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Environmental protection, innovation and price-setting behavior in Spanish manufacturing firms☆

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ABSTRACT

In this paper, we analyze the effects of environmental protection regulation on process and product innovation decisions and their impact on price-setting behavior in Spanish manufacturing firms throughout 2009–2014. To this end, we estimate several discrete choice probit models using firm-level data. Our results show a positive relationship between the existence of environmental regulations (environmental expenditures as a proxy) and innovation. However, the magnitude of the effects and their significance depend on the type of innovation and the size of the firms: environmental regulation positively impacts process innovation only in large firms (>200 workers) while it positively impacts product innovation exclusively in small firms (up to 200 workers). Taking into account innovation activities, we additionally explore the behavior of product prices. We obtain that process innovation increases the probability of reducing prices for both small and large firms; while product innovation only raises the likelihood of increasing prices for the former. Finally, we look into the determinants of investment in environmental protection and find a positive impact of environmental regulation.

1. Introduction

Growing awareness of economic agents concerning the effect of their decisions on the environment has made environmental protection one of the main concerns of developed economies. In fact, social pressure has led international organizations, such as the European Union, to implementing protocols aimed at pursuing this objective.[1] This has resulted in a significant increase in environmentally-related firm expenses such as pollutant emission reduction, waste management or energy savings.

The effects of environmental regulation (ER) on firm decisions have been extensively discussed. The traditional view claimed that ER reduces firm competitiveness by raising costs and reducing productivity. Porter (1991) and Porter and Van der Linde (1995) challenged this view, arguing that a well-designed ER may create incentives for innovation that could offset the costs of fulfilling new regulations and improve firm competitiveness. Thus, the so-called Porter hypothesis defends that ER may lead to a win-win situation improving both the environment and company competitiveness. The theoretical justification is that companies face market failures that ER can help to overcome by promoting innovations that improve their efficiency and productivity. Among these market imperfections, the literature highlights the existence of asymmetric information, market power, organizational and behavioral failures or R&D spillovers (see Ambec et al., 2013).

Given the relevance of the Porter hypothesis in designing environmental policies, empirical literature has tried to verify its validity. Following the terminology used by Jaffe and Palmer (1997), we may distinguish among three versions of the hypothesis. First, the "narrow" version ensures that flexible regulation (market-based instruments) provides firms with a greater incentive to innovate than a prescriptive regulation (technology-based standards) does. Second, the "weak" version asserts that ER encourages firm environmental innovation activities. Finally, the "strong" version asserts that ER induces firms to find new products or processes that both comply with the regulation and increase competitiveness.

A first goal of this paper is to provide additional evidence of the "weak" version of the Porter hypothesis (PH) testing whether environmental regulation increases the probability of innovating. Our paper contributes to this literature in several ways. First, we use total product and process innovation (green and non-green) as a measure of innovation when analyzing the "weak" version of the PH. In next section, we explain the importance of considering total innovations rather than just considering green innovation. Second, we use firm-level data while the empirical evidence mostly uses data at the macro or sectoral level of aggregation (Rexhäuser and Rammer, 2014; Rubashkina et al., 2015) and analyze the effects of ER exploring the differences between small and large firms, an issue that literature generally ignores.

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[1] The European Union Emissions Trading System (EU ETS) is an example.

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A second objective is to analyze the impact of product and process innovation on the probability of changing prices as an approximation to the "strong" version of the PH. Some authors have analyzed the impact of process and product innovations on price setting (e.g., Smolny, 1998) but, to the best of our knowledge, this has never been done within the context of the Porter hypothesis.

Finally, we explore the factors that encourage companies to invest in environmental protection. In particular, we analyze the impact of ER. Firms subject to ER can meet the associated restrictions simply by incurring in current expenditures or, alternatively, by investing in new equipment that allows them to produce with less polluting technologies. While the second alternative may be more costly for companies in the short-run, it can be more environmentally-friendly because it helps prevent and reduce future levels of pollution.

The paper is organized as follows. Section 2 presents the hypothesis development and discusses the connection to existing literature. Section 3 describes the data set. Section 4 analyzes the decision to innovate. Section 5 looks at price setting decision and, Section 6 presents environmental protection investment analyses. Section 7 concludes. Finally, the Appendix A shows the variable definitions and the descriptive statistics.

2. Hypothesis development and previous literature

The empirical literature has tested the weak version of the Porter hypothesis using either input or output measures of innovation and, in some cases, both.[2] The number of patents (in particular, green patents) is the most widely analyzed output measure. In general, it finds a positive relation between ER and green patents (see, Brunnermeier and Cohen (2003), Popp (2003, 2006), Johnstone et al. (2010), Lanoie et al. (2011) or Lee et al. (2011) among others). Jaffe and Palmer (1997) use both an input (R&D expenses) and an output (patents) measure of innovation activities. They find a positive and significant effect on aggregate R&D activity and a non-significant effect on the total number of successful patent applications.

In this paper, we consider innovation in a broader sense by using product and process innovation as a measure of innovative activity. Literature scarcely studies the impact of ER on product and process innovation and mainly focuses on eco-product and eco-process innovation (see, for example, Cleff and Rennings, 1999; Horbach et al., 2012). Yet we use data of Spanish manufacturing firms to explore whether engaging in environmental expenditures (as a proxy of environmental regulation) affects the decision to introduce new or improved products and/or processes. Therefore, the first hypothesis to be tested is:

Hypothesis 1. Environmental regulation increases the probability of innovating in product and process.

We test this hypothesis by specifying a discrete choice model decision that allows us to explore whether the magnitude of the effects and their significance depend on the type of innovation and the size of the firms.

Our database allows no distinction between green and non-green innovation. Nevertheless, Kneller and Manderson (2012) and Rubashkina et al. (2015) point out that focusing exclusively on environmental innovations (as many papers do) is not enough. Even though ER increases environmental innovation, it may harm non-environmental innovation due to budget constraints. In fact, Kneller and Manderson (2012) find a non-positive impact of ER on total innovation despite the increase in environmental innovation.

Porter's hypothesis argues that ER can improve firm competitiveness. The literature has taken different measures of competitiveness as a reference to test this hypothesis; e.g., trade, productivity, gross value added, profitability, employment, product prices, output, market share or investment.[3] In this paper, we analyze the implications of innovation decisions on the economic performance of firms by focusing on the behavior of the product prices.

A company can improve its competitive position in the market either by incorporating process innovations that allow it to reduce production costs or by introducing new (or improved) and more attractive products to consumers than the products offered by competitors. In the first case, reductions in marginal costs could be translated into price reductions; in the second case, the consumers' greater willingness to pay could allow firms to increase prices.[4] Then, the second hypothesis to be tested is:

Hypothesis 2. The type of innovation affects product price-setting.

In order to address this issue, we specify two separate probit equations to analyze the decision to reduce prices and the decision to increase them. We expect process innovation to impact positively on the likelihood of price reductions; and product innovation to impact positively on the likelihood of price increases.[5] To deal with the potential endogeneity problem of process and product innovation, we instrument them with their predicted probabilities. If Hypothesis 1 holds, ER affects these probabilities.

Finally, we explore the factors that encourage companies to invest in environmental protection. In particular, it is relevant to analyze the impact of ER. Thus, we test a third hypothesis.

Hypothesis 3. Environmental regulation increases environmental investment.

Testing this hypothesis provides information regarding the extent to which the ER influences long-run decisions that may affect the environment more permanently. In analyzing this relationship, we consider other potential determinants (e.g., firm size, participation in international markets and the existence of foreign capital) in consonance with similar studies carried out in other countries such as Ireland or Sweden (see, Haller and Murphy, 2012; Hammar and Löfgren, 2006).

3. Data description

The Survey on Business Strategies (ESEE) supplies the data set used in this paper. This data is an unbalanced panel survey of Spanish manufacturing firms, representative of both sector (using the NACE classification) and firm size. This database is particularly useful for our analysis because it is conducted annually and provides yearly information on a large number of firm characteristics uncontained in other databases. In addition to this, the innovation data of the most widely used statistics (the CIS data) refer to a three-year period, even though they are collected every year, while the ESEE gives annual information on innovation.[6]

Although the ESEE has been available since 1990, questions about environmental protection decisions were not reported until 2009. Hence, we use information from 2009 to 2014, the latest data available.

[2] See, for example, Ambec et al. (2013) for a revision of this empirical literature.

[3] Since Jaffe et al. (1995) many empirical studies have analyzed the impact of environmental regulations on competitiveness. See Dechezleprêtre and Sato (2017) for a very recent survey on this topic.

[4] Ambec and Lanoie (2008) review the empirical literature that analyzes different mechanisms that justify potential revenue increase or cost reduction owed to better environmental practices.

[5] Smolny (1998) finds that product innovations increase prices, while not revealing a conclusive effect of process innovations on prices. González et al. (2011), for Spanish manufacturing firms 1991–2001, find that product innovations positively affect the likelihood of firms to increase prices and that process innovations affect their likelihood to reduce prices. These papers take no account of the impact of environmental regulation on innovation.

[6] Besides, firms performing R&D are overrepresented in the Spanish version of the CIS data (the Business Innovation Survey). This is yet another reason why the ESEE data is more adequate for analyzing the yes/no innovation decision. Details on the ESEE database can be found in: https://www.fundacionsepi.es/investigacion/esee/en/spresentacion.asp.