

Rural industries and water pollution in China

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Abstract

Water pollution from small rural industries is a serious problem throughout China. Over half of all river sections monitored for water quality are rated as being unsafe for human contact, and this pollution is estimated to cost several per cent of GDP. While China has some of the toughest environmental protection laws in the world, the implementation of these laws in rural areas is not effective. This paper explains the reasons for this implementation gap. It argues that the factors that have underpinned the economic success of rural industry are precisely the same factors that cause water pollution from rural industry to remain such a serious problem in China. This means that the control of rural water pollution is not simply a technical problem of designing a more appropriate governance system, or finding better policy instruments or more funding. Instead, solutions lie in changes in the model that underpins rural development in China.

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The house is new, the money is enough, but the water is foul, and life is short.

(A popular saying in coastal China, from Schmidt, 2002)

1. Introduction

Water supply and quality are fundamental issues in China. A few years ago, the debate about who will feed China emphasised scarcity of farmland and the food crisis (Brown, 1995). Yet the most critical resource in China is not land or food, but water (as Brown later (2001) came to recognise). Not only are per capita water resources limited (Niu and Harris, 1996) and the spatial distribution of water resources extremely uneven, there is also significant waste of water. This waste is related to inefficient irrigation practices, leaking water pipes, and water pollution. Growing municipal and industrial waste discharges, coupled with limited wastewater treatment capacity, are the principal drivers of water pollution. About two-thirds of the total waste discharge into rivers, lakes and the sea derives from industry, and about 80% of that is untreated.

Most of the untreated discharge comes from rural industries.

Rural industries stand out as one of the most spectacular respondents to China's 1978 economic reform. They represent a middle ground between private and state ownership and have not developed in any other country on such a large scale and at such a rapid rate. They have become the driving force behind China's economic growth and a significant engine of China's transition, with double-digit growth rates since the late 1970s. To a large degree, this growth of rural industry was neither planned nor anticipated (Bruton et al., 2000).

However, the environmental cost of China's rural industrialisation is enormous. Rural industry consumes massive quantities of water and pollutes a large proportion of rural water bodies (Anid and Tschirley, 1998; Wheeler et al., 2000). While a few large rural enterprises have advanced technology and sophisticated wastewater treatment facilities, rural enterprises are characterised by their small scale, outmoded technology, obsolete equipment, poor management and heavy consumption of water resources (Qu and Li, 1994). As a result, water pollution is a serious problem wherever there are rural industries. Over 80% of China's rivers have some degree of contamination (Qi et al., 1999). China's 2002 *State of the*

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Environment Report shows that 70% of the 741 river sections monitored were unfit for human contact (pollutions levels at or above Grade IV standard) (SEPA, 2002). The most polluted was the Hai River, where 86% of monitored sections were unfit for human contact.

China's environmental policy is widely considered as a comparatively success in urban areas, with marked declines in urban pollution (Florig et al., 1995; Zhang et al., 1997; Abigail, 1997). However, these efforts rarely reach the rural areas, where environmental policy is not effective (Florig et al., 1995; Zhang et al., 1997; Abigail, 1997). One of the names for this phenomenon is a policy 'implementation gap' (Chan et al., 1995). It is the aim of this paper to understand the reasons for this implementation gap. Previous studies have attributed it to a combination of factors, including legislative shortcomings, poorly designed policy instruments, an unsupportive work environment for environmental regulators, and a pro-growth political and social environment (Chan et al., 1995; Wong and Hon, 1994; Ross, 1992). These are important; however, we argue that the most fundamental factors causing rural water pollution are the very same factors that have underpinned the economic success of rural industry. The problem of water pollution, we argue, is therefore unlikely to be remedied by discrete institutional changes, and instead requires a transformation of the models associated with rural development.

We present this argument in the following sections. We begin by explaining the characteristics of rural industry and the reasons for its success. This will be followed by a summary of the water crisis as it relates to rural industry. In Sections 4–6, we explain our interpretation of the reasons for water pollution problems in rural China. Section 4 is focussed on how the characteristics of rural

industry contribute to rural water pollution; in Section 5, we review the institutional arrangements that make it difficult to control water pollution by rural industry; and in Section 6, we emphasise how the on-going transition has made water pollution control more difficult. The conclusion integrates this evidence and explains our interpretation of it.

2. Rural industrialisation

The rise of rural industry is one of the outcomes of China's transition. The rural household responsibility system introduced in the late 1970s released hundreds of millions of peasants from the farming sector. To accommodate increasing under- and unemployment in China's countryside, the central government allowed industrial development in rural areas (Lin, 1997; Oi, 1995; Lieberthal, 1995). Peasants were encouraged "to leave the land but not the village" (*litu bu lixiang* in Chinese) (Tan, 1993; Wang, 1997). As a result, over 120 million peasants abandoned agriculture to work in the emerging rural industrial sector.

By the end of 2003, China had nearly 22 million rural enterprises, producing output valued at ¥191 billion, which is 15 times that of 1988 (National Bureau of Statistics of China (NBSC), 2004). The total added value contributed by rural enterprises accounted for over 30% of China's GDP, compared with only 12.3% in 1988. In 2003, rural industry employed over 135 million from the rural labour pool without need for state investment (Table 1). Many 'made-in-China' products are manufactured by rural enterprises. From 1995 to 2000, exports by TVEs grew at an average annual rate of 10% (NBSC, 2004; Fu and Balasubramanyam, 2004). In 2004, TVE exports accounted for one-third of China's total exports (NBSC, 2004). So,

Table 1

TVEs size: number of enterprises and employment by category of ownership: China, 2003

Enterprise category (registered as)	Number of enterprises		Total employees		Employees/enterprise
	(000)	%	(000)	%	Persons
Urban ^a	197.22	100	25 6390	100	1331
SOEs ^b	34.28	17.4	68 760	26.8	2005
Others	162.94	82.6	187 630	73.2	1151
TVEs total	21 850.8	100	135 729.3	100	6
Domestic	21 796.1	99.7	128 433.2	94.6	6
Collective	292.1	1.3	12 359.7	9.1	42
Share-holding cooperative	84.8	0.4	3670.2	2.7	43
Joint operation	26.7	0.1	666.5	0.5	25
Limited liability	202.8	0.9	10 272.8	7.6	51
Share holding	32.4	0.1	1819.4	1.3	56
Private	2542.4	11.6	38 708.6	28.5	15
Individual	8940.1	40.9	29 916.9	22.9	3
Others	9674.8	44.3	31 019.1	22.9	3
Hong Kong/Macau/Taiwan	38.0	0.2	4928.6	3.6	130
Foreign	16.7	0.1	2367.6	1.7	142

Source: NBSC (2004).

^aIncluding all SOEs and these non-state enterprises with annual sales over 5 million Yuan. Almost all of them are located in either cities or towns.

^bSOEs include all SOEs and all those enterprises with State as the major share holder.

although TVEs have simple production methods and have obtained technical expertise from staff formerly employed in state-owned enterprises (SOEs) (Peng et al., 1997), they have clearly outperformed SOEs in terms of growth, job creation and profitability (Chen and Jefferson, 1999).

In this paper, rural industry is taken to mean all businesses located in rural areas and involved in non-agricultural activities. Rural industry can be broadly classified into two categories of ownership: township (*xiang*) and village (*cun*) enterprises as collective enterprises (strictly speaking, TVEs), and private rural enterprises. This latter category includes a heterogeneous group of enterprises of different sizes, types of business, organisational structure, and ownership. However, there are many different rural industrialisation models in China. Based on the sources of initial investment, structure of ownership, industrial orientation, income distribution and management systems, Chinese economists (Ding et al., 2004; Zuo, 2001) classified TVEs into three generic models: (1) the Sunan model (Southern Jiangsu model); (2) the Wenzhou model; and (3) the Pearl River Delta model. They are different because of their firm size, technical sophistication and their initiative drivers. The Sunan model is characterised by a dominant initial investment by township and village government; the Wenzhou model by private investors; and the Pearl River Delta model by foreign direct investment and export-oriented manufacturing. These models are neither static nor exclusive.

The boundary between TVEs and private enterprises has blurred over time (Weitzman and Xu, 1994; Naughton, 1994; Che and Qian, 1998). Some TVEs have been transformed into joint stock co-operatives, others partially privatised (with local governments continuing to hold a stake) and others even wholly privatised by the sale of the entire stake to managers, employees and/or community residents (Xu and Tan, 2002). Many private investors have become shareholders of TVEs in Sunan and many private enterprises in Wenzhou have been merged to form a collectively owned corporation. The ownership of rural enterprises can be private or collective or a combination of shareholders in local communities, village and township governments, and local and foreign private owners (Table 1).

Many explanations have been offered for the remarkable success of rural industry in the Chinese economy (e.g., Byrd and Lin, 1990; Nee, 1992; Chang and Wang, 1994; Ho, 1994; Weitzman and Xu, 1994; Naughton, 1994). Success has been seen to be due to the shortage of major product markets in the 1980s in China, cheap rural labour, tax concessions from local governments, and the problems of state industries (Byrd and Lin, 1990; Ho, 1994; Naughton, 1994). Other contributions to their success have come from their unique institutional structure that facilitates co-operation through implicit contracts among community members (Weitzman and Xu, 1994); the inter-organisational relationship between TVEs and local governments (Chen and Jefferson, 1999; Fan, 1997) and

TVEs' capacity to adapt and configure their strategy in response to the external competitive environment (Luo et al., 1998, 1999). However, two of the success factors are especially important for the pollution performance of rural industry.

One of the most important of these is the fact that many rural enterprises face hard budget constraints. For private enterprises, family saving is the major source of capital: they have limited opportunity to access bank loans or attract government investment. TVEs are in a slightly better position because they receive local township or village government sponsorship, though the limited tax base means that such financial support is insufficient. TVEs also have limited access to financing through the banking sector. Even though local governments often act as guarantor and supporter for their TVEs' applications for bank loans, banks are hesitant to lend to what they consider to be risky enterprises, and banks have been encouraged in the past by the central government to support the ailing SOE sector instead. Therefore, rural industries have very strong incentives to ensure that their operations are profitable. Such hard budget constraints force rural industrial operators to focus mainly on generating profits for their survival, and they are therefore extremely reluctant to incur costs to conserve water use or control pollution.

Another common driving force for the success of rural industry is the strength of local government networks. The existing research has described the advantages stemming from the TVEs' peculiar 'internal institutional form' that facilitates cooperation through implicit contracts among community members locked into an ongoing relationship (Nee, 1992; Weitzman and Xu, 1994). The success of TVEs is mainly due to the interaction of TVEs with the whole community through a "set of interlocking financial, administrative, personnel, and other ties" (Byrd, 1990, p. 74) and the existence of a strong 'cooperative culture' (Weitzman and Xu, 1994).

The local township or village governments give birth to TVEs, and they appoint TVE managers, and act as financial intermediaries by financing TVEs and using their connections to find alternative sources of financing. In return, local governments share the profits generated by their TVEs. With an inefficient legal system, the local government is the only body that can settle disputes arising from the operation of TVEs. As we will argue, such a 'parenting' relationship is one of the key factors to the 'implementation gap' identified in China's environmental protection system.

For rural private enterprises, keeping good *guanxi* (in the Chinese business world, *guanxi* is understood as the network of relationships among various parties that cooperate together and support one another) with local government is extremely important for survival. Few private enterprises depend on local government for financial assistance or marketing their products, but they keep close *guanxi* with local officials, including local

environmental monitors and inspectors. Such close *guanxi* can include bribery in various forms. As our fieldwork interviews (with peasants and village heads in four villages in Jinan and Zhengzhou and with their municipal/provincial government water officials in October 2005) show, managers are sometimes ‘informed’ before environmental inspections are carried out so that they can temporarily shut down their polluting functions, only to return to ‘normal’ operation after the inspection is over.

There are, then, a variety of reasons for the emergence of this remarkable growth engine of the Chinese economy. Some of these reasons are directly related to the polluting tendencies of that engine. Before we examine these reasons more deeply, we briefly identify the main characteristics of the water pollution problems that are attributable to rural industry.

3. Rural industry and the water crisis

Rural industries have been widely criticised for their waste of natural resources, including water resources, due to substandard equipment and basic technology (Shen et al., 2005; Edmonds, 1994; Wong, 1999). Most rural industries have no wastewater or hazardous waste treatment facilities. Almost all wastewater is directly discharged into local river systems. According to the State Environmental Protection Agency (SEPA, 2002), the total discharge of sewage and wastewater in China was 62 billion tons in 2000, of which only 24% was treated up to the national standard; the rest was not treated or treated but not up to the national standard before being discharged or used for irrigation. It has been conservatively estimated that TVEs alone discharge over 10 billion metric tons of wastewater per year, which is half of the industrial wastewater discharge in China. According to Zhao and Wong (2002), 76% of wastewater created serious pollution while only five per cent of wastewater was discharged at the required standard. As the data from SEPA demonstrates, this untreated wastewater has polluted most Chinese rivers, and 3/4 of China’s lakes have significant levels of pollution (SEPA, 2002).

Since the year 2000 there has been a decline in the number of environmental accidents in China (Table 2).

Whereas the number of environmental accidents in China grew rapidly between 1997 and 2000, the number fell between 2000 and 2003. Of all the classes of environmental accidents, water pollution accidents are the most frequent, and they have become more frequent between 1997 and 2003. Of course, some of these are from SOEs and large urban industries, but the enforcement of environmental regulations in cities, anecdotal evidence and media reports suggest that the majority of these accidents are caused by rural enterprises. There is probably also significant under-reporting of water pollution accidents from rural industries due to the close connections between environmental regulators and rural entrepreneurs (discussed later).

Water pollution and consumption by rural industry are related to the type of industrial activity. The major water polluters include an array of industries such as paper and pulp milling, chemical manufacturing, metal casting, and brick making that produce large quantities of wastewater, adding nitrogen, phosphates, phenols, cyanide, lead, cadmium, mercury, and other pollutants to the water near rural residential areas—the same water that is used for drinking. The worst water polluters are those rural industries related to papermaking, cement and bricks (Xu, 1999). For example, TVE paper mills in Henan Province consume 3.6 times more water per unit of paper production than do state-owned paper mills (according to interviews in 2005). In China, these three sectors have increased their production dramatically: between 1978 and 1993 the volume of paper produced from rural industries increased from 0.4 to 10.3 million tons, the volume of cement from 3.3 to 127.6 million tons, and the number of bricks from 73 to 494.8 billion (NBSC, 1995). With these large increases in production have come concomitantly large increases in emissions of pollutants into waterways.

Water pollution and consumption by rural industry are also of course related to the density of production sites. Xu et al. (2001) compare the density of TVEs in the provinces of China (using TVEs output value per land area) and the ratio of wastewater to runoff (using TVEs discharged wastewater per cubic metre of runoff). Their results show a clear positive correlation between the economic density of TVEs and the runoff load that they generate ($r = 0.93$). Provinces in which TVEs produce a lot of output per unit

Table 2
Number of environmental accidents in China (1997, 2000, 2003)

Type of accident	1997		2000		2003	
	Number of accidents	%	Number of accidents	%	Number of accidents	%
Total accidents	1992	100.0	2411	100.0	1843	100.0
Water pollution	986	49.5	1138	47.2	1042	56.5
Air pollution	752	37.7	864	35.8	654	35.5
Solid waste pollution	55	2.8	103	4.3	56	3.0
Noise pollution	119	6.0	266	11.0	50	2.7
Other pollution	80	4.0	40	1.7	41	2.2

Source: NBSC (2004).

area have a high ratio of wastewater to runoff; these are principally the provinces along the coast and in the south. There are also some provinces in the drier north and west (such as Tianjin, Hebei, Henan, and Ningxia) that have high levels of rural industrialisation and associated high levels of wastewater to runoff.

As a result of this pollution, water is now a public health risk in China—arguably even more so than air pollution (Schmidt, 2002). Over half of China's 1.3 billion people drink water contaminated with chemical and biological wastes such as petroleum, ammonia nitrogen, volatile phenols, and mercury (SEPA, 2002). The health impacts of water pollution have been costed at US\$3.9 billion annually (World Bank, 1997), and there is evidence that the increasing incidence of cancers is associated with pollution of drinking water (Banister, 1998; UNDP, 2002). Maurer et al. (1998) list a number of studies that link wastewater from TVEs with health effects such as elevated cancer rates and abnormal pregnancy outcomes (for example, spontaneous abortions, premature births, birth defects). Xu (1992) finds that the incidence of disease differs between more and less polluted regions; in the most polluted areas, chronic disease is up to three times more common than in the nation as a whole. Xu (1992) also finds that average mortality in polluted areas is 4.7 per 1000, higher than the average of 3.6 in less polluted areas.

Environmental degradation costs China dearly, though that cost has been estimated using various techniques with varying outcomes (Smil and Mao, 1998; World Bank, 1997). The aggregate annual cost of environmental damage has been estimated to be between 4.5% and 18% of GDP: water pollution is estimated to cost between 0.6% and 4.5% of GDP, with estimates centring on 1.7%, about the same as the cost of air pollution.

A number of analysts argue that poor regulation and enforcement of environmental measures allows many small rural enterprises to operate without waste treatment facilities (Jahiel, 1997; Lin, 1997; Qu and Li, 1994). The Chinese government has imposed a pollution levy on industrial polluters since 1979 and introduced a new incentive-based pollution control programme in which the environmental performance of firms is rated from best to worst using five colours—green, blue, yellow, red and black—and the ratings are disseminated to the public through the media (Xie and Florig, 1997; Wang et al., 2004). This system is arguably one of the most complete pollution levy systems in developing countries. However, the levy has been criticised as being too low to give polluters incentives to reduce their emissions, for the water pollution fees are small relative to the marginal costs of pollution control (Wang, 2000; Wang and Wheeler, 2000; Vermeer, 1999; Krupnick, 1992; World Bank, 1992; Sinkule, 1993). Thus, many enterprises simply choose to pay the effluent or emissions fee rather than incur the costs of pollution control. Further, because effluent and emissions fees and fines can be lower than even the operating and maintenance costs of pollution control equipment,

many enterprises that install pollution control equipment have little incentive to operate it once installed. For example, Sinkule (1993) reveals a case in which the operating costs for wastewater treatment were more than eight times the fee imposed for not operating the equipment.

In addition to the pollution levy, since the mid-1990s the Chinese government has taken several important steps towards pollution control. The government will punish whoever is in violation of State environmental regulations and causes serious pollution of land, water or the atmosphere. The penalty is up to 3 years imprisonment and a fine. Up to 7 years imprisonment can be imposed in the most serious cases. (The most extreme measures include capital punishment under the codification of environmental crimes introduced in 1997.) All relevant ministries of the central government—including SEPA, the Ministry of Agriculture, the State Planning Commission and the State Economic and Trade Commission—issued new regulations to curb pollution by TVEs in 1997. The new regulations hold the county magistrates and township mayors responsible for environmental regulation enforcement. In addition, the central government will cut off all state funding for rural enterprises that are considered environmental hazards. Governments has warned that it may revoke business licenses, cut off power supplies and state funding or detain managers on criminal charges to bring polluting TVEs into line (*South China Morning Post* (Hong Kong), 17 December 1996).

The central government has set up tough regulations and targeted certain geographical areas as priorities for pollution control. In 1997, it started a so-called '33211' programme targeting priority pollution control projects in geographical areas which were experiencing major environmental problems: three rivers (Huai, Hai, and Liao), three lakes (Tai, Chao and Dianchi), two control regions (which were major sources of SO₂ and acid rain), one sea (Bohai), and one city (Beijing—in consideration of the 2008 Olympic Games).

The Huai River valley is an area of particular concern to the central government. The director of the SEPA has himself inspected the Huai River valley regularly and ordered the closure of thousands of polluting factories. The water pollution control campaign in the Huai River valley is the first river valley based, large-scale water pollution control program conducted in China. In these programs, China has targeted 15 categories of small rural enterprises, such as paper pulp mills, textile mills, dyeing mills, small chemical plants, small breweries and small currying mills—the '15 small' enterprises. There has been closure of more than 40 000 of these 15 small heavy pollution factories on the Huai River and 70 000 throughout China (Xi and Xu, 2002).

The experience of the Huai River valley in water pollution shows that the political will of the government, especially at the national level, is critical to the success of water pollution control. However, the introduction of

tough environmental legislation and closure of many polluting factories in rural areas have not solved the water pollution problem. This is mainly because the legislation and implementation as well as the campaigns have failed to consider the unique nature of rural enterprises and the difficulties faced by environmental law enforcement in rural areas. In the remainder of this paper we will discuss these factors, under three headings—the nature of rural industry (its size, locational characteristics and relation to local officials), the institutional framework that prevents agencies from effectively enforcing environmental policies and regulatory mechanisms, and the on-going economic transition.

4. The characteristics of rural industry

4.1. *Small is not beautiful*

One of the common characteristics of rural industry is small enterprises. The mushrooming Chinese economy allows a few small rural enterprises to become large and some successful rural enterprises have grown to employ well over 1000 workers. Likewise, those rural enterprises registered as foreign or Hong Kong/Macau/Taiwan owned employed on average over 130 workers (Table 1). Nevertheless, the average size of all rural enterprises was only six employees in 2003. In fact, more than 93% of all the rural enterprises are run by rural households (MoA, 1995). Most rural enterprises are relatively small; indeed, most private enterprises in rural China are family run businesses, many using outdated methods and primitive production technology with low energy and resource use efficiency and high pollution (Liu, 1992).

There is, though, some geographical variation in the size and productivity of rural enterprises across China

(Table 3). Along the coast, rural industries tend to employ more workers and to have higher values of output per worker than in inland areas. Tibet is a notable exception—here rural industries are large but the value of their output per worker is low. Overall, the smallness and relatively low value of output per worker means that these industries lack the resources to manage their waste streams effectively (Lin, 1997).

4.2. *Dispersion of rural industries*

In addition to their smallness, China's rural enterprises are also spatially dispersed. SOEs and other large non-state enterprises with annual output of more than ¥5 million are mostly located in the 669 major cities of China, but rural enterprises are located almost in every corner of China's territory. The more than 21 million rural enterprises are spread widely in 43 735 towns and 734 715 villages. This dispersal is a significant point of difference from western economies. Since the Industrial Revolution, urban areas have been the sites for most industries in the west, whereas rural industrial development on a massive scale has never occurred (Fothergill, 1985; Fulton, 1974).

Such a pattern of enterprises scattered in villages and townships makes environmental monitoring difficult. Not only is it difficult to monitor rural enterprises because of their dispersed locations, it is also the case that China's environmental monitoring stations are under staffed. In China, there were 46 000 environmental monitoring staff and inspectors in 2003 most of whom are located in urban administrative centres. Even if all environmental monitoring staff were assigned to monitor water pollution from rural enterprises, each staff member would have to be responsible for 111 rural enterprises. Because environmental monitoring staff are insufficient to mount frequent

Table 3
China's rural industry: average size and output value per worker by province (in 2003)

Region	Employees per enterprise (persons)	Output value per worker (000 RMB)	Region	Employees per enterprise (persons)	Output value per worker (000 RMB)
China total	6.3	111	Anhui	6.3	60
Shanghai	52.1	264	Shandong	6.2	137
Chongqing	24.4	94	Heilongjiang	6.2	106
Tibet	19.8	50	Jiangxi	5.1	63
Jiangsu	10.2	184	Hunan	5	70
Tianjin	10.2	173	Guizhou	4.8	59
Zhejiang	10	204	Shaanxi	4.6	52
Guangdong	9	112	Liaoning	4.6	184
Shanxi	8.5	87	Inner M.	4.5	91
Hebei	8.4	126	Sichuan	4.5	88
Beijing	8	141	Qinghai	4.3	52
Fujian	7.7	125	Guangxi	4	53
Gansu	7.1	67	Yunnan	4	63
Henan	7	89	Ningxia	3.7	44
Hainan	6.8	61	Jilin	3.4	87
Hubei	6.6	93	Xinjiang	2.5	46

Source: NBSC (2004).

Note: an Approximate exchange rate is \$US1 = RMB 8.

unannounced inspections, rural enterprises are not properly inspected (Sinkule, 1993). For example, 2000 employees in Zhejiang EPA have to monitor over one million TVEs, which means that each staff member on average has to monitor 500 rural enterprises (in addition to urban enterprises).

Another reason for the omission of many rural enterprises from the environmental inspection system is related to the current policy of levy charges. According to the regulation, 80% of discharge fees are returned to industries for investment in waste treatment facilities; the remaining 20% goes to the Environmental Protection Bureau (EPB). This money collected from industries is crucial to the EPB's operation: to pay for employees' salaries and bonuses, research funding, environmental supervision, and environmental education campaigns. However, in the current pollution levy system, fines imposed on small enterprises for pollution violations are very small and, as we have seen, most rural enterprises are very small indeed. Thus, the revenue from pollution fee collection could drop significantly if local EPBs allocated most of their limited resources to monitoring small, scattered, rural enterprises. Such revenue is essential in the development and maintenance of local waste treatment facilities so the local EPB has to give priority to the larger enterprises and more serious polluters, leaving small rural enterprises immune. For example, Xu (1999) found that in 1998 over 90% of Jiangsu's rural enterprises were not in compliance and only a small number of the polluting enterprises were inspected by the local environmental monitoring station (which was based in the county town). Only three of these polluters received warning notices from the station, and they were all located in the town. Factories in rural areas producing similar types but greater amounts of wastewater had never been inspected by the EPB (Xu, 1999).

4.3. Administrative constraints

Local governments' close financial links to rural industry also limit their enforcement of environmental regulations. As the Chinese economy becomes increasingly decentralised, local governments are required to carry more responsibility for environmental performance. However, rural industries are the major sector of employment of local labour and also the major financial source for local government. This is due to the fact that China's system of public finance is highly centralised. Local governments are only allowed to retain a small amount of tax income to offset expenditure, normally sufficient to provide only limited support for the basic operation of a town government. However, so-called extra-budgetary revenues are not subject to budgetary supervision by higher levels of government. These revenues can be derived from supplementary agricultural, industrial and commercial taxes. Before 1980, extra budgetary revenues were largely drawn from supplementary agricultural taxes. Following the

spread of rural industries and central government's restrictions on local supplementary taxes, such 'extras' now come mainly from local enterprises. In many parts of the coastal region, the majority of local governments' extra-budgetary revenues now come from these enterprises, which have thus become a big income generator for town governments (Song and Du, 1990). Che and Qian (1998) have shown that local governments receive direct profit from local rural enterprises. Lieberthal (1995) suggests that rural industries can account for up to 80% of the community's total revenues. In addition, town and village governments protect rural industries because they are often the guarantors for rural enterprises' loans. If the rural industries were to face economic losses because of the enforcement of environmental regulations, the town and village governments would also face economic losses.

Local governments are also integrated with the management of TVEs. Village heads, other political cadres or their relatives manage many village enterprises. Such a double role becomes problematic when local environmental staff inspect pollution control activities in these industries. Conflicts of interest make the local officials reluctant to penalise what are virtually their own enterprises for waste discharges. Bribery and corruption at small and local scales are the extreme forms of such linkages.

Many local government officials and rural enterprise managers complain that pollution abatement funds do not go to rural enterprises but to urban and state owned enterprises (Wang and Lu, 1997). Local officials are also concerned about the negative impact on the competitiveness of local products in the market if strict pollution control is imposed. They believe that forcing a marginally profitable enterprise to set up an expensive waste treatment facility would be equivalent to ordering it to shut down, since the costs would have to be transferred to its products and the rising prices of its products would force it out of the market, causing rising unemployment and falling township or village revenues. In addition, local officials would not want to force their local enterprises to set up waste treatment facilities unless their competitors in other villages and towns were forced to do the same upgrading to the same standards and at the same time. They do not want their local products to lose price competitiveness.

Therefore, the multiple roles of the village and town governments, together with the uneven implementation of environmental laws, make it difficult for local authorities to penalise enterprises for environmental pollution. It is not surprising that Chan et al. (1995) found that over a quarter of local officials responsible for administering the pollution levy in the cities of Guangzhou, Zhengzhou and Nanjing disagreed with the polluter pays principle (Chan et al., 1995). Smil's comment reflects the local officials' concern: "If you are a local official, you don't want to interrupt TVEs or burden them with environmental controls. If you do that, they will just move to the next county." (quotation from Schmidt, 2002, p. 515).

In addition, the promotion criteria for local government officials are mainly related to the economic growth rate of their locality. Environmental protection is not listed as one of the criteria except if serious environmental disasters are made public and raise concern. Such a system indirectly contributes to failure in pollution control. Many local governments become more lenient towards the polluters when they are under pressure to meet their investment goals (Zhang and Ferris, 1998).

So, the financial success of a township or village government and the social success of its officials depend on the continued economic success of its enterprises—creating strong countervailing forces against environmental regulation. An immediate consequence of this dependence of local governments on rural industry is that rural enterprise managers often resist or even scorn local environmental inspectors when they come to collect discharge fees. Some studies show the existence of local resistance to the pollution levy system (Florig et al., 1995; Wang and Lu, 1997). Since local government officials support them, rural enterprise managers tend not to treat environmental monitoring staff seriously. For example, in a study of rural enterprises in Zhejiang, Xu (1999) found that only 3.2% of rural enterprises fully complied with the environmental inspectors' orders for waste treatment, nearly two fifths ignored the order, and another 16% partially complied. Many enterprises that were issued orders simply terminated production—which is good for the environment but justifies the concerns of local officials about the impacts of environmental regulation on economic growth. The limited scale of capital investment facilitates this cut-and-run behaviour.

These conditions lead to a levy collection system with two notable characteristics. The first is collection by negotiation. The amount that the EPB finally collects is the result of a negotiation between the two sides rather than based on officially set fees. Sometimes, local government officials give instructions for the fee to be collected. However, the EPBs are typically weak agencies within the local bureaucracy, so they often end up on the losing side of such a negotiation. The second feature is collection by relationship. At the local level, the levy is often collected on the basis of personal relations between the local bureaucracy and enterprises. If EPB officials have a personal relationship with the heads of enterprises, small fees are levied. In the absence of personal ties, enterprises are charged larger fees.

However, the factors that give rise to this effect are precisely the factors that have been important in encouraging rural enterprises to grow so fast and to make such a contribution to the Chinese economy and the rural workforce. The development of the Household Responsibility System gave farmers the incentive to economise on farm labour and to find alternative sources of off-farm work. These farmers were short of capital, distributed all over the country, and (usually) lacking technical skill; their principal asset was abundant, cheap labour. Furthermore,

township and village governments themselves in the 1980s often established these enterprises and one of the reasons for their success—then, as now—was their close ties to those governments. Such enterprises as these farmers set up were bound to have the characteristics that we have identified in this section as factors leading to a gap in the implementation of pollution regulation. The growth, emergence and success of TVEs are inextricably bound up with their water polluting characteristics.

5. Institutional framework

The factors identified in the previous section only partially explain the problem of environmental enforcement. The national environmental protection system is also a significant factor. When the reform program was introduced in 1978, the central Chinese government also introduced a legal framework for environmental protection and, as mentioned above, tough punishments are stipulated in the laws for violating environmental regulations. Since 1978, many water pollution laws have been issued including the environmental protection law (1979), a water pollution prevention and control law (1984), a water resources law (1988), a water and soil conservation law (1991), an improved environmental protection law (1989), and a revised national water law that came into force in late 2002 (Jahiel, 1997; Ross, 1992; Yuan and Chen, 2005). The central government has also released a series of management guidelines, regulations, and standards for environmental protection (Environmental Protection Commission, 1986, 1987, 1990, 1991).

To facilitate the enforcement of these laws and regulations, the central government set up eight policy implementation mechanisms: environmental impact assessment, the three synchronisations (pollution controls are to be incorporated into the design, construction, and operation phases of new projects), pollutant discharge fees, the discharge permit system, the environmental responsibility system, annual assessment of urban environmental quality, centralised pollution control, and limited time treatment (Jahiel, 1997; Sinkule and Ortolano, 1995). China now has a comprehensive legal framework and a nationwide organisational structure for implementing environmental protection measures in both urban and rural areas (Jahiel, 1997).

However, the existing institutional structure is problematic. At the top level, the chief organ of water administration is the Ministry of Water Resources but the State (sometimes called National) Environmental Protection Agency (SEPA) is the main body responsible for water pollution control. SEPA and the Ministry of Water Resources are complemented in their roles by at least five other ministries which are also responsible for water use and pollution protection: agriculture, land and resources; urban and rural construction; forestry; transportation; and the State Development Planning Commission (Gu and Sheate, 2005). For example, TVEs are

regulated by the Ministry of Agriculture; urban water supply systems are the responsibility of the Ministry of Urban and Rural Construction; water is supplied by water supply corporations; while sewage and wastewater treatment is managed by the EPA.

The structure of environmental organisations in China is a grid of vertical and horizontal linkages. In the vertical hierarchy, each level of government below SEPA has an environmental bureau; and there are provincial, prefecture, municipal, county and township EPB. As subsidiaries of SEPA, these bureaus have numerous responsibilities including environmental impact assessment, monitoring, discharge fee collection, and environmental education (Sinkule and Ortolano, 1995). Other departments with sectoral environmental protection responsibilities at the same level of government manage pollution or resource issues in their respective sectors and collaborate with the EPB in environmental supervision and management. The relationship between EPBs and other government authorities is structured in vertical and horizontal dimensions (Jahiel, 1998; Sinkule and Ortolano, 1995; Mao and Zhang, 2003). An EPB belongs to two distinct government units. Vertically, a local bureau is part of the environmental protection functional line from the national level (SEPA) through provincial, municipal, and district/county EPBs and as such receives policy mandates and program direction from the upper-level EPB. Horizontally, it is also one of the departments in a local government and relies heavily on that government for financial support. The head of a local government has the authority to appoint and remove the director of the EPB within his/her jurisdiction (Gu and Sheate, 2005).

Not surprisingly, the vertical and horizontal dual institutional structure for environmental protection sometimes functions poorly. EPBs at various levels of government are still in a relatively weak position in the government political hierarchy: local EPBs or other environmental units have relatively low bureaucratic status (Jahiel, 1994). The vertical functional line does not work when a local EPB is pressured by the local government. In the horizontal bureaucratic hierarchy at the same level of government, the EPB is often challenged by other authorities with much longer histories and more powerful influence over regulatory enforcement and decision making. Furthermore, other local government departments at the same level of government (a township or village, say) cannot be *required* by an EPB at the same level to act to protect the environment: only a higher level EPB (in the county government, say) can *require* such action. This is important because the administration of TVEs falls under the jurisdiction of local agriculture departments.

Guanxi also heavily influences environmental policy implementation. Good *guanxi* between government departments is important and EPBs need to keep good *guanxi* with other government departments. In addition to levying fees on enterprises that exceed pollution discharge standards, environmental protection bodies can issue orders to

shut down enterprises that repeatedly fail to meet national standards. Closing a plant, however, requires the support of other departments, such as the planning, construction and other powerful industrial bureaus committed to economic development. Not surprisingly, these other bureaus often fail to support an EPB's decision. In addition, an EPB's cooperative *guanxi* will ensure effective monitoring of the polluting enterprises. For example, the industrial and commercial department approves industrial operation licenses and without good *guanxi* with this department, EPBs remain uninformed about such fundamental matters as where enterprises are located and what they are producing. Although, by law, all new enterprises that produce pollution should be approved by the EPB, they often are not. The reason is poor coordination and perhaps rivalry between departments.

Since the administrative structure places the local EPBs under the dual supervision of both local government and the upper level EPBs, local EPBs find it difficult to carry out their mandates. In particular, the township environment coordinators have to monitor pollution and other environmental problems at the direction of the upper-level EPBs; they have to satisfy local government officials; and they have to deal with water polluters directly. As indicated, local government officials often protect TVEs and other rural enterprises from the prescribed consequences of their pollution. The central government tries to remedy such problems by using the mass media, environmental organisations, environmental education programs, and environmental students' movements to raise public awareness of environmental issues (Hamburger, 1998).

These factors are the product of institutional design failures. Many of the current environmental orders are the result of deals between local environmental protection agencies, SEPA, other ministries, local governmental bodies and the polluting enterprises themselves. They are therefore often ineffective, and their creation is inefficient. The degree of actual compliance and enforcement depends on the region concerned and the personalities of the different players involved. However, as we will demonstrate in the following section, these weaknesses are themselves directly related to the character of the transition in China from a command to a more market-oriented economy.

6. Administrative transition

We have already claimed that the factors that underpin water pollution among TVEs are also the factors that have helped TVEs become so important: in that respect, water pollution is integral to the model of TVE growth. But Section 5 demonstrated some institutional weaknesses that prevent the complete regulation of rural industry by the state's environmental protection system. To a large degree, these weaknesses reflect the character of the transition in China.

In a political sense, transition in China has involved a decentralisation of power from the central to the local levels of government, empowering the local levels of government and permitting distinct, regional models of development to emerge (Webber et al., 2002). Local elites now have substantial flexibility to pursue economic goals for themselves and their localities. In many accounts, this local flexibility is one of the key factors that have underpinned the rapid growth of China's economy over the past quarter of a century (Whiting, 2001; Li, 2005; Horowitz and Marsh, 2002).

However, it is this same local flexibility and power that underpins the matrix government structure and which makes economic development exclude environmental considerations. The financial and other associations with local enterprises make local governments unable and unwilling to implement water pollution regulations. The case of the Huai River basin indicates that only when the SEPA director himself is personally in charge of pollution control in targeted areas do local officials have to cooperate with the national regulations. However, such an approach cannot fix the pollution problems in the far more numerous rural areas.

Local flexibility and power contributes to the water pollution problems of rural areas in another way. The clean up of cities in China has put urban enterprises under increasing pressure to modify the environmental impacts of their operations. Polluters have two options when they are targeted in this way. One is to move their operation to rural areas where the environmental regulations are less strictly enforced and environmental standards are lower. This movement has led to a large scale relocation of pollution. For example, according to Xu (1999), over 700 industrial enterprises in central Shanghai were classified as 'serious polluters' and relocated to outlying suburbs as part of a campaign to reduce pollution within the city (Wu and Wang, 2007; *China Environmental Reporter*, 1997). Some enterprises moved to rural areas in the neighbouring provinces of Jiangsu, Anhui and Zhejiang. The second option is to upgrade their production equipment to meet the environmental standard and to sell the disused equipment, often sold to rural enterprises. Xu's (1999) survey in Qinshan in Zhejiang province indicates that village enterprises are particularly frequent users of second-hand equipment from urban areas—that had been banned from cities by strict pollution discharge regulations. This, too, has led to an increase in the amount of pollutant discharge in villages.

7. Conclusion

Rural industrial growth in China has occurred almost outside central environmental management systems. Despite a variety of new laws, regulations and guidelines, implementation gaps still exist. The current water pollution control system relies on a top-down approach to monitoring, control and supervision. While this may work in cities

where industries are spatially concentrated and pollution-monitoring systems are well developed, it does not work in the rural areas where water polluting industries are dispersed in villages and have close associations with local government officials. Water pollution control regulations can be applied to rural industries only to the degree that local government officials are able and willing to implement environmental standards and exercise authority.

The problems of controlling rural water pollution derive from the same characteristics of Chinese development that have proved so successful in generating rapid economic growth. The limited capital investment, small labour forces and dispersal over the countryside that made the TVE model so adaptable to the conditions of the Chinese countryside are also the conditions that make rural enterprises so polluting and hard to monitor. The close ties to local government that have underpinned the competitive success of rural enterprises against the more sophisticated urban enterprises are also the ties that make it so difficult to enforce environmental regulations in rural areas. The power and flexibility of local governments to set their own development agendas has encouraged governments to adopt a variety of models of development suitable to their regional conditions, but has also worked to reduce the power of the central government to set uniform standards of practical regulation.

In other words, it is not possible to separate the problem of controlling rural water pollution from the model of development that the Chinese state has been following. Rural water pollution is an integral, if only implicit, effect of that model. It follows that, to control water pollution from rural industry more effectively will be to modify the model of (rural) development. It is not possible to expect to control rural water pollution simply by encouraging more effective local regulation; it is the development model that has to change. There are two obvious contending possibilities of change. One is to reverse the empowerment of local governments. This would give the central government more direct control, but would mean that local individual paths of development would probably be discouraged, and it would impose a huge monitoring task on SEPA. The other is to alter the relative salience of economic growth and environmental quality within local societies through raising environmental awareness, providing media with more freedom to report on environmental conditions, and giving citizens more voice in local government affairs. This requires the government to allow these kinds of inherently social changes, even though they may in turn modify the nature of governance in rural areas. Indeed, there have been some changes that are facilitating some such democratisation of local environmental governance, which is appropriate given that rural water pollution is primarily a product of—and impacts on—local rural societies.

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