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# Environmental regulation and the productivity of Japanese manufacturing industries

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**Abstract**

This paper attempts to provide empirical evidence on issues concerning: (a) the effect of the stringency of environmental regulations (as measured by pollution control expenditures) on innovative activity (as measured by R&D expenditures) and on the average age of capital stock and (b) the productivity enhancement effect of environmental regulations in Japanese manufacturing industries. The empirical findings in the paper show that the pollution control expenditures have a positive relationship with the R&D expenditures and have a negative relationship with the average age of capital stock. It is also shown that increases in R&D investment stimulated by the regulatory stringency have a significant positive effect on the growth rate of total factor productivity.


*JEL Classification:* O33; Q55; Q58

*Keywords:* R&D; Capital stock age; Total factor productivity; Porter hypothesis

## 1. Introduction

Japanese local and national governments established environmental policies to combat serious industrial pollution in the 1960s and 1970s. Adopting a command-and-control approach, they set and tightened emission standards for pollutants in order to achieve environmental quality targets.[1] Some articles review the performance of the regulatory approach in Japan. Weidner (1995) claims that the environmental policy for controlling emissions of sulfur oxides and

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[1] In Japan, there is a charge on $SO_x$ emissions required by the Compensation Law for Pollution-Related Health Damage, which is discussed below.

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nitrogen oxides from stationary sources in Japanese industries such as steel, paper and pulp and chemicals can be evaluated as a successful case. OECD (1977) argues that the stringent environmental regulations stimulated technological innovation in Japanese industries: 'The possibilities of science and technology are such that they extend the frontiers of rationality. Costs of processes that have not yet been invented cannot be estimated. They are said to be very high or even infinite, but may well turn out to be reasonable. The Japanese experience in the field of pollution abatement lends support to the idea that to a large extent it is not technology that should constrain policy choices, but policy choices that should constrain technology (OECD, 1977, pp. 85–86)'. The OECD review of the environmental policies in Japan states that, although pollution control pushed up the production costs of the industries, the additional costs did not seriously impair the competitiveness.

In the U.S., many studies seeking to ascertain the cause of the slowdown in productivity growth during the 1970s were undertaken. The attention of several economists was focused on environmental regulation that was considered as one of the factors contributing to the poor productivity performance. Using data for the U.S. manufacturing sector, Christainsen and Haveman (1981) estimate that the fraction of the labor productivity slowdown explained by public regulations during 1973–1977 is 12–21%. Gray (1987) measures the impact of both environmental and workers' health and safety regulation on productivity growth in U.S. manufacturing industries. The study finds that environmental regulation reduced the annual rate of productivity growth by 0.17–0.28%, accounting for 12–19% of the slowdown in the 1970s.

Barbera and McConnell (1986) attempt to identify the differential economic consequences of environmental regulation across four U.S. industries (paper, chemicals, primary metals and stone, clay and glass (SCG)). They show that pollution abatement capital expenditures had a significant negative impact on labor and capital productivity in chemicals, primary metals and SCG. Gollop and Roberts (1983) estimate the effect of environmental regulation on the productivity performance in the electric power industry. They use a translog cost function that allows them to measure regulatory impact on specific inputs and develop an index of regulatory intensity. The estimation result is that sulfur dioxide emission regulations reduced the rate of productivity growth for electric utilities by 0.59% per year during 1973–1979. Gray and Shadbegian (1995) examine the impact of pollution abatement expenditures on plant-level productivity in the paper, oil and steel industries. They find a negative relationship between a plant's abatement costs and productivity levels.

The direct effect of purchasing abatement capital on firms' performance is a reduction in productivity because total input costs become higher for the same level of output. In addition, abatement activity may change the amount or combination of conventional inputs. A possible case of this indirect impact is that abatement requirements encourage capital turnover that can lead to productivity improvement. The negative direct effect of environmental regulation can be mitigated if the indirect effect is positive. Barbera and McConnell (1990) examine these two components of the regulatory impact for five polluting industries in the U.S. and find that the total effect is to retard productivity growth. They show that the fraction of the decline in productivity growth due to abatement between the 1960s and the 1970s ranges from 10% to 30% across the industries.

While environmental regulations in a nation are generally perceived as likely to have a negative impact on the productivity of the domestic industries, Jaffe et al. (1995) point out that empirical studies examining the economic impacts of environmental regulations do not find a significant adverse effect of tougher environmental regulations on the competitiveness of U.S. manufacturing industries. Michael E. Porter argues that costs for compliance with environmental