The Roles of Community Pressure in Ecologizing Industrial Production: Evidence from Jiangsu Province's Petrochemical Industry

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Abstract: Jiangsu's petrochemical industry has undergone a fast development with an average increased rate of 9 percent. Accompanying with the rapid economic development, some 'ecologizing' changes have also occurred within the industry. Among a variety of factors that may bring in these changes, community pressure is playing a significant role. By using a set of well-documented sector-level data and community-level data from 1996 to 2001 of Jiangsu Province and its petrochemical industry, this paper tries to give some evidences for the significant role of community pressure on the 'ecologizing' process in Jiangsu's petrochemical industry.

Key words: ecologizing; community; Jiangsu Province; petrochemical industry

1. Introduction

The ecological modernization theory has identified two central projects that constitute the heart of the ecological transformation or the ecological restructuring of processes of production and consumption (Mol, 1995). One is 'ecologization of the economy' and the other is 'economization of the ecology'. The former suggests that improving environmental quality hinges on the development, innovation and diffusion of new key technologies:

> "Technological systems in which the environmental cannot be safeguarded should be either restructured or replaced by more environmentally sound ones which fulfill – inasmuch as is ecologically possible – similar functions."

Since 1980s, Jiangsu Province has been undergoing a rapid economic development with an average rate of 12.6%. In the year of 2001, it achieved 951.2 billion Yuan[1] of GDP, which has 2.9 centesimal points above the national average level (Jiangsu Province Statistical Yearbook, 2002). During these years the petrochemical industry has become one of Jiangsu's pillar industries with its great contributions to the province's economy.

From the facts collected in Jiangsu Province and the industry, we can safely assert that, behind the fast development of Jiangsu's petrochemical industry, there is obvious sign to indicate that ecologizing changes have begun to occur. These changes may be brought in

[1] One Chinese Yuan is close to 8.2 US dollar.

by a variety of factors such as the changing role of state, market and others. This paper tries to provide empirical evidences for the effect of community pressure on the environmental improvement or the 'ecologizing' process in Jiangsu's petrochemical industry. The results show that the changing community characters and community pressure are close correlative with these ecologizing changes.

2. The Development of Jiangsu' Petrochemical Industry (1996-2001)

Due to its special geographic advantage[2], the petrochemical industry is one of pillar industries of Jiangsu's industrial economy. These years Jiangsu's petrochemical industry has undergone a fast development with an average increased rate of 9 percent (Jiangsu Economy and Trade Committee, 2002). In 2001, this sector achieved total industrial production value of 173.1 billion Yuan.

This section tries to depict a picture of the petrochemical industry in resource use and pollution discharge. First, the status and changes in resource use and pollution discharge of the industry from 1996 to 2001 are evaluated (2.1). Then the subsection 2.2 analyzes pollution abatement and environmental investment of the industry.

2.1 Resource Use and Pollution

Table 1 and 2 summarize the amount of water use, energy consumption and industrial wastewater, waste gas, waste solid as well as the main pollutants produced in Jiangsu's petrochemical industry from the year of 1996 to 2001. Combined with the data of the industrial production value of relevant year, the resource use intensity and pollution intensity for each year are also calculated (Table 3 shows the case of the year of 2001). Figure 1 and 2 show the changes in water use, energy consumption and pollution produced intensity of Jiangsu's petrochemical industry from the year of 1996 to 2001.

From the figures, it can be observed that both the resource (water, energy) use and main pollutants (e.g. COD, SO_2) produced intensity have been decreasing to some extent (because of technological innovation, management enhanced, and so on). However, the resource use and pollution produced are still keeping in a certain level. Therefore, with the increasing of production value of the petrochemical industry, the burden on resource and environment is also accordingly increasing, which can get evidence from the increasing amount of resource use and pollution produced in the petrochemical industry.

Based on such facts, it can be judged that, although the intensity of resource use and pollution produced has a certain decrease, on the whole, the production mode itself of Jiangsu's petrochemical industry is rather a linear mode, which is characterized by 'high input and high output'.

[2] Jiangsu province is located in the south of China. It possesses more than 1,100 kilometers watercourse of Yangzi River, which provides geographic opportunities for the development of petrochemical industry. These years Jiangsu Province has witnessed that the industrial economy is increasingly gathering along the Yangzi River.

During the 1990s, the production value of Jiangsu's petrochemical industry has been increasing with an average rate of 9.4%. However, because of the resource use and pollution produced level as just analyzed, the consumption of resource and the 'production' of to pollution are also increasing nearly with the same rate. This case brings massive pressure to this industry's, even to Jiangsu's, sustainable development. On one hand, Jiangsu is rather lack of all kinds of natural resource and most of its production raw materials depend on import from other province or abroad; one the other hand, this kind of production mode (i.e., 'high input and high out put') demands more and more resource for fast economic development, as a result, the production brings in larger and larger environmental impact. So carrying out environmental protection and improving plants' environmental performances are the large challenge that the petrochemical industry has to confront when the industry seeks to sustaining fast development.

Table 1: *The data of water use and energy consumption of Jiangsu's petrochemical industry (1996~2001)*

	The number of plants in account	Industrial production value (10^4 Yuan)	Industrial water use (10^4 ton)	Coal consumption (10^4 ton)	Fuel oil consumption (10^4 ton)
1996	376	3415563.2	274436.04	764.08	49.53
1997	917	5202237.7	309141.24	852.74	49.99
1998	938	4844074.7	282627.00	785.15	48.63
1999	984	5432243.1	311146.58	797.17	49.93
2000	953	8469538.9	312203.30	768.38	56.07
2001	975	7133330.8	397092.59	894.33	53.14

Data source: *Jiangsu province environmental statistical reports* (1996~2001).

Table 2: *The status of pollution produced and discharge of Jiangsu's petrochemical industry (1996~2001)*

	Wastewater (10^4 ton)	COD Produced[3] (ton)	Waste gas (10^4 m^3)	SO_2 Produced (ton)	Waste solid (10^4 ton)
1996	80028.68	128264.53	9505502	181096.44	430.76
1997	76498.91	213758.63	12549346	185654.76	470.01
1998	70416.17	180694.28	9421108	178201.00	411.80
1999	72654.04	187400.37	9716211	153727.38	408.12
2000	71168.06	180433.05	9625672	154457.80	352.43
2001	85709.52	435344.95	12127954	176340.74	458.08

Data source: also from Jiangsu Province environmental statistical reports (1996~2001). The amount of 'produced' is attained by the amount of 'discharge' plus 'removed'.

[3] In this paper, the term 'COD produced' is employed, rather than 'COD discharge'. Here 'COD produced' is defined as 'COD discharge' plus 'COD removed'. Compared to discharge, COD produced can reflect more about the status of the production system itself. Therefore, more or less, it can show the ecological efficiency of a plant's production mode. In this sense, we cannot determine that a plant with low COD discharge is very environmentally efficient in production, because the low COD discharge can attain through many other ways such as end-of-pipe treatment facilities. With the same reason, 'SO_2 produced' is used.

Table 3: *The resource use and pollution produced intensity of Jiangsu's petrochemical industry in the year of 2001*

Resource Use intensity		Pollution produced	
Water use intensity (ton/10^4Yuan)	556.7	Waste water discharge intensity (ton/10^4Yuan)	120.2
Coal consumption intensity (kg/10^4 Yuan)	1253.7	COD produced intensity (kg/10^4 Yuan)	21.0
Fuel oil consumption (kg/10^4 Yuan)	74.5	Waste gas discharge intensity (10^4 m^3/ 10^4 Yuan)	1.7
		SO_2 produced intensity (kg/10^4 Yuan)	26.7
		Waste solid produced intensity (kg/10^4 Yuan)	642.2

Data source: the data of 'intensity' is calculated by the amount of resource use and pollution produced divided by the data of industrial production value of the relevant year.

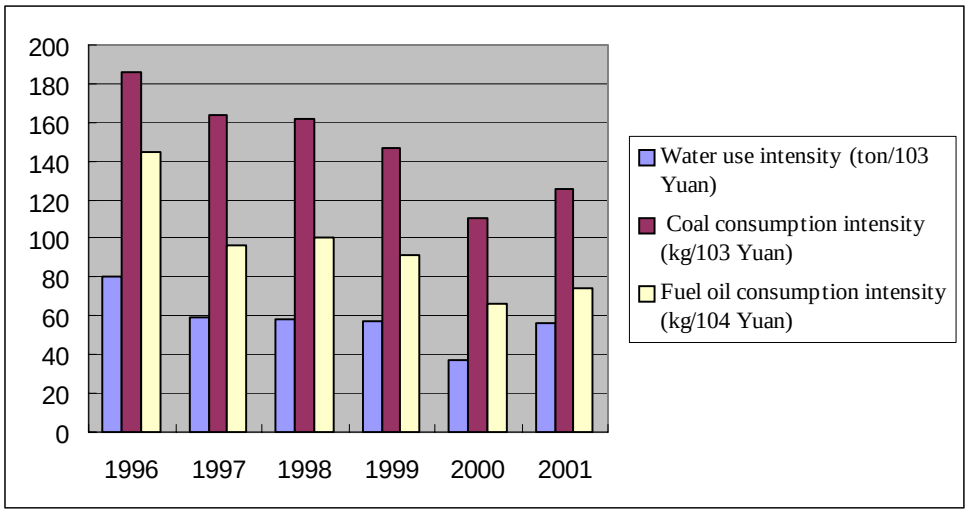

Figure 1: *The changes in water use, energy consumption intensity of Jiangsu's petrochemical industry from the year of 1996 to 2001*

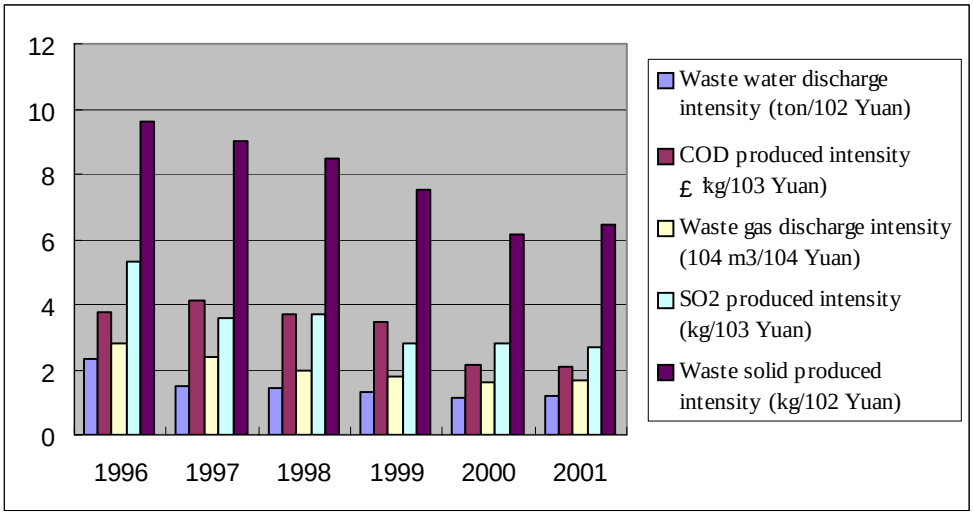

Figure 2: *The changes in wastewater discharge, waste gas discharge, waste solid produced and main pollutants produced intensity of Jiangsu's petrochemical industry from the year of 1996 to 2001*

2.2 Pollution Control and Environmental Investment

Facing the threat mentioned above, these years Jiangsu's petrochemical industry continuously enhances the ability to solve environmental problems as well as increases the environmental investment.

Jiangsu's petrochemical industry encourages foreign investment. Up to 2001, it has absorbed nearly 4 billion US dollar foreign investment including more than 70 large cooperative projects with over 10 million US dollar. These foreign investment and projects to a large degree promotes the technologies' constructing and even the industry's restructuring. Besides the foreign investment, Jiangsu's petrochemical industry itself is also addressed in technological innovation and improvement with much fund. For instance, in the year of 2001 Jinling Petrochemical Corporation and Yangzi Petrochemical Corporation4 spent 5.46 billion Yuan on new technological improvement projects. (Jiangsu ETC[5], 2000)

These investments on technological improvement including foreign and domestic enhance the production efficiency to some extent. Besides these, it also lays emphases on pollution control with end-of-pipe treatment. The year of 1996 to 2001 saw a gradually increasing of the removal efficiency of COD and SO2. Figure 3 shows such increasing trend. Especially the COD removal efficiency increases drastically from these years and in 2001 nearly 82% COD in wastewater was removed. These efforts have played a great role in reducing the environmental impact.

[4] Both these two corporations are the sub-company of SINOPEC.
[5] In this paper, the 'ETC' is abbreviation for the Economic and Trade Commission; and 'EPB' is for the Environmental Protection Bureau.

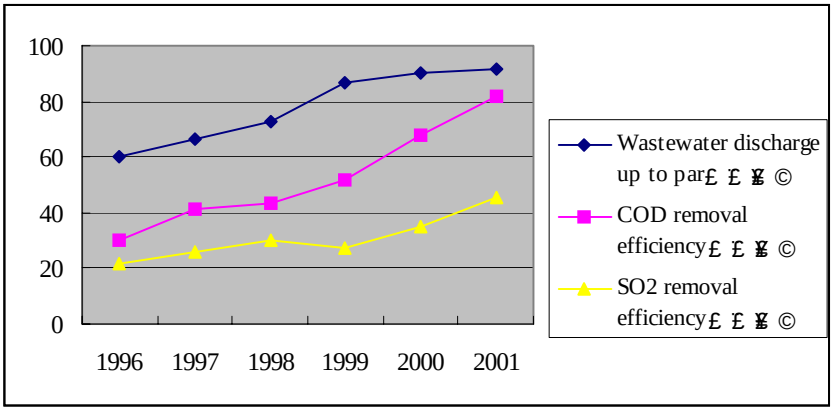

Figure 3: *The changes in main pollutants removal efficiency of Jiangsu's petrochemical industry from 1996 to 2001*

At the same time, the financial inputs for pollution treatment are also correspondingly increasing these years. Compared with 1996, just for the maintenance and run of the environmental facilities, the fees increased nearly 120% (Figure 4).

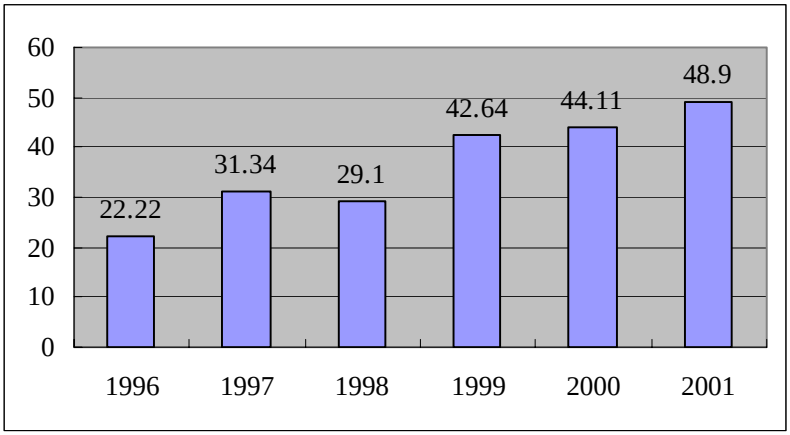

Figure 4: *The fees for maintenance and run of environmental facilities of Jiangsu's petrochemical industry from 1996 to 2001 (Unit: million Yuan)*

Data Source: Jiangsu EPB, 2002. *Reports on environmental quality*.

As analyzed above, we can conclude that, although the mode of production in Jiangsu's petrochemical industry is still holding a 'linear' style with pretty high resource use and pollution produced intensity, changes have also occurred from production itself to pollution control. This kind of trend will lead to an ecological way for the future development of the industry.

Undoubtedly, these changes are caused by various factors. Mol (1995) has summarized and analyzed the role of state and market in these radical changes in environmental protection. In Jiangsu Province, the industrial policies and environmental policies on the national and provincial level have been playing a vital role in this kind of trend. In these years, over 100 petrochemical enterprises have carried out cleaner production

demonstration according to the claims of Jiangsu Province [6]. In 2002-2003, 52 petrochemical enterprises out of 262 demonstrated enterprises are carrying out cleaner production projects. Seeking to more profits in the market is another important factor for these changes. Only by continuously improving management and technology level, the enterprises can increasingly enhance the production efficiency.

Among these factors, the pressure from society, especially from communities, is also a significant one. Behind these changes on environmental performance in the petrochemical industry, the characters of communities of Jiangsu Province are also undergoing many changes these years. During these years, community incomes have risen rapidly, and literacy rates have also continued to improve. Communities with more resources and greater interest in environmental protection consequently increase pressure for industrial pollution abatement. This can get support from the analysis of the data on the community level in section 3.

3. Community-level Data Analysis

During the era of Chinese economic reform beginning from the late 1970s, incomes of Jiangsu's residents have risen continuously. Figure 5 has given a picture of the incomes increasing trend from 1996 to 2001. During these 6 years, incomes of Jiangsu's residents have increased by 0.8 times.

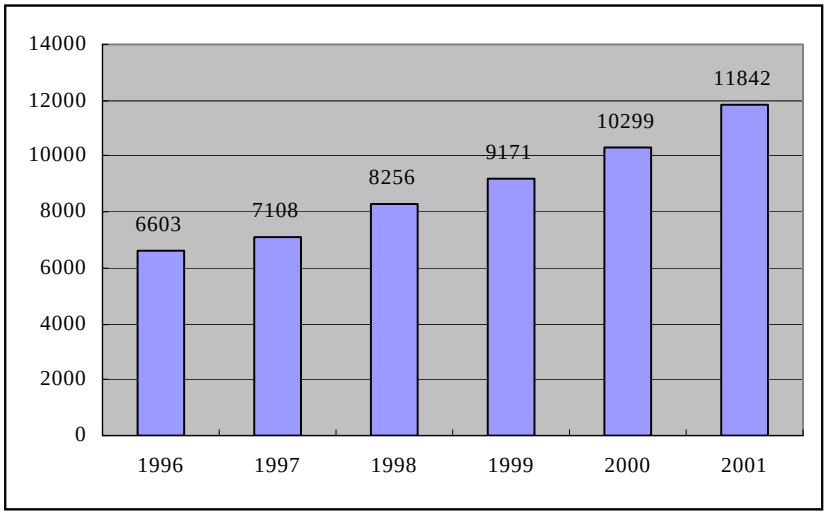

Figure 5: *The average income of communities in Jiangsu Province from 1996 to 2001 (Unit:Yuan)*

Data source: *Jiangsu Province Statistical Yearbook of 2001*.

[6] Jiangsu Province is one of the first provinces that claim to carry out cleaner production on the whole provincial level. In 1996, Jiangsu EPB and ETC drafted 'Opinions on Implementing Cleaner Production Audits'. The document was eventually issued by the Governor's Office to give it greater authority. The EPB and ETC are the agencies in charge of the cleaner production demonstration plan. Since 1997, Jiangsu Province has been carrying out 5 groups of demonstration with totally over 650 enterprises. Among these enterprises, petrochemical enterprises are selected as important target case.

Accompanying with the higher and higher income level, the literacy rates of communities have also continued to improve in Jiangsu Province. As the fifth census of China has disclosed, compared with the data of 1990, in 2000 the number of those who have received college education has increased by 1.7 times[7]. Because the census is not conducted every year, those data are available only for these two years. However, from Jiangsu Province Statistical Yearbooks, we can get another set of data to illustrate the educational status of Jiangsu Province from the year of 1996 to 2001. In these years the number of college students have rapidly increased from 31 to 78.7 per 10 thousand populations of Jiangsu Province (Figure 6).

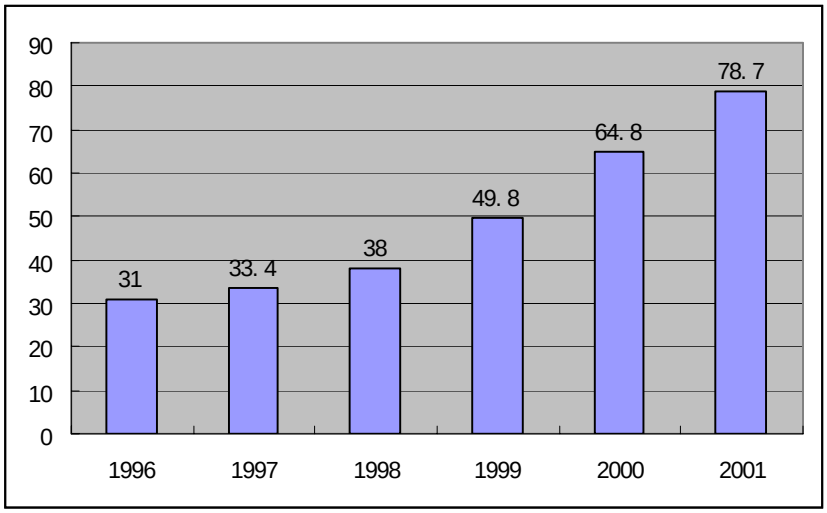

Figure 6: *The number of college students per 10 thousand populations in Jiangsu Province from 1996 to 2001*

Data source: *Jiangsu Province Statistical Yearbook*, 1996~2001.

As they have become wealthier and better-educated, the communities increasingly care about health of themselves and show greater interest in environmental protection. Therefore, while under formal regulation, Jiangsu's petrochemical industries are also constantly under pressure from local communities for further pollution control. The EPB of Jiangsu Province is also actively responding to a citizen complaint program with which any citizen can write, call or visit the local office of environmental authorities for any environmental issues. Responding to those complaints, the EPBs investigate the issues mostly by doing field inspections. Issues are for the most part solved with polluters' correcting the problems. From the year of 1996 to 2001, the EPBs of Jiangsu Province have received thousands of complaints (with letters and visits) each year. As illustrated by Figure 7, the numbers of these complaints on environmental issues are increasing year after year. Accordingly, the increasing numbers of complaints have also significantly increased the numbers of inspections of the environmental authorities and

[7] These data are from the result of the fifth census carried out in the year of 2000 in China. Compared with the result of the fourth census conducted in 1990, the number of those who have received college education rises from 1474 to 3917 per 100 thousand populations. For more information about the fifth census, see the website: http://www.stats.gov.cn/tjgb/rkpcgb/dfrkpcgb/200203310071.htm

increased the settling of the various environmental issues. It can be assumed that the yearly increasing numbers of complaints on environmental problems are close correlative with the power of communities themselves, including their income level and also their educational degree.

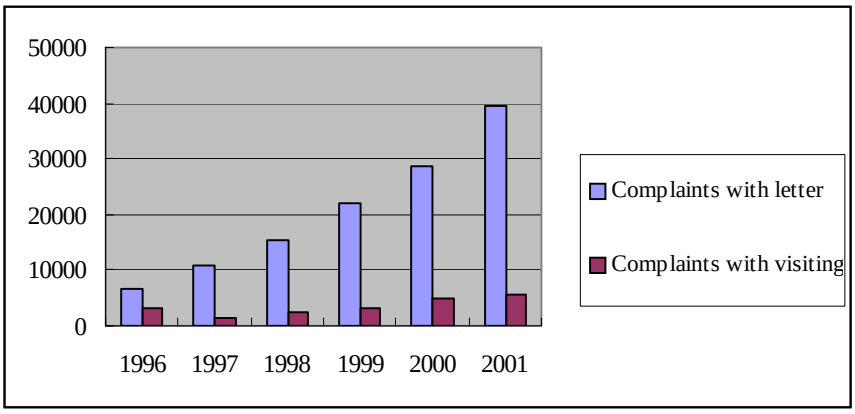

Figure 7: *The number of college students per 10 thousand populations in Jiangsu Province from 1996 to 2001*

Data source: *Jiangsu province environmental statistical reports* (1996~2001).

4. Mechanism Discussion: as a conclusion

In literature, two kinds of empirical studies have demonstrated the existence community pressure of industrial pollution (Pargal et al., 1996; 1997 and World Bank Development Research Group, 1999). Both these two kinds of studies suggest that communities can strongly influence plants' environmental performances in cases where formal regulation is present or absent.

As a conclusion of this paper, this section tries to carry out some mechanism analyses of community pressure in the 'ecologizing' process.

To systematically analyze the processes of environment-induced social change in industrial society, Mol (1995) adopted and developed a triad network, namely, policy networks, economic networks and societal networks. Plants' environmental performances are strongly influenced by varieties of actors and factors (Figure 8 merely shows a part of them). Generally speaking, plants are always seeking to the largest profits and therefore trying to minimize the total cost. Assuming that C is the total cost of inputs that a plant spends on the production system and the pollution control. Due to the environmental policy, the plant has to pay fees (F) for it discharges pollutants (e.g. COD or SO_2, assuming x is the total amount of the pollutants) to the environment. Therefore, both C and F are functions of x. To optimize (minimize all the cost of the plant) this issue, so the target function is given as follow:

Minimize $C(x) + F(x)$ (1)

To solve for the optimization, the first order condition needs fulfill:

$\partial C/\partial x + \partial F/\partial x = 0$ (2)

The first term in (2) is the cost reduction of an extra unit of pollution discharge. So the marginal abatement cost (MAC) of x is:

$MAC = - \partial C/\partial x$ (3)

The second term in (2) is the marginal fees of pollution discharge (P, it can also be seen as pollution discharge price). So:

$P = \partial F/\partial x$ (4)

If F is a linear function of x, P is therefore a constant. So (2) indicates that a plant controls its pollution up to a base line where the marginal abatement cost equals the marginal fees of pollution discharge.

Given pollution discharge price P, the total amount of discharge pollutants (x) is a function of P (pollution discharge demand function):

$x = f(M)$ (5)

From equations (2) to (5), the marginal abatement cost function be derived as:

$MAC = f^{-1}(x)$ (6)

Actually, the fees (F) that a plant has to pay for its pollution discharge (x) might consist of two parts: one is a financial penalty such as paying a discharge fee; the other is caused by damage to the plant, such as risk of being shut-down, reputation damages as well as community complaints. Then the pollution discharge price (P) also has two parts: one corresponding to the explicit financial charges (P_1) and another corresponding to implicit damages to the plant (P_2), from equations (2), (3) and (4), this equation is available:

$MAC = P_1 + P_2$ (7)

Using these equations, one can conduct quantitative analysis for the relationships among pollution charge, pollution abatement cost and community pressure, as Wang (2000) did. In this study they are used for qualitative analysis of the effect of community pressure on plants' environmental performances.

Obviously, if there are no community complaints or other damages to a plant, its pollution marginal abatement cost is relatively low. This case is most ideal for the plant which is seeking to minimize all its cost. However, if there are many complaints, especially the complaints have lead to considerable damage to the plant, the plant have to spend higher cost in its production. In this case, plants are readily to adopt varieties of

measures to avoid community complaints. Therefore, community pressure do play significant role in improve plants' environmental performances.

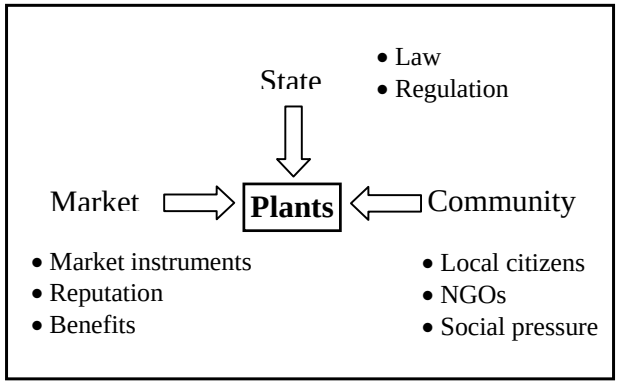

Figure 8: *The possible factors that influence environmental performances of plants*

References:

1. A.P.J. Mol, 1995. *The refinement of production: ecological modernization theory and the chemical industry*. Utrecht: Van Arkel, the Netherlands.
2. H. Wang, 2000. *Pollution charge, community pressure and abatement cost: an analysis of Chinese Industry*. World Bank Policy Research Working Paper.
3. Jiangsu Province ETC, 2000. *Plan of Jiangsu Province pivot technologies imprvement projects for the year of 2001.*
4. Jiangsu Province EPB, 2002. *Reports on environmental quality of Jiangsu Province*.
5. Jiangsu Province EPB, 1997. *Jiangsu province environmental statistical reports* of 1996.
6. Jiangsu Province EPB, 1998. *Jiangsu province environmental statistical reports* of 1997.
7. Jiangsu Province EPB, 1999. *Jiangsu province environmental statistical reports* of 1998.
8. Jiangsu Province EPB, 2000. *Jiangsu province environmental statistical reports* of 1999.
9. Jiangsu Province EPB, 2001. *Jiangsu province environmental statistical reports* of 2000.
10. Jiangsu Province EPB, 2002. *Jiangsu province environmental statistical reports* of 2001.
11. Jiangsu Province ETC, 2002. *2001' White Book of Petrochemical Industry.*
12. *Jiangsu Province Statistical Yearbook of 2001*. Beijing: China Statistic Press, China.
13. Pargal, Sheoli, and D. wheeler, 1996. *Informal environmental regulation in developing countries.* Journal of Political Economy, vol. 104, no. 6.
14. Pargal, Sheoli, H. Hettige, M. Singh and D. wheeler, 1997. *Formal and informal regulation of industrial pollution: comparative evidence from Indonesia and United States*. World Bank Working Policy Research Working Paper.
15. World Bank Development Research Group, 1999. *Greening the industry: new roles for communities, markets, and governments*. UK: Oxford University Press.