



Implementing stricter environmental regulation to enhance eco-efficiency and sustainability: a case study of Shandong Province's pulp and paper industry, China

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ABSTRACT

There has been much debate on the topic of whether stricter environmental regulations can promote environmental performance and economic performance at the same time. Different researchers have used different indicators to measure environmental performance and economic performance in their empirical studies. However, it is a surprise that few studies have checked the relationship between environmental regulation and eco-efficiency, as the latter is widely regarded as a quite powerful tool of considering ecology and economy together.

In this study the background is the implementation in 2003 of the Stricter Discharge Standard (SDS) in Shandong Province's Pulp and Paper Industry (SPPI), compared to the national standards of China. The stricter regulations were intended to promote corporate change from passive management to active control and from end-of-pipe treatment to cleaner production. This study investigated the eco-efficiency trends of SPPI from 2001 to 2008 in three fields: water efficiency, energy efficiency and environment efficiency. A "de-linking" and "re-linking" tool was used to attain a further evaluation. The study showed that with the implementation of stricter regulation most of the efficiency indicators (except CO₂ emission and energy consumption) had achieved significant improvements, and the overall environmental performance trends of SPPI showed it to be more sustainable. However, the study also found that it was not enough to address a single indicator in the environmental regulation of the pulp and paper industry. More holistic eco-efficiency indicators need to be further considered and introduced to the industry as the next step to create true sustainable development.

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1. Introduction

Since the 1980s, a massive shift to manufacturing in China has not only brought economic development, but also environmental pollution, as well as high energy and resource consumption. An ambitious policy to keep the pace of environmental protection with the fast economical development has been regarded as the top priority in China. The most traditional instrument for environment management, environmental regulation, has always been used as the first choice by the Chinese government. One of these policies was setting environment discharge standards for the industry,

which are widely used in China. These standards play an important role in environmental protection. However, there is still a dilemma: on the one hand, as a fast developing country China is in general still in the stage of rapid industrialization, with has resulted in lagging environmental standards which have not been able to cope with the environmental pressure brought by the rapid development of industry, and this has also been addressed by other researchers (Zeng et al., 2005; Zhang et al., 2008). With the improvement of living standards, there are increasing concerns from different stakeholders about environmental quality, especially in the developed eastern regions of China. This concern drives local policy makers, who have to reconsider whether the national standards can be effective to meet regional development goals (Liu et al., 2010). On the other hand, the "polluter's heaven theory" argues that introduction of a stricter environmental standard will

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increase the cost for those polluting sectors, thus reducing their competitiveness, and bringing negative influences for attracting direct foreign investment which is crucial for a developing nation. This mind set often causes policy makers to hesitate in implementing new environmental standards (Das and Das, 2007; Dowell et al., 2000; Grote et al., 2001; He, 2006).

The paper industry has experienced lots of attention because of its high resource and energy consumption in combination with significant pollutants being generated. Lots of efforts, not only from the academic world, but also from industry itself and governmental bodies, have been addressed to search worldwide for a sustainable development for the pulp and paper industry (Browne et al., 2001; Koleff, 1998; Lodenius et al., 2009; Szabo et al., 2009). China has one of the largest paper industries in the world, and the paper production and consumption have both grown significantly in the last 20 years. Simultaneously, a lot of pollutants are generated by the paper industry, including Chemical Oxygen Demand (COD), Ammonia Nitrogen (AN), dust, SO₂ and greenhouse gases. Shandong Province has the largest paper production share in China, which also results in serious environmental problems, especially water pollution. Although the central government has already formulated national discharge standards for the pulp and paper industry, it has failed to change the trend of a deteriorating environmental situation. One of the most fundamental reasons for this failure is that even if all the producers were to reach the requirements of the discharge standards GB3554-2001, it would still be far from complying with the environmental protection targets on an aggregate level. This is because the COD concentration of qualified waste water in GB3554-2001 is 450 mg COD/L, which is even higher than non-treated municipal waste water. Under these circumstances, Shandong Province first of all implemented a much stricter emission standard (with special focus on the COD level of discharged waste water) compared to China's general PPI discharge standards in the SPPI sector. The province has thus been ahead of the other provinces since 2003. Table 1 shows the implementation of stricter standards divided into three phases. This can be compared to a sort of "Installment Regulation Program": on one hand, it is a top-down regulation, which means "legally must be met, or as an absolute threshold of performance that must not be exceeded" (Rothwell, 1992). On the other hand, firms can achieve stricter emission standards step by step. The intention of these stricter standards was to promote corporate change from passive management to active control and from end-pipe-treatment to cleaner production.

However, at the beginning phase of implementation, there were objections from some enterprises. They argued that the new standards would topple the SPPI. Even within the government itself, there were doubts. It was argued that more emphasis should be given to the technical feasibility and cost of the industry. It is not a surprise to have those doubts, and actually there has been a substantial body of literature concerning the effects of environmental regulations on industry. Traditionally, it has been argued that environmental regulations reduce economic growth, increase the costs and place them at a competitive disadvantage in the long

run (Jaffe et al., 1995; Thomas, 2009). However, there are an increasing number of researchers that have different opinions. Some researchers suggested that regulation can promote firms to develop from end-of-pipe to cleaner production and improve competitiveness, and there are "win-win" opportunities (Porter and Vanderlinde, 1995). For developing cleaner production, there has been a lot of evidence. Reijnders (2003) examined the role of prices and regulation in influencing cleaner production and found that updated regulations might emerge as more specific instruments furthering cleaner production. Geng et al. (2010) pointed out that regional government or governmental regulations have the value of leadership in promoting cleaner regional production in a China's province context. Luken and Rompaey (2008) examined drivers for environmental sound technology adoption by manufacturing plants in developing countries context and pointed out that current regulatory requirement are most important for a pollutant intensive subsector, such as the pulp and paper industry. For improving competitiveness, there is also lots of research that has been conducted. Triebswetter and Hitchens (2005) examined the impact of environmental regulation on competitiveness in the German manufacturing industry and found regulation did not cause economic damage. Zhang et al. (2008) suggested that tightening environmental standards to reflect updated circumstances is necessary and it may help the firms to improve their competitiveness and promote a "win-win" situation. They also made assumptions and challenged future research to check whether firms might again make efforts to improve their environmental performance when the local regulations such as emission standards become stricter. Lopez-Gamero et al. (2010) tried to explore the relation between environmental regulation and firm's environmental management, competitiveness and financial performance in a comprehensive picture. However, there is one indicator which was not examined in their studies, and that is an eco-efficiency indicator. Eco-efficiency, because of its inherent advantages of considering economics and ecology at the same time, has been widely accepted since 1990s (WBCSD, 2000). It also has been proposed as an index in firm's accounting statements and has proven to be a powerful tool in environmental reporting (UNCTD, 2004; Van Gerven et al., 2007). Moreover, developing countries such as China, urgently need to "achieve improvements in resource productivity and eco-efficiency" in order to have sustainable development (Yuan et al., 2006). Hence, eco-efficiency is a very good indicator to reflect that "win-win" situation. However, it is a surprise that there is little literature concerning the relationship between environmental regulation and eco-efficiency. Fernandez-Vine et al. (2010) found that regulations are the driving forces for eco-efficiency in the SMEs of Venezuela. In the present study, a research hypothesis was made: implementing stricter environmental regulation can increase the overall eco-efficiency of a regional industry and thus also increase the sustainability.

This paper explores the relationship between stricter regulation and eco-efficiency of SPPI. The research boundary in this study is limited to the manufacturing process. In order to assess the eco-efficiency change of SPPI during the studied period, a number of

Table 1
Discharge standards of COD in water pollutants for the pulp and paper industry in Shandong Province and China.

Period	Wood pulp		Straw pulp		Paper products mg/L
	Natural color mg/L	Bleached mg/L	Natural color mg/L	Bleached mg/L	
2003–2006 ^a	300	350	380	420	100
2007–2009 ^a	150	200	250	300	100
After 2010 ^a	120	120	120	120	100
2001–2008 ^b	350	400	400	450	100

^a Local standards of Shandong Province.

^b National standards of China, GB3544-2001.

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