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How do different innovation forms mediate the relationship between environmental regulation and performance?

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ABSTRACT

The Porter Hypothesis (PH) challenges the traditional view on the relationship between environmental regulation and performance by arguing that different innovation forms stimulated by regulations can improve firm performance. However, little of the extant literature discusses how different innovation forms mediate the relationship involved in the Porter Hypothesis. Therefore, in this study, we attempt to provide a model to compare the mediation roles of process innovation and product innovation in the PH, using data from 35 industrial sectors in China from 2001 to 2010. Empirical results indicate that while both process innovation and product innovation mediate the causal link between environmental regulation and performance, product innovation has a slightly stronger mediation effect than process innovation.

1. Introduction

In the past several decades, the Porter Hypothesis has attracted much attention from academics and policy makers. In the early 1990s, Michael Porter and his colleague Van der Linde challenged the conventional wisdom that regulations increase firms' environmental compliance costs, hence limiting their investment in other activities, ultimately leading to low performance (Porter, 1991; Porter and Van der Linde, 1995). They provided a contrary view by stating that more severe but well-designed environmental regulations may lead to greater productivity and higher performance by triggering innovations. Their view on this causal chain between environmental regulation, innovation, and performance is well known as the Porter Hypothesis (PH). The PH provides us with a fresh positive perspective on the relationship between environmental regulations and economic development, and it has stimulated many research efforts among scholars and policymakers (Klassen and Whybark, 2000; Triebswetter and Wackerbauer, 2008). More and more relevant literature has tested the relationships between environmental regulation, innovation, and firm performance (Palmer and Portney, 1995; Thomas, 2009; Wan Alwi et al., 2016).

According to the PH, innovation plays a mediating role in the relationships between environmental regulation, innovation, and firm performance. Through innovation stimulated by environmental regulation, firms have lower energy consumption or higher quality products, the benefits of which exceed the cost of compliance (defined by Porter as innovation offsets), finally leading to better performance. From Porter's point of view, innovation occurs in two forms when firms face environmental regulation (Porter, 1991; Porter and Van der Linde, 1995). The first innovation form occurs in the product process. Firms curb pollution emissions through technical transformation in their production line, or just in the end-of-pipe. The second innovation form aims at reforming the products themselves. Through new designs, firms produce less-polluting and better-performing new products. According to the literature in the innovation management field, these two forms mentioned by Porter are consistent with the concepts of process innovation and product innovation (Adner and Levinthal, 2001; Fondas, 1994; Danneels, 2002; Li and Atuahene-Gima, 2001).

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Porter further demonstrated that the two different innovation forms could lead to different innovation offsets, which are the reasons why environmental regulation can actually improve firm performance. Process innovation results in process offsets because it can increase the utilization rate of resources, to cover parts of costs. Product innovation is considered to be the main factor producing product offsets, because this innovation form aims at designing and producing green and popular products. Porter thinks in theory that different forms of innovation may play different roles and they might derive from different innovation strategies and investments (López-Gamero et al., 2010; Porter and Van der Linde, 1995).

However, few empirical studies focusing on the different innovation forms in the PH have been conducted. In the extensive body of literature discussing the PH in theory and practice, scholars have simply used different variables to measure innovation, such as R&D expenditures and patent applications, lacking a deeper understanding of the different innovation forms in the PH (Jaffe and Palmer, 1997; Artz et al., 2010). In reality, both process innovation and product innovation often exist simultaneously (López-Gamero et al., 2010). They are two different steps taken by firms to respond to external stress from environmental regulation. Therefore, simply using R&D expenditures as innovation inputs or patent numbers as innovation outputs leads to a relatively vague understanding of innovation forms (Yang et al., 2012; Rexhäuser and Rammer, 2014). In this way, it is difficult to distinguish between the two innovation forms identified by the PH.

Therefore, this study sets out to examine the role of innovation in the PH by taking into account innovation forms, in the terms of process innovation and product innovation. Following Porter's original idea, we consider innovation as playing a mediating role in the relationship between environmental regulation and performance. In the PH, a clear causal link is revealed from environmental regulation to innovation and then from innovation to performance. Such a causal relationship just is in line with the mediation model, in which innovation is a mediator between environmental regulation and performance. In this paper, two different innovation forms are involved, so a multiple mediation model is chosen for a comprehensive testing model. In the prior literature, most researchers used industry-level data to examine the PH, because data from firms is relatively difficult to obtain. Likewise, considering the data availability, an industry-level panel data for 35 Chinese industrial sectors from 2001 to 2010 is employed in our study.

The contributions of this paper to the literature are threefold. First, to strengthen our understanding on the innovation forms of the PH, we distinguish innovation forms into process innovation and product innovation, and compare their differential mediation effects in the relationship between environmental regulation and performance. Despite much research on the PH, there is a lack of understanding regarding the different innovation forms. Therefore, our research can provide a newer and more in-depth empirical analysis from an innovation management perspective to discuss the environmental regulation problems.

Second, a comprehensive framework is adopted in this paper to empirically test the PH. Scholars have divided the PH into a weak version, which focuses on the relationship between regulation and innovation, and a strong version, testing that innovation induced by environmental regulation contributes to higher firm performance (Jaffe and Palmer, 1997; Ambec et al., 2013). In the earlier studies, we can find some relevant empirical literature only on the weak PH, or only on the strong PH. Recently, a handful of papers have started to test both the weak and the strong version of the PH. In fact, the essence of the PH is a causality between environmental regulation, innovation, and performance, in which innovation plays a role of mediation. Therefore, we need a complete framework to involve all elements, rather than the weak version or the strong version separately.

Third, this empirical study enriches the extant literature on the PH from the perspective of an emerging economy, China. As one of the biggest developing countries, China's serious environmental problems have drawn worldwide attention. As a result, we urgently need to find a solution to resolve the stress between environmental regulation and business performance. Our research thus can provide the Chinese government and policy makers in other developing countries with information when they face the same problems.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and provides a conceptual model. Section 3 introduces the data and methods used in this study. Section 4 presents empirical results. Finally, in Section 5, we provide an in-depth discussion, including some theoretical and managerial implications. The limitations of this study will also be addressed to guide future research.

2. Literature review and conceptual framework

Environmental regulation has been a controversial and unavoidable issue for a long time, due to the dilemma between economic development and environment constraints. The conventional viewpoint is that environmental regulations, such as taxes on environmental production, and expenditures on pollution abatement, reduce business performance because they increase firms' cost burdens, and deter firms from some profitable investments (Gray, 1987; Kalt, 1985). This view has been challenged by a number of researchers, in which the Porter Hypothesis is notably proposed by Porter and Van der Linde. The PH is not the first theory to go against the conventional wisdom on innovation (Hicks, 1963), but its systematic explanation about the causal relationship between environmental regulation, innovation, and performance rekindled the debate on environmental regulations. Using case analysis, Porter and Van der Linde explain that environmental pollution itself is a waste of resources and causes low productivity for firms, so if the regulations are well designed, they can trigger innovation. Through innovation, firms will achieve more efficient resource utilization and produce popular green products, which may offset the costs of regulatory compliance and enhance performance (Ambec et al., 2013; Porter, 1991; Porter and Van der Linde, 1995). Actually, the PH proposes a logical chain from environmental regulation to innovation, and then to performance.

From the perspective of the PH, innovation stands in the center of the causal chain. As Porter stresses, the positive effect of environmental regulation on firm performance contributes to innovation offsets. Further, he claims that innovation offsets can be broadly divided into process offsets and product offsets, because innovation is not only technology changes but also new product design. Different innovation forms lead to different innovation offsets. Process innovation may bring process offsets because when firms use new technology to solve pollution, they can also improve resource utilization and reduce energy consumption. These offsets result in cost reduction, as they are helpful for firm performance. Product offsets occur because product innovation yields better-performing green products, which are beneficial for firms in generating sales. In fact, Porter's understanding about innovation forms conforms to studies on innovation management (Rosenkranz, 2003; Becker and Egger, 2013). In the field of innovation research, process innovation and product innovation are two general classifications that distinguish and compare different kinds of innovation activities, and especially their influences on firm performance (Martínez-Ros and Labeaga, 2009). Thus, according to the original arguments and the evidence from innovation literature,