



Research article

Firm performance and the role of environmental management[☆]Tommy Lundgren^{a,*}, Wenchao Zhou^{a,b}^a Centre for Environmental and Resource Economics, Umeå University, 901 87, Umeå, Sweden^b Centre for Regional Science, Umeå University, 901 87, Umeå, Sweden

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ABSTRACT

This paper analyzes the interactions between three dimensions of firm performance – productivity, energy efficiency, and environmental performance – and especially sheds light on the role of environmental management. In this context, environmental management is investments to reduce environmental impact, which may also affect firm competitiveness, in terms of change in productivity, and spur more (or less) efficient use of energy. We apply data envelopment analysis (DEA) technique to calculate the Malmquist firm performance indexes, and a panel vector auto-regression (VAR) methodology is utilized to investigate the dynamic and causal relationship between the three dimensions of firm performance and environmental investment. Main results show that energy efficiency and environmental performance are integrated, and energy efficiency and productivity positively reinforce each other, signifying the cost saving property of more efficient use of energy. Hence, increasing energy efficiency, as advocated in many of today's energy policies, could capture multiple benefits. The results also show that improved environmental performance and environmental investments constrain next period productivity, a result that would be in contrast with the Porter hypothesis and strategic corporate social responsibility; both concepts conveying the notion that pro-environmental management can boost productivity and competitiveness.

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1. Introduction

Corporate environmental impacts have received increasing attention in the last decades, and the main focus has been on climate impacts and greenhouse gas emissions.¹ Alongside with the increasing overall societal environmental concerns, firms have also experienced increasing pressure from governmental

environmental policy. Whether environmental policy can improve firms' competitiveness has been, and still remains, a debate since the Porter hypothesis was introduced in 1995 (see e.g. Brännlund et al., 1995; Porter and van der Linde, 1995; Jaffe and Palmer, 1997; Gray and Shadbegian, 2003; Hamamoto, 2006; Brännlund and Lundgren, 2010).² Also, firms may go beyond compliance voluntarily, take a proactive role in environmental protection (self-

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¹ In Sweden, reducing climate impacts is listed in the first place among the 16 environmental quality objectives and the government is aiming for zero net emission in 2050 (Swedish Environmental Protection Agency, 2002).

² The Porter argument claims that there is a potential win-win solution of more stringent regulation. Supporters of this “no cost” policy paradigm, such as Cairncross (1992), Schmidheiny (1992), and Porter and van der Linde (1995), propose that firms need to change from the view that environmental management is an extra cost to a new and broader perspective that it could improve competitiveness and in the end even increase competitiveness. Opponents of this view, like Gray and Shadbegian (1993), Walley and Whitehead (1994), and Palmer et al. (1995) say that it is costly to be “green” and allocating resources to environmental management means sacrificing economic performance.

regulation), and implement so called corporate social responsibility (CSR). CSR can generally be considered as firms' strategic management aiming to meet societal expectations and minimize negative environmental impacts without compromising competitiveness.³ In the last few decades, studies on whether CSR can contribute to firms' performance are flourishing, but evidence is not clear-cut.⁴ In any case, whether performance is driven by regulation or self-regulation (CSR), understanding the relationships between firms' environmental investments and the actual economic and environmental and energy performances is crucial when evaluating the impacts of environmental management in general.

Swedish industry contributes to about 20% of GDP and is an important piece of the country's economic growth (Naucier et al., 2012). The industry uses almost 40% of Sweden's final energy consumption. Although the energy use is mainly biofuels and electricity (from hydropower and nuclear), fossil fuel still constituted about 22% in 2011, and was responsible for 80% of the greenhouse gas emissions (Swedish Energy Agency, 2013). Due to the important role the industry has in the economy, and for the environment, there is an increasing demand in society for responsible business practices (Bénabou and Tirole, 2003, 2010; Besley and Ghatak, 2005).⁵ The empirical results drawn from this paper are based on data from a detailed firm-level data-set from Swedish manufacturing.

The aim of this paper is to estimate the relationships between firm performances in three dimensions - productivity, environmental performance, energy efficiency - and to evaluate the impacts of environmental investments. Further, our purpose is to investigate in detail the causal directions between these variables using a panel vector auto-regression (VAR) approach. This is to our knowledge the first comprehensive assessment of various aspects of firm performance and the role of environmental management in the literature. Environmental investment is here defined as a firm's efforts to reduce its environmental impact, i.e., improving environmental performance, which may in turn affect the firm's competitiveness in terms of change in productivity, and more (or less) efficient use of energy. We ground firm performance measurements in microeconomic production theory, and hence follow the advice of Paul and Siegel (2006) who are critical to the vast amount of studies using "subjective" CSR scores and financial performance rather than economic performance indexes (for this strand of literature, see overview in Margolis et al., 2009). Our production economic based approach, along with the panel VAR setting, is methodologically novel in studying issues connected to CSR, and it helps us discover new evidence when it comes to the relationship between environmental management, energy and environmental performance, and productivity.

In the empirical application, we use Malmquist type of indexes of productivity, environmental performance, and energy efficiency, to measure firm performance. Then we carry out a second stage regression analysis to study the relationships between the firm

performances and environmental investment. Recognizing that the Malmquist indexes are estimated rather than observed, and, as pointed out by Simar and Wilson (1999), that these indexes are biased,⁶ we adopt Simar and Wilson's bootstrap procedure to correct the estimated Malmquist indexes. Another objective of this study is to evaluate how the firm performances and environmental investment are causally related. Does an increase in environmental performance follow an increase in productivity or vice versa? Is there, as you would expect, a positive interaction between environmental investment and environmental performance? Are environmental performance and energy efficiency positively related? In this study, we address our research questions taking into account properly the dynamic dimension, which is in line with, e.g., Ambec et al. (2013) who argue that there is a lack of dynamic concern when assessing these types of relationships. To address this concern, in the second stage, we utilize a panel VAR methodology: an econometric model that can examine the causal and dynamic relationships between the variables of interest, and can handle the inherent endogeneity problem present in our empirical application. In principle, all variables we are examining are endogenous to the firm and simple correlations or an empirical methodology that does not account for the endogeneity problem will generate results that are not statistically sound. The VAR method enables us to investigate the relationships between the three performances and environmental investments without explicitly having to specify a rigorous, firm level, economic structural model.

The data-set used in the empirical analysis is a firm-level, industry-wide panel of Swedish manufacturing firms during the years 2002–2008. This data allows us to generate a deeper view of economic and environmental performance at the firm level, and enables us to estimate the relationships between firm performances and to evaluate specifically the impacts of environmental investments. As far as we know, this is the first study that uses a panel VAR approach to examine the causal and dynamic relationships of firm performances of this kind, and explicitly assess the role of environmental investment at the firm-level using an industry-wide collection of data.

The present study contributes to the literature in at least four respects. *i*) Firm performance is assessed in three dimensions on firm level – productivity (and its components), energy efficiency, and environmental performance. *ii*) The indexes that we use to measure firm performance are consistent in the sense that all are estimated using the Malmquist index approach, which is soundly grounded in production theory. *iii*) In exploring the relationships, we integrate the four variables of interest (including environmental investments/management) into a system of multiple, cross-sectional time series, and as such, our model allows for estimating the causal effects between all four variables, without requiring to, *a priori*, explicitly specify the causal directions. *iv*) We use a representative sample of firm-level, panel data consisting of 14 Swedish industry sectors, and thus our findings to a large extent are representative of the population of Swedish industrial firms as a whole, both in terms of environmental investments and firm performances.

The sum of the above contributions delivers unparalleled evidence on the covariation and causal relationships between different aspects of firm performance and environmental management, which adds novel and highly relevant empirical knowledge to the existing literature on environmental management and firm performance.

³ A nice collection of papers regarding the economics of CSR can be found in McWilliams (2015). This collection examined the five related and most significant elements of this subject - theoretical perspectives, firm financial performance, socially responsible investing, environmental performance and strategic CSR – to provide a comprehensive exploration of the literature on CSR and its economic consequences.

⁴ See discussions of motivations behind CSR and empirical evidence in e.g. McWilliams and Siegel (2000, 2001), Paul and Siegel (2006), Reinhardt et al. (2008), Margolis et al. (2009), Lundgren (2011), and Kitzmueller and Shimshack (2012).

⁵ From a societal welfare point of view, it is desirable that environmental management strategies meet environment needs, and meanwhile maintain competitiveness.

⁶ See detailed discussion of the lack of statistical underpinning of the calculated Malmquist indexes in Simar and Wilson (1999).

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