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Environmental impact of China's village and township industry (1988—1992): a comparison with urban industry

Xu Song-ling

Centre for Environment and Development, Chinese Academy of Social Sciences, Beijing 100732, China

Abstract—This paper starts by a comparative study of economic-pollutional coefficients between China's village and township industry (VTI) and urban industry, and points out that they share a common pattern of pollution discharge growth. A computable method is then proposed for estimating VTI's pollution discharges of the objective year, based on the base-year pollution data, the production growth factor, the abating-pollution-technique-progress factor. The estimates of VTI's pollution discharges for year 1992 were worked out according to three scenarioes of selecting abating- pollution-technique progress factor, and the acceptability of results were analyzed and identified. Finally, the VTI's importance for China's environmental management were interpreted in terms of the conservative estimate of VTI's pollution discharges.

Keywords: village and township industry (VTI), economic pollution relative index, production growth factor, abating-pollution-technique-progress factor.

1 Introduction

Village and township industry (VTI) is becoming a very important component of China's economy and environment. In 1992, VTI produced nearly 40% of China's industrial output. Because industry is the most important source of environmental pollution, much attention is paid to the impacts of VTI on China's environment. The following questions have been raised in China's environmental circles: how to assess VTI's environmental impact? How to evaluate VTI's importance to China's environment? Strictly speaking, these questions are difficult to answer. The National Environmental Protection Agency of China (NEPA) has not yet established a systematic, regular and accurate data base of VTI pollutant discharges since VTI enterprises are usually small and widely scattered. Only a few of investigations of VTI pollutant sources were made before 1991. It is therefore necessary to find another way to measure VTI's environmental impact. In China, urban industry is the major object of environmental statistics. Its economic and environmental data are rather completed and standardized. This provides the possibility of using urban industry as a reference for interpreting VTI's environmental impact and assessing its environmental importance.

This study starts with introducing a method for analyzing the environmental impact of VTI sector-structure and sector-technique. The following two sections describe VTI's sector-structure environmental impact during 1988—1992 and VTI's sector-technique environmental impact of 1989 respectively. Finally an economic-environmental analysis is made of VTI for 1992 which shows VTI's importance to China's environment.

The period 1988—1992 was selected for the study because the selection is limited by the availability of data, and the period contains several different phases which are important for understanding changes in the environmental impact of VTI. Both the analysis and conclusions of this paper are drawn from an independent research report. The data used in the report come from following sources: 《Yearbook of China's environmental statistics》, 《Annual of China's environment》, 《Statistics of China's village and township industry》, and 《Annual of China's village and township industry》. All these are official publications in China.

2 The method for analyzing VTI's environmental impact

The environmental impact of China's village and township industry can be represented by VTI's total pollution discharge. The discharge dependents upon three factors: total VTI production, sector structure, and sector technical levels. The relationship between determinants of pollution originating from the VTI sectors can be logically formulated as

$$W_i^v = C^v \sum_j \alpha_j^v \cdot \gamma_{ij}^v \tag{1}$$

and

$$\Gamma_i^v = \sum_j \alpha_j^v \cdot \gamma_{ij}^v, \tag{2}$$

where, W_i^v is the discharge from VTI of pollutant i measured as a unit of weight, C^v is the total production value of VTI measured in the monetary unit "10^4 Yuan"; Γ_i^v is the VTI's economic-pollution coefficient for pollutant i which is valued by VTI's pollutant i discharge per 10^4 Yuan; α_j^v is the VTI's sector-structure coefficient for sector j valued as sector j's share in VTI's production; γ_{ij}^v is the economic-pollution coefficient for sector j and pollutant i valued as pollutant i's discharge per 10^4 Yuan of output from sector j. It is clear that C^v shows VTI's production size, α_j^v shows VTI's sector structure, γ_{ij}^v shows VTI's sector technical levels, and Γ_i^v shows the integrative effect of combining VTI's sector structure and sector technical levels.

Using the same logic, pollutant discharges of China's urban industry can also be formulated as

$$W_i^u = C^u \sum_j \alpha_j^u \cdot \gamma_{ij}^u \tag{3}$$

and

$$\Gamma_i^u = \sum_j \alpha_j^u \cdot \gamma_{ij}^u, \tag{4}$$

where u denotes China's urban industry.

For interpreting VTI's environmental impact with reference to urban industry, a set of pollution indexes can be constructed as follows: VTI's pollution index relative to urban industry for pollutant i, termed $A_i^{v/u}$; VTI's sector-structure pollution index relative to urban industry for pollutant i, termed $S_i^{v/u}$; VTI's sector-technique pollution index relative to urban industry for pollutant i, termed $T_i^{v/u}$; VTI's economic-pollution-coefficient index relative to urban industry for pollutant i, termed $\Omega_i^{v/u}$; VTI's production-size index relative to urban industry, termed $D^{v/u}$.

Using equations (1)—(4), $\Lambda_i^{v/u}$, $\Omega_i^{v/u}$ and $D^{v/u}$ can be shown respectively as

$$\Lambda_i^{v/u} = W_i^v / W_i^u, \tag{5}$$

$$\Omega_i^{v/u} = \Gamma_i^v / \Gamma_i^u \tag{6}$$

and

$$D^{v/u} = C^v / C^u. \tag{7}$$

The formulation of $S_i^{v/u}$ and $T_i^{v/u}$ must need satisfy certain conditions.

As $S_i^{v/u}$ is related to both the production and pollutant i discharges of all sectors, a condition for valuing $S_i^{v/u}$ needs to be made in order to capture the sector-structure different between VTI and urban industry rather than the sector-technique difference. It can be assumed that VTI's technical level is equivalent to that of urban industry. That is to say, $\gamma_{ij}^v = \gamma_{ij}^u$. Thus $S_i^{v/u}$ can be represented as:

$$S_i^{v/u} = (\sum_j \alpha_j^v \cdot \gamma_{ij}^u)/(\sum_j \alpha_j^u \cdot \gamma_{ij}^u) \tag{8}$$

or

$$S_i^{v/u} = (\sum_j \alpha_j^v \cdot \gamma_{ij}^v)/(\sum_j \alpha_j^u \cdot \gamma_{ij}^v) \ . \tag{8'}$$

A difference actually exists between Equation (8) and Equation (8') because γ_{ij}^v is not really equal to γ_{ij}^u. Nevertheless Equation(8) is selected here since urban industry is used as a reference in the study.

It is usually difficult to calculate $T_i^{v/u}$ directly. However, $\Omega_i^{v/u}$ can logically be represented as

$$\Omega_i^{v/u} = S_i^{v/u} \cdot T_i^{v/u}. \tag{9}$$

If γ_{ij}^v and γ_{ij}^u are known, then $\Omega_i^{v/u}$ can be calculated using Equation(2), (4) and (6), and $T_i^{v/u}$ is also computable in terms of Equation(9).

Now the relationship between $\Lambda_i^{v/u}$, $D_i^{v/u}$, $S_i^{v/u}$ and $T_i^{v/u}$ can be represented as

$$\Lambda_i^{v/u} = D_i^{v/u} \cdot S_i^{v/u} \cdot T_i^{v/u}. \tag{10}$$

It can be seen from Equation (10) that VTI's pollution index is the product of VTI's production index, sector-structure index and sector-technique index. In the sections below, $S_i^{v/u}$ is used to measure VTI's sector-structure environmental impact and its changes during 1988—1992, and $T_i^{v/u}$ measures VTI's sector-technique environmental impact in 1989.

3 VTI's sector-structure environmental impact

In the study of VTI's sector-structure environmental impact, the economic and environmental data of China's urban industry are adopted from《Yearbook of China's environmental statistics》(1988, 1989, 1990 and 1991) and 《Annual of China environment》(1992), both of which were compiled by National Environmental Protection Agency and The VTI's economic data drawn from 《Statistics of China's village & township enterprises》(1988, 1989, 1990, 1991 and 1992) and《Annual of China's village & township enterprises》(1988, 1989, 1990, 1991 and 1992), both of which were compiled by the Department of Village & Township Enterprises, Ministry of Agriculture.

What needs to be an addressed at first is the different coverage of urban industry for the two periods (1988—1990 and 1991—1992) that appear in NEPA publications. For 1988—1990, the environmental statistics for urban industry are represented by 82 cities of China. For 1991—1992, urban industry includes county-managed industry and above. The difference should be considered carefully for the purpose of interpreting $S_i^{v/u}$.

To describe VTI's sector-structure environmental impact, 20 sectors are classified. They are mining, tap water supplying, food, beverage and tobacco making texture, sewing, leather and fur products, wood and bamboo products, furniture, paper-making and paper products, printing, handicrafts, electricity and heating, petroleum treating, cocking and gas, chemical products, building materials, metalling, metal products, machinery and electrical equipment, and miscellaneous. The classification is for stressing pollutional-type sectors.

The study covers 5 kinds of pollution. They are waste water (WW), sulfur dioxide(SO_2), smoking dust(SD), non-smoking dust (NSD) and solid waste(SW). These are the standard catalogues of China's environmental statistics.

Based on Equation(6), $S_i^{v/u}$ can be calculated for different pollutants for the years 1989—1992 from which the average $S_i^{v/u}$, termed $\bar{S}_i^{v/u}$, for periods of 1988—1990 and 1991—1992 can also be computed. The results are shown in Table 1.

Table 1 The index of VTI sector-structure environmental impact relative to urban industry: $S_i^{v/u}$ for 1988—1992

Item	1988	1989	1990	1988—1990 average	1991	1992	1991—1992 average
WW	0.897	0.946	0.875	0.906	0.799	0.818	0.81
SO_2	0.974	0.923	0.880	0.926	0.706	0.737	0.721
SD	0.943	0.972	0.905	0.938	0.731	0.750	0.740
NSD	2.94	3.13	2.80	2.96	2.37	2.20	2.28
SW	1.07	1.29	1.20	1.19	0.775	0.905	0.840

Now we can analyze the following two aspects of VTI's sector-structure environmental impact: (1) characteristics of VTI's sector-structure environmental impact relative to urban industry, and (2) changes in VTI's sector-structure environmental impact from 1988 to 1992.

3.1 Characteristics of VTI sector-structure environmental impact

According to Table 1, measures of $S_i^{v/u}$ for 1988—1990 and 1991—1992 showed that: (1) During 1988—1990, VTI's sector-structure emissions of NSD and SW are higher than that of urban industry since $\bar{S}_{NSD}{}^{v/u}=2.9$ and $\bar{S}_{SW}{}^{v/u}=1.2$, and those of WW, SO_2, and SD are slightly lower than the comparable levels for urban industry as shown by $\bar{S}_i^{v/u}=0.90$, 0.93 and 0.92, respectively. (2) During 1991—1992, VTI's sector-structure emission of NSD is much higher than that of urban industry since $\bar{S}_{NSD}{}^{v/u}=2.3$, and those in WW, SO_2, SD and SW are lower than the comparable levels for urban industry as these are 0.81, 0.72, 0.74 and 0.84, respectively.

One sees a common tendency for $\bar{S}_i^{v/u}$ for 1988—1989 to be consistently larger than for 1991—1992. This result, however, comes from the different coverage of urban industry between 1988—1990 and 1991—1992 by China's environmental statistics. The difference of $\bar{S}_i^{v/u}$ between the two periods can not be used to show an improvement of VTI's sector-structure environmental impact during this time. It really shows that the sector-structure environmental impact of county-managed industry is more serious than that of city-managed industry.

Now it can be tentatively concluded that during 1988—1992, VTI's sector-structure emission of NSD is much higher than urban industry, that of SW is similar to urban industry, and the emissions of WW, SO_2 and SD are lower than urban industry.

It is easy to understand the above conclusions in terms of major pollutant-type sectors of VTI and urban industry. For WW, the main sources of urban industry are the chemistry sector and metallurgical sector whose contribution to WW is about 40% of total urban industry WW. But these two sectors for VTI are small; their production share is only about 0.35 of that of urban industry. For SO_2 and SD, the main contributions within urban industry are the electricity and heating sectors, whose combined contribution is over 40% of these pollution emissions in urban industry. But the sector in VTI is rather smaller and its production share is only about 0.11 of that of urban industry. For NSD, the major source is the building materials sector, which contributes 60% of the total NSD discharge of urban industry. The sector in VTI is much bigger; its production share is 4.1 times of that of urban industry. For SW, the sources included sectors of mining, metalling, electricity and heating, chemical products, and building materials. The sum of their production shares is about equivalent in VTI and urban industry.

3.2 The change of VTI's sector-structure environmental impact during 1988—1992

Table 1 also shows a series of changes of $S_i^{v/u}$ during 1988—1992(Fig.1) which are of considerable significance to understand VTI's sector-structure environmental impact.

During 1988—1989 and with the exception of SO_2, $S_i^{v/u}$ rises. During 1989—1990, $S_i^{v/u}$ falls.

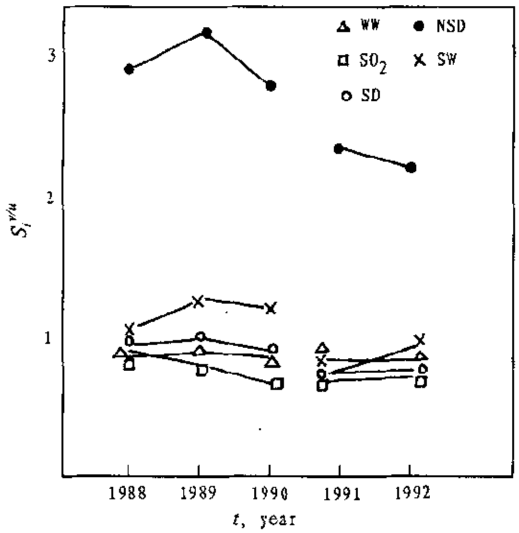

Fig. 1 The changes of VTI's sector-structure pollution index $S_i^{v/u}$ during 1988—1992

During 1991—1992 and with the exception of NSD, $S_i^{v/u}$ rises again. Because the economic and environmental data for urban industry published by NEPA confirm that the sector-structure emissions of urban industry are, by and large, stable during 1988—1992, changes in the $S_i^{v/u}$ coefficients actually reveal that VTI's sector-structure emissions are rising during 1988—1989, falling during 1989—1990, and again rising during 1991—1992.

Changes in VTI's sector-structure emissions during 1988—1992 are generally consistent with changes in policies of VTI management. Before 1989, VTI development was generally uncontrolled. During 1989—1991, a policy was advanced to regulate VTI structure, especially to limit the development of high pollution sectors. After 1991, the growth of the VTI sectors has been accelerating.

The interrelationship between changes in the $S_i^{v/u}$ coefficient and in VTI policies can be further investigated with a comparison of the development of key pollution sector within VTI urban industry during 1988—1992. Key pollution sectors include mining, food and beverage making, dyeing, paper-making, coking, chemical products, building materials, smelting, electricity and heating. Two kids of parameters first need to be calculated: (1) overall economic growth rates of VTI and urban industry in different periods, terms G^v and G^u; (2) economic growth rates of key pollution sectors for VTI and urban industry correspond to different periods, termed g^v and g^u. Thus an index, called the growth index of VTI's key pollution sector shares relative to urban industry, term $R^{v/u}$, can be formulated as

$$R^{v/u} = (g^v/G^v)/(g^u/G^u). \tag{11}$$

The $R^{v/u}$ of 1988—1989, 1989—1990 and 1991—1992 are calculated and shown in Table 2.

Table 2 Growth index of pollutional sector shares of VTI production relative to urban industry $R^{v/u}$ for 1988—1989, 1989—1990 and 1991—1992

	Year					
	1988—1989		1989—1990		1991—1992	
Items	VTI	Urban industry	VTI	Urban industry	VTI	Urban industry
g, %	14.6	6.2	12.8	4.2	47.2	9.7
G, %	14.0	9.9	13.5	3.9	51.4	14.4
$R^{v/u}$	1.67		0.88		1.34	

It is clear that the inter-temporal changes of $R^{v/u}$ are consistent with those of $S_i^{v/u}$s. The following conclusions can be drawn: (1) the VTI's sector-structure environmental impact mainly depends on the comparative growth of its key pollution sectors; (2) VTI's sector-structure environmental impact is greatly affected by government policies on VTI management, especially on VTI environmental issues; (3) since 1992 VTI has been growing comparatively rapidly, causing VTI's sector-structure environmental impact to become worse. This tendency may continue for a long term. The reasons are that: high polluting sectors will continuously be transferred from foreign countries and China's cities into townships and villages to reduce environmental costs in these more advanced regions; during its preliminary phase, VTI has to start by developing resource-based and environmental-based sectors which usually include little technical content and mainly rely on local resource and environmental carrying capacity. The tendency towards increasing pollution will not be subside until these two conditions are altered.

4 VTI's sector-technique environmental impact

VTI's technical level is another key factor affecting VTI's environmental impact. It is not behind the technical level of urban industry. The difference between them is real and usual.

VTI's technical level includes two aspects: technologies and equipments for production, which affect pollutant forming, and technologies and equipments for pollutant control, which affect pollution discharge.

It is an accepted fact that in both of these respects the technical levels of VTI are lower than those of urban industry. To describe the impact of VTI's technical level on VTI's pollution emission, VTI's sector-technique pollution coefficient, namely $T_i^{v/u}$, needs to be quantified and analyzed. Furthermore to understand VTI's impacts on waste water, a number of water pollutants and relevant sector-technique environmental impact should be considered since the pollution of waste water actually depends on its concentrations of water pollutants. Water pollutants covered in the study include COD, heavy metals (HM), cyanogen compounds (CC) and volatile phenol (VP). Quantification and analysis of $T_i^{v/u}$ are based on the data of 1989. For this year NEPA organized a country-wide investigation of major pollutant sources of VTI. The study provides the necessary data for VTI's pollutant discharges.

Due to limited data availability, the quantification and analysis of $T_i^{v/u}$ have to be confined to key pollution sectors. This approach is still reasonable and acceptable since the environmental impact of an industrial system depends fundamentally on its key pollution sectors.

The $T_i^{v/u}$ coefficient of 1989 can be calculated following Equation (9). The results are shown in Table 3.

Based on Table 3, a number of findings can be made: (1) except for WW, the $T_i^{v/u}$ shows that VTI sector-technique emissions are generally higher than those for urban industry. Considering that water quality depends mainly on water pollutants, we can conclude that VTI's sector-technique emissions of WW is actually much higher than that of urban industry; (2) comparing $T_i^{v/u}$ to $S_i^{v/u}$, we find that except for WW and NSD, $T_i^{v/u} > S_i^{v/u}$. This shows that the VTI's environmental impact depends more on VTI's technical levels than on VTI's sector structure; (3) $\Omega_i^{v/u}$ represents the integrative impacts of sector structure and sector techniques. Since the $\Omega_i^{v/u} > 1$, VTI's economic-pollution coefficients are higher than those of urban industry.

Table 3 The index of VTI's economic-pollution coefficients relative to urban industry and the index of VTI's sector-technique pollution relative to urban industry: $\Gamma_i^{v/u}$, $T_i^{v/u}$ for 1989

	Pollutants								
Index	WW	COD*	HM*	CC*	VP*	SO_2	SD	NSD	SW
$\Omega_i^{v/u}$	0.568	1.776	3.517	1.146	5.776	1.469	2.574	4.464	9.611
$S_i^{v/u}$			0.897			0.974	0.943	2.94	1.07
$T_i^{v/u}$	0.630	1.877	3.718	3.211	6.106	1.508	2.620	1.520	8.982

* Lacking the data of 82 cities, the calculations of relevant $\Gamma_i^{v/u}$, $T_i^{v/u}$ and $S_i^{v/u}$ are based on the following two assumptions: (1) the 82-city share of China's pollutant discharges is equal to its WW share; (2) the coefficient $S_i^{v/u}$ for water pollutant is equal to $S_i^{v/u}$ for WW.

The discussion of VTI's sector-technique environmental impact can be further extended in accord with a generalized understanding of the technique concept. The "technique" can be understood to contain two aspects: the "hard" and the "soft". The former is that discussed above. The later is relates to management issues. Table 4 presents the relevant parameters which characterize environmental management levels of VTI and urban industry.

Table 4 Environmental-management-quality indicators of VTI and urban industry: a comparison (1989)

	VTI[1]	Urban[2] industry	Ratio of VTI to urban industry
Ratio of standard-reached WW discharge	14.8	54.8	0.27
Ratio of WW processing	7.99	29.6	0.27
Ratio of WW-processed-and-standard reached discharge	16.3	67.6	0.24
Ratio of waste gas processing	21.0	69.6	0.30
Ratio of NSD recycling	20.6	29.6	0.26
Ratio of SW discharging	33.6	6.02	5.58

1. Data from Annual of China environment (1991); 2. data from Yearbook of China's environmental statistics (1989)

It is clear from Table 4 that the parameters of VTI, showing positive effects of environmental management, e. g. pollution-treatment ratio, standard-maintained ratio, NSD recycling ratio, *etc*. are about 1/3 the levels of urban industry. The policy "three measures must be taken simultaneously" implementation ratio for VTI of 14.5%, is only 1/6 that of urban industry (about 90%). However, the VTI parameter, showing the negative effects on environmental management, namely SW discharging ratio, is 5.58 times of that of urban industry. It is obvious that the difference in management levels between VTI and urban industry is also one of the most important reasons for a high VTI's sector-technique environmental impact.

5 VTI's environmental impact of 1992 and its economic-environmental implications

5.1 VTI pollutant discharges of 1992: an estimate

For estimating VTI pollutant discharging in 1992, Equation(1) needs to be revised. The year 1989 is selected as the base year since the discharges from the key pollution sectors of VTI are known based on NEPA's investigation. The 1992 is the year for which we wish to calculate the discharges. Firstly, Equation (1) should be revised as

$$W_i^{v,o} = C^{v,o}\alpha_j^{v,o}\gamma_{ij}^{v,o}, \tag{12}$$

where o denotes the objective year, namely 1992. In Equation (12), $C^{v,o}$ is knowns, $\alpha_j^{v,o}$ is computable. The critic coefficient for computing $w_i^{v,o}$ is $r_{ij}^{v,o}$. The relationship between $\gamma_{ij}^{v,b}$ in 1989 and $\gamma_{ij}^{v,o/B}$ in 1992 can be shown as

$$\gamma_{ij}^{v,o} = \alpha_{ij}^{v,o/B}\gamma_{ij}^{v,B}, \tag{13}$$

where $\alpha_{ij}^{v,o/B}$ denotes a coefficient of pollution-reducing technical progress for sector j and pollutant i during 1989—1992. Theoretically there are four possibilities for the value of $\alpha_{ij}^{v,o/B}$. (1) $\alpha_{ij}^{v,o/B}>1$. This means that technical regress occurred in VTI during 1989—1992; (2) $\alpha_{ij}^{v,o/B}=1$. This means that no technical progress occurred in VTI during 1989—1992; (3) $\alpha_{ij}^{v,o/B}=0$. This means that a non-pollution production technique appeared in VTI during 1992; (4) $0<\alpha_{ij}^{v,o/B}<1$. This means that a certain technical progress occurred in VTI during 1989—1992.

Obviously possibilities (1) and (3) are not real. Possibilities (2) and (4) are worth considering. A problem involving possibility (4) concerns: how to quantify it? To do this we refer the urban industry. Following Equation(13) $\alpha_{ij}^{u,o/B}$ can be calculated since $\gamma_{ij}^{u,o}$ and $\gamma_{ij}^{u,B}$ are known based on data from NEPA publications.

Coefficients $\alpha_{ij}^{u,o/B}$ and $\alpha_{ij}^{v,o/B}$ can be valued as $\alpha_{ij}^{u,o/B} = \gamma_{ij}^{u,o}/\gamma_{ij}^{u,B}$ and $\alpha_{ij}^{v,o/B} = \alpha_{ij}^{u,o/B}$. This means that VTI's technical progress is equivalent to urban industry during 1989—1992 or $\alpha_{ij}^{v,o/B} = (1+\alpha_{ij}^{u,o/B})/2$. This means that VTI's technical progress is equivalent to one half the progress of urban industry.

Three scenarios for quantifying $\alpha_{ij}^{v,o/B}$ can be proposed for estimating VTI's pollution discharges of the year 1992. Those are $\alpha_{ij}^{v,o/B}=1$, $\alpha_{ij}^{v,o/B} = \alpha_{ij}^{u,o/B}$ and $\alpha_{ij}^{v,o/B}=(1+\alpha_{ij}^{u,o/B})/2$. Table 5 presents different estimates of VTI's discharges in 1992 in terms of each of these three scenarios.

Table 5 VTI's pollution discharges in 1992: estimates

Scenario	Pollutants								
	WW, 10^8t/a	COD, 10^4t/a	HM, t/a	CC, t/a	VP, t/a	SO_2, 10^4t/a	SD, 10^4t/a	NSD 10^4t/a	SW, 10^4t/a
I	36.53	287.58	2414.0	1739.6	12542.0	353.96	533.12	567.50	7100
II	31.60	233.34	1849.6	1289.9	10282.0	291.87	410.43	482.9	6421
III	26.67	179.10	1285.3	840.3	8021.9	229.78	287.74	397.88	5800

It is necessary to evaluate the potential range of errors for the estimates. Error may result from two sources. One is the data for VTI's pollution discharges in 1989. These will usually be less than the real amount, and lead to a "conservative" estimate of $\gamma_{ij}^{v,B}$. The other potential source of error is changed in VTI's sector structure, product structure or technology structure during 1989—1992. Following some transfer of key pollution production from urban industry into VTI, these factors will increase VTI's emissions. They are, however, not fully included in the present consideration of $\alpha_{ij}^{v,o/B}$. For these two reasons, $\alpha_{ij}^{v,o/B}$ will be under-estimated.

Now the plausibility of these three estimates can be assessed. The estimate of scenario I may be reasonable since an over-estimate resulting from the "no-technical-progress" hypothesis may be compensated by an under-estimate of $\gamma_{ij}^{v,B}$. The estimate of scenario II seems to be ideal. The estimate of scenario III is unacceptable since it is still based an over-estimate of VTI's technical progress.

5.2 The environmental-economic implications of VTI's discharges in 1992

The environmental-economic implications of VTI's discharges in 1992 can be conservatively estimated in terms of scenario II. First, two sorts of indicators need to be introduced for the interpretation. One is VTI's environmental and economic shares of China's total pollution discharges and industrial production, which can be valued by

VTI share = (VTI value) /(VTI value + urban-industry value).
The other indicator is the growth rate of VTI shares (1992—1989), which can be calculated as
VTI growth rate = (VTI share of 1992)/(VTI share of 1989) .
The calculation for both of indicators are shown in Table 6.

Table 6 Indicators of showing VTI's economic and environmental implications in China's industry:1992

Industrial production	Pollution discharges								
	WW	COD	HM	CC	VP	SO_2	SD	NSD	SW
1. VTI economic and environmental shares of China's economy and environment, %									
34.24	11.90	24.61	56.66	27.02	61.78	18.08	32.04	45.84	71.28
2. Growth ratio of VTI's economic and environmental shares during 1989—1992									
1.47	1.895	1.570	1.690	2.015	2.068	1.663	2.140	2.078	2.402

It is very clear from Table 6 that in 1992 and among 9 types of pollutants, VTI's environmental shares for HM, VP, NSD and SW exceeded VTI's economic share(34.24%), VTI's environmental share for SD(32.04%) is equivalent to VTI's economic share, and the remaining VTI environmental shares for WW, COD, and SO_2 are less than VTI's economic share. The average of VTI's environmental shares is higher than VTI's economic share. Furthermore, among the VTI's environmental shares that exceed VTI's economic share, there are three types for which the discharges are larger than those of urban industry and represent the major sources of China's total discharges. It can be concluded from the above analyses that VTI has a major impact on China's environment, similar to urban industry.

It is also clear from Table 6 that VTI's environmental and economic shares rise during 1989—1992. However, what needs to be emphasized is the fact that the growth rates of VTI's environmental shares are generally larger than those of VTI economic share(1.47). The average of the former is 1.95, about 1.32 times that of the later. This shows that the growth of VTI's emissions exceed that of VTI's production, and is rather high. It is not the quality of development that China seeks.

6 Summary

VTI's sector-structure environmental impact is at present not higher than that of urban industry, but it is increasingly rising as VTI growth.

VTI's sector-technique environmental impact is obviously higher than that of urban industry. The impact of VTI's technical levels on the environment is larger than that of VTI's sector structure. This becomes the most important factor through which VTI impacts on the environment.

Both urban industry and VTI are becoming two major sources of environmental pollution in China. It can be predicted that VTI's environmental impact will increase since the growth rate of its environmental share is greater than that of its economic share.

VTI is the most dynamic part of China's economy. What usually draws attention is its economic benefits, not its explicit and implicit environmental impacts. It may be the major reason why China's "point" (e.g. cities) environmental quality is being improved but "area" (region, river basin etc.) environmental quality is being degraded. VTI's environmental management is still a "blind area" in China. This should not continue. Undoubtly, much attention should be paid to VTI, more than to urban industry. The faster the better.

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