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Corporate governance, environmental regulations, and technological change



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ABSTRACT

This paper investigates the relationship between environmental regulations and innovation by focusing on the automobile industry in a cross-country setting. We provide empirical evidence that the presence of agency problems mitigates the negative effects of environmental regulations on overall R&D activity, which leads to full compensation when the degree of agency problems is sufficiently high. Guiding our empirical analysis, we provide a general model consistent with the structure of existing ownership data. Specifically, we model ownership structure as a combination of two extreme corporate governance types. On the one extreme there are profit maximizers, and on the other extreme there are managers who are only concerned with their private benefits. The model leads to a simple country level ownership indicator and shows that if an economy is dominated by firms with higher agency problems, then pollution tax might even increase overall R&D, while reducing pollution. According to our estimations, such an outcome is possible only for out-of-sample values of the ownership indicator, where the degree of agency problems is extremely high.

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1. Introduction

The conventional view is that enhancing environmental quality via regulations hampers productivity growth by imposing extra costs on firms, such as reducing incentives to innovate. Mitigating this concern, there is a growing literature providing empirical and theoretical evidence that more stringent environmental regulations direct R&D towards environment-friendly technologies (see surveys by [Jaffe et al., 2003](#); [Ricci, 2007](#); [Vollebergh, 2007](#); [Popp et al., 2010](#)). While ameliorating the negative effect on productivity, in an economy with profit maximizing firms, induced innovation may not totally offset the productivity loss, since it may crowd out some of the existing R&D activity ([Popp and Newell, 2012](#)). Indeed, if a given regulation is able to enhance overall productivity, profit maximizing firms are expected to adopt it even in the absence of the regulation. A limited number of empirical studies present opposing evidence that environmental regulations increase not only R&D on clean technologies, but “overall” R&D activity. For example, [Jaffe and Palmer \(1997\)](#) find that within industries, there is a positive relationship between total R&D expenditure and the stringency of environmental regulation proxied by pollution abatement costs. [Hamamoto \(2006\)](#) supports this finding by providing evidence from Japanese industries. In the current paper, we address these conflicting findings. Our analysis differs from the general treatment by departing from the profit maximizing manager assumption. By focusing on the automobile industry, this paper provides cross-country empirical evidence that agency problems play a mitigating role on the negative effects of

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environmental regulations on overall R&D activity, which leads to full compensation when the degree of agency problems is sufficiently high.

Guiding our empirical analysis, we provide a general model that is consistent with existing ownership data, and where departure from profit maximization is modeled as a combination of two extreme corporate governance structures. In the corporate governance literature, following [Jensen and Meckling \(1976\)](#), it is argued that, due to the agency problems associated with the separation of ownership and managership, firms may not be profit maximizers. As argued by [Nelson and Winter \(1982\)](#) and [Hart \(1983\)](#), while the maximization of profits is in line with the interests of the owners, firm behavior may also be determined by so called *satisficing managers* concerned with their private benefits. In [Hart \(1983\)](#), it is assumed that the managers get a fixed utility when their income satisfies a minimum level, and a utility of $-\infty$ otherwise. Under this condition, it is shown that owners may choose to pay a fixed wage as long as the firm achieves a threshold profit level, and zero otherwise. Another way to explain this situation is that managers obtain private benefits of control as long as they avoid bankruptcy; however, they have a negative utility, if the firm is out of business (see [Aghion and Griffith, 2005](#)). We incorporate this approach in order to illustrate the implications of ownership–managership separation on the relationship between aggregate innovation and environmental regulation. We assume that a fraction of firms are governed by managers who are only concerned with their private benefits.¹ The usefulness of this framework is that we are able to construct a simple country level indicator of corporate governance structure as a combination of two extreme cases, where profit maximizers are on the one extreme, and satisficing decision makers on the other. Therefore, we are able to present a general model leading to testable implications given the properties of existing data on ownership structure.

Our model indicates that environmental regulation reduces the incentives of firms to innovate by eroding the monopoly rents for *owner-controlled firms*. However, for *managerial firms* where ownership and managership are separated, this conclusion is no longer valid. Since the managers are only concerned with their private benefits, environmental regulations act as a disciplinary device, forcing them to innovate more. Depending on the prevalence of managerial firms in the economy, this distinction between owner-controlled and managerial firms makes it possible for environmental regulations to spur overall innovation, while ameliorating environmental pollution.

We conduct a country level empirical analysis in order to test the prediction that in countries where managerial firms are more common, the negative effect of more stringent environmental regulations on overall innovation diminishes. Our main proxy for environmental stringency is tax-inclusive fuel prices across countries. As suggested by [Aghion et al. \(2012\)](#), fuel prices can be considered as a proxy for the shadow price of carbon, which may have an impact on innovative behavior in the automobile industry. By using patent counts of countries in this industry as an indicator of innovative activity, we test whether fuel prices have a differential effect on innovation depending on the relative prevalence of managerial firms. In order to construct a measure of ownership structure, we rely on firm level data. We classify firms as managerial or owner-controlled depending on their ownership concentration, and construct a country level indicator for ownership structure in order to investigate the differential effects of fuel prices on the patent counts of the automobile industry depending on the ownership structure.

Our nonlinear count data estimations with fixed effects show that fuel prices have a lower innovation discouraging effect in countries where the fraction of managerial firms is higher. Strikingly, if the ownership structure is sufficiently diffused, the negative effect of fuel prices is totally compensated by its indirect effect in relation to the ownership structure, which leads to an insignificant marginal effect on innovation. The predicted net marginal effects of fuel prices for out-of-sample values of the ownership indicator turns out to be positive if a country is fully characterized by ownership–managership separated firms. However, the significance of this positive effect is not robust. These results are robust to accounting for overdispersion in the patent data, potential feedback effects from innovation to ownership structure, using dynamic count-data fixed effect estimation techniques, sample selection concerns in constructing the ownership indicator, endogeneity due to omitted variables, and using government R&D expenditure on environmental protection instead of fuel prices as a proxy for environmental stringency.² We introduce dynamics into our non-linear fixed effects estimations by employing the pre-sample mean scaling (PSM) estimator suggested by [Blundell et al. \(1999\)](#), and take care of endogeneity following [Wool-dridge \(2014\)](#).

This paper is related to the literature investigating the effects of environmental regulations on innovation (see the surveys by [Jaffe et al. \(2002, 2003\)](#) and [Vollebergh \(2007\)](#)). There are a number of studies investigating the effect of environmental regulations on green innovation (for example [Wagner, 2008](#); [Brunnermeier and Cohen, 2003](#); [Gray and Deily, 1996](#); [Gray and Shadbegian, 1998](#)). [Popp \(2006\)](#), [Dekker et al. \(2012\)](#), and [Johnstone et al. \(2010\)](#) provide cross-country evidence as in the current paper. [Popp \(2002\)](#) and [Aghion et al. \(2012\)](#) show that environmental regulations can increase clean innovation due to directed technological change. While all of these papers investigate a potential increase in patenting activity in clean technologies in response to environmental regulations, the focus of the current paper is overall innovation. There are a limited number of empirical studies on the relationship between various measures of environmental stringency and overall innovative activity (for example [Jaffe and Palmer, 1997](#); [Alpay et al., 2002](#); [Berman and Bui, 2001](#); [Lanoie et al.,](#)

¹ Throughout the paper, we use the terms “managerial firms” and “managers” in order to indicate the underlying assumption of satisficing behavior. Similarly, the terms “owner-controlled firms” and “owners” are used in order to indicate the underlying profit maximization assumption.

² Using government expenditure on environmental issues is a common strategy in the literature to proxy environmental stringency. As discussed in [Brunel and Levinson \(2013\)](#), some types of government expenditure are inverse measures. Government R&D expenditure on environmental issues, which is expected to relax the burden on the private sector, is an example of such a measure.

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