



## Analysis

## Environmental regulation and investment: Evidence from European industry data

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## ABSTRACT

This paper contributes to the empirical literature on the effects of environmental regulation on investment. In particular, we ask whether and how strongly an industry's investment responds to stringency in environmental regulation. Environmental regulation is measured as (i) an industry's total current expenditure on environmental protection, and (ii) a country-industry's revenue from environmental taxes. Focusing on European data of manufacturing industries between 1998 and 2007, we estimate the differential impact of environmental stringency on four types of investment: gross investment in tangible goods, in new buildings, in machinery, and in 'productive' investment (investment in tangible goods minus investment in abatement technologies). Both environmental variables enter positively, and their quadratic terms exhibit significantly negative parameter estimates. This, in turn, indicates a positive but diminishing impact of environmental regulation on investment.

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## 1. Introduction

Environmental economists typically arrive at very different conclusions about the economic effects of environmental regulation. For instance, one argument that has recently attracted increasing attention is that firms intend to locate their business activities in countries or regions where environmental standards are relatively low. By way of contrast, others emphasize the availability of (clean) natural resources as factor inputs. In this case, one would expect a positive rather than a negative impact of environmental regulation on firm activities.

This paper analyzes the role of environmental regulation on industry-specific investment in European countries. Unlike the previous literature mainly focusing on the effects of environmental regulation on international investment (i.e., locational choices of multinational firms), we ask whether tighter environmental standards are associated with higher or lower investment at a given location.<sup>1</sup> Specifically, we are interested in the differential impact of environmental stringency on four types of country-industry-specific investment: (i) gross investment in tangible goods, (ii) gross

investment in construction and alteration of buildings (henceforth investment in new buildings), (iii) gross investment in machinery, and (iv) 'productive' investment, defined as the difference between gross investment in tangible goods minus investment in abatement technologies. Environmental regulation is measured as (i) an industry's total current expenditures on environmental protection, and (ii) a country-industry's revenue from environmental taxes. Empirically, we rely on a sample of nine manufacturing industries at the NACE 2-digit level in 21 European countries between 1998 and 2007. This represents the lowest level of aggregation for environmental regulation available for a broader cross section of European countries.

Our empirical findings suggest that environmental regulation as measured by environmental expenditures and revenues from environmental taxation is positively related to (all types of) investment. We also observe significantly negative quadratic terms for both variables, indicating that the costs of compliance with stricter environmental regulation (i.e., higher levels of environmental expenditures and taxes) are above their benefits. For a reasonable range of environmental regulation, however, we may conclude that such regulation is positively associated with country-industry-specific investment in our sample of European countries and industries.

The paper is organized as follows. In Section 2, we briefly review the related empirical literature. Section 3 derives the empirical investment equation, where a special focus is given to the inclusion of environmental regulation. Section 4 summarizes the data and discusses the variables used in the empirical specification. In Section 5,

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we present the empirical findings and a sensitivity analysis. Section 6 concludes.

## 2. Previous Empirical Research: An Overview

According to a survey by Jaffe et al. (1995: 146) “[t]wo sources of evidence can be used to investigate the sensitivity of firms’ investment patterns to environmental regulations: changes in direct foreign investment and siting decisions for domestic plants.”<sup>2</sup> Thereby, studies on national investment at a given location are relatively scarce compared to the large body of research focusing on the role of environmental regulation on investment decisions of multinational firms (FDI).<sup>3</sup> Two notable exceptions are Garofalo and Malhotra (1995) and Greenstone (2002).

Garofalo and Malhotra (1995) rely on the manufacturing sector in 34 U.S. states between 1983 and 1989. They find a modest negative impact of pollution abatement expenditures on state-industry-specific net capital formation. Greenstone (2002) utilizes data from U.S. manufacturing firms and county-specific information on pollutant-specific attainment status between 1967 and 1987 (subsumed under four time periods). The empirical findings suggest that strict regulations retard investment. By way of contrast, studies on environmental regulation and trade or FDI are less clear with regard to the relationship between those variables.<sup>4</sup>

The focus of this paper is on the impact of environmental regulation on national, country-industry-specific investment. Although this issue is not fully related to previous research (since FDI is only part of total investment), we can draw two important conclusions from the above mentioned research. From a theoretical point of view, we can firstly rely on three prominent hypotheses regarding the influence of environmental regulation on investment decisions of firms.

First, the ‘pollution haven hypothesis’ states that firms (especially from dirty industries) tend to locate their production activities in countries or regions with low environmental standards to avoid higher environmental compliance costs. In this case, we would expect a negative relationship between environmental regulation and investment.

Second, the ‘factor endowment hypothesis’, in contrast, emphasizes that abundance in (natural) resources improves the production possibilities of firms. Accordingly, industries may accept tighter regulations in order to benefit from abundant input factors (see Copeland and Taylor, 2004) as long as advantages in endowment outweigh the corresponding costs from regulation. We therefore infer that stringency in regulations only increases firm activities if environmental costs are lower than the endowment benefits associated with environmental stringency (e.g., a sophisticated resource management might induce a better quality of natural resources). In this case, we should find a positive relationship between environmental regulations and investment. However, if expenditures to meet environmental regulations are relatively high, we would observe a negative impact of regulation. This, in turn, motivates an empirical specification where environmental regulation

enters in a non-linear fashion. In the empirical analysis below, we include quadratic terms to account for such non-linearities.

Third, van der Porter and Linde (1995) point out that an industry’s competitiveness can be enhanced by properly designed environmental policies to stimulate the application of new, innovative technologies.<sup>5</sup> They argue that innovations are able to reduce the costs of meeting environmental regulations and, at the same time, induce a productive use of resources. Although they primarily focus on environmental regulation and innovation, their arguments can be assigned to the relationship between environmental regulation and investment as innovation and investment are tightly connected. Accordingly, we can infer that companies have an incentive to invest in cleaner production technology to mitigate higher abatement costs (at a given production level). Such investments may either originate from national firms or from companies abroad (i.e., inward FDI) and can lead to higher productivity and, therefore, to an advantage over industries in other countries/regions without such regulations (in the following, we refer to this view as ‘Porter hypothesis’). Then, we would expect a positive impact of environmental regulation on investment activities of firms. However, and very similar to the factor endowment hypothesis, if policies to meet environmental standards are very expensive and, therefore, the role of innovation is relatively unimportant, it might be the case that the positive impact of regulation changes to negative. Again, this motivates a non-linear relationship between environmental regulation and investment.

The second lesson that can be drawn from previous research is that the estimation results are sensitive to the measurement of environmental regulation and to the empirical specification (see Jeppesen et al., 2002 for a survey). Generally, environmental regulation relates to restrictions imposed on polluters to increase their cost of production. Such regulations include social and product norms, legal standards or emission charges. To proxy these dimensions of environmental policies, previous studies used pollution abatement costs (see Garofalo and Malhotra, 1995; Gray and Shadbegian, 1998; Keller and Levinson, 2002; Levinson and Taylor, 2008; Shadbegian and Gray, 2005; Jug and Mirza, 2005), environmental taxes (see Levinson, 1999; Dean et al., 2005), attainment status of counties regarding particular environmental regulations (see Greenstone, 2002), pollutant emissions in tons (see Xing and Kolstad, 2002), the difference between shadow and market price of the polluting input (see Van Soest et al., 2006), or composite measures captured by various indices (see List and Co, 2000; Cagatay and Mihci, 2006). We follow this lead using (total current) expenditures on environmental protection as the first indicator of environmental regulation. Second, we refer to environmental taxation arguing that a high burden of such taxes is associated with tighter regulation (see Levinson, 1999; Dean et al., 2005). Environmental tax burden is measured by the country-industry specific revenue from environmental taxes.

As discussed above, expenditures on environmental protection and taxation should affect an industry’s investments negatively if firms try to mitigate additional environmental costs by reducing production at a given location. In contrast, both variables are expected to reveal a positive impact if the gains from abundant resources or innovation and productivity outweigh the costs of compliance with environmental stringency. However, if these costs are relatively high we would observe a negative impact of expenditures on protection and taxation on all types of investments used below. This, in turn, should be accounted for by a non-linear specification in the subsequent empirical analysis.

<sup>2</sup> One obvious reason to keep attention on both types of investment is that (the change in) foreign direct investment is, by definition, also included in national investment.

<sup>3</sup> See List and Co (2000), Brunnermeier and Levinson (2004) and Copeland and Taylor (2004), for excellent overviews over this literature.

<sup>4</sup> A negative association has been found, for example, by Xing and Kolstad (2002), List et al. (2003), Brunnermeier and Levinson (2004), Jug and Mirza (2005), Spatareanu (2007), Dam and Scholtens (2008), and Levinson and Taylor (2008). Positive effects of environmental regulation on FDI or trade are observed in Levinson (1996), Cole and Elliot (2003), Dean et al. (2005) and Costantini and Crespi (2008). Mulatu et al. (2004), Javorcik and Wei (2004) and Cave and Blomquist (2008) provide mixed evidence on this issue.

<sup>5</sup> van der Porter and Linde (1995) state that environmental regulations have to fulfill three requirements to stimulate innovation and productivity: First, regulations should allow a flexible approach how to meet them. Second, they should promote ongoing innovation by setting market incentives such as pollution taxes or tradable permits. Third, they have to be coordinated and administered efficiently.

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