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Analysis

Effects of environmental regulation on actual and expected profitability ☆

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ABSTRACT

The Porter hypothesis asserts that properly designed environmental regulation motivates firms to innovate, which ultimately improves profitability. In this study, we test empirically the Porter hypothesis and the competing hypothesis that regulation undermines profitability ("costly regulation hypothesis"). In particular, we estimate the effect of clean water regulation, as reflected in the stringency of firm-specific effluent limits for two regulated pollutants, on the profitability of chemical manufacturing firms. As our primary contribution, we contrast the effect of clean water regulation on actual profitability outcomes and its effects on investors' expectations of profitability. Our results for actual profitability are consistent with the Porter hypothesis, while our results for expected profitability are consistent with the costly regulation hypothesis. Thus, our empirical results demonstrate that investors do not appear to value the positive effect of tighter clean water regulation on actual profitability.

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1. Introduction

Opposing theoretical arguments exist regarding the effect of environmental regulation on profitability. Porter and van der Linde (1995) assert that properly designed environmental regulation motivates firms to innovate, which ultimately improves profitability. As long as firms perceive their production processes and products as elements in a dynamic setting rather than a static setting, firms seize regulation as an opportunity to invest in technologies and techniques that not only minimize strains on the environment but also maximize the efficiency of production processes and/or improve the quality of products. The result is lower costs and/or higher revenues. This argument has become known as the Porter hypothesis.

The Porter hypothesis contradicts conventional wisdom, as articulated by studies such as Palmer et al. (1995). While critics of the Porter hypothesis concede that regulation does sometimes lead to cost savings or quality improvements and that firms do not always operate as efficiently as might be possible, the critics reject the notion that firms systematically operate inefficiently, arguing that firms voluntarily seek opportunities to improve profitability regardless of regulation. In particular, critics claim that environmental regulation generally undermines firms' abilities to pursue opportunities to improve profitability. We identify this opposing argument as the "costly regulation" hypothesis.

In this study, we test these two hypotheses by jointly assessing the effects of environmental regulation on two different aspects of profitability: actual profitability and expected profitability. Three previous studies explore one of these two aspects (Rassier and Earnhart, 2010a, 2010b, 2011), but no previous study explores the two aspects jointly. To capture actual profitability, we use an accounting-based measure of profitability, return on sales (i.e., profits divided by sales), which reflects results reported in a firm's financial statements. To capture expected profitability, we use a market-based measure of financial performance, Tobin's q (i.e., market value divided by replacement costs). This measure reflects investors' current expectations of profitability according to the discounted present value of a firm's future stream of profits, as demonstrated in the dividend discount model, which is based on efficient market theory. As our measure of environmental regulation, we use permitted wastewater discharge limits for two regulated pollutants — biochemical oxygen demand (BOD) and total suspended solids (TSS) — that are imposed on individual facilities according to state-level and industry-level criteria pursuant to the Clean Water Act (hereafter "clean water regulation").

While not necessarily one of the primary factors driving profitability, permitted discharge limits may have the potential to meaningfully

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influence profitability. Permitted discharge limits are commonly cited directly or indirectly as a risk factor in chemical firms' annual reports.[2] As important, pollution abatement and control expenditures are substantial. As a share of U.S. gross domestic product, total expenditures for pollution abatement and control were approximately 1.8% from the mid-1970s to the mid-1980s. Water pollution expenditures represent a sizable portion of overall expenditures. Specifically, in the chemical manufacturing sector, operating costs for water pollution abatement and control are a relatively large component of overall operating costs for pollution abatement and control. The share was approximately 30% in 1999 and 2005.[3]

Our analysis in this study contributes to the economic literature that studies the effects of environmental regulation on various aspects of firms such as innovation, financial performance, employment, productivity, investment and location decisions, and costs. In particular, our analysis in the present study builds on Rassier and Earnhart (2010a, 2010b, 2011). These previous studies examine the effect of environmental regulation on one, but not both, of the financial performance measures used in the present study. Moreover, relative to the present study, these previous studies use different data frequencies, panel estimators, regressor sets, and parameterizations of environmental regulation. Our primary contribution in this study is three-fold: (1) present a side-by-side comparison of the effects of environmental regulation on the return on sales and Tobin's q, (2) link these two outcomes by identifying return on sales as a measure of actual profitability and interpreting market value in Tobin's q as investors' current expectations of future profitability, and (3) employ behavioral finance theory for explaining the differences between the two sets of estimation results based on this identification of return on sales and interpretation of market value. Thus, the value added of our current study is not the exploration of new outcomes but the joint assessment of the two related outcomes. To strengthen our analysis, our study utilizes a panel data set. Thus, we are able to control more completely for heterogeneity across firms and exploit both inter-firm and intra-firm variation.

Our empirical results indicate that tighter clean water regulation (i.e., lower permitted discharge limits for BOD and TSS) generates higher returns on sales for chemical firms. In particular, a 10% decrease in an average firm's permitted discharge limit increases the average firm's return on sales by approximately 2%. In contrast, tighter clean water regulation reduces Tobin's q for chemical firms. A 10% reduction in the average firm's permitted discharge limit prompts a decrease of approximately 0.0076% in the average firm's Tobin's q ratio, which reflects a decrease in market value of approximately $1.8 million.

Our results for actual profitability are consistent with the Porter hypothesis, while our results for expected profitability are consistent with the costly regulation hypothesis. In particular, investors in chemical firms do not appear to value the positive effect of tighter clean water regulation on actual profitability. Instead, investors appear to expect a negative effect from tighter regulation. The difference in the effects of clean water regulation on actual profitability and Tobin's q are inconsistent with the Porter hypothesis and efficient market theory. In order to explore and interpret these differences more thoroughly, we employ insight from the behavioral finance literature, which uses "irrationalities" to explain investors' decisions.

2. The Effects of Environmental Regulation on Profitability

This section briefly describes the theories that seek to explain the influence of environmental regulation on profitability and the empirical studies that explore this influence.

2.1. Opposing Theoretical Arguments

Porter and van der Linde (1995) argue that properly designed and implemented environmental regulation ultimately improves profitability. In particular, environmental regulation removes the organizational inertia that impedes innovation. Once this inertia is removed, firms improve their resource productivity. Thus, firms seize regulation as an opportunity to develop and employ technologies and techniques that improve the efficiency of production processes and/or the quality of products. The former improvement decreases production costs and the latter improvement increases revenues.[4] This argument represents the thrust of the "Porter hypothesis".

From an economic point of view, the Porter hypothesis contradicts conventional wisdom. Consistent with this conflict, some economists question the validity of the Porter hypothesis. In particular, Palmer et al. (1995) reject Porter and van der Linde's (1995) broad assertion that environmental regulation removes organizational inertia by providing firms with information and incentives that competitive markets somehow systematically fail to provide. Instead, Palmer et al. (1995) posit that firms in general voluntarily seek profit-increasing opportunities regardless of regulation. This general claim aside, Palmer et al. (1995) concede that tighter environmental regulation may sometimes lead to cost savings because firms do not always operate efficiently or may lead to quality improvements because firms do not always fully appreciate market opportunities. Rather than a catalyst, environmental regulation generally serves only to constrain firms' abilities to pursue profit-increasing opportunities. As one specific consequence, firms facing more stringent regulation incur higher treatment costs (hereafter the "costly regulation hypothesis").

Additional studies explore the theoretical feasibility of the Porter hypothesis. In general, the studies rely on market failures to achieve outcomes predicted by the Porter hypothesis (Lanoie et al., 2011). Simpson and Bradford (1996) build a model that supports the Porter hypothesis when firms operate in imperfectly competitive markets. Ambec and Barla (2002) and Gabel and Sinclair-Desgagné (2002) demonstrate the validity of the Porter hypothesis in the presence of systematic organizational failures. Jaffe et al. (2005) and Mohr (2002) obtain theoretical outcomes consistent with the Porter hypothesis in cases of knowledge spillovers. King (1999, 2000) and King and Lenox (2002) explore particular aspects of the organizational behavior underlying the Porter hypothesis. Finally, Xepapadeas and de Zeeuw (1999) use a model of vintage capital to show that an emissions tax negatively affects profits.

2.2. Empirical Literature

Innovation is the first outcome in a series of three outcomes through which environmental regulation ultimately improves profitability according to the Porter hypothesis. The second outcome is measurable cost savings or revenue enhancements (i.e., "innovation offsets"). The third outcome is improved financial performance. While no empirical study comprehensively assesses all three outcomes, several studies empirically examine one of the three outcomes or related outcomes. Thus, we identify the studies in four sets. The first set of studies explores the effect of environmental regulation on innovation (Arimura et al., 2007; Brunnermeier and Cohen, 2003; Burtraw, 2000; Gray and Shadbegian, 1998, 2003; Jaffe and Palmer, 1997; Johnstone and Labonne, 2006; Lanoie et al., 2011; Nelson et al., 1993; Popp, 2010). A second set of studies looks at price premiums and costs, which can be roughly interpreted as innovation offsets (Ambec and Barla, 2006; Bjorner et al., 2004; Gray, 1987; Hazilla and Kopp, 1990; Jorgenson and Wilcoxen, 1990; Roe et al., 2001; Teisl et al., 2002). A third set of

[2] As examples, see the 2001 annual reports of four representative chemical firms: Dow Chemical, E.I. Du Pont de Nemours, Rohm & Haas, and Mississippi Chemical.

[3] The statistics cited here represent the most recent pollution abatement costs and expenditures published by the U.S. Bureau of Economic Analysis and the U.S. Census Bureau.

[4] In Porter and van der Linde's (1995, page 101) own words, properly designed regulation can lead to greater profitability because it induces "innovation offsets [that] can exceed the costs of compliance".