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Are stronger environmental regulations effective in practice? The case of China's accession to the WTO

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ABSTRACT

This paper investigates the effects of environmental policy on environmental conditions resulting from China's accession to the WTO. We estimate environmental technological efficiency under both weak and strong disposability assumptions and use the difference to calculate the pollution abatement cost (PAC). We then undertake Tobit regression analysis on several explanatory variables, including dummies for different time periods and regions. Generally, our findings show that China's accession to the WTO did not guarantee better environmental conditions even though China adopted stronger regulations to meet the higher standards. In particular, the eastern region does not seem to be strictly regulated. These interesting results may be partly attributable to China's need to attract foreign investment and may represent a case in which institutional regulations are not always effective in practice.

1. Introduction

Recently, environmental issues have become an important topic not only for developed countries but also for developing countries, including China. China has achieved rapid economic growth of nearly 8% every year since its economic reform and opening-up in 1978.However, some of China's increased gross domestic product (GDP) seems to come at the cost of environmental quality, and environmental pollution has become an increasingly serious problem in China. Considering this, the development of a low carbon economy was put forward in the third session of China's National People's Congress in March 2010.

This paper investigates how the World Trade Organization (WTO) has influenced China's environmental policy and conditions since China's accession to the WTO in 2002. In general, we expect that China would have been able to adopt the latest technologies in management since 2002 and would benefit as a result. Furthermore, we might expect that environmental regulation has been strengthened to match international standards. For example, the Stricter Discharge Standard (SDS) was successfully implemented in Shandong Province's pulp and paper industry (SPPI) in 2003 (see Wang et al., 2011). At the same time, China has also attracted more foreign direct investment (FDI), thanks to its membership in the WTO. WTO entry may have significant impacts on the environmental policies of China. Considering this, we discuss the role of China's accession to the WTO in terms of China's environmental regulation and environmental conditions; we refer to these "WTO effects". We examined whether they actually occurred by reference to actual data.

Another consideration is how environmental issues differ among regions. For example, the eastern region tends to pay more attention to environmental protection due to its higher economic level. It is widely accepted that environmental considerations will be given greater importance in the eastern region but less in the western region, where economic development and increased income might be given priority over environmental issues (see Dong et al., 2010). We have termed these regional differences "regional effects".

This paper explores the aforementioned effects by using the concept of pollution abatement cost (PAC) developed by Färe et al. (2007). According to Färe et al. (2007), PAC is the gap between

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environmental technological inefficiency under strong and weak disposability. If environmental regulation is strengthened, pollution abatement activities will become burdens to corporations. Because corporations are required to purchase pollution-reducing equipment, the production cost will increase. We estimated the PAC by both period and region to determine whether the PAC has increased following WTO membership. Furthermore, we attempted to analyze the determinants of PAC using regression analysis.

There are two ways to treat the variable of environmental pollution. First, we can regard environmental pollution as an input variable. Tzouvelekas et al. (2006) and Chen (2009), for example, treated "environmental pollution" as an input variable, and then estimated green total factor productivity based on Solow's residual. On the other hand, we can consider environmental pollution as a 'bad' output variable. For example, Chung et al. (1997) estimated the productivity change in the Swedish pulp and paper industry using a directional output distance function approach.

Sarkis and Weinrach (2001) used data envelopment analysis (DEA) to evaluate environmentally conscious waste-treatment technologies, in which the input variables were capital cost savings and operational cost savings, and the output variables were low-level waste and other discharges. Bevilacqua and Braglia (2002) also adopted the DEA method to estimate the environmental efficiency of seven AgipPetroli oil refineries in Italy from 1993 to 1996. Whereas many previous papers used the traditional distance function only, Hu et al. (2008) employed the directional distance function using the DEA method to estimate environmental efficiency under the weak disposability assumption in China's provinces. Tu (2008) calculated ETE and studied the determinants of ETE using data from 1998 to 2005. In addition, Wang et al. (2010) estimated the environmental efficiency and environmental TFP of 30 provinces (excluding Tibet) from 1998 to 2007. Fujii et al. (2011) applied the directional distance function to measure environmentally sensitive productivity changes in both US and Japanese manufacture firms. Additionally, they also computed the Leuenberger[1] productivity indicator.

This paper differs from the previous studies as follows. First, we estimate two ETEs under both weak and strong disposability, whereas most existing studies focus only on estimation of the weakly disposable ETE. We compute China's PAC[2] using both ETEs. Second, we put forward WTO effects and regional effects, and test two assumptions by use of actual data and empirical analysis. Third, we analyze how per capita GRP (gross regional product) and FDI influence PAC. Last but not least, because PAC ranges between 0 and 1, we apply Tobit regression analysis.

The main findings are as follows: we cannot confirm that WTO membership has strengthened China's environmental regulation. Rather, it seems that the degree of environmental regulation in terms of PAC has decreased and SO_2 emission has increased since China's accession to the WTO. The hypothesis of regional effects is not supported, either. We expected that the eastern region would have the largest PAC, but a simple analysis of data showed that the PAC in the east was the smallest among the regions. In other words, it seems that in practice, the eastern provinces have loosened their environmental regulations and reduced PAC; thus, environmental conditions have not been significantly improved.

In Section 2, we review the related literature. We calculate ETE under weak and strong disposability in Section 3. In Section 4, we present PAC and analyze the determinants of PAC. A conclusion is provided in Section 5.

2. Theory and background

2.1. Environmental technology

Färe et al. (2007) introduced environmental technology from the aspect of weak disposability of outputs and null-jointness. Consider the following environmental production technology:

$$P(x) = \{(y, b) : x \text{ can produce } (y, b)\}, x \in R_+^N \tag{1}$$

Where $P(x)$ is the production set, and x is the input variable with N-dimensions denoted by $x = (x_1, \ldots, x_N) \in R_+^N$. There are two output variables: one is a good or desirable output with an M-dimensions denoted by $y = (y_1, \ldots, y_M) \in R_+^M$, and the other is a bad or undesirable output with a J-dimensions denoted by $b = (b_1, \ldots, b_J) \in R_+^J$. Our production objective involves how to enlarge the good output and reduce the bad output (Färe et al., 2007). There are three important properties of the environmental technology:

2.1.1. Property (1): null-jointness

$$\text{If } (y, b) \in P(x) \text{ and } b = 0, \text{ then } y = 0 \tag{2}$$

Property (1) shows that bad outputs are co-produced with good outputs. We can produce no good outputs without producing bad outputs (Färe et al., 2007, p.1057).

Before we address weak and strong disposability, we define "disposability". "Disposability" generally refers to the ability to discard or dispose of unwanted commodities (Färe et al., 1994, p. 38).

2.1.2. Property (2): weak disposability

$$\text{If } (y, b) \in P(x) \text{ and } 0 \le \theta \le 1, \text{ we can obtain} (\theta y, \theta b) \in P(x) \tag{3}$$

Here, θ is a changing scalar, and $0 \le \theta \le 1$. In other words, we can decrease bad outputs only if we decrease good outputs by at least the same rate of θ. This implies that we cannot discard bad outputs at no cost. This case is related to environmental regulation (Färe et al., 2007, p. 1057). Here, the weak disposability assumption allows us to change good and bad outputs proportionately.

2.1.3. Property (3): strong disposability

$$\text{If } (y, b) \in P(x) \text{ and } y\prime \le y, \text{ it implies} (y\prime, b) \in P(x) \tag{4}$$

Strong disposability allows for non-proportionate change between good and bad outputs. When inputs and bad outputs remain constant, then any output vector with fewer good outputs is also feasible. This condition is related to an unregulated environment (Färe et al., 2005, 2007, p. 474, p. 1057).

[1] The Malmquist index is the productivity change without considering the environmental impact, the Malmquist index is used with distance functions, which can be used when the good and bad outputs are treated symmetrically. Whereas the Malmquist–Leuenberger index, which is sometimes called as Leuenberger productivity indicator, is the productivity change considering environmental impacts and thus linked with directional distance function.

[2] Following Färe et al. (2007), we estimate PAC by the inefficiency gap between strong disposability and weak disposability. There are other methods to calculate the PAC. For example, Dong et al. (1998) adopted another equation to estimate PAC in which impacts such as waste-water discharge, effluent concentration of the *n* pollutants, etc. are used as the explanatory variables.