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Western Development and Environmental Policies

Beginning with Premier Zhu Rongji's statement in 2001 on eight important tasks for China's economic development, which includes the development of the poor region of western China, the chapter reviews the justification of this project in a market economy and its main features. One feature is the protection and improvement of the environment, a topic considered in the second part of this chapter. A study on the factors affecting industrial pollution of air and water is reported which shows how economic reform helps reduce pollution.

Developing the poor western region and improving the environment are two important tasks of the Chinese government in the twenty-first century. To appreciate the importance of these tasks in the overall planning strategy of the Chinese government, one can refer to Premier Zhu Rongji's "Report on National Economic and Social Development during the Tenth Five Year Plan," delivered to the People's Congress on March 5, 2001 (see the *People's Daily Overseas Edition* for that day, where it is summarized on p. 2).

The report stated the following eight most important tasks to be achieved during the tenth Five Year Plan period of 2001–5. These tasks are, in the order listed in sections 3 to 10 of the Report, (1) increasing the productivity and income of the agricultural sector, (2) changing the structure of industry towards more high-technology industry, (3) developing the western region in a strategy of regionally balanced economic development, (4) investing in human capital in a strategy of promoting science, technology, and education for the betterment of the nation, (5) deepening reform and the open-door policy, (6) raising the living standard of the people and completing a social welfare system, (7) maintaining a sustainable economic development strategy, and (8) building a democratic society with the rule of law and spiritual culture and a national defense system. Task (3) is the subject of the first half of this chapter, task (4) the subject of chapters 12 and 21, task (5) the subject of chapters 4, 13, 15–18, task (6) the subject of chapters 9 and 12, task (7) the subject of the second half of this chapter and chapter 7, task (8) the subject of chapter 20, and task (2) the subject of section 20.4. Task (1) will be briefly discussed in section 10.2.4.

10.1 Inequality in Per Capita Consumption and East-west Disparity

An important reason for adopting a strategy for western development is the inequality of income or consumption per capita among residents of the west and the east in China. Table 9.5 provides information on the distribution of per capita consumption by province. To measure the degree of inequality of consumption across province, one can take natural logarithms of per capita consumption expenditure, to be denoted by x , and compute the standard deviation of x using provincial observations. The standard deviation measures the degree of variation of per capita consumption in proportional terms. Comparing the standard deviation estimated from the 1998 data with the estimate from the 1981 data tells us whether consumption inequality among provinces has changed during this period. The standard deviation of the natural logarithm of rural consumption expenditure per capita in 1981, computed for the 28 provinces listed in table 9.2, is 0.2612, compared with 0.3475 in 1998 for the same 28 provinces based on the data in table 9.5. Thus consumption inequality among provinces increased between these two years, at the average rate of $(0.3475 - 0.2612)/17 = 0.00508$, or about half of a percentage point per year. To see whether the increase in consumption disparity has slowed down I have computed the same standard deviation for 1993, using data on page 281 of the *Statistical Yearbook of China, 1994*, and obtained 0.3370. The average rate of increase in the standard deviation in the five years from 1993 to 1998 is $(0.3475 - 0.3370)/5 = 0.0021$, much slower than 0.00508. Thus the rate of increase in disparity slowed down in the late 1990s but was still in the range of two-tenths of one per cent per year.

A related question is whether rural per capita consumption increased in the poorest provinces and at what rate. From table 9.2, the three provinces with lowest consumption in 1981 were Gansu, Yunnan, and Ningxia, with per capita rural consumption of 135.23, 137.75, and 141.68 respectively. From table 9.5, in 1998 these three provinces had per capita rural consumption of 939.55, 1312.31, and 1327.63 yuan. The general retail price index given in table 9-2 of the *Statistical Yearbook of China, 1999* is 110.7 in 1981, 128.1 in 1985, and 370.9 in 1998; the general consumer price index for rural areas is 100.0 in 1985 and 319.1 in 1998. To approximate the increase in consumer prices for rural areas we assume the same proportional increase in these two indices between 1981 and 1985 to obtain a value of 86.4 for the latter index in 1981. The increase in rural consumer prices from 86.4 to 319.1 is a factor of 3.69. The increase in the nominal value of per capita consumption is $939.55/135.23 = 6.95$ for Gansu, 9.81 for Yunnan, and 7.89 for Qinghai. If we consider the two other poorest provinces as of 1998 among the original 28, namely Shanxi and Guizhou, with consumption per capita of 1056.45 and 1094.39, and consider their improvement from the 1981 values of 147.78 and 162.51 in table 9.2, we find factors of 7.15 and 6.73. Thus Guizhou is the province which improved the least between 1981 and 1998. The improvement in real consumption during this period is only a factor of $6.73/3.69$ or 1.82. In terms of exponential rate of increase per year, Guizhou experienced a rate of 0.035.

To summarize our discussion on disparity as measured by the dispersion in rural consumption per capita among provinces, the disparity has increased at the rate of

about half a percentage point per year between 1981 and 1998, but the rate of increase has slowed down to 0.2 of a percentage point in the last 5 years of this period. There have been significant increases in the level of real consumption per capita in all provinces in the meantime. Even Guizhou, the province with the slowest rate of increase among the original 28 provinces, experienced an average exponential rate of increase of 0.035 per year.

What policy implications, if any, can be drawn from these facts? To the extent that the poor provinces have not caught up with the rest, it is morally desirable and politically necessary for the government and the rich provinces to assist them in improving their productivity and standard of living. This is a motivation for the government's policy of western development, a subject to be treated in the next section. While attention is paid to western development, one should not lose sight of the need to continue the development of the rich provinces along the coast. These provinces are still very poor compared with some other regions in Asia and the rest of the world. If China is to compete in the global economy it needs to have institutions and people that can do the job. In order to do this it is necessary to have communities that have per capita incomes not much below world standards. Here comes the paradox of increasing disparity. The communities made up of the high-quality institutions and people who can compete in the world market are bound to be rich communities like Hong Kong and Shanghai. Their presence will increase our measure of income disparity among regions.

10.2 Developing the Western Part of China

10.2.1 *The government's reasons for western development*

As shown in table 9.5, there is much income disparity among the regions of China, with the western region being the poorest. The Chinese divide the 27 provinces (some administratively called autonomous regions) on the mainland into four regions. The northeast consists of Liaoning, Jilin, and Heilongjiang. The middle region consists of the 8 provinces of Shanxi, Hebei, Henan, Hubei, Hunan, Guangdong, Guangxi, and Hainan. The eastern region consists of 6 provinces, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong. The western region consists of 10 provinces, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Inner Mongolia, and Xinjiang, and the Chongqing municipality. Please refer to the map in the appendix to chapter 3.

The land of the western region covers an area of about 5.4 million square kilometers, accounting for 66 percent of the national territory. The general population in the region is 285,000,000, or 23 percent of the national population. The western regions are rich in energy resources. The 60 minerals which have been discovered in the nation can be found in the region, among which minerals such as titanium, copper, mercury, lead, and zinc are numbered first in national reserves. The reserves of coal account for 38.6 percent of those of the whole nation, with oil 41 percent, steel 46.8 percent, potassium 96.7 percent, and water energy 82.3 percent. The reserves per capita are much higher than the average level in the nation. The western regions will become a resource warehouse for future industrialization and modernization in

China. The region has advantages in agricultural and livestock husbandry. It is an important area for growing commodity grain as well as for transferring cottons. There is great potential for developing utilizable land resources for agriculture in general. In addition, the western regions also enjoy the advantages of bordering on several neighboring countries. This is beneficial for developing trade along the borders, and economic as well as technological cooperation.

From the political point of view, the development of the west is important. It was a part of the development strategy announced by Deng Xiaoping in the early 1980s and pursued by Premier Zhao Ziyang in the mid-1980s. To achieve rapid national development Zhao told the people that the eastern coastal provinces should be allowed to develop first, but after the eastern provinces become rich they should help promote western development. Such a strategy was accepted by the people and was carried out. At the end of the 1990s, it was time for the government to carry out the second part of its strategy and to fulfill its promise to the people in the western region.

Finally, from the economic development point of view, there are plenty of land and natural resources in the western region. Mineral deposits are plentiful. Oil and gas can be explored and extracted. Water resources can be utilized for agriculture and for electricity generation. Land can be used to lower the population density of the coastal regions. The development of these resources will be good for increasing output and will improve consumption standards for the entire economy.

10.2.2 Economic justifications for western development

We have pointed out the reasons for China's government to develop the west. Are these reasons justified from the economic viewpoint?

First, income inequality by itself is not necessarily a sign of poor economic performance. If rewards are given for talent and effort, differences in income among individuals in a society will naturally result. Of course, having talent and good working habits may themselves be the outcome of an individual's luck, including inherited intellectual and physical traits, family wealth, and family education. Similarly, if talents and efforts differ among the residents of different regions, there will be differences in regional incomes. Here also good fortune may play a role. Some regions have better resources just as some individuals have better inherited traits than others. Some regions are better located just as some individuals are better positioned socially because of family connections. While income inequality among people and regions is not necessarily bad, and is in fact necessary to promote talents and to encourage hard work, it is generally agreed that helping the disadvantaged is socially desirable. Helping the disadvantaged is not the same as preventing those who are able from becoming rich. Helping the development of the western regions of China is not the same as stifling the development of the coastal regions. I believe that this point is well understood by the leaders of China. We should regard the policy of western development as a strategy to help the disadvantaged and to improve their productivity, and not just to equalize China's regional income distribution, because there is no effort to make the coastal provinces develop more slowly.

In fact, maintaining the rapid growth of the eastern region is necessary for China's

rapid development, but the result may be to perpetuate or even widen the income disparity between the east and the west. China still needs a rich coastal region to help develop the poor western region. This main tenet of the development strategy in the 1980s to encourage the east to get rich is still true in the twenty-first century. The difference is that the government can pay attention to western development because the country is now in a better position to pay for it. Because of its geographical and cultural advantages the eastern region has been able to develop very rapidly. The government is trying to develop the west partly to help the disadvantaged and partly because it is complementary to the development of the east.

Given the importance of western development, the government recognizes that the east needs to be further developed because a richer eastern region can help develop the west. China needs very talented people and world-class institutions to develop the entire country. These institutions are mostly located in highly developed regions where salaries are high and facilities are modern. The eastern region is not up to world standards yet.

For China's economic and educational institutions to be world class it may not need a very high per capita income, but only a sizable sector consisting of very talented people and very good economic and educational institutions. In the early years of the People's Republic of China, the Party and government leaders failed to recognize this point. The best factories, commercial banks, and stock markets were destroyed in the 1950s. The best universities were closed. The most learned people and able entrepreneurs were mistreated and not allowed to use and develop their talents. The Chinese government has learned an expensive lesson and now allows the most talented to flourish to a considerable extent. The main exceptions are the limitations to private entrepreneurship (discussed at the end of chapter 16) and to intellectual freedom (discussed in chapter 21). Both limitations are derived from the basic notion that the government needs to control all aspects of life.

Building infrastructure is generally accepted as a government responsibility because the amount of capital and the risk involved may be too large for private investment, especially in the Chinese context at the turn of this century. The Chinese government has allowed and in fact encouraged foreign private capital to come to build infrastructure, including superhighways. Private capital did come. The first and best-known privately funded superhighway is the toll road connecting Hong Kong and Guangzhou built by the Hong Kong entrepreneur Gordon Wu. The risk from the viewpoint of an outside investor is higher than for the government, who can go through red tape and guide the project to completion more easily than a foreign investor. A government engaged in national development planning may also have more information than the private investor concerning the total development strategy, and this affects the profitability of each investment project. The Yangtze River dams might be too large and difficult a project for foreign investors, requiring tens of billions of US dollars and the resettling of millions of people in the area. Perhaps not enough foreign capital would be forthcoming to build all the infrastructure that the government wishes to build, including infrastructure for the western region.

Granted the need for infrastructure building, what is the economic justification for the government to develop the west by moving people and physical resources to the region? As far as migration is concerned, people have moved from the poor provinces to the richer provinces in the coastal areas to earn a better living. This migra-

tion is economically efficient because the wage or marginal productivity of a laborer in the richer provinces is higher. A laborer working one month to receive 200 yuan in the west now gets 350 yuan in the east. His movement raises national income by 150 yuan per month. Then why move the high-productivity people from the east to the west? The same question can be asked for the movement of physical and financial capital. People in a market economy invest their capital in the east because their rate of return is higher. They invest to build a factory in the east to get a return of 15 percent per year. They would build the factory in the west if the rate of return were higher. The same is true for government capital. One justification for the government to move human, physical, and financial capital to the west is economy of scale. When sufficient numbers of people and amounts of capital move, the rates of return can be higher.

Infrastructure-building also requires and justifies moving human and physical resources to the west. These resources are needed to build not only physical infrastructure like railroads and highways, but also soft infrastructure like legal and educational institutions. From the viewpoint of China's western development strategy, some of its current economic disadvantages, including geographical location, lack of convenient transportation, and lack of talented people, will become less relevant in the age of cyberspace of the twenty-first century. With modern technology, people can do research, communicate for business management, and trade without regard to location. However, economy of scale enters here as well, even in the age of cyberspace. Silicon Valley in California is successful because many talented people in related fields are located in one place. Furthermore, these people require good transportation facilities when they take business trips or travel just for pleasure. The government hopes that when the west becomes more developed, the east and in fact the whole economy will get more resources for development, and the people in both the west and the east will be better off.

10.2.3 Government strategy

Western development was made a top priority government policy in 1999. A Leading Group for Western China Development was formed in the State Council with Premier Zhu Rongji as its chairman. The city of Chongqing in Sichuan province was made a municipality in 1999 and given a leadership role to promote western development.

To provide research support for the formulation of appropriate strategies, the Municipal Government of Chongqing, the Chinese Academy of Social Science, the Ministry of Foreign Trade and Economic Cooperation, and the Representative Office of UNDP to China jointly initiated a research project on "The Development of the Western Part of China and Chongqing in the 21st Century." In June 2000 these organizations jointly sponsored the Chongqing International Symposium for the Development of the Western Part of China to discuss the strategies required. Several hundred government officials from Beijing and from related provinces, Chinese and foreign scholars, and interested international officials participated in this symposium. The invitation to participants stated:

The implementation of the western China development strategy and the acceleration of western China's development are important components of the modernization strategy of China. In the middle 1980s and early 1990s China's leader Mr. Deng Xiaoping advanced the idea of "two big situations." One refers to fully developing the advantages of the eastern coastal areas, accelerating reform and opening to the outside world. The second situation refers to achieving a comfortable living for the entire Chinese population and helping the western part to expedite its development.

The goals, steps, and measures of western China development have already been listed in the medium- and long-term plans for national economic and social development. The Chinese government plans to accelerate infrastructure construction, to enhance ecological environment protection and improvement, to emphasize the readjustment of the industrial structure of the west, to promote the development of science, technology and education and training, and to take the deepening of reform and opening up as the great impetus behind the western development.

We thus note that there are five major components in the official western development strategy. First is infrastructure construction. Second is environmental protection and improvement. Third is adjustment of the industrial structure in the west. The existing structure of industry is the result of past attempts to build in the west heavy and defense industries under central planning. More emphasis on consumer goods industry is contemplated. Fourth is the promotion of science, technology, and education. Fifth is carrying out further economic reform and the open-door policy.

The last two components are policies that apply to the development of the nation as a whole. The second is also a national policy, which we will discuss in the second half of this chapter. Infrastructure-building and industrial structure readjustment involve the direct allocation and reallocation of resources by the government.

Infrastructure-building includes land, air, and water transportation facilities, power generation plants, and water conservation projects (with the large dams along the Yangtze River being most notable and subject to scrutiny in the foreign media). Improving transportation facilities, especially the building of railroads and highways, is necessary for the development of the west. It would permit the shipment of natural resources and products from the west to the coastal areas and indirectly to the rest of the world. It would allow modern technology and equipment to be transported to the west. Science and education are the soft components of infrastructure broadly defined. Their importance is fully recognized by Chinese government leaders. The hard and soft components complement one another. Transportation facilities are required, for example, to build good universities and sustain their staff. Educated personnel with knowledge of science and technology are required for the construction of modern transportation facilities and power plants. However, it is difficult to evaluate how successful an infrastructure-building project will be. The government is devoting a large amount of resources to infrastructure. Even if the end result is good, the cost might be higher than it is worth. A careful study is needed to reach valid conclusions concerning the Chinese government's efforts to develop the west.

In summary, the Chinese government conceives of western development as a part of the overall development strategy. In this strategy the continuation of the development of the east is also considered a priority. The east has to be further developed in order for China to be competitive in the world economy. High-technology industry should be developed in the coastal areas. Western development not only serves to

raise the standard of living for the population in the west, but to provide resources and markets for the products of the east. The entire economy is expected to benefit from the increase in aggregate demand resulting from the western development strategy. First, there will be an increase in investment demand in the form of infrastructure-building, a subject discussed in section 7.5. Second, as the western regions get richer, demand for consumer goods will also increase. The government emphasizes the use of market forces to achieve western development. The building of physical infrastructure and of human capital will make the economic environment in the west more attractive for domestic and foreign investment. A larger and more integrated domestic market is good for the national economy.

10.2.4 Development of the agricultural sector

Since the development of the agricultural sector is closely related to western development and is not treated elsewhere in this book, this is the proper place to discuss it briefly. It is also the first important task mentioned in Premier Zhu Rongji's report of March 2001, which I referred to at the beginning of this chapter. Readers interested in the reform of Chinese agriculture should consult Johnson (1996, 1998).

The Chinese government succeeded in reforming the agricultural sector simply by allowing the farm households to have their own land to farm, as we discussed in chapter 3. Up to the latter part of the 1990s the Chinese government had neglected the development of the agricultural sector by devoting to it only a small fraction of government expenditures while controlling the distribution of agricultural products to urban areas. The emphasis on increasing productivity in the agricultural sector in the tenth Five Year Plan appears appropriate. In fact, by changing the technology in agriculture, it is possible to increase output per acre several times. The introduction of hybrid corn in the United States in the 1930s, more than doubling output per acre, is an outstanding example. Recall that according to Buck (1930), whom I referred to in section 1.3, farm output per acre in China in the late 1920s was about the same as that in the United States. Technological innovations in agriculture in the United States in the ensuing years have made all the difference. There are good researchers in agricultural sciences in China, but a great deal of experimentation in the field is required to invent crops that suit particular local climate and soil conditions in order to increase overall productivity in China significantly.

The Joint Commission on Rural Reconstruction (JCRR) made a very important contribution to the development of agriculture in Taiwan. It introduced new technology and provided farmers with education on farm management and marketing of farm products. Exchanges between both sides of the Taiwan Strait through official channels have transferred some of the know-how of JCRR to the mainland. In addition, private enterprises has also participated in the transfer. As mentioned above, the encouragement of participation from the nongovernment sector is a part of the government strategy for western development.

In particular, I would like to mention the effort of an outstanding entrepreneur, Cao DingAi, Board Chairman of Hainan Liquida Farming Industrial Investment Co. Ltd., with its headquarters located at Haikou, capital of Hainan province. Cao grew up on a very poor farm in Guizhou, the poorest province of China. He managed to

receive a graduate education in mathematics and economics and later became an entrepreneur, after working in the Hainan branch of the People's Bank. He started the above company, which owns controlling shares of over 15 cooperative farms in Hainan and in his home province, Guizhou. In each farm he helped the farmers organize a cooperative by pooling their land. He introduced new farming technology, much borrowed from Taiwan and from the JCRR in particular. He has taught the farmers not only how to farm more effectively but how to market their products, some to Hong Kong. His has been a very successful business, benefiting all parties concerned as well as China's development of agriculture. This is an outstanding example of entrepreneurship at work in China.

10.3 Environmental Policies

The government of the People's Republic of China neglected and practically ruined much of the physical environment of the country for three decades from the 1950s to the 1970s. According to documentation by Judith Shapiro (2001), Chairman Mao was responsible for a lot of this damage. The government began to pay some attention in the 1980s, and has been paying serious attention to protecting and improving the environment since the mid-1990s.

Parts of China's physical environment were ruined unintentionally, by neglect or ignorance. For example, there is Kunming Lake near the city of Kunming in Yunnan Province. The government decided to fill a part of the lake to increase land for agricultural production. Not only was the beauty of the lake affected, but the ecology of the area around it was changed, with the result that insufficient rainfall is available for the growing of some crops. Forests in many parts were cut down to provide lumber and firewood, and there was soil erosion affecting the amount of sand and mud flowing into the rivers and increasing the likelihood of flood. It is said that the very serious flood in 1998 was the result of the lack of environmental protection in the years preceding it. Reduction of green areas has allowed deserts to form. For example, Beijing is now getting more blowing sand from its northwest. Pollution has also become a serious problem in many cities. Since 1987, because of government efforts, water pollution has decreased in China, but air pollution has not.

The air and water in China, especially in the urban areas, are among the most polluted in the world. Of the world's 10 most polluted cities in the year 1999, 9 are reported to be in China. Air pollution comes from industrial waste and from the burning of coal for cooking and heating in many cities. The extensive use of coal for energy is one reason for air pollution. As the country becomes industrialized, pollution from both industrial and consumer sources will increase because of higher levels of output and consumption, the latter from increase in the use of automobiles, unless pollution per unit of output or consumption can be reduced.

The Chinese government became aware of the environmental problems and has made serious attempts to protect and improve China's environment. In 1979, China passed the Environmental Protection Law for Trial Implementation. The 1982 Constitution included important environmental protection provisions. Article 26 of the Constitution requires that "the state protects and improves the environment in which people live and the ecological environment. It prevents and controls pollution and

other public hazards." There are also provisions on the state's duty to conserve natural resources and wildlife.

Based on these provisions a number of special laws have been enacted. These include the Water Pollution Prevention and Control Law of 1984, the Air Pollution Prevention and Control Law of 1987, the Water and Soil Conservation Law of 1991, the Solid Waste Law of 1995, the Energy Conservation Law of 1997, and several important international agreements, including the Kyoto and Montreal Protocols.

Like many other laws in China, these laws are poorly enforced. The main reasons are the lack of a modern legal enforcement system, the lax attitude of the Chinese people towards such laws, and the economic costs of obeying them. The same reasons apply to the poor enforcement of the laws to protect intellectual property rights. These reasons will continue to hinder the enforcement of environmental laws for some time to come.

However, environmental conditions will improve in China for three reasons. One is the government's strong resolve. The second is that in many circumstances, unlike the case of the enforcement of laws to protect intellectual properties, the government has the power to enforce the law because the operation of an industrial enterprise requires the approval of and often economic assistance from the government. The government not only punishes offenders but provides economic incentives for people to act according to the economic welfare of society. There are a number of incentive schemes adopted by the Chinese government for industrial producers. For a particular industry, a limited amount of rights to pollute are auctioned to the highest bidders among industrial enterprises which find it necessary to produce waste material. Levies to polluters, restrictions on the quantity of pollution permitted, and the sales of tradable permits are economic means to control pollution in China. Wheeler, Dasgupta, and Wang (1999) have provided econometric evidence that a pollution levy does have a negative effect on the quantity of water and air pollution per unit of output, as we will discuss in the next section. Third is that as the economy gets richer the demand for cleaner water and air will increase, and so will the ability to pay for the cost to achieve it.

Because of the above-mentioned government policies, state and nonstate enterprises have tried to find cleaner technology to produce and to generate power from coal. Governments of cities like Shanghai have tried to adopt urban planning strategies that are friendly to the environment. Space within a city is reserved for planting trees in order to improve air quality. Travelers to Beijing, Shanghai, and Guangzhou in 1998 to 2000 would have noticed that these cities became cleaner and the air quality improved during this period.

In evaluating China's environmental protection policies, observers residing in developed economies should bear in mind that China is still a fairly poor country in the process of economic development. Such a poor country is eager to get rich quickly. In so doing its people may be willing to inhale some slightly polluted air and drink some slightly polluted water to enable industrial output to increase. The cost of producing the same output with less pollution will be higher. In other words, allowing some pollution will enable gross domestic product to be higher, even when we allow for the cost of pollution (which has been estimated to be 3–8 percent of GDP: *China 2020*, p. 71). In terms of announced policy, the Chinese government appears to be taking the protection and improvement of the environment seriously. It is

unwilling to sacrifice the quality of the environment to increase current output. It appears to be aware of the possible effects of damaging the environment on future output and future economic welfare in general. Yet the standard of environmental protection may still be more lenient than that in a more developed economy.

10.4 A Study of Industrial Pollution

This section summarizes the main findings of a study on industrial pollution in China reported in Wheeler, Dasgupta, and Wang (1999). The main purposes of this study were to assess the effects of different factors on industrial pollution, to look at the impact of economic reforms and of pollution regulation, and to examine whether China can improve its environment and achieve economic growth at the same time.

First let's begin with some facts. Industrial pollution accounts for over 70 percent of total pollution, including 70 percent for waste water, 72 percent for SO_2 emissions, 75 percent for flue dust, and 87 percent for solid wastes, according to estimates of China's State Environment Protection Agency (SEPA). The remaining sources are nonindustrial productive sectors and consumers. Since 1987, water pollution has improved but air pollution has not for the country as a whole. Approximately 4,000 people suffer premature death from air pollution related illness each year in Chongqing, 4,000 in Beijing, and 1,000 in Shanghai and Shenyang. Industrial pollution tends to be less serious, not more, in the more developed provinces. For example, the rich areas of Shanghai, Beijing, and Guangdong have less air pollution than the poor areas of Sichuan, Chongqing, and Liaoning, for reasons that will be discussed presently.

To study the factors contributing to pollution, an econometric analysis is performed. Both air and water pollution are studied. Pollution by industrial enterprises is measured by pollution density, which is the amount of air pollution or organic water pollution (chemical oxygen demand, or COD) in waste water discharged per unit of industrial output. The analysis is based on the following hypotheses. First, regulation is an important factor. It is measured by "effective levies," the amounts of levies actually collected (effective) per unit of above-standard discharge of air pollutants or waste water. Richer regions demand better environmental quality and tend to have better enforcement of environmental regulations. Second is industrial composition. If coal mining is highly polluting, then having a larger fraction of industrial output in this industry increases pollution intensity. Third is the size of the plant. There are economies of scale in the sense that a larger plant can produce the same output with less emission of pollutants. Fourth, state-owned enterprises tend to have higher pollution density partly because of their lower productive efficiency.

Using cross-section data for 29 provinces in the period 1987-93, an equation was estimated to explain the log of air or water pollution intensity in province j ($j = 1, 2, \dots, 29$) by the above explanatory variables. The first is the log of effective levy in province j . The second is a set of variables s_{kj} , for the share of industrial output in province j contributed by industry k , where different k 's represent coal mining, transportation equipment, chemical fibers, etc. The third is the share of industrial output in province j produced by large plants. The fourth is the share of industrial output in province j produced by state enterprises. The coefficients of log effective levy in the

three air pollution intensity (separated into SO₂ intensity, smoke intensity, and dust intensity) equations and the water pollution intensity equation are respectively -0.321, -0.796, -0.434, and -0.835 (tables A.2 and A.1 of Wheeler, Dasgupta, and Wang, 1999). All coefficients are statistically significant, showing that increasing effective levies will lead to reduction in pollution intensity. The coefficients of shares of industrial output are reasonable. The coefficients of the share of output produced by large plants in the above four equations are negative and significant. The coefficients of the share of output produced by state enterprises are all positive and significant.

The results of the above statistical analysis show that economic reform will lead to less air and water pollution by increasing the average size of industrial plants and by reducing the share of output produced by state enterprises. Economic reform also will lead to better regulation in the form of increased effective levy. To measure this effect, a second equation is estimated to explain the log of effective levy by relevant economic variables. The variables include log pollution density, log population density, log income per capita, log industry share. Higher pollution density requires larger effective levy. The fact that its coefficient is positive (table A.1(b)) for the levy on water (COD) implies that government regulation is effective in the sense of charging more in the provinces where pollution intensity is high. The positive coefficients of log population density and of log income per capita would imply that economic reform will lead to increase in effective levy through increasing these two explanatory variables. The second coefficient also explains why richer communities in China tend to have less pollution.

However, higher levy and even lower pollution intensity do not imply cleaner air or water. The latter is measured by the amount of pollutant per unit of air or water. Pollution intensity measures only the amount of pollutant per unit of industrial output. As the economy grows, the amount of industrial output also grows, leading to lower-quality air or water if pollution intensity remains the same. The quantitative analysis of the paper cited suggests that, by choosing appropriate policies on pollution levies, China can indeed reduce pollution intensity at a faster rate than the rate of growth of industrial output, and thus improve its environment as the economy grows.

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- 1 In the first section of this chapter we measure disparity among provinces using rural consumption per capita. Would you prefer using rural income per capita instead? Explain your answer. Table 10-16 of the *China Statistical Yearbook, 1999* provides data on the per capita net income of rural households for all provinces for selected years from 1978 to 1995 and annually from 1995 to 1998. Would you expect our results to change much if income data are used instead of consumption data?
- 2 What are the reasons for the Chinese government to adopt the western development strategy? Are these reasons sound?
- 3 What are the main components of China's western development strategy?
- 4 In what respects does the western development strategy adopted by the Chinese government follow the rules of the market economy? Are there any respects in which the rules of a market economy are violated?
- 5 In what ways did the Chinese government neglect the protection of the environment from the 1950s to the 1970s?
- 6 Describe the major components of the environmental policy of China.
- 7 Explain why rich communities tend to have less pollution.
- 8 Name four of the most important factors that can explain pollution density in a province, pollution density being defined as the quantity of pollutant (air or water) emitted per unit of output. How is each factor measured? Explain why the coefficient of each factor should be positive or negative.
- 9 What are the channels through which economic reform will lead to less pollution?