BOD₇ Production Function of the Finnish Pulp and Paper Industry

MINNA-MAARI H. KARVONEN

Traditional neoclassical production theory analyzes the relationship in a production process between inputs and outputs which have a positive market value for the producer. The externalities of production, which have nonpositive market values, are discarded or included as the cost in a cost function. This paper studies the relationship between biological oxygen demand (BOD) emissions, an output of nonpositive value, and traditional factors of production, that is, investments, labor, output, and raw materials. An emissions production function is theoretically presented and empirically estimated with data from the Finnish pulp and paper industry. The approach is based on the observation that it is the minimization of effluents rather than, or together with, the maximization of yields, that increasingly defines the technological frontier of production processes. The empirical function estimation demonstrates the validity of the proposed novel modeling approach. (JEL O40, Q20)

Introduction

In many industries and in many countries, technological development has accelerated in the past decades. In some countries, as in the case of Finland, the growth of industrial output and technological development as its by-product has been especially pronounced in the postwar years. At the same time, increasing environmentalism has urged industrial designers and planners of new technology to incorporate aspects of environmental management and protection into the new technologies that are introduced to the market.

Emissions are an unwanted by-product of the production process of goods. They can be eliminated either by improving the process to produce less waste and emissions or by installing equipment that handles emissions in some sensible way. It is rather obvious that, for example, the amount of labor does not have a bearing on emissions reduction. The choice of raw materials and energy as well as the choice and age of technologies are decisive. This analysis focuses on the pulp and paper industry in Finland. Due to the abundance of virgin wood fiber as raw material, nonwood fibers are not used in pulping or are used only to a negligible extent. The analysis here focuses on the effects of investments on both emissions formation in the industry as well as on the use of wood fibers and the need for labor. It is assumed, a priori, that technological development is the most decisive factor in shaping the emissions profile of the industry.

The age of a mill or of its production equipment is a direct reflection of its level of technology. The latest technology is also the most advanced. Figure 1 shows the cumulative

*University of Jyväskylä—Finland.
pulp production in Finland in thousand metric tons and the biological oxygen demand (BOD) emissions per metric ton.

FIGURE 1
Cumulative Pulp Production and BOD<sub>7</sub> Emissions: 1994

FIGURE 2
Normalized Water Emissions Coefficients: 1994