recognition of the deposit of microorganisms for the purposes of patent procedure	1994
TRIPS (signatory country)	1994

Source: Bosworth and Yang (2000)

POLICIES TO ENCOURAGE MORE PRODUCTIVE R&D

The Government should consider these measures:

- Creating and maintaining an environment favorable to the fast and healthy development of SMEs engaged in new and high technology. The success of SMEs in developing high-tech industry at home and abroad shows that they are more flexible in meeting the market demand for new technology and are therefore able to achieve rapid growth in the market.
- Reforming SOEs to diversify their ownership, promote the “publicly owned and privately run” model, or let the private sector buy them out. A modern corporate governance structure should be established to resolve problems associated with incentives and information.
- Speeding up the transformation of “military” enterprises to “civil” enterprises, providing incentives for military enterprises to commercialize their technological innovations, and introducing modern corporate governance principles into military enterprises
- Transforming state-owned R&D institutes to private-owned, independent R&D enterprises

- Encouraging universities and colleges to establish their commercial arms to speed up the commercialization of technological innovations. The Ministry of Education should have a more liberal policy toward universities' involvement in R&D activities.

MACRO POLICIES TO ENCOURAGE R&D ACTIVITIES IN AREAS WITH COMPETITIVE ADVANTAGES

Macro policies that the Government might consider to encourage R&D include the following:

- Reforming VAT to encourage enterprises in the Western Region to invest in high-tech equipment (see Chapter 2)
- Allowing enterprises to deduct (or even overdeduct) R&D inputs from company income tax. For example, enterprises could be encouraged to fund R&D activities in universities and colleges and establish a strategic alliance between industry and the universities. Options might include allowing enterprises to deduct 150 percent of R&D funds invested in a university from company income.

Notes

1 The *Circular of the State Council on Policies and Measures Pertaining to the Development of the Western Region* states:

More support will be given to the Western Region in the allocation of funds included in various science and technology plans, gradually increasing the overall amount of funding for science and technology. With the focus on the key tasks of Western Region development, the scientific and technological capacity of the Western Region should be built and enhanced, and arrangements should be made to tackle key, general technical problems and to disseminate and industrialize major technological advances.

The transfer of military technology to civilian use and production should be supported. Research institutions and institutions of higher learning in the region should be supported in their efforts to strengthen relevant applied research and basic research. The reform of the science and technology development system should be deepened, speeding up the transformation of applied research institutions into enterprises, consolidating cooperation between schools, enterprises and research institutes, and integrating scientific development and economic growth. A proportion of sales income of enterprises in the Western Region may be used for technological development and the allowed amount may be raised as necessary. Innovation funds for small and medium-sized technology-oriented enterprises should intensify their support for qualified projects in the Western Region. The registration with local bureaus of industry and commerce should be simplified for scientists and technicians who wish to set up technology-oriented companies in the Western Region, and they are allowed to hold an increased proportion of shares, stock options or intellectual property equity.

2 Fan et al. (2001).

3 See Yong Sang (2001).

4 Gao, Zhiqian (2000).

5 In Australia, most biotechnological research is conducted by the Government-funded Commonwealth Science and Industry Research Organization. In the US, most research is conducted by the research department of drug companies, following strict procedures set by the Federal Government.

6 Huang et al. (2001).

7 *China Daily* (2000).

8 See Goldstein and O'Connor (2000).

9 Jingzhi Liu (2000).

10 Clegg et al. (2000).