Charles University in Prague

Faculty of Humanities

Environmental Studies

Environmental policy and firm financial performance

PhD Thesis

Author: Mgr. *et* Mgr. Eva Horváthová

Supervisor: Doc. Ing. Lubomír Lízal, PhD.

Academic year: 2015/2016

Declaration of Authorship

I hereby declare that this dissertation thesis is my original work and that all sources and literature used are listed. This dissertation thesis has not been used to acquire a different or the same university degree.

Signature

Acknowledgements

I would like to gratefully acknowledge to all people who supported me during the Ph.D. studies, especially my family. I am also grateful to all, who contributed to the each paper included in the dissertation.

Moreover, the research of the paper “Does environmental performance affect financial performance? A meta-analysis” was supported with the research grant no. 402/09/2049 of Czech Science Foundation and no. 25309 of Grant Agency of Charles University.

The research leading to these results has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7/2007-2013/ under REA grant agreement number 609642.

Abstract

In my PhD thesis I investigate the relationship between corporates´ financial and environmental performances. The concept of quantitative environmental performance measures was introduced to enable to compare and analyse environmental impacts of different socio-economic units e.g. companies, countries, regions. In my dissertation, I use environmental performance measures to examine their effect on the financial performance of different companies.

In the first chapter, I apply a meta-analysis to examine the results of the previous studies which investigate the impact of firms´ environmental performance on their financial performance. The outcomes propose that it is important to account for the omitted variable bias such as unobserved firm heterogeneity. The results suggest that it takes time for the environmental regulation to materialize into the financial performance, too.

In the subsequent two chapters I study Czech firms over 2004-2008. First I study the intertemporal effects of corporates' environmental performance on financial performance controlling for the standard set of factors e.g. a company size, financials or an industrial sector. In this chapter I suggest an improved measure of firms´ environmental performance, which is comparable for most European countries. The results indicate that it takes more than one accounting period before firms can benefit from innovations and decreasing pollution.

In the last chapter I study why Czech firms voluntarily implement environmental management systems. I investigate both EMAS and ISO 14001 environmental management systems. The results indicate that environmental management systems are typically implemented by large firms and by those firms that initially pollute the environment more. On the other hand, I find no impact of the firm's financial performance and labor costs on the probability of environmental management systems implementation.

Keywords: environmental performance, corporates´ financial performance, environmental management systems, Czech Republic

Abstrakt

Ve své disertační práci zkoumám vztah mezi finančními výsledky firem a jejich vlivem na životní prostředí tzv. environmentální výkonností/profilem firem. Tato kvantitativní měřítka vlivu firem na životní prostředí se začala používat, aby bylo možné porovnávat vliv různých socio-ekonomických jednotek např. podniků, zemí, regionů, na životní prostředí. V disertační práci zkoumám vliv environmentální výkonnosti firem na finanční výkonnost těchto firem.

V první kapitole aplikuji meta-analýzu k analýze předchozích studií, které zkoumaly vliv environmentální výkonnosti na finanční výsledky těchto firem. Výsledky ukazují, že je třeba brát v úvahu vliv opomenutých proměnných jako například nezahrnutou heterogenitu firem. Výsledky také naznačují, že trvá určitý čas, než se ve finančních výsledcích firem promítne vliv regulací životního prostředí.

V dalších dvou kapitolách studuji české firmy v období let 2004-2008. Nejdříve zkoumám, jak se v čase mění vliv environmentální výkonnosti firem na jejich finanční výsledky. V práci používám standardně používané vysvětlující proměnné jako např. velikost firem nebo průmyslové odvětví, ve kterém firma podniká. V této kapitole navrhuji nové měřítko firemní environmentální výkonnosti, které je možné použít ve většině evropských zemích. Výsledky ukazují, že trvá více jak jedno účetní období než firmy mají prospěch z inovací a poklesu znečišťování životního prostředí.

V poslední kapitole zkoumám, proč české firmy dobrovolně používají environmentální systémy řízení podniků. Zkoumám jak EMAS, tak ISO 14001. Výsledky ukazují, že environmetální systémy typicky používají větší firmy a firmy, které zpočátku znečišťovaly životní prostředí více. Na druhou stranu nenacházím žádný vliv firemních finančních výsledků a mzdových nákladů na pravděpodobnost používání těchto systémů v českých podnicích.

Klíčová slova: environmetální výkonnost, finanční výkonnost firem,
environmentální systémy řízení podniků, Česká republika

Content

Introduction

The purpose of this introduction is to give a background of the topic of this dissertation – i.e. the interactions between an environmental and a financial performance and to introduce the three chapters included in the dissertation.

Since the publication of the Our Common Future in 1987 (a report published by the World Commission on Environment and Development) a sustainable development became one of the important challenges facing our world. The idea of sustainability promise a shift towards a world in which natural resources are preserved for the next generations. However, is the economic growth compatible with the environmental sustainability? This question is being studied on different levels since the introduction of the sustainability concept (Arrow et al., 1995; Brock and Taylor, 2005; Giannias et al., 2003; Grossman and Krueger, 1995). The sustainability on the corporate level has been broadly studied theoretically as well as the financial-environmental relationship has been empirically tested (for review of corporate sustainability research, see Salzmann et al., 2005).

Traditionally, the trade-off between the economic growth and the environmental regulation (as a tool to induce lower corporates´ environmental impacts) was presumed. To the theoretical debate on the corporates´ financial-environmental relationship, Michael Porter (Porter, 1991) introduce a new important concept in 1990s´. According to him, properly designed environmental regulation can lead to the win-win situations, in which both firms and environment gain (a social welfare increases by better conditions of environment and the private sector benefits through improved competitiveness). The idea of the Porter hypothesis is that properly designed environmental regulation can both impose cost on firms (e.g. production, compliance, managerial, labour and abatement cost) and also benefits in spurring innovations. The innovations can be both more environmental friendly and cost-saving, and so the savings can more than fully offset the increased cost.

Porter also emphasizes the dynamic view of an abatement to the regulation. While at the begging the compliance cost may rise, the potential for the offset can even growth faster, so the net cost of compliance can subsequently fall. According to Porter, the innovation offsets can occur either in process offsets (increase in the corporate productivity) or product offsets (superior products). The Porter hypothesis has been discussed extensively (both in academic and political discussions) since it suggests that the environmental protection and the sustainability is compatible with the economic growth (Ambec et al., 2011).

The academic discussion (for example Palmer et al. (1995), Porter and van der Linde (1995a,b), Walley and Whitehead (1994)), was accompanied with the empirical research examining the validity of this hypothesis (see for example Filbeck and Gorman (2004), Halkos and Sepetis (2007), Hart and Ahuja (1996), Konar and Cohen (2001)). One approach, how the Porter hypothesis is typically empirically tested, is the investigation of the impact of environmental regulation on the corporate profitability. Since the frequent lack of information on the changes in the environmental regulation, the environmental regulation is proxied (in some studies) by quantitative environmental performance measures (Ambec et al., 2011). Next, the environmental performance concept was introduce to compare environmental impacts of different companies and facilities. Tyteca (1996) define environmental performance indicators as "analytical tools that allow one to compare various plants in a firm, or various firms in an industry, with each other and with respect to certain environmental characteristics". Although the idea of environmental performance is very similar in various empirical and theoretical studies, several environmental performance measures have been used during the last decades of research (Tyteca, 1996). And as Wehrmeyer (1993) noted, "Science has not yet come forward with a universally accepted and absolute measure of how to compare and evaluate different environmental impacts.".

Although the effect of environmental regulation and performance (which often stands as a proxy for environmental regulation) on firms´ financial performance has been widely tested, the results are not still conclusive (Ambec et al., 2011, Konar and Cohen, 2001, Wagner, 2001). Interestingly, about half of relevant empirical studies find support for Porter hypothesis (i.e. better environmental performance improves financial performance), about 16% of studies rule out the validity of Porter hypothesis and the remaining studies find virtually no connection between environmental and financial performance. Considering the importance of the Porter hypothesis for the concept of sustainable development, the results of these primary studies is disturbing. Therefore, I examine why the primary studies differ so markedly in their results about the effect of environmental performance on financial performance in my dissertation. I also contribute with some additional empirical evidence on Porter hypothesis. Overall, the aim of this dissertation is to contribute to the ongoing debate on the environmental-financial performance.

To study this relationship I apply following different statistical frameworks. First, I statistically examine the regression results of the previous studies that investigate the impact of firms´ environmental performance on their financial performance. In the first chapter, I use a meta-analysis, specifically a meta-regression, which is recently widely used method to summarise and assess the vast empirical results of research in a comprehensive and rigorous manner (Nelson and Kennedy, 2009; Stanley and Jarrell, 1989). In the next two chapters, I study the effect of the environmental performance on the corporates´ financial performance using the firm-level data. I estimate various panel data models for a sample of Czech firms. Next, I describe each chapter of my dissertation in a greater detail.

In the first chapter titled **"Does environmental performance affect financial performance? A meta-analysis"**, I examine how corporates´ environmental performance affect their financial performance. Since the results are not conclusive after more than two decades of empirical research, I use a meta-analysis to summarize the relationship and examine the underlying differences among primary studies. More specifically, I investigate whether the methodological choice (e.g. the type of estimation method), or the data type (e.g. American vs. European studies) can influence the research outcomes. I also examine whether time coverage and the number of observations play a role in this heterogeneity. Next, I investigate both whether the relationship between the environmental performance and the financial performance has geographical elements and whether the type of environmental and financial variables used can influence the outcomes. I also control for whether the study was published in a refereed journal. The results indicate that the likelihood of finding a negative link (firms with greater environmental impacts are more profitable) significantly increases using the correlation coefficients and portfolio studies instead of more advanced econometric methods e.g. panel-data analysis. This result suggests that it is important to account for the omitted variable bias such as unobserved firm heterogeneity. The results also imply that appropriate time coverage is important in order to establish a positive link between the environmental performance and the financial performance (better environmental performance improves financial performance). This result suggests that it takes time for the environmental regulation to materialise into the financial performance.

In the subsequent two chapters I apply the same data set of the Czech firms over 2004-2008. The chapter **"The impact of environmental performance on firm performance: Short-term cost and long-term benefits?"** studies the intertemporal effects of corporates' environmental performance on financial performance. In this chapter I suggest an improved measure of firms´ environmental performance, which is based on the weighting various pollutants according to their dangerousness to environment. The newly proposed environmental performance measure is comparable for all European countries, which report to the European Pollutant Release and Transfer Register. Using this measure of the environmental performance applied to the firm level data from the Czech Republic, I find that decreased firms´ emissions deplete company profitability for the next year, but improve at the two years horizon. Altogether, the results support the Porter view of the impact of environmental regulation on firm financial performance in the long run. Notably, the results indicate that it takes more than one accounting period before firms can benefit from innovations and decreasing pollution.

The last chapter "**Why do firms voluntarily adopt environmental management systems? The case of the Czech Republic**" studies why firms voluntarily implement environmental management systems. I investigate both EMAS and ISO 14001 environmental management systems. I find that environmental management systems are typically implemented by large firms and by those firms that initially pollute the environment more. The probability of implementation of EMS is also influenced by the industry in which the company operates. On the other hand, I find a little support that the adoption of environmental management systems is influenced by the firm's financial performance and labor costs.

I am the sole author of all the chapters in this dissertation. The first chapter of this dissertation titled **"Does environmental performance affect financial performance? A meta-analysis"** was published as Horváthová (2010) in *Ecological Economics*. The article has been widely cited in many well-established journals with the impact factor. The Google Scholar reports that this paper was cited 115 times (as of November 2, 2015).

The second chapter of this dissertation **"The impact of environmental performance on firm performance: Short-term cost and long-term benefits?"** was also published in *Ecological Economics* as Horváthová (2012). According to Google Scholar, the article was cited 18 times (as of November 2, 2015).

The last chapter of my dissertation "**Why do firms voluntarily adopt environmental management systems? The case of the Czech Republic**" is not published in journal yet. It was presented at 16th International Conference of Postgraduate Students, Young Scientists and Researchers, University of Economics in Prague.

Literature

Ambec, S., Cohen, M. A., Elgie, S., Lanoie, P. 2011. The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? Resources for the Future Discussion Paper 11-01.

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C.S., Jansson, B.-O., Levin, S., Maler, K.-G., Perrings, C., Pimental, D. 1995. Economic Growth, Carrying Capacity, and the Environment. Science 268, 520-521.

Brock, W. A., Taylor, M. S., 2005. "Economic Growth and the Environment: A Review of Theory and Empirics," Handbook of Economic Growth, in: Philippe Aghion & Steven Durlauf (ed.), Handbook of Economic Growth, edition 1, volume 1, chapter 28, pages 1749-1821 Elsevier.

Filbeck, G., Gorman, R.F., 2004. The relationship between the environmental and financial performance of public utilities. Environmental and Resource Economics 29, 137–157.

Giannias, D.A., Liargovas, P., Alexandrovich, C.Y., 2003. Economic Growth and the Environment: The European Union Case. The Journal of Developing Areas, 37(1): 1-12.

Grossman, G., M., Krueger, A.B., 1995. Economic Growth and the Environment. The Quarterly Journal of Economics 110, 353-377.

Halkos, G., Sepetis, A., 2007. Can capital markets respond to environmental policy of firms? Evidence from Greece. Ecological Economics 63, 578–587.

Hart, S.L., Ahuja, G., 1996. Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Business Strategy and the Environment 5, 30–37.

Horváthová, E., 2010. Does environmental performance affect financial performance? A meta-analysis. Ecological Economics 70, 52-59.

Horváthová, E., 2012. The impact of environmental performance on firm performance: short-term costs and long-term benefits?. Ecological Economics 84, 91-97.

Konar, S., Cohen, M.A., 2001. Does the market value environmental performance? Review of Economics and Statistics. 83 (2), 2814–2890.

Nelson, J.P., Kennedy,P.E., 2009. The use (and abuse) of meta-analysis in environmental and natural resource economics: an assessment. Environmental & Resource Economics 42 (3), 345–377.

Palmer,K.,Oates,W.E.,Portey,P.R.,1995.Tightening environmental standards: the benefit- cost or the no-cost paradigm? Journal of Economic Perspectives 9(4), 119–132.

Porter, M.E., 1991. America's green strategy. Scientific American 264 (4), 96.

Porter, M.E., van der Linde, C., 1995a. Green and competitive: ending the stalemate. Harvard Business Review 73 (5), 120–134.

Porter, M.E., van der Linde, C., 1995b. Toward a new conception of the environment– competitiveness relationship. Journal of Economic Perspectives 9 (4), 97–118.

Salzmann, O., Ionescu-Somers, A., Steger,U., 2005. The Business Case for Corporate Sustainability: Literature Review and Research Options. European Management Journal 23(1), 27–36.

Stanley, T.D., Jarrell, S.B., 1989. Meta-regression analysis: a quantitative method of literature surveys. Journal of Economic Surveys 3 (2), 161–170.

Tyteca, D., 1996. On the Measurement of the Environmental Performance of Firms – A Literature Review and a Productive Efficiency Perspective. Journal of Environmental Management 46, 281-308.

Wagner, M., 2001. A review of empirical studies concerning the relationship between environmental and financial performance. What Does the Evidence Tell Us?. Center for Sustainability Management. 52 pp.

Walley, N., Whitehead, B., 1994. It's not easy being green. Harvard Business Review. 46–52.

Wehrmeyer, W., 1993. The scientific measurement of environmental performance. Paper presented to ESRC workshop on Environmental Performance Measurement and Reporting, University of Wolverhampton, U.K., 25 August 1993.

World Commission on Environment and Development. 1987. *Our common future.* Oxford University Press.

List of tables

1. Does environmental performance affect financial performance? A meta-analysis

Abstract

What do we know about the impact of environmental regulations/performance on firm performance? After more than three decades of theoretical as well as empirical research, the results seem to remain inconclusive. Some papers suggest that regulations harm firms, while others claim that regulations may contribute positively and give an impetus to innovations. Therefore, I examine the heterogeneity in financial - environmental performance nexus, empirically carrying out a meta-regression analysis of 64 outcomes from 37 empirical studies to uncover the underlying factors, which can influence the observed variation in the empirical results. The results suggest both that the empirical method used matters for the nexus and that the likelihood of finding a negative link between environmental and financial performance significantly increases when using simple correlation coefficients instead of more advanced econometric analysis. The results also indicate that the portfolio studies tend to report a negative link between environmental and financial performance. This likely reflects the omitted factors in portfolio studies. The positive link is found more frequently in common law countries than in civil law countries. The results also point to the importance of appropriate time coverage to establish a positive link between environmental and financial performance.

1.1 Introduction

How does environmental performance/regulation (EP) affect financial performance (FP)? After more than three decades of theoretical as well as empirical research, the results still seem to be inconclusive (Konar and Cohen, 2001, Wagner, 2001). Regarding the theory, researchers within the neoclassical school argue that environmental regulation imposes additional costs for firms (Palmer et al. 1995, Walley and Whitehead, 1994). Standard neoclassical theory argues that improved EP leads to an increase in costs. This view is based on the premise that pollution abatement and environmental improvements have decreasing marginal net benefits. On the other hand, Porter (1991) puts forward that environmental regulation can lead to win-win situations in which both social welfare as well as private benefits of firms increase. Similarly, Porter and van der Linde (1995a, 1995b) argue that properly designed environmental regulation may give rise to innovations, which can partly or fully offset the cost of complying with environmental law. They claim that environmental innovations are likely to happen because pollution is a sign of economic inefficiency. However, these two views (a negative "traditionalist" vs. a positive "revisionist" relationship between EP and FP) are challenged by a third line of thought that proposes an inverse U-shaped relationship (Lankoski, 2000, Wagner, 2001). This view predicts a positive relationship between EP and FP up to the level of EP where economic benefits are maximised. In addition, McWilliams and Siegel (2001) argue for a neutral relationship between social and FP because firms that do not invest in social responsibility will have lower costs and lower prices, while firms that invest in social responsibility will have higher costs but will have customers eager to pay higher prices.

On the empirical side, King and Lenox (2001), Konar and Cohen (2001), Russo and Fouts (1997) find that it pays to be green, that is, EP contributes positively to the FP, while others find the opposite, such as Cordeiro and Sarkis (1997), Jaggi and Freedman (1992), Stanwick and Stanwick (1998) and some authors cannot reach a clear conclusion, such as Cohen et al. (1997), Earnhart and Lizal (2007a) or Wagner (2005). Nevertheless, Wagner (2001) notes that previous literature reviews indicate a moderate positive relationship between EP and FP or that no systematic relationship exists. On the other hand, Cordeiro and Sarkis (1997) note that previous empirical evidence tends to find a short-term negative relationship, while long-term impacts appear to be more promising.

The explanations for why empirical results between EP and FP are inconclusive vary as well. For example, Konar and Cohen (2001) argue that early empirical studies suffer from several problems, such as a small sample size and the lack of objective environmental criteria. Cohen at al. (1997) explain that a lack of objective criteria to evaluate EP also exists. Other problems with early studies are that they often did not account for important moderating factors such as the firm size or country location (Wagner 2001). Filbeck and Gorman (2004) suggest that the contradictory findings are influenced by the fact that environmentally efficient companies can be efficient in other production processes as well. Another considerable factor is that successful companies can spend more on environmentally friendly technologies. Griffin and Mahon (1997) point out to the difficulty of generalising the results of particular studies because of the absence of clear definitions of EP and FP. Another problem with empirical studies is that some studies omit certain variables that influence profitability (Elsayed and Paton, 2005). Derwall et al. (2005) and Ullman (1985) note that inconclusive research outcomes are mainly explained by both different methodologies as well as financial and environmental variables.

To my knowledge, the underlying factors behind the variation in the results on the link between EP and FP have not been studied systematically. Therefore, in this paper, I bridge this gap in the literature and empirically address the heterogeneity in the financial – environmental nexus within the meta-regression analysis of financial and environmental performance.

A meta-analysis is a recently widely used method to summarise and assess the vast empirical results of research in a comprehensive manner. While it originated in the medical research, meta-analysis has also been extensively applied in economics in recent decades (Stanley, 2001, Stanley and Jarrell, 1989). In economics, meta-regression is used especially to model heterogeneity in empirical outcomes (Stanley, 2001). As a result, the outcomes of each study are explained by the characteristics of the study, such as the econometric methods, the country coverage or the type of variables employed. Meta-regression can thus shed light on the underlying reasons of study-to-study variations. For example, Florax et al. (2005) use meta-regression to investigate the variations in willingness to pay for reduced pesticide-risk exposure. Debrezion et al. (2007) use meta-analysis to evaluate the impact of railway stations on the property value. Frooman´s (1997) meta-analysis of 27 event studies finds that corporate social irresponsibility significantly decreases shareholders' wealth. Applying meta-analysis, Cavlovic et al. (2000) find that both methodological choice and pollutant types affect the estimates of the environmental Kuznets curve. Li et al. (2007) also reach similar conclusions based on an extended sample of Cavlovic et al.'s (2000) data. Recently, Richardson and Loomis (2009) have provided a meta-analysis of economic value of threatened, endangered and rare species. An extensive overview of meta-analysis in environmental and resource economics is available in Nelson and Kennedy (2009).

In this paper, I employ a meta-analysis framework to uncover the factors underlying the heterogeneity in environmental and financial nexus observed in empirical studies. Using the meta-regression analysis, I investigate whether the methodological choice (e.g., the type of estimation method) or the data type (e.g., American vs. European studies) can influence the research outcomes. The methodological choice is represented with different estimation methods, such as correlation coefficients or panel data models. I also examine whether time coverage and the number of observations play a role in this heterogeneity. Next, I investigate both whether the relationship between EP and FP has geographical elements to shed light on the potential differences in law systems (Di Vita, 2009) as well as whether the type of environmental and financial variables used can influence the outcomes. I also control for whether the study was published in a referred journal.

The paper is organised as follows. In section 1.2, I describe the data and econometric methodology. Section 1.3 summarises the empirical results. Conclusions are provided in section 1.4. An appendix with descriptive statistics and the details on the papers included in the meta-analysis follows.

1.2 Data and methodology

1.2.1 Data

Studies to be included in the meta-analysis were identified by the extensive literature search during the period December 2008 – February 2009. Scopus, Econlit, Google Scholar, RePEc as well as extensive Internet search and cross-references were examined. The primary criterion for selection was that the paper empirically investigates the impact of EP on FP, irrespective of the particular quantitative method employed. The baseline estimates do not include studies that only approximate EP with environmental certification or the adoption of an environmental policy because the link between EP and environmental certification or the adoption of environmental policy is not necessarily correlated with better EP (see, e.g., Darnall and Sides, 2008). Nevertheless, in order to test the sensitivity of the results, an extended sample that also includes studies based on participation in an environmental program or the adoption of environmental policy is also examined. Appendix A reports the complete list of environmental variables employed in each study used. The studies published in refereed journals as well as papers presented in conferences or published as a working papers are included to compare the outcomes of published and unpublished papers. A similar approach was adopted or recommended, for example by Stanley (2001) and Woodward and Wui (2001).

In this study, I analyse the outcomes of regression analyses and portfolio studies and not event studies. This is motivated by the fact that regression and portfolio studies usually examine long-term (in months or years) relationships between EP and FP and event studies examine short-term (in days) stock-market reactions. For a meta-analysis of event studies, see Frooman (1997). Given that social responsible portfolios are set up not only on environmental criteria but also on, for example, nuclear involvement, military works, family benefits, charitable giving, and so on, the EP of the included companies is not straightforward, studies that compare returns of socially responsible portfolios and “standard” portfolios are not included as well. The final sample consists of 64 outcomes from 37 empirical studies. For comparison, the sample is thus largely comparable to other well-known meta-analyses, such as

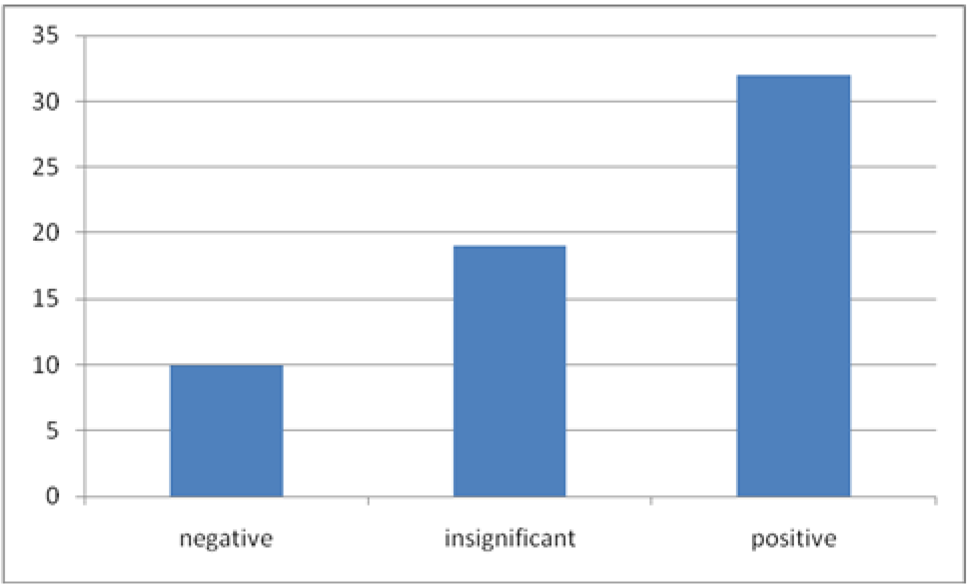
Darnall and Sides (2008), who use 9 studies, Ashenfelter et al. (1999), who employ 96 different outcomes from 27 studies and Egert and Halpern (2006), who utilise 32 research papers.

Each study was carefully examined to identify the estimated relationship between EP and FP and factors that can influence it (number of years, country coverage, variables used, etc.). Because studies generally involve more than one model specification, each study was examined for whether the results are stable across the specifications and whether some general conclusion can be determined from the study. If one paper reached different results in terms of the EP-FP nexus, then more results were included in the meta-analysis for one study. If one study identified, for example, no relationship for model specifications without a lagged EP but a positive relationship for the specifications with lagged EP, then the study was included only twice in spite of more than two model specifications in the primary study. To deal with the possible over-representation of primary studies that reach heterogeneous findings, I employed the ordered probit estimation technique with sampling weights (more on the estimation below).

The explanatory variables can be classified as either the methodological or data type. Methodologically independent variables include the estimation method: multiple regressions – cross-section or pooled estimates (30 observations), correlation coefficients (4 observations), panel data analysis (14 observations), portfolio studies (12 observations) and 3SLS (4 observations). The data-type explanatory variables characterise the data used in primary studies: the number of years and number of observations employed, information on whether the paper was published in a refereed journal, country coverage (North America vs. Europe), the type of financial variable used (accounting vs. market-based or the mixture of market-based and accounting), the type of environmental variable (qualitative or quantitative), the year of publication and the number of lagged years of the environmental variable. A dummy variable was constructed for each estimation method. All of the above-mentioned explanatory variables are dummy variables other than the number of years, the date of publication, the number of lagged years and the number of observations.

Descriptive statistics are reported in Appendix B. Graph 1 shows a great variation in FP-EP nexus. There were 35 positive relationships found between EP and FP, 10 negative relationships and 19 insignificant relationships. The meta-analysis is based on 30 US and Canadian studies (48 observations) but on only 7 European studies (16 observations). Asian studies were included only in the extended sample, which also includes studies that approximate EP with environmental certification or the adoption of environmental policies. The extended sample consists of 33 US and Canadian studies (57 observations), 9 European studies (19 observations) and 3 Asian studies (19 observations).

Graph 1.1 The number of negative, positive and insignificant relationships found between environmental and financial performance.



1.2.2 Methodology

Meta-analysis is an extensively used statistical method for combining the results of several empirical studies with related research hypotheses; see, for example, Cavlovic et al. (2000), Darnall and Sides (2008), Li et al. (2007), Mulatu et al. (2001), Orlitzky and Benjamin (2001), Richardson and Loomis (2009), Stanley (2001) or Stanley and Jarrell (1989). For an overview of meta-analysis in environmental and resource economics, see Nelson and Kennedy (2009).

Among meta-analysis researchers, there is no clear consensus about the selection process of observations. Some authors prefer only one observation per study, such as EPA (2006) and Stanley (2001), while other authors, such as Babetskii and Campos (2007), Florax et al. (2005), include all available estimates. The first meta-studies used only one observation per study (Stanley, 2001), while more than one or all available observations are currently used, as in Doucouliagos and Stanley (2009). However, Nelson and Kennedy (2009) note that the majority of meta-analyses in environmental economics utilise multiple observations from each primary study (which is also the case in this article). Still, after conducting Monte Carlo simulation, Bijmolt and Pieters (2001) recommend to use multiple observations because using only a single observation per each primary study leads to a serious loss of information.

Because I am interested in the direction of the effect of EP on FP rather than in the magnitude of the effect, I employ the ordered probit method to assess the determinants of the overall effect. A similar study design in meta-analysis to study the directional effect has been conducted, for example, by Babetskii and Campos (2007) or Jeppesen et al. (2002). The dependent variable is coded as follows. The studies that identify a negative impact of EP on FP were assigned the value of -1. The studies that find a positive impact were assigned 1, and studies with insignificant impact were assigned 0.

In this paper, a higher environmental impact of a firm, such as, higher emissions leads to a lower EP (and vice versa). As a result, the positive relationship between EP and FP means that a company with a lower environmental impact (higher EP) has better (higher) financial results. This approach was chosen due to its intuitive perception (pollution is often viewed as a sign of inefficiency and a waste of resources, such as Porter (1991) or Porter and van der Linde (1995b), so the EP variable can be seen also as a measure of efficiency – a less efficient firm pollutes more, so it has lower EP) and because this set up is generally used (Ambec and Lanoie, 2008 or Wagner, 2001).

Because some studies are involved only once, whereas other studies are represented with more observations, the ordered probit with sampling weights was used to estimate the model. Sampling weights are important because, as Nelson and Kennedy (2009) note, using multiple observations from one study is likely to cause econometrical problems because estimates from the same study are likely to be correlated. On the other hand, this issue mainly causes problems in studies that study an aggregate effect in contrast to studies that explain heterogeneity among studies. Similarly, Bloom and Idson (1991) note that standard errors are biased if sampling weights are ignored. A recent application of this weighting scheme within ordered probit model is provided by Case et al. (2008). The weight is thus equal to 1/number of regression specifications used per each primary study. The following model was estimated:

$Pr(Y_i = j|X_i, \beta_j) = \Phi(X'\beta) + \varepsilon_v$

where

Y is a categorical variable capturing the relationship between EP and FP identified within a primary study

Y=1 for positive relationship between EP and FP

Y=0 for no relationship

Y=-1 for negative relationship

X_i is a vector of explanatory variables such as the number of years, estimation method, a country or the type of financial variable.

I hypothesise that the results will be influenced by the econometric method employed. I suppose that different outcomes are obtained using multiple regression, simple correlation coefficients or panel data methods. From the methodological point of view, the panel data methods are more preferable because they attempt to control for firm-specific unobserved time-invariant factors. As a result, the panel data technique can alleviate the omitted variable problem that is likely to arise from studying the impact of EP on FP. Some authors of the studies included in the meta-analysis compare the results of different methods, for example, Salama (2005) or Telle (2006), and find that the estimation method instead matters for the results.

Di Vita (2009) shows that in industrialised countries with common law system, there is less pollution than in the countries of civil law system. He interprets this finding with the better protection of creditors and investors under the common law system. Within the context of Di Vita (2009), I expect that in the countries with common law systems, it is more likely that there will be a positive relationship between EP and FP.

Next, because it is likely that it takes time until the improved EP is translated into FP, I expect that using lagged environmental variables will have impact on the results. This view is consistent with many studies that use lagged environmental variables, such as Earhart and Lízal (2007b), Hart and Ahuja (1996), Konar and Cohen (2001). For example, Hart and Ahuja (1996) find that there is no relationship between EP and FP in the model without a lagged environmental variable, while there is a positive relationship in the model with the lagged environmental variable. Because the different lags are used, I examine the number of lagged years used in each study. Alternatively, I also introduce a simple dummy variable, which takes the value of one if the lag environmental variable is included and zero otherwise. In the same venue, I expect that the longer time period likely results in a higher probability that the positive impact of EP on FP will be detected.

Another factor that is likely to influence the results is a type of financial variable used. In fact, I can distinguish between three basic types of financial variables – accounting variables (return on assets, return on equity and return on sales are used most frequently), market-based variables, such as stock-market returns or the price to earnings ratio, and a mixture of accounting and market-based variables (Tobin´s Q is used in most cases). I suppose that financial variables containing market expectations (market-based and mixture of accounting and market based) will have a significantly different impact on the estimations because they contain market expectations in addition to rather backward-looking accounting information. However, I do not hypothesise on the direction of the effect.

Next, another supposition is that the type of environmental variable can also influence the results. Cavlovic et al. (2000) demonstrate that the pollutant type affects the detected shape of the environmental Kuznets curve. I suppose that there will be a different impact from using a qualitative environmental variable (which mainly includes environmental ratings) and a quantitative environmental variable, such as the volume of waste generated or the amount of air emissions.

1.3 Results

Table 1.1 reports the results of ordered probit with sampling weights[1]. More specifications are presented to shed light on the stability of the results. The first specification contains all explanatory variables. The second specification contains all explanatory variables as well, but it is estimated for the extended sample, which also includes the studies that approximate EP with environmental certification or adoption of environmental policy. The last two specifications do not include selected explanatory variables. More specifically, the third specification does not include the explanatory variable “number of observations”, and the fourth specification does not contain a variable “number of years” to detect the influence of estimation method because panel data and regressions are more likely to be employed with the longer time coverage. In addition, more treatments were evaluated without significant changes in the results. This includes the elimination of various insignificant explanatory variables, different environmental variable classification, the inclusion of only one dummy for both correlation coefficients and portfolio studies (i.e., the estimation methods with potentially higher omitted variable bias) or the inclusion of the dummy variable for lagged environmental variable instead of “number of years lagged”. These results are discussed below and are available upon request.

The results indicate that the outcomes are largely stable across model specifications. The results suggest that the likelihood of finding a negative link between EP and FP significantly increases if the primary study employs correlation coefficients and in the portfolio studies (the results do not change significantly if we include only one

[1] I carried out an approximate LR test to examine the appropriateness of parallel slopes. The null hypothesis of parallel slopes has never been rejected. Nevertheless, it has to be kept in mind that this test has not been structured for the case of sampling weights.

dummy variable for both correlation and portfolio studies). This may be due to the possible omitted variable bias in these studies. For example, comparing only the stock market returns of firms that differ in EP, we omit many possible factors, such as the size of the company or industry sector, which are likely to influence the results. On the other hand, using multiple regressions or panel data, there is no statistical effect on the outcome.

The results also point to the importance of an appropriate time coverage, which is captured by the variable "no. of years" in order to establish a positive link between EP and FP. However, using lagged environmental variables, which are captured by "number of years lagged", has no statistical effect on the results. These results remain unchanged if we include a dummy variable "lagged environmental variable" instead of "number of years lagged". The result that lagged environmental variable has no impact is somewhat unexpected because it is widely argued that it takes time for EP to be transformed into FP. Also, "number of observations" is not statistically significant at conventional levels.

There seems to be no impact of using different financial variables or from whether the paper was published in referred journal. The lack of impact of different FP variables is a bit surprising because both accounting and market-based variables contain somewhat different pieces of information. Stock market returns represent true gains to shareholders (dividends paid out or appreciated stock prices), while accounting returns cannot be directly realised by shareholders. Next, stock market returns are not subject to different accounting techniques and can be compared directly across firms.

The positive link between EP and FP is found more frequently in studies that use a qualitative environmental variable. The results remain nearly unchanged when the different environmental variable classification is applied (i.e. rating vs. otherwise). The qualitative measures contain more information than the amount of emission a company emits. However, the information can be rather subjective and does not need to be highly correlated with the company's actual impact on the environment.

The positive link is also found more frequently in common law countries (US, Canada and UK) than in civil law countries. This finding is in line with Di Vita (2009), who finds that in developed countries under common law systems, there is lower pollution compared with developed countries under civil law systems. The results indicate that the outcomes do not change much if the UK studies are excluded from this set. The difference between European and American studies can also be caused by the different geographical factors in America and Europe. However, Theyel (2000) finds that organisational factors play a more significant role in the adoption of environmental practices rather than in geographical ones. Similarly, Florida et al. (2001) find little evidence that geographical factors, such as spatial clustering or agglomeration, affect the adoption of environmental practices. It is also demonstrated that the shape of the environmental Kuznets curve differs among countries (Cavlovic et al. 2000). Cavlovic et al. (2000) find that using data from developed economics and the sample size significantly affect the shape of the environmental Kuznets curve.

Finally, the results also indicate that the year of a study's publication (which captures the possible temporal patterns in the research agenda as well as the changes in technology adoption) has no significant influence on the results.

Tab. 1.1 Meta-analysis regression: What matters for EP-FP nexus?

	[1]	[2]	[3]	[4]
Number of observations	0.00	0.00		0.00
	(0.00)	(0.00)		(0.00)
Estimation m. –regression	-1.30**	-0.92	-0.79	-1.01
	(0.63)	(0.63)	(0.63)	(0.62)
Estimation m. –panel data	-0.61	-0.79	-0.21	-0.20
	(0.62)	(0.61)	(0.61)	(0.6)
Estimation m. –correlation coef.	-2.59***	-2.01***	-1.96**	-2.29**
	(0.90)	(0.73)	(0.90)	(0.90)
Estimation m. - portfolio studies	-2.39***	-1.84**	-1.40*	-1.82**
	(0.85)	(0.83)	(0.83)	(0.80)
Number of years	0.15**	0.10*	0.12**	
	(0.06)	(0.05)	(0.06)	
Number of lagged years	0.38	0.36	0.12	0.22
	(0.32)	(0.29)	(0.27)	(0.29)
US+Canada	1.45***	1.34**		1.03**
	(0.51)	(0.58)		(0.52)
EU		0.41		
		(0.53)		
US+Canada+UK			0.82*	
			(0.45)	
Type of financial var. - accounting	-0.10	-0.32	-0.35	-0.12
	(0.50)	(0.37)	(0.44)	(0.50)
Paper published in ref. journal	-0.71	-0.55	-0.58	-0.54
	(0.64)	(0.48)	(0.55)	(0.53)
Type of environmental var. - qualitative	1.24***	0.83**	0.68	1.13***
	(0.42)	(0.39)	(0.43)	(0.40)
Year of publication	0.02	0.01	0.01	-0.02
	(0.04)	(0.03)	(0.03)	(0.04)
Number of observations	63	94	64	63
Pseudo R2	0.23	0.18	0.17	0.19

Note: Order-probit estimates with sampling weights. Dependent variable is categorical variable capturing the relationship between environmental and financial performance identified within a study. Standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

1.4 Conclusion

In this paper, I examine why the results of more than three decades of research on environmental-financial performance are still inconclusive. I perform a meta-analysis of 64 outcomes from 37 empirical studies to uncover the underlying factors that influence the variation in the empirical results in terms of EP-FP. The results suggest that the likelihood of finding a negative link between EP and FP significantly increases when using the correlation coefficients and portfolio studies. On the other hand, the use of multiple regressions and panel data technique has no effect on the outcome. This suggests that it is important to account for omitted variable biases such as unobserved firm heterogeneity. The results also suggest that appropriate time coverage is important in order to establish a positive link between EP and FP. This suggests that it takes time for environmental regulation to materialise in financial performance (Hart and Ahuja, 1996, Konar and Cohen, 2001).

The positive link between EP and FP is found more frequently in common law countries than in civil law countries. This finding is in line with Di Vita (2009), who finds that in the developed countries under common law systems, there is lower pollution compared to the developed countries under civil law systems. The difference between European and American studies can be also caused by the different geographical factors in America and Europe. However, Theyel (2000) finds that organisational factors play a more significant role in the adoption of environmental practices than in the adoption of geographical ones. Similarly, Florida et al. (2001) find little evidence that geographical factors such as spatial clustering or agglomeration affect the adoption of environmental practices.

It does not seem to be important which type of financial performance is used. On the contrary, the type of EP matters. The meta-regression analysis shows that if the primary study employs qualitative measures of EP, it is a more likely to find a positive impact of EP on FP. The results also do not depend on whether the particular paper was published in a refereed journal. Similarly, there is no evidence of temporal patterns in the findings of primary studies.

In terms of future research, it would be fruitful to investigate whether the EP-FP nexus differs across the industries. However, this task is far from easy because the majority of studies deal with more than one industry, and it is difficult to identify the impact of various industries. Next, in the context of Di Vita (2009), it would also be interesting to shed more light on how legal systems contribute to the EP-FP nexus. Another research task is to investigate the relationship between EP and FP in a variety of different functional models and the impact of different EP measures, such as in research on the environmental Kuznets curve.

Acknowledgements

I thank Roman Horváth, Tomáš Havránek, Lubomír Lízal, Jan Melichar, Milan Ščasný, Fusako Tsuchimoto, seminar participants at the Charles University Environment Centre, at the 11th International Conference of Postgraduate Students, Young Scientists and Researchers, University of Economics in Prague and at the 45th Meeting of Euro Working Group on Financial Modelling, Technical University of Crete and two anonymous referees for helpful comments. The research is supported with research grant no. 402/09/2049 of Czech Science Foundation and no. 25309 of Grant Agency of Charles University.

1.5 References

*Al-Tuwaijri, S., Christensen, T.E., Hughes II, K.E., 2004. The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach. Accounting, Organizations and Society 29, 447–471.

Ambec, S., Lanoie, P., 2008. Does it pay to be green? A systematic overview. Academy of Management Perspectives 22(4), 45-62.

Ashenfelter, O., Harmon, C., Oosterbeek, H., 1999. A review of estimates of the schooling/earning relationship, with tests for publication bias. Labour Economics 6 (4), 453-470.

Babetskii, J., Campos, N.F., 2007. Does Reform Work? An Econometric Examination of the Reform-Growth Puzzle. IZA Discussion Paper No. 2638.

*Barth, M.E., McNichols, M.E., 1994. Estimation and Market Valuation of Environmental Liabilities Relating to Superfund Sites. Journal of Accounting Research Vol. 32 Supplement 1994, 177-209.

*Bhat, V.N. 1998. Does environmental compliance pay? Ecotoxicology 7, 221-225.

Bijmolt, T.H.A., Pieters, R.G.M., 2001. Meta-analysis in marketing when studies contain multiple measurements. Marketing Letters 12(2), 157-169.

*Blank, H.D., Daniel W.E., 2002. The Eco-Efficiency Anomaly. Quantitative Evaluation & Development. 15 p.

Bloom, D.E., Idson, T.L., 1991. The Practical Importance of Sample Weights. American Statistical Association. Proceedings of the Section on Survey Research Methods, 620-624.

Case, A., Lee, D., Paxson, C., 2008. The income gradient in children's health: A comment on Currie, Shields and Wheatley Price. Journal of Health Economics 27, 801–807.

Cavlovic, T.A., Baker, K.H., Berrens, R.P., Gawande, K., 2000. A meta-analysis of environmental Kuznets curve studies. Agricultural and Resource Economics Review 29(1), 32–42.

*Chen, K.H., Metcalf, R.W., 1980. The Relationship Between Pollution Control Record and Financial Indicators Revisited. The Accounting review 55(1), 168-177.

*Cohen, M.A., Fenn, S.A., Konar, S., 1997. Environmental and Financial Performance: Are They Related? WP Vanderbilt University. 40 p.

*Cordeiro, J.J., Sarkis, J., 1997. Environmental proactivism and firm performance: evidence from security analyst earnings forecasts. Business Strategy and the Environment 6, 104-114.

*Cormier, D., Magnan, M., 1997. Investors' Assessment of Implicit Environmental Liabilities: An Empirical Investigation. Journal of Accounting and Public Policy 16, 215-241.

*Cormier, D, Magnan, M., Morard, B., 1993. The impact of corporate pollution on market valuation: some empirical evidence. Ecological Economics 8, 135-155.

**Curcio, R.J., Wolf, F.M., 1996. Corporate environmental strategy: impact upon firm value. Journal Of Financial And Strategic Decisions 9(2), 21-31.

Darnall, N., Sides, S.S., 2008. Assessing the Performance of Voluntary Environmental Programs: Does Certification Matter? Policy Studies Journal 36(1), 95-117.

Debrezion, G., Pels, E., Rietveld, P. 2007. The impact of railway stations on residential and commercial property value: A meta-analysis. Journal of Real Estate Finance and Economics 35, 161-80.

*Derwall J., Guenster, N., Bauer, R., Koedijk, K., 2005. The eco-efficiency premium puzzle. Financial Analyst Journal 61(2), 51-63.

Di Vita, G. 2009. Legal Families and Environment Protection: Is there a causal relationships? Journal of Policy Modeling 31(5), 694-707.

*Diltz, D.J., 1995. The private cost of socially responsible investing. Applied Financial Economics 5, 69-77.

Doucouliagos, H., Stanley, T.D., 2009. Publication Selection Bias in Minimum-Wage Research? A Meta-Regression Analysis. British Journal of Industrial Relations 47(2), 406-428.

*Dowell, G., Hart, S., Yeung, B., 2000. Do Corporate Global Environmental Standards Create or Destroy Market Value? Management Science 46(8), 1059-1074.

*Earnhart, D., Lizal, L., 2007a. Effect of Pollution Control on Corporate Financial Performance in a Transition Economy. European Environment 17, 247–266.

*Earnhart, D., Lizal, L., 2007b. Does Better Environmental Performance Affect Revenues, Cost, or Both? Evidence From a Transition Economy. William Davidson Institute Working Paper Number 856.

Egert, B., Halpern, L., 2006. Equilibrium exchange rates in Central and Eastern Europe: A meta-regression analysis. Journal of Banking & Finance 30, 1359–1374.

*Elsayed, K., Paton, D. 2005. The impact of environmental performance on firm performance: static and dynamic panel data evidence. Structural Change and Economic Dynamics 16, 395–412.

EPA, 2006. Report of the EPA work group on VSL meta-analysis. 35 p.

*Feldman, S.J., Soyka, P.A., Ameer, P., 1996. Does Improving a Firm's Environmental Management System and Environmental Performance Result in a Higher Stock Price? (Washington, DC: ICF Kaiser).

*Filbeck, G., Gorman, R.F., 2004. The Relationship between the Environmental and Financial Performance of Public Utilities. Environmental and Resource Economics 29, 137–157.

Florax, R.J.G.M., Travisi, C.M., Nijkamp, P., 2005. A meta-analysis of the willingness to pay for reductions in pesticide risk exposure. European Review of Agricultural Economics 32, 441-67.

Florida, R., Atlas, M., Cline, M., 2001. What makes companies green? Organizational and geographical factors in the adoption of environmental practices. Economic Geography 77 (3), 209-224.

Frooman, J., 1997. Socially irresponsible and illegal behavior and shareholder wealth: a meta-analysis of event studies. Business and Society 36(3), 221–249.

*Gottsman, L., Kessler, J., 1998. Smart Screened Investments: Environmentally-screened Equity Funds that Perform. Journal of Investing 7(3), 15-24.

Griffin, J., Mahon, J., 1997. The corporate social performance and corporate financial performance debate: twenty five years of incomparable research. Business and Society 36(1), 5–31.

*Guenster, N., Derwall J., Bauer, R., Koedijk, K., 2006. The Economic Value of Corporate Eco-Efficiency. Academy of Management Conference Paper. Available at SSRN: http://ssrn.com/abstract=675628.

**Halkos, G., Sepetis, A., 2007. Can capital markets respond to environmental policy of firms? Evidence from Greece. Ecological Economics 63, 578-587.

*Hart, S.L., Ahuja, G., 1996. Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Business Strategy and the Environment 5, 30-37.

**Hibiki, A., Higashi, M., Matsuda, A., 2003. Determinants of the Firm to Acquire ISO14001 Certificate and Market Valuation of the Certified Firm. Discussion Paper No. 03-06. 21 pp.

*Hughes II., K.E., 2000. The Value Relevance of Nonfinancial Measures of Air Pollution in the Electric Utility Industry. The Accounting Review 75(2), 209-228.

*Jaggi, B., Freedman, M., 1992. An examination of the impact of pollution performance on economic and market performance of pulp and paper firms. Journal of Business Finance Accounting 19 (5), 697–713.

Jeppesen, T., List, J.A., Folmer, H., 2002. Environmental regulations and new plant location decisions: evidence from meta-analysis. Journal of Regional Science 42(1), 19-49.

**Khanna, M., Damon, L.A., 1999. EPA´s voluntary 33/50 program: impact on toxic releases and economic performance of firms. Journal of Environmental Economics and Management 37, 1-25.

*King, A.A., Lenox, M.J., 2001 Does It Really Pay to Be Green? An Empirical Study of Firm Environmental and Financial Performance. Journal of Industrial Ecology 5(1), 105-116.

*King, A.A., Lenox, M.J., 2002. Exploring the Locus of Profitable Pollution Reduction. Management Science 48(2), 289-299.

*Konar, S., Cohen, M.A., 2001. Does the Market Value Environmental Performance? Review of Economics and Statistics. 83(2), 2814-289.

Lankoski, L., 2000. Determinants of environmental profit. An analysis of firm-level relationship between environmental and economic performance. Helsinki University of Technology Institute of Strategy and International Business Doctoral Dissertation. 188 p.

Li, H., Grijalva, T., Berrens, R.P., 2007. Economic growth and environmental quality: a meta-analysis of environmental Kuznets curve studies. Economics Bulletin 17 (5), 1-11.

*Mahapatra, S., 1984. Investor Reaction to Corporate Social Accounting. Journal of Business Finance and Accounting 11 (1), 29-40.

McWilliams, A., Siegel, D., 2001. Corporate social responsibility: a theory of the firm perspective. Academy of Management Review 26 (1), 117–127.

**Mohn, W.H., 2006. Green and profitable? The potential returns to good environmental management. MA Thesis Linacre College. University of Oxford.

*Molloy, L., Erekson, H., Gorman, R., 2002. Exploring the relationship between environmental and financial performance. Workshop on Capital Markets and Environmental Performance. 55 p.

Mulatu, A., Florax, R.J.G.M., Withagen C.A.A.M., 2001. Environmental regulation and competitiveness: A Meta-Analysis of International Trade Studies. Tinbergen Institute Discussion Paper TI 2001-039/3. 38 pp.

**Nakao,Y., Amano, A., Matsumura, K., Genba, K., Nakano, M., 2007. Relationship Between Environmental Performance and Financial Performance: an Empirical Analysis of Japanese Corporations. Business Strategy and the Environment 16, 106–118.

Nelson, J.P., Kennedy, P.E., 2009. The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment. Environmental & Resource Economics. 42(3), 345-377.

Orlitzky, M., Benjamin, J.D., 2001. Corporate social performance and firm risk: A meta-analytic review. Business and Society. 40(4), 369-396.

Palmer, K., Oates, W.E., Portey, P.R., 1995. Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm? Journal of Economic Perspectives 9(4), 119-132.

Porter, M.E.,1991. America's green strategy. Scientific American 264(4), 96.

Porter, M.E., van der Linde, C., 1995a. Green and competitive: Ending the stalemate. Harvard Business Review 73(5), 120-134.

Porter, M.E., van der Linde, C., 1995b. Toward a new conception of the environment-competitiveness relationship. Journal of Economic Perspectives 9(4), 97-118.

Richardson, L., Loomis, J., 2009. The total economic value of threatened, endangered and rare species: An updated meta-analysis. Ecological Economics 68(5), 1535-1548.

*Russo, M.V., Fouts, P.A., 1997. A resource-based perspective on corporate environmental performance and profitability. Academy of Management Journal 40(3), 534-559.

*Salama, A., 2005. A note on the impact of environmental performance on financial performance. Structural Change and Economic Dynamics 16, 413–421.

*Sarkis, J., Cordeiro, J.J., 2001. An empirical evaluation of environmental efficiencies and firm performance: Pollution prevention versus end-of-pipe practice. European Journal of Operational Research 135, 102-113.

*Spicer, H.B., 1978. Investors, Corporate Social Performance and Information Disclosure: An Empirical Study. The Accounting review 53(1), 94-111.

Stanley, T.D., 2001. Wheat from chaff: Meta-analysis as a quantitative literature review. Journal of Economic Perspectives 15(3), 131-150.

Stanley, T.D., Jarrell, S.B., 1989. Meta-regression analysis: a quantitative method of literature surveys. Journal of economic surveys 3(2), 161-170.

*Stanwick, P.A., Stanwick, S.D., 1998. The Relationship Between Corporate Social Performance and Size, Financial and Environmental Performance. Journal of Business Ethics 17(2), 195-204.

*Telle, K., 2006. "It pays to be green" - a premature conclusion? Environmental & Resource Economics. 35, 195–220.

Theyel, G., 2000. Management practices for environmental innovation and performance. International Journal of Operations & Production Management 20(2), 249-266.

**Thomas, A., 2001. Corporate environmental policy and abnormal stock price returns: an empirical investigation. Business Strategy and the Environment 10, 125–134.

Ullman, A.A., 1985. Data in Search of a Theory: A Critical Examination of the Relationships Among Social Performance, Social Disclosure, and Economic Performance of U.S. Firms. Academy of Management Review 10(3), 540-557.

Wagner, M., 2001. A review of empirical studies concerning the relationship between environmental and financial performance. What does the evidence tell us?. Center for Sustainability Management. 52 p.

*Wagner, M., 2005. How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry. Journal of Environmental Management 76, 105–118.

*Wagner, M., Nguyen, Van P., Azomahou, T., Wehrmeyer, W., 2002. The relationship between the environmental and economic performance of firms: An empirical analysis of the European paper industry. Corporate Social Responsibility and Environmental Management 9, 133–146.

Walley, N., Whitehead, B., 1994. It's not easy being green. Harvard Business Review 46-52.

**Watson, K., Klingeberg, B., Polito, T., Guerts, T.G., 2004. Impact of environmental management system implementation on financial performance. A comparison of two strategies. Management of Environmental Quality 15 (6), 622-628.

*White, M.A., 1996. Corporate Environmental Performance and Shareholder Value. Working Paper WHI002, McIntire School of Commerce.

Woodward, R.T., Wui, Y.-S., 2001. The economic value of wetland services: a meta-analysis. Ecological Economics 37, 257–270.

*Yamashita, M., Sen, S., Roberts, M.C., 1999. The rewards for environmental conscientiousness in the U.S. capital markets. Journal of Financial and Strategic Decisions 12(1), 73-82.

* Denotes papers used in the meta-analysis

** Denotes papers included in the extended sample.

1.6 Appendix A

List of the environmental variables used in each study

Al-Tuwaijri et al., 2004	Ratio of toxic waste recycled to total toxic waste generated.
Barth and McNichols, 1994	Estimated environmental liabilities.
Bhat, 1998	Penalties assessed for violations of environmental regulations.
Blank and Daniel, 2002	Innovest's Eco-Efficiency rating system.
Chen and Metcalf, 1980	Council on Economic Priorities rating system.
Cohen et al., 1997	Number of environmental litigation proceedings, Superfund sites, number of noncompliance penalties, dollar value of noncompliance penalties, volume of toxic chemical releases, number of oil spills, volume of oil spills, number of chemical spills.
Cordeiro and Sarkis, 1997	The difference of total waste generated and total releases, and changes in these variables.
Cormier and Magnan, 1997	Water pollution measures.
Cormier et al., 1993	Pollution index based on waste-water pollution, average concentration of sulphuric anhydride and biochemical oxygen demand.
Derwall et al., 2005	Innovest's rating.
Diltz, 1995	Council on Economic Priorities rating system.
Dowell et al., 2000	Dummy variable on standards used by firms (local, US and global standards). Validation on firms and TRI data confirms that firms with local standards pollute the most, while firms adopting global standards that exceed any national standard pollute the least. Firms applying US standards abroad were in between these two extremes.
Earnhart and Lízal, 2007a, b	Lagged absolute level of air pollutant emissions.
Elsayed and Paton, 2005	Management Today Survey of Britain's Most Admired Companies evaluation criteria.
Feldman et al., 1996	Score based on firm's environmental management practices and philosophy. The average annual change in TRI releases per unit of firm capital.
Filbeck and Gorman, 2004	The Investor Responsibility Research Centre Compliance Index.
Gottsman and Kessler, 1998	Revenue-normalised EP measures (Investor Responsibility Research Centre data): emissions efficiency; compliance; spill frequency; waste generation rates.
Guenster et al., 2006	Innovest Eco-efficiency scores.
Hart and Ahuja, 1996	Emissions reduction.

Hughes, 2000	Average percentage of SO_2 emission relative to total emissions (SO_2, NO_X, CO_2).
Jaggi and Freedman, 1992	A pollution index from The Biochemical Oxygen Demand, Total Suspended Solids and pH.
King and Lenox, 2001	Total emissions, relative emissions and industry emissions.
King and Lenox, 2002	The sum of a release of the 246 toxic chemicals weighted by its toxicity.
Konar and Cohen, 2001	One-year lagged aggregate pounds of toxic chemicals emitted per dollar revenue of the firm.
Mahapatra, 1984	Pollution control expenditures.
Molloy et al., 2002	IRRC Emissions Efficiency Index - the ratio of reported toxic chemical emissions to the company's revenues.
Russo and Fouts, 1997	Environmental rating.
Salama, 2005	Management Today 'Britain's Most Admired Companies survey.
Sarkis and Cordeiro, 2001	Environmental efficiency scores based on data envelopment analysis technique.
Spicer, 1978	Council on Economic Priorities rating system.
Stanwick and Stanwick, 1998	Toxic Release Inventory data.
Telle, 2006	Logarithms of index consisting of several pollutants, e.g., greenhouse gases, acids, particles and ozone precursors.
Wagner, 2005	Outputs-oriented index score: SO_2, NOx, and Chemical Oxygen Demand. Inputs-oriented index score: total energy input and total water input.
Wagner et al., 2002	Aggregated index of emissions (SO_2, NOx and Chemical Oxygen Demand).
White, 1996	Corporate environmental responsibility measured by environmental reputation indices based on information published by the Council on Economic Priorities.
Yamashita et al., 1999	Companies' environmental conscientiousness scores published in Fortune magazine.
Curcio and Wolf, 1996	Council on Economic Priorities rating.
Hibiki et al., 2003	Adoption of ISO14001.
Halkos and Sepetis, 2007	Adoption of ISO14000 or EMAS.
Mohn, 2006	The Nikkei Environmental Management Survey.
Nakao et al., 2007	Environmental index.
Khanna and Damon, 1999	Participation in the 33/50 Program.
Thomas, 2001	Adoption of an environmental policy.
Watson et al., 2004	Adoption of EMS.

1.7 Appendix B

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variable	64	0.39	0.75	-1	1
Estimation m. –regression	64	0.47	0.50	0	1
Estimation m. –panel data	64	0.22	0.42	0	1
Estimation m. –correlation coef.	64	0.06	0.24	0	1
Estimation m. - portfolio studies	64	0.19	0.39	0	1
Lagged environmental variable	64	0.34	0.48	0	1
Number of years	64	5.09	3.56	1	15
Number of lagged years	64	0.41	0.64	0	3
US+Canada	64	0.75	0.44	0	1
US+Canada+UK	64	0.84	0.37	0	1
Type of financial var. - accounting	64	0.58	0.50	0	1
Paper published in ref. journal	64	0.80	0.41	0	1
Type of environmental var. - qualitative	64	0.36	0.48	0	1

Table – Frequencies among Selected Variables

	Dep. v. - negative rel.	Dep. v. - no rel.	Dep. v. - positive rel.	Est. m. – regression	Est. m. – panel data	Est. m. – correlation coef.	Est. m. - portfolio studies	US + Canada	EU
Est. m. – regression	4.7%	14.1%	28.1%						
Est. m. –panel data	1.6%	9.4%	10.9%						
Est. m. – correlation coef.	3.1%	0.0%	3.1%						
Est. m. - portfolio studies	4.7%	4.7%	9.4%						
US+Canada	12.5%	15.6%	46.9%	37.5%	10.9%	6.3%	18.8%		
EU	3.1%	14.1%	7.8%	9.4%	10.9%	0.0%	0.0%		
Type of financial v. - accounting	9.4%	21.9%	26.6%	28.1%	17.2%	4.7%	3.1%	35.9%	21.9%
Paper published in ref. journal	12.5%	25.0%	42.2%	37.5%	20.3%	6.3%	9.4%	56.3%	23.4%
Type of envi. v. - qualitative	1.6%	9.4%	25.0%	20.3%	3.1%	3.1%	7.8%	26.6%	9.4%
Lagged envi. v.	3.1%	12.5%	18.8%	15.6%	12.5%	0.0%	4.7%	18.8%	15.6%

Note: The table contains frequencies of data that falls into each category of dependent variable as well as the frequencies among selected independent variables.

2. The impact of environmental performance on firm performance: Short-term costs and long-term benefits?

Abstract

We examine the intertemporal effect of environmental performance on financial performance and propose a method to assess the environmental performance in a fuller manner based on the weighting various pollutants according to their dangerousness to environment. Using our improved measures of environmental performance applied to the firm level data from the Czech Republic, the results suggest that while the effect of environmental performance on financial performance is negative for environmental performance lagged by 1 year lag, it becomes positive for 2 years lag. As a consequence, our findings indicate that Porter hypothesis holds in the long-run.

2.1 Introduction

How does environmental performance (EP) affect firm financial performance (FP)? Although the relationship has been empirically examined for over three decades nowadays, no consensus has been reached yet. According to a recent meta-analysis on the effect of environmental performance on financial performance (Horváthová, 2010), about 15% of studies find a negative effect; about 30% of studies find no effect and 55% of studies find a positive effect. However, the meta-analysis as well as its underlying primary studies is less concerned about the possibility that the effect of environmental performance on financial performance is time-varying. More specifically, it is not explicitly concerned about the possibility that the direction of effect is different in the short-term than in long-term.

Porter (1991) stipulates that better environmental performance may be beneficial for firms since pollution is a sign of economic inefficiency. We hypothesize that if "Porter hypothesis" is valid, it is valid especially in the long-term, as it is likely to take time for firms to restructure and adjust to new environmental regulations. Indeed, the meta-analysis shows that the primary studies using the lagged, instead of current, values of environmental performance are more likely to deliver positive effect of EP on FP and therefore support the Porter hypothesis. So far, there is a little evidence on "time-varying Porter hypothesis" (Rassier and Earnhart, 2011).

To identify the effect of EP on FP accurately, the measurement of EP is evidently of crucial importance. Contrary to the financial performance measures, the measures for environmental performance are far from being standardized. Some researchers use a simple qualitative environmental variable, while others construct various types of quantitative environmental variable, typically some particular type of pollutions. Clearly, there is a risk of mis-measurement of EP, if only some pollutants are considered and others remain ignored. This is also supported in our data; the correlation among the amount of various pollutants in our firm-level dataset is not high even if we use almost 100 different types of emissions. As a consequence, the comprehensive measure of EP is important for the literature estimating the effect of EP on FP. Clearly, the weight of various pollutants should be normalized. The difficulties in data availability and comparability can be overcome on the European level using data obtained from the European Pollutant Release and Transfer Register. As concerns the normalization of the weights given to different pollutants, this can be done over the so-called reporting thresholds. The thresholds are set by the European Commission according to harmfulness of pollutants to environment and are equal in all reporting states.

Last but not least, the motivation for estimating the effect of EP on FP is that we use the firm level data for the Czech Republic. While EP-FP nexus has been examined extensively for the developed countries, this evidence is virtually non-existent for the Central and Eastern European countries (Horváthová, 2010). To our knowledge, the only research conducted on the environmental-financial performance relationship is by Earnhart and Lízal (2007 a,b). These two studies examine Czech firms for the transition years 1996-1998, i.e. the period several years after the fall of communism, which was characterized by the intense restructuring of Czech firms and more generally, by government reforms aiming to promote transition to market-oriented economy. We examine longer "post-transition" period of 2004-2008, when the Czech Republic was already member of the European Union.

In this article, we examine the inter-temporal effect of EP on FP as well as propose a more comprehensive measure of EP based on the European Pollutant Release and Transfer Register data, which includes air, water, land as well as off-site transfers of waste and of pollutants in waste water. The weight of these input variables is assigned based on the dangerousness of pollutants. Using the improved measure for EP, the results suggest that improving EP is associated with additional costs to firms in the short-term (more specifically, when we use 1 year lag of EP). On the other hand, the EP lagged by 2 years exhibits a positive effect on FP giving some support to Porter hypothesis.

The paper is organised as follows. We extensively review the relevant literature in section 2.2. Section 2.3 describes the data and econometric methodology. The results are presented in section 2.4.Conclusions are available in section 2.5.

2.2 Literature Review

Traditionally, it has been argued that environmental regulation has rather been associated with the additional costs to firms (Palmer et al., 1995, Walley and Whitehead, 1994). Due to complying with environmental law, firms have to invest in new more environmentally friendly equipment or cleaners to decrease the environmental impacts of factories. On the other hand, Porter (1991), Porter and van der Linde (1995) introduce a different perspective on this debate. Following Porter´s idea, the so-called 'revisionists' propose that environmental regulation can lead to win-win situations in which social welfare as well as the private benefits of firms can both increase. They particularly criticise a static approach of 'traditionalists', who have, according to them, been overlooking the possible positive impact of innovation dynamics. They postulate that pollution is a sign of inefficiency within the production process and that waste is a non-recoverable cost (Shrivastava and Hart, 1995). This view (widely labelled as the “Porter hypothesis”) raises extensive debate and critiques by, for example, Jaffe et al. (1995) and Palmer et al. (1995), and it prompts research on the empirical examination of environmental-finance performance nexus.

In principle, there are three basic approaches to studying the impact of environmental on financial performance: portfolio analyses, event studies and regression studies (Ambec and Lanoie, 2008). Portfolio analyses compare the returns on portfolios consisting of companies with higher environmental performance with portfolios of companies without criteria on environmental performance. Event studies investigate the impact of a particular event (news about environmental performance, awards, lawsuits etc.) on a single stock. Regression analysis is employed to study the relationship between firms’ characteristics (including environmental performance) and their financial performance.

The first studies conducted were based mainly on the pollution data published by the Council on Economic Priorities in the US, such as Chen and Metcalf (1980), Spicer (1978). These studies typically use the simple correlation coefficients to explore the relationship between environmental and financial variables. The initial evidence on the positive relationship between EP and FV provided by Spicer (1978) was challenged by Chen and Metcalf (1980). Using the same data as Spicer (1978), they show that the positive correlation disappeared with additional control variables. Comparing pollution control expenditures with market returns, Mahapatra (1984) finds a negative correlation. Next, Jaggi and Freedman (1992) find a negative relationship between the pollution performance index and economic performance firms in the pulp and paper industry. Findings of Feldman et al. (1996) suggest that environmental improvements may lead to an increase in a company’s stock price. As evidenced, even the first studies have been inconclusive.

More recent studies utilise a broader spectrum of environmental as well as financial variables and employ more advanced statistical techniques. Studies conducted in the

1990s typically employ cross-section or pooled estimates, such as Hart and Ahuja (1996), Russo and Fouts (1997), while in the next decade panel data methodology became more popular. In their frequently cited paper, Russo and Fouts (1997) analyse 243 companies over 1991-1992. They conclude that better environmental performance (environmental ratings of firms based on compliance records, expenditures on waste reduction, etc.) is associated with better financial performance (measured by the return on assets). Their results show that the returns to environmental performance are higher in high-growth industries. Another widely cited work is that by Hart and Ahuja (1996). They study the relationship between emission reduction and firm performance. Using the sample of manufacturing, mining and production firms for 1989-1992, they find that “it pays to be green”. According to their analysis, the return on sales and return on assets significantly increase in the following year after reducing emissions, while it takes about two years to increase the return on equity.

Considering heterogeneity in the previous empirical results, several studies investigate the impact of different estimation methods. Nevertheless, the studies find that different empirical methods lead to different results in terms of the EP-FP nexus. Telle (2006) finds a positive relationship between EP and FP when using OLS regression but finds no relationship when using random-effect panel data. Telle (2006) discusses the shortcomings of previous studies, such as the problem of omitted unobserved variables or a short time period. According to him, although several studies control for factors such as the firm size, capital or industry, there still remain some variables such the age of capital or quality of management, which can be correlated with environmental performance, thus indicating biased and inconsistent estimates. Salama (2005) compares the results of simple OLS regression and robust median regression. He finds no relationship for the OLS regression but a positive relationship for robust regression. King and Lenox (2001) extensively analysed 652 U.S. manufacturing firms during 1987-1996. Although OLS results suggest a positive relationship between environmental and financial variables, their conclusions are not straightforward. After applying fixed- and random-effects panel analysis, they conclude that the association between better financial performance and lower emissions can be caused by unobservable firm-specific characteristics and strategic position. Likewise Telle (2006) they suggest that the next study should focus on underlying firm characteristics affecting the relationship between environmental and financial performance. Elsayed and Paton (2005) compare the results of cross-section, pooled, static and dynamic panel data estimation. Although they find only limited evidence of a significant impact of EP on FP using panel data, they find a significant positive relationship when applying the cross-section and pooled estimations.

A simultaneous-equations framework is applied by Al-Tuwaijri et al. (2004) and Wagner et al. (2002). While Wagner et al. (2002) find a negative and insignificant relationship between EP and FP, Al-Tuwaijri et al. (2004) find a positive one. Wagner (2005) find again both a negative (for the emission-based index) and no (for the inputs-based index) relationship between environmental and economic performance.

Yamashita et al. (1999) apply the event-study methodology and investigate the long-term relationship between a company's environmental performance and its stock-market performance. They find that companies with poorer environmental conscientiousness scores underperformed other companies.

The US studies are commonly based on Environmental Protection Agency´s Toxic Release Inventory data. Cordeiro and Sarkis (1997) employ analyst earnings per share forecasts as a financial performance variable. They demonstrate a negative relationship between EP measured by the Toxic Release Inventory data and 1- and 5-year earnings per share forecasts for a sample of 523 US firms in 1992. In their next study, Sarkis and Cordeiro (2001) find that environmental efficiency (evaluated on the basis of Toxic Release Inventory data) is also significantly negative related to financial performance measured by return on sales. Next, according to Konar and Cohen (2001) poor environmental performance (measured by the toxic emissions obtained from the Toxic Release Inventory) decreases the intangible asset value for the manufacturing firms, which belong to the S&P500. Their results show that a 10% drop in the emissions of toxic chemicals results in a $34 million increase in market value. Dowell at al. (2000) compare the market value of firms with the different environmental standards. At first, they verify that the firms with the stringent global environmental standards pollute the least (measured by emissions from Toxic Release Index), while firms adopting poor local standards pollute the most. They find that the firms adopting stringent global standards have much higher market values than firms adopting less stringent standards. Molloy et al. (2002) extensively analyse 339 S&P500 firms, mainly from the manufacturing sector. First, they conclude that Toxic Release Inventory emissions have no statistically significant impact on one-year holding period returns. Next, they find that poor (good) environmental performance has a statistically significant positive (negative) impact on returns. They conclude that investors perceive environmental improvements as being costly unless investments are made in response to regulations and to avoid penalties. Authors explain their surprising results with the later time period under study (due to a decrease in demand for "green" stocks following the increased demand for "green" stocks recorded in previous studies) and controlling for management quality.

Next, Guenster et al. (2006) uses Innovest Strategic Value Advisors ratings as a proxy for environmental performance. This rating is based on more than 60 criteria, which assess firms' ability to create more value while using fewer environmental resources, such as water, air, oil or coal. Their analysis, based on monthly data from 1996 to 2002, suggest a positive relationship between eco-efficiency and firm value.

Bhat (1998) examines the impact of environmental compliance (measured with the penalties imposed for violation of environmental regulations) on financial performance (measured with profit margin). The results suggest a positive impact of the degree of environmental compliance on the profit margins.

Hughes (2000) studies the effect of the amount of airborne emission on the market value of equity. He finds that the pollution proxy variable is value relevant for high-polluting utilities. This result is in line with Barth and McNichols (1994), whose results suggest that investors assess not accrued corporate liabilities and discount their share price accordingly. Next, Cormier and Magnan (1997) investigate how investors assess the financial implications of a firm's environmental performance, too. They find that the market assesses implicit environmental liabilities (a firm that pollutes more leads to higher environmental liabilities and thus higher expected costs and losses) in some industries, such as pulp and paper, while there is weaker evidence in other industries, such as metal and mining. Cormier et al. (1993) investigate the relation between the market valuation of publicly listed corporations and a pollution index. They find evidence for a positive relationship between EP and FP.

The majority of the papers are based on U.S. and Canadian data; other counties were not studied so extensively. The early studies (70s and 80s) are exclusively U.S. studies based on pollution data published by the Council on Economic Priorities because there were only limited environmental data in other countries. Presently, the major part of studies is still based on the U.S. and Canadian data. Fewer studies deal with European data, and there are only few studies analysing emerging or Asian countries; examples of these are Earhart and Lízal (2007a,b) (evidence on emerging market economy) or Nakao et al. (2007) (evidence on Asia). Earnhart and Lízal (2007a) indicate that better pollution control neither improves nor undermines financial access, while Earnhart and Lízal (2007b) show there to be a positive impact of lagged environmental performance on financial performance.

While some researchers do not use the lagged EP (e.g. Al-Tuwaijri et al. (2004), Filbeck and Gorman (2004), Russo and Fouts (1997),) and analyse contemporaneous effect of EP on FP, others examine different lags of EP. For example, Hart and Ahuja (1996) use one, two and three years lagged EP, Earnhart and Lízal (2007a, b) and Telle (2006) use one year lagged EP. Hart and Ahuja (1996) find that emission reduction has no significant effect on firm financial performance in the year when emissions were reduced, while it enhances FP in 1 and 2 years after emission reduction with a peak in the second year after reduction. The studies by Freedman and Jaggi (1992, 1994) examine long-run effects of EP on FP. Freedman and Jaggi (1992) find that pulp and paper enterprises were not negatively affected after pollution reduction (both a 6-year and a 9-year time horizon). Freedman and Jaggi (1994) find that in the long-run, there is no (positive or negative) association between input cost and pollution performance. Rassier and Earnhart (2011) find that lower emissions improve firm financial performance, both in short and long run with a stronger effect in the long run.

Based on portfolio analysis of S&P companies, Cohen et al. (1997) conclude that there is at least no penalty in investing in environmentally high-performing firms. Filbeck and Gorman (2004) studied relationship between environmental compliance and financial performance in electric utilities over 1996-1998. Likewise, Cohen et al. (1997) divide the companies into less-compliance and more-compliance portfolios, but unlike in Cohen et al. (1997) they do not find a positive relationship between environmental and financial performance (measured by the Sharpe and Treynor index). They explain these results by using only electric utilities, a more recent time period and using compliance index, which does not measure how proactively a company is attempting to move beyond compliance. Derwall et al. (2005) find that a more eco-efficient portfolio (based on Innovest Strategic Value Advisors' corporate eco-efficiency score) earns significantly higher returns than a less eco-efficient portfolio. Accordingly, White (1996) finds that a portfolio consisting of more environmentally responsible companies outperforms the market and portfolio from less responsible companies. Based on the Innovest rating, Blank and Daniel (2002) conclude that the top-ranked performers in Innovest's rating system outperform other companies. Gottsman and Kessler (1998) find that portfolios of good environmental performers return more than the S&P 500 and that portfolios of poor environmental performers return less than the S&P 500. Diltz (1995) examines 28 common stock portfolios and concludes there to be a positive correlation between environmental performance and stock market returns.

2.3 Data and Econometric Model

2.3.1 Data

This section describes the data used to assess the effect of EP on FP. The yearly data are used for both environmental and financial characteristics. As concerns the EP, we use two types of environmental data. Besides the data on environmental performance, we also employ data on environmental managerial systems in order to test the impact of environmental managerial systems on the financial performance.

Contrary to financial indicators, the construction of environmental performance indicator varies in the previous studies due to different data availability and relatively short history of standardised environmental reporting. Some previous research uses a qualitative environmental variable, which is mainly represented with an environmental rating (e.g., Blank and Daniel (2002), Curcio and Wolf (1996), Derwall et al. (2005), Russo and Fouts (1997)), the adoption of environmental management systems (e.g., Halkos and Sepetis (2007), Hibiki et al. (2003), Watson et al. (2004)) or the adoption of environmental policy (e.g. Thomas (2001)). Others construct different types of quantitative environmental variable such as the ratio of toxic waste recycled to total toxic waste generated (e.g. Al-Tuwaijri et al. (2004)), emissions reduction (e.g. Hart and Ahuja (1996)) or the sum of the amount of air emissions emitted (e.g. Earnhart and Lízal (2007a, b)). The problem with these measures of EP is that among each pollutant that the dangerousness of pollutants per unit emitted varies. So the aggregation of different types of pollutants and its comparison may be misleading and requires normalization. In addition, the emission reduction and ratio of recycled waste is known to be sensitive to the initial amount of pollutant emitted.

In addition, other researchers construct various indices. For example, Telle (2006) use index consisting of several pollutants, (e.g. greenhouse gases, acids, particles and ozone precursors). Wagner et al. (2002) compute an aggregated index of emissions (SO_2, NO_X and Chemical Oxygen Demand) or Wagner (2005) construct outputs-oriented index (emissions of SO_2, NO_X, and Chemical Oxygen Demand) and inputs-oriented index (total energy input and total water input). These indices are mainly based on Jaggi and Freedman (1992) approach. The Jaggi and Freedman (1992) approach normalize the environmental data comparing each pollutant to its best value among the observed data set. Since the resulting indicator is sensitive to the factors influencing the data set, the results can be interpreted only with reference to the data used.

Since it has been found that the type of environmental performance indicator affects the environmental-financial performance relationship (Horváthová, 2010), a more accurate assessment of environmental performance is likely to be beneficial. Besides the issue of EP calculation, there is also great variability in data sources. Each source of environmental data contains different variables due to differences in data collection, measurements and data reporting, so the data can be compared with difficulties. On the European level, the difficulties with data comparability can be overcome using European Pollutant Release and Transfer Register (EPRTR). EPRTR contains quantitative environmental data, which are comparable across different regions.

Environmental performance data in this study are obtained from the Integrated register of pollutant emissions (freely available at www.irz.cz) which is a part of EPRTR. EPRTR provides a publicly available access to an environmental data from industrial facilities in the European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland. EPRTR contains the data on an annual basis since 2007. In addition, it contains the data for 2001 and 2004. The data for missing years (e.g. 2005 and 2006 to match our financial data) are available in the national registers (see www.irz.cz) and were gathered under the same rules.

EPRTR contains data on 93 pollutants releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water from key pollutants including heavy metals, pesticides, greenhouse gases and dioxins. Data collection and reporting is standardised over all pollutants in all countries. Therefore, datasets are comparable among all participating countries. Each pollutant is reported in this dataset if the emitted amount exceeds a reporting threshold. The reporting thresholds are set up concerning the main impact of the pollutants on human health and on the environment (the thresholds are set out by the European Commission in the Article 5 of the EPRTR

Regulation[2]). Each facility has to report to the register, if it releases pollutants above the thresholds specified for each media (air, water and land).

In this paper, we use the EP indicator, in which the emitted amount is normalized according to the reporting threshold. Since the harmfulness of each pollutant differs and also the relative amount of each pollutant emitted differs, we do not add total amounts. Instead, we first divide the emitted amount by the reporting threshold, if emissions are higher than the threshold. Since the reporting thresholds are the same for all companies across all EPRTR participating countries, this approach enable the comparison of the EP index across different data sets.

The environmental performance for *i*-th firm in year *t* is thus defined:

$$EP_{i,t} = \sum_{j=1}^{93} \frac{P_{i,j,t}}{RT_{\ j}} \qquad \text{if } P_{i,j,t} \geq RT_j \text{ and 0 otherwise}$$

where $EP_{i,t}$ is an environmental performance of a company

$P_{i,j,t}$ is an absolute amount of emission for pollutant *j*

RT_j is a reporting threshold for pollutant *j*

Next, the data on environmental managerial systems are collected using publicly available database (www.iso.cz) and double-checking the websites of companies. Each company is examined for the certification of both EMAS (Eco-Management Audit Scheme)[3] and ISO 14001[4]. The majority of firms are certified with the ISO 14001, because EMAS is limited only to the EU markets. Since EMAS and ISO 14001 share the same objective (to provide good environmental management) we do not distinguish these two and classify the firms as complying with the environmental managerial systems regardless the certification type.

---

[2] EPRTR Regulation - Regulation (European Commission) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:033:0001:0017:EN:PDF

[3] EMAS - an environmental standard developed by the European Commission

[4] ISO 14000 (the International Organization for Standardization 14000 series) - environmental management standards. ISO 14001 specifies the requirements for environmental management system.

The financial data are obtained from a commercial firm database CreditInfo. Creditinfo Czech Republic used to be part of German business information provider Creditinfo SCHUFA GmbH, since 2011 CreditInfo Czech Republic is part of Soliditet, a leading provider of credit & business information in the Nordics. The database provides firms' full balance sheets and profit-loss statements for the vast majority of Czech companies (more than 2.3 million business and non-profit economic subjects). The database also identifies firm's industrial classification. The balance sheets are set up and audited according to the Czech law, which is largely harmonized with the EU laws. The statements are also utilized by various government agencies and were previously used by other researchers (for example, see Eriksson (2005), Carmin (2003)).

Merging data on environmental managerial systems, firms' emissions and financial data results in 1176 yearly observations over 2004-2008. The basic descriptive statistics are reported in Table 2.1.

Table 2.1 Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Assets	1176	2674.1	15568.6	0.48	311377
Debt to total assets	1176	0.50	0.67	0	17.93
ROA	1176	0.05	0.24	-6.18	2.27
ROE	1176	0.14	1.04	-21.60	10.15
Sales	1177	760.3	10026.8	0	211026
Profit in current accounting period	1165	191.2	1233.9	-2176.6	25803
Environmental performance	1176	250.5	1969	0	49333
Environmental certification	1176	0.14	0.35	0	1
Industry - NACE (A)*	1176	0.32	0.47	0	1
Industry - NACE (BCF)*	1176	0.34	0.47	0	1
Industry - NACE (DE)*	1176	0.13	0.34	0	1
Industry - NACE (GHI)*	1176	0.14	0.35	0	1

Notes: * NACE - A (Agriculture, forestry and fishing); NACE - B, C, F (Mining and quarrying, Manufacturing, Construction), NACE - D, E (Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities), NACE - G, H, I (Wholesale and retail trade; repair of motor vehicles and motorcycles, Transporting and storage, Accommodation and food service activities) and NACE - J, L, M, N, R, S (Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities, Arts, entertainment and recreation, Other services activities). Assets, sales and profit in the thousands of CZK.

2.3.2 Econometric Model

This section describes the econometric model that is used to examine the intertemporal effect of EP on FP. The following generic regression is estimated:

$$FP_{i,t} = \beta_0+\beta_1*EP_{i,t-1}+ \beta_2*EP_{i,t-2} +\beta_3*X_{i,t-1}+ \beta_4*EMS_{i,t}+ \sum_{i=1}^{n} \mu_i*Industry\ dummies_i+ e_{i,t}$$

where $FP_{i,t}$ represents the measure of financial performance. To shed light of the robustness of results, we use both the return on assets (ROA) and return on equity (ROE) as the dependent variable. In addition, we also run regressions for restricted sample from which we exclude the firms, which do not pollute environment.

The explanatory variables contain both environmental and financial variables. Environmental variables include the environmental performance lagged by one and two years, $EP_{i,t-1}$ and $EP_{i,t-2}$, as defined above, and the dummy on environmental managerial systems, $EMS_{i,t}$. EP is lagged, since as argued in the previous research (e.g. Hart and Ahuja (1996), Earnhart and Lízal (2007 b), Konar and Cohen (2001)), it takes time for EP to have an effect on FP. To examine the time-varying relationship between EP and FP, we use environmental performance both lagged by one year as well as lagged by two years.[5] In addition to EP, we also examine whether environmental certification has an impact on financial results of companies.

Next, we control for some standard set of financial variables - the company size (the logarithm of total assets) and indebtedness (the ratio of debt to total assets), both lagged by one year. We also test for the industry effects (according to NACE codes[6]). To reduce a number of explanatory variables, we group the NACE codes into the following groups: NACE - A (Agriculture, forestry and fishing); NACE - B, C, F (Mining and quarrying, Manufacturing, Construction), NACE - D, E (Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities), NACE - G, H, I (Wholesale and retail trade; repair of motor vehicles and motorcycles, Transporting and storage, Accommodation and food service activities) and NACE - J, L, M, N, R, S (Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities, Arts, entertainment and recreation, Other services activities). $e_{i,t}$ stands the residual, which consists of unobserved firm characteristics and white-noise residual.

2.4 Results

This section contains the results on the inter-temporal effect of environmental performance on financial performance. The results are presented in Tables 2.2 and 2.3.

[5] It would be interesting to examine more lags, but this would decrease substantially the number of observations for our regression analysis.
[6] NACE - the Statistical Classification of Economic Activities in the European Community.

Table 2.2 – Does Environmental Performance Affect Financial Performance?
Dependent variable: Return on assets (ROA)

	(1)	(2)	(3)	(4)
Environ. performance in t-1	1.80E-05***	1.80E-05***	1.80E-05***	1.80E-05***
	(-3.32E-06)	(-3.34E-06)	(-3.19E-06)	(-3.16E-06)
Environ. performance in t-2	-1.25E-05***	-1.25E-05***	-1.25E-05***	-1.25E-05***
	(-2.23E-06)	(-2.27E-06)	(-2.18E-06)	(-2.16E-06)
Log of assets in t-1	0.01***	0.01***	3.24E-03	2.72E-03
	(-0.00)	(-0.00)	(-0.00)	(-0.01)
Environmental certification		-0.00	-0.012	-0.01
		(-0.01)	(-0.01)	(-0.01)
Industry - NACE (A)			-0.12***	-0.13***
			(-0.03)	(-0.03)
Industry - NACE (BCF)			-0.06***	-0.06***
			(-0.02)	(-0.02)
Industry - NACE (DE)			-0.05**	-0.05**
			(-0.02)	(-0.02)
Industry - NACE (GHI)			-0.07***	-0.07***
			(-0.03)	(-0.03)
Debt to total assets in t-1				-0.01
				(-0.02)
Constant	-0.12**	-0.12**	0.08	0.10
	(-0.06)	(-0.06)	(-0.07)	(-0.08)
Number of observations	240	240	240	240
Number of firms	136	136	136	136
R2	0.1	0.1	0.19	0.19
Hausman test (chi2)	3.65	7.2	5.12	6.11
Significance level	0.16	0.07	0.16	0.11

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Environmental performance is defined in the Data section and is constructed in the way that the higher firms´ emissions generate higher score for environmental performance.
NACE - A (Agriculture, forestry and fishing); NACE - B, C, F (Mining and quarrying, Manufacturing, Construction), NACE - D, E (Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities), NACE - G, H, I (Wholesale and retail trade; repair of motor vehicles and motorcycles, Transporting and storage, Accommodation and food service activities) and NACE - J, L, M, N, R, S (Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities, Arts, entertainment and recreation, Other services activities).

Table 2.2 gives the regression results with the ROA (return on assets) as the dependent variable. Since we study the intertemporal pattern of the impact of EP on FP, we employ both one year lagged and two years lagged environmental performance measures. Several specifications are estimated in order to shed light on the robustness of the results. First, we control only for a company size (the logarithm of total assets). Second, we examine the impact of environmental certification as well. Third, we examine the impact of industrial branches (according to the NACE codes) and fourth, we control for indebtedness, too. The results indicate that higher emissions increase financial performance in the subsequent year, but decrease financial performance after two years. As a consequence, this gives certain support to the claim that Porter hypothesis is more likely to prevail in the long-term.

Our results indicate that the type of industrial activity has an effect on financials. Environmental certification is found to have no impact on ROA. This result may be caused by the high costs of both implementing and maintaining environmental management, and at the same time higher firms' revenues generated in response to the implementation of environmental certification (environmental certification can enable access to new business opportunities, such as public contracts). For example, Clausen et al. (2002) estimate that the implementation costs of environmental certification for companies over 500 employees range from € 85 000 to € 322 000. However, the impact of environmental certification on environmental performance is not studied in this paper and it is likely that environmental certification has an impact on EP rather than on FP.

In Table 2.3, we present the results for the determinants of financial performance for firms with EP higher than 0 to eliminate non-polluting firms. The results are largely in line with those presented in Table 2.2.

Table 2.3 Does Environmental Performance Affect Financial Performance?
Subsample: environmental performance>0.
Dependent variable: Return on assets (ROA)

Environmental performance in t-1	1.80e-05***	1.80e-05***	1.80e-05***	1.79e-05***
	-3.32E-06	-3.34E-06	-3.18E-06	-3.00E-06
Environmental performance in t-2	-1.25e-05***	-1.25e-05***	-1.25e-05***	-1.24e-05***
	-2.22E-06	-2.27E-06	-2.18E-06	-2.06E-06
Log of assets in t-1	0.0130***	0.0130***	0.00297	-0.00058
	-0.00452	-0.00438	-0.00448	-0.00507
Environmental certification		-0.000516	-0.012	-0.0115
		-0.0145	-0.0151	-0.0148
Industry - NACE (A)			-0.126***	-0.140***
			-0.0261	-0.0276
Industry - NACE (BCF)			-0.0548**	0.0567***
			-0.0215	-0.0216
Industry - NACE (DE)			-0.0501**	0.0632***
			-0.0229	-0.024
Industry - NACE (GHI)			-0.0704***	0.0772***
			-0.0272	-0.0266
Debt to total assets, in t-1				-0.0613**
				-0.0267
Constant	-0.120*	-0.120*	0.0867	0.170**
	-0.063	-0.0616	-0.0679	-0.0835
Number of observations	234	234	234	234
Number of firms	134	134	134	134
R2	0.10	0.10	0.20	0.20
Hausman test (chi2)	4.32	7.74	5.72	7.83
Significance level (Prob>chi2)	0.12	0.06	0.13	0.06

Notes: See Table 2.2.

Comparing our results to previous literature, Rassier and Earnhart (2011), explicitly focus on the inter-temporal effect of EP on FP. They study U.S. firms and measure the EP by permitted wastewater discharge limits and use the returns on sales as the FP measure. Rassier and Earnhart (2011) find that lower emissions improve firm financial performance both in short and long run with a stronger effect in the long run (long-run is represented with 6-quarter lag structure i.e. 1,5 year lag overall). Therefore, our results do not accord fully with previous literature. For the 1 year lag, we find the opposite effect than Rassier and Earnhart (2011). Nevertheless, the 2 years lag – presumably more important than the short-term effect – is in line with Rassier and Earnhart (2011).

Next, we carry out a number of robustness checks. The results remain largely unchanged, when the ROE (return on equity) instead of ROA is used as the dependent variable. We examine the same model specifications as for the ROA with similar results. The increased firm´s emissions deplete company return in the two years horizon, while improve only in the short-term. Environmental certification and other financials have no impact on ROE. Finally, we examine the results based on the sample of large firms. The firms with assets greater than median are included in the sample, while small firms are excluded. Again the results remain unchanged. These results are available upon request.

All in all, the results support the Porter view of the impact of environmental regulation on firm financial performance, but in contrast to previous literature our findings put forward that Porter hypothesis is likely to prevail only in the long-term.

2.5 Conclusions

The effect of environmental performance on financial performance stays at the forefront of environmental economics. Many important issues arise to evaluate the effect properly and we tackle some of these in this paper. Despite many papers were written on this topic, we still do not have a sufficient evidence about the intertemporal effect of EP on FP. Porter hypothesis (Porter, 1991) stipulates that better EP is beneficial for firms. Although Porter and van der Linde (1995) do not spell out the effect in some specific time horizon explicitly, the authors imply that the positive effects are stronger in the long-term. Intuitively, it is clear that it may take time until firms adjust to new environmental regulations, as they often have to carry out a sizeable investment in order to comply with these regulations. Therefore, it might be the case that Porter hypothesis is likely to be more relevant in the long-term.

Therefore, disentangling the time-varying effects is vital in order to assess the Porter hypothesis.

Similarly, the measurement of EP plays a role for understanding the effect of EP on FP. Many previous papers focused on particular type of emissions or mixed various emissions without appropriate normalization. We use almost 100 different types of emissions and propose to normalize different emissions according to their impact on human health and on the environment. As a measure of the impact of each pollutant on environment, we choose the reporting thresholds as set out by the European Union.[7]

We study intertemporal effect of the EP on FP using a sample of Czech firms in 2004-2008. Using our improved measure of EP, we find that increased firm´s emissions deplete company profitability in the 2 years lag period, but improve in the 1 year lag period. These results support the previous findings, to a certain degree. Rassier and Earnhart (2011) find that lower emissions improve firm financial performance both in short and long-term with a stronger effect in the long run. Although our results on the short-term effect of EP on FP differ from those of Rassier and Earnhart (2011), both studies find that investing in EP improves FP in the long-term.

All in all, the results support the Porter view of the impact of environmental regulation on firm financial performance in the long run. Notably, the results indicate that it takes more than one accounting period before firms can benefit from decreasing pollution.

Acknowledgements

I am grateful to two anonymous referees, Lubomír Lízal, and seminar participants at the Charles University Environment Center for helpful comments. I thank Tereza Havránková and Lenka Jandová (both CENIA, Czech information agency of the

[7] Article 5 of the EPRTR Regulation - Regulation (European Commission) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC

environment) for providing datasets from which I was able to calculate the environmental performance and environmental managerial systems indicators.

2.6 References

Al-Tuwaijri, S., Christensen, T.E.,Hughes II, K.E., 2004. The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach. Accounting, Organizations and Society 29, 447–471.

Ambec, S., Lanoie, P., 2008. Does it pay to be green? A systematic overview. Academy of Management Perspectives 22 (4), 45–62.

Barth, M.E., McNichols, M.E., 1994. Estimation and market valuation of environmental liabilities relating to superfund sites. Journal of Accounting Research 32 Supplement, 177–209.

Bhat, V.N., 1998. Does environmental compliance pay? Ecotoxicology 7, 221–225.

Blank, H.D., Daniel, W.E., 2002. The eco-efficiency anomaly. Quantitative Evaluation &Development 15 pp. Available at: http://innovestgroup.net/pdfs/Eco_Anomaly_7_02.pdf.

Carmin, J. 2003. Non-governmental organisations and public participation in local environmental decision-making in the Czech Republic. Local Environment: The International Journal of Justice and Sustainability. 8(5), 541-552.

Chen, K.H., Metcalf, R.W., 1980. The relationship between pollution control record and financial indicators revisited. The Accounting Review 55 (1), 168–177.

Clausen, J., Keil, M., Jungwirth, M., 2002. The state of EMAS in the EU: literature survey. http://ec.europa.eu/environment/emas/pdf/general/literature_study_020506_en.pdf.

Cohen, M.A., Fenn, S.A., Konar, S., 1997. Environmental and Financial Performance: Are They Related?. WP Vanderbilt University. 40 pp.

Cordeiro, J.J., Sarkis, J., 1997. Environmental proactivism and firm performance: evidence from security analyst earnings forecasts. Business Strategy and the Environment 6, 104–114.

Cormier, D., Magnan, M., 1997. Investors' assessment of implicit environmental liabilities: an empirical investigation. Journal of Accounting and Public Policy 16, 215–241.

Cormier, D., Magnan, M., Morard, B., 1993. The impact of corporate pollution on market valuation: some empirical evidence. Ecological Economics 8, 135–155.

Curcio, R.J., Wolf, F.M., 1996. Corporate environmental strategy: impact upon firm value. Journal Of Financial And Strategic Decisions 9(2), 21-31.

Derwall, J., Guenster, N., Bauer, R., Koedijk, K., 2005. The eco-efficiency premium puzzle. Financial Analyst Journal 61 (2), 51–63.

Diltz, D.J., 1995. The private cost of socially responsible investing. Applied Financial Economics 5, 69–77.

Dowell, G., Hart, S., Yeung, B., 2000. Do corporate global environmental standards create or destroy market value? Management Science 46 (8), 1059–1074.

Earnhart, D., Lízal, L., 2007a. Effect of Pollution Control on Corporate Financial Performance in a Transition Economy. European Environment 17, 247–266.

Earnhart, D., Lízal, L., 2007b. Does better environmental performance affect revenues, cost, or both? Evidence from a transition economy. William Davidson Institute Working Paper Number 856.

Elsayed, K., Paton, D., 2005. The impact of environmental performance on firm performance: static and dynamic panel data evidence. Structural Change and Economic Dynamics 16, 395–412.

Eriksson, T., 2005. Managerial pay and executive turnover in the Czech and Slovak Republics. Economics of Transition. 13(4), 659–677.

Feldman, S.J., Soyka, P.A., Ameer, P., 1996. Does Improving a Firm's Environmental Management System and Environmental Performance Result in a Higher Stock Price?. ICF Kaiser, Washington, DC.

Filbeck, G., Gorman, R.F., 2004. The Relationship between the Environmental and Financial Performance of Public Utilities. Environmental and Resource Economics 29, 137–157.

Freedman, M., Jaggi, B., 1992. An investigation of the long run relationship between pollution performance and economic performance: The case of pulp and paper firms. Critical Perspectives on Accounting, 3(4), 315-336.

Freedman, M., Jaggi, B., 1994. Analysis of the Association between pollution performance and input cost factors: The case of electric utility plants. Journal of Accounting and Public Policy, 31-48.

Gottsman, L., Kessler, J., 1998. Smart screened investments: environmentally-screened equity funds that perform. Journal of Investing, 7 (3), 15–24.

Guenster, N., Derwall, J., Bauer, R., Koedijk, K., 2006. The economic value of corporate eco-efficiency. Academy of Management Conference Paper. Available at SSRN: ttp://ssrn.com/abstract=675628.

Halkos, G., Sepetis, A., 2007. Can capital markets respond to environmental policy of firms? Evidence from Greece. Ecological Economics 63, 578–587

Hart, S.L., Ahuja, G., 1996. Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. Business Strategy and the Environment 5, 30–37.

Hibiki, A., Higashi, M., Matsuda, A., 2003. Determinants of the Firm to Acquire ISO14001 Certificate and Market Valuation of the Certified Firm. Discussion Paper No. 03-06.

Horváthová, E., 2010. Does environmental performance affect financial performance? A meta-analysis, Ecological Economics, 70(1), 52-59.

Hughes II, K.E., 2000. The value relevance of nonfinancial measures of air pollution in the electric utility industry. The Accounting Review 75 (2), 209–228.

Jaffe, A., Peterson S. R., Portney, P.R., Stavins, R., 1995. Environmental Regulation and the Competitiveness of U.S. manufacturing: What Does the Evidence Tell Us?. Journal of Economic Literature 33 (1): 132-163.

Jaggi, B., Freedman, M., 1992. An examination of the impact of pollution performance on economic and market performance of pulp and paper firms. Journal of Business Finance Accounting 19 (5), 697–713.

King, A.A., Lenox, M.J., 2001. Does it really pay to be green? An empirical study of firm environmental and financial performance. Journal of Industrial Ecology 5 (1), 105–116.

Konar, S., Cohen, M.A., 2001. Does the market value environmental performance? Review of Economics and Statistics. 83 (2), 2814–2890.

Mahapatra, S., 1984. Investor reaction to corporate social accounting. Journal of Business Finance and Accounting 11 (1), 29–40.

Molloy, L., Erekson, H., Gorman, R., 2002. Exploring the relationship between environmental and financial performance. Workshop on Capital Markets and Environmental Performance. 55 pp.

Nakao, Y., Amano, A., Matsumura, K., Genba, K., Nakano, M., 2007. Relationship between environmental performance and financial performance: an empirical analysis of Japanese corporations. Business Strategy and the Environment 16, 106–118.

Palmer, K., Oates, W.E., Portey, P.R. (1995). Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm? Journal of Economic Perspectives, 9(4), 119-132.

Porter, M.E., 1991. America's green strategy. Scientific American 264 (4), 96.

Porter, M.E., van der Linde, C., 1995. Toward a new conception of the environment–competitiveness relationship. Journal of Economic Perspectives 9 (4), 97–118.

Rassier, D.G., Earnhart, D., 2011 Short-run and long-run implications of environmental regulation on financial performance. Contemporary Economic Policy 29(3), 357-373

Russo, M.V., Fouts, P.A., 1997. A resource-based perspective on corporate environmental performance and profitability. Academy of Management Journal 40 (3), 534–559.

Salama, A., 2005. A note on the impact of environmental performance on financial performance. Structural Change and Economic Dynamics 16, 413–421.

Sarkis, J., Cordeiro, J.J., 2001. An empirical evaluation of environmental efficiencies and firm performance: pollution prevention versus end-of-pipe practice. European Journal of Operational Research 135, 102–113.

Shrivastava, P., Hart, S., 1995. Creating sustainable corporations. Business Strategy and the Environment. 4(3), 154-165.

Spicer, H.B., 1978. Investors, corporate social performance and information disclosure: an empirical study. The Accounting Review 53 (1), 94–111.

Telle, K., 2006. “It pays to be green” — a premature conclusion? Environmental &Resource Economics 35, 195–220.

Thomas, A., 2001. Corporate environmental policy and abnormal stock price returns: an empirical investigation. Business Strategy and the Environment 10, 125–134

Wagner, M., 2005. How to reconcile environmental and economic performance to improve corporate sustainability: corporate environmental strategies in the European paper industry. Journal of Environmental Management 76, 105–118.

Wagner, M., Nguyen, Van P., Azomahou, T., Wehrmeyer, W., 2002. The relationship between the environmental and economic performance of firms: an empirical analysis of the European paper industry. Corporate Social Responsibility and Environmental Management 9, 133–146.

Walley, N., Whitehead, B., 1994. It's not easy being green. Harvard Business Review 46-52.

Watson, K., Klingeberg, B., Polito, T., Guerts, T.G., 2004. Impact of environmental management system implementation on financial performance. A comparison of two strategies. Management of Environmental Quality 15 (6), 622–628.

White, M.A., 1996. Corporate environmental performance and shareholder value. Working Paper WHI002. McIntire School of Commerce.

Yamashita, M., Sen, S., Roberts, M.C., 1999. The rewards for environmental conscientiousness in the U.S. capital markets. Journal of Financial and Strategic Decisions 12 (1), 73–82.

3. Why do firms voluntarily adopt environmental management systems? The case of the Czech Republic

Abstract

We examine why firms voluntarily implement environmental management systems. Employing both the ISO 14001 and EMAS management systems and using firm-level data for the Czech Republic, we find that environmental management systems are typically adopted by large firms and by those firms that initially pollute the environment more. These systems are more commonly implemented by firms operating in service industries. On the other hand, we find little support that the adoption of environmental management systems is influenced by the firm’s financial performance and labor costs.

3.1 Introduction

The system of environmental regulation around the globe is changing (Fiorino, 2006). In the new system, environmental responsibility of companies more commonly takes a form of corporate self-regulation built into a corporate business model. A voluntary adoption of environmental management systems (EMS) represents the most common type of behaviour how firms exhibit their corporate social responsibility.

The number of firms implementing environmental management systems is increasing each year all over the world (European Environmental Agency, 2014, ISO, 2014). Naturally, the question, which arise is “Why do some firms voluntary participate in these programs while other not?”. Clearly, the question has been studied extensively but the answer is far from being conclusive. As Alberini and Segerson (2002) note, different research has led to the different findings with a vast list of firms´ characteristics as well as external influences e.g. regulatory pressure.

Our research contributes to the existing literature in the following ways. First, it focuses on ISO 14001 as well as on EMAS. As Bracke et al. (2008) note, previous research analysed ISO 14001 and the only study focusing on EMAS is provided by Bracke et al. (2008).

Second, we examine the Czech Republic, i.e. one of central European countries. Bracke et al. (2008) emphasizes that the previous studies largely focus on the EPA´s voluntary programs in the United States (see for example Arora and Cason, 1995, or Videras and Alberini, 2000) or on the ISO 14001 adoption in Japan. The adoption of ISO 14001 by Japanese firms is studied, for example, by Hibiki et al. (2003) or Nakamura et al. (2001). The research on the adoption of environmental management systems in Europe, and especially on Central and Eastern Europe, is very rare. To our best knowledge, the only studies which study Central and Eastern Europe are Henriques and Sadorsky (2006) and Garcia et al. (2009). They study factors that influence the decision to adopt environmental management practices by Hungarian manufacturing firms in 2003. Garcia et al. (2009) study the adoption of environmental management practices (the establishment of environmental plans and environmental departments) in the six Central and Easterner European countries during 90s´. They find that the adoption of environmental management practices is driven by enforcement activities, public disclosure of environmental performances of firms, export-orientation and firm size.

We find that the larger and more polluting firms are more likely to adopt environmental management system. We find that the probability of EMS adoption is also influenced by the industry in which the company operates. However, we find no impact of labor cost and financial performance.

The paper is organized as follows. The environmental management systems are described in the section 3.2. Section 3.3 summarize the previous research. Data are described in the section 3.4 and then econometric model in section 3.5 follows. Results are discussed in the section 3.6 and short conclusions are recapitulate in section 3.7.

3.2 Environmental management systems

An Environmental Management System (EMS) is a type of a voluntary pro-environmental approach that firms around the globe can implement. A participation in the voluntary environmental approaches is a manner to signal firm´s involvement in a corporate social responsibility.[8] The EMS is a set of processes and practices that enable an organization to decrease its environmental impact. The United States´ Environmental Protection Agency (EPA, 2013) defines EMS as "a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency ".

There are more standards on EMS available. Internationally, ISO 14001 (environmental management standard published by the International Organization of Standardization) represents the most common. At the European level, firms often opt for the Eco-Management and Audit Scheme (EMAS). Besides these two widespread international standards, there are many other standards at the country level such as the British Standard 7750 or the programs developed by the US Environmental Protection Agency such as Energy Star, 33/50, Green Lights. In the Czech Republic, ISO 14001 and EMAS are particularly used. We discuss and compare the ISO 14001 and EMAS standards below.

3.2.1 ISO 14000

The ISO 14000 represents the international standard for EMS published by the International Organization for Standardization (ISO). The ISO 14000 family includes particularly the ISO 14001 standard, which represents the core set of standards for designing and implementing an effective environmental management system. Other standards included are, for example, ISO 14004 (Environmental management systems - general guidelines on principles, systems and supporting techniques),

[8] Other voluntary environmental approaches are for example publishing social, environmental and sustainable reports, voluntary agreements, eco-labelling, and fair trade. See recent survey by Dragusanu et al. (2014).

14020 - 14025 (Environmental labels and declarations), ISO 14031 (Environmental performance evaluation), 14040 – 14049 (Life Cycle Assessment) or ISO 14064 (Measuring, quantifying, and reducing Greenhouse Gas emissions). The original ISO 14001, which was in operation since 1996, was upgraded in 2004 with the new ISO 14001/2004 standard. A new revisited version of ISO 14001 is expected in 2015 to respond to the latest trends (ISO, 2014).

A number of ISO 14001 certified companies is permanently increasing worldwide. According to the European Environmental Agency (2014), there were slightly less than 20 ths. ISO 14001 registered organizations and sites in 2001 in the European Union. This number dramatically increased to more than 80 ths. in 2009.

3.2.2 EMAS

The EU Eco-Management and Audit Scheme (EMAS) was introduced by the European Union council regulation No.1836/93, requiring an implementation in the all European Union Member States (EU EMAS, 2014). EMAS represents a management tool for companies and other organizations to evaluate, report and improve their environmental performance. Originally, it was (the first version EMAS I was in operation since 1995) restricted to industrial sector. In 2001, the scheme has been opened to all economic sectors including public and private services (EMAS II). In 2009, the EMAS Regulation was revised for the second time (EMAS III, Regulation (EC) No 1221/2009). Importantly, it has been opened to the organizations located both inside and outside EU, EEA and accession countries (EMAS Global).

The ISO 14001 Environmental Management System requirements are an integral part of EMAS. Moreover, the EMAS takes into account additional elements to support organizations that continuously improve their environmental performance. While the EMAS and ISO 14001 share the same objective (to provide good environmental management) they are different in a number of ways, e.g. the legal basis (EMAS is under legal basis, while ISO 14001 is under the private law), the role of auditor (EMAS - requires the independence of the auditor, ISO - advises the independence of the auditor), the external verification (EMAS through accredited environmental verifiers, ISO without external verification), improvement (EMAS - requires annual improvement of environmental performance, ISO - requires periodical improvement but without a defined frequency). EU EMAS website (EU EMAS, 2014) provides further details on the differences between ISO 14001 and EMAS.

Comparing the number of companies certified under ISO 14001 and EMAS in the EU countries, there is more than 10 times more organizations registered under ISO 14001 than under EMAS standards (European Environmental Agency, 2014). According to the European Environmental Agency (2014), two reasons are behind this difference. First, the EMAS is stricter and second, the ISO 14001 has a global scope.

3.3 Literature Review

There is an extensive evidence on the determinants of corporate participation in the voluntary environmental management programs. Although many studies suggest that the probability of EMS adoption increases with the firm size and product visibility, Alberini and Segerson (2002) note that the impact of the firm size is not conclusive. They argue that practically all studied firms have been large and hence it is difficult to assess the impact of firm size generally. The majority of studies examine ISO 14001 certification adoption e.g. Nakamura et al. (2001); Hibiki et al. (2003), Potoski and Prakash (2005) and the US Environmental Protection Agency programs e.g. Arora and Cason (1995 and 1996), DeCanio and Watkins (1998), Khanna and Damon (1999), Videras and Alberini (2000). The results of the main studies on EMS adoption are summarized below.

3.3.1 ISO 14001 research

Since ISO 14001 is the most widespread international environmental management system, adoption of this system has been broadly worldwide studied.

The adoption of ISO 14001 certification has been largely studied using the Japanese data, since ISO 14001 certification is often used by Japanese firms. Hibiki et al. (2003) find that large firms, which are profitable, export-oriented and with higher

R&D expenditures are more likely to adopt the ISO14001 certificate. In addition, they find that the probability of EMS adoption is influenced by the industry in which the firm operates. Nishitani (2009) analyses ISO 14001 adoption by Japanese firms, too. He finds that the determinants of ISO 14001 adoption evolve over time. In the first period of ISO adoption, large firms with lower debt ratios were more likely to adopt the certification. In the next period, when most of the firms already adopted ISO 14001, the determinants are somewhat different. The firms with higher export ratios, higher proportions of stock held by other corporations, larger size and better economic performance were more likely to certificate. In the last period, no systematic determinants of the certification adoption were found. Next, Nakamura et al. (2001) study the ISO 14001 certification adoption by large Japanese manufacturing firms. They conclude that the implementation rates are affected by the firm size, the average age of firm employees, export ratio and debt ratio.

The adoption of ISO 14001 is also studied using the Mexican data (Dasgupta et al., 2000; Blackman and Guerrero, 2012; Blackman, 2010). Dasgupta et al. (2000) find that firm specific characteristics e.g. company size and environmental training, play a significant role in the ISO 14001 adoption while stakeholder pressure does not. Another study on Mexican data is Blackman and Guerrero (2012). They find that regulatory fines, which stand as a proxy for regulatory pressure and environmental performance, induce environmental certification. They also find that firms, which are exporting overseas, importing inputs and are relatively large, have higher probability of certification.

Potoski and Prakash (2005) studies US firms and find that the government inspections and more stringent pollution regulations encourage firms to join ISO 14001. In addition, the facilities with moderate compliance records and the facilities operating in areas with more educated residents are more likely to join ISO 14001. Nevertheless, American researches study particularly environmental management programs designed by the US Environmental Protection Agency.

3.3.2 Other environmental management systems

The American studies typically examine 33/50 and Green Lights programs, which are the programs designed by the US Environmental Protection Agency. Arora and Cason (1995, 1996) study the US firms' participation in program 33/50. This voluntary program encourages firms to reduce releases and transfers of 17 toxic chemicals. They find that the firm size and industry effects are important determinants of firms' participation decisions. In addition, they find that public information and awareness play important role in the adoption of 33/50 program suggesting that the adoption of these programs provide a signalling value to the customers and general public. Khanna and Damon (1999) analyse 33/50 program and find that firms participate in the program if their expected gains are higher than the implementation cost of the program. They also test for communities pressure e.g. non-government and trade organizations. Videras and Alberini (2000) examine why firms participate in the EPA´s three voluntary programs (33/50, Green Lights and WasteWise). They find that larger firms are more likely to participate in these programs and they explain it with a better visibility of large firms. They conclude that publicity is an important factor of participation. In the programs related to highly regulated pollutants, the more pollution the firm emits, the higher probability of joining the program is. According to this result, there is a correction mechanism so that the firms polluting the environment the most try to reduce the environmental burden they produce. Next, the empirical results on participation in 33/50 program e.g. Khanna and Damon (1999), Videras and Alberini (2000), support the idea suggested by Segerson and Miceli (1998) and Maxwell et al. (2000). According to these two studies, firms adopt environmental management systems to pre-empt more stringent mandatory regulation or to soften enforcement of existing regulation.

While the research on the adoption of EPA´s voluntary programs or ISO 14001 is comprehensive, the European program EMAS is so far studied less commonly. Bracke et al. (2008) is the first study dealing with EMAS certification and studying European data. They find the following drivers of EMAS registration: financial structure, company size, profitability, average labor cost, type of firm´s activities and headquarter location. Next, Blanco and Borsky (2013) study the EMAS implementation in the all European Union countries from 1995 to 2010. Interestingly, they find that stricter environmental law reduce the number of EMAS certificates. They also find that better executive efficiency of a government increase the number of EMAS certification.

3.4 Data

This section describes the data we use to assess firms' decision to implement EMS. The yearly data from 2004 to 2008 are used for all variables.

The financial data are obtained from a commercial firm database CreditInfo. The database provides firms' full balance sheets and profit-loss statements for the vast majority of Czech companies (more than 2.3 million business subjects). The database also identifies firm's industrial classification.

The data on EMS are collected using the publicly available database (see www.iso.cz). All data on EMS were double-checked by examining the websites of companies. Each company is examined for the certification of both EMAS and ISO 14001. The vast majority of firms are certified with the ISO 14001.

The environmental performance data in this study are obtained from the Integrated Register of Pollutant Emissions (freely available at www.irz.cz) which is a part of European Pollutant Release and Transfer Register (EPRTR). The EPRTR provides a publicly available access to an environmental data from industrial facilities in the European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland. The EPRTR contains the data on an annual basis since 2007. In addition, it contains the data for 2001 and 2004. The data for missing years (e.g. 2005 and 2006 to match our financial data) are available in the national registers (see www.irz.cz) and were gathered under the same rules.

The EPRTR contains data on 93 pollutants releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water from key pollutants including heavy metals, pesticides, greenhouse gases and dioxins. Data collection and reporting is standardized over all pollutants in all countries. Therefore, datasets are comparable among all participating countries. Each pollutant is reported in this dataset if the emitted amount exceeds a reporting threshold. The reporting thresholds are set up concerning the main impact of the pollutants on human health and on the environment (the thresholds are set out by the European Commission in the Article 5 of the EPRTR Regulation[9]). Each facility has to report to the register, if it releases pollutants above the thresholds specified for each media (air, water and land).

Merging the financial data with environmental performance and EMS data, we obtain a database, which contains 552 firms and 1177 observations. The Table 3.1 presents the basic descriptive statistics. The majority of firms are not certified (either EMAS or ISO 14001). There are 167 observations with environmental certification and there is only one firm which is EMAS certificated. The low participation rate in the total sample is in line with other similar research e.g. Arora and Cason (1996), Bracke et al. (2008), Potoski and Prakash (2005). Bracke et al. (2008) analyse both EMAS and ISO 14001 and find a rather high ISO 14001 participation, too. They note that, somewhat in contrast to theory, EMAS and ISO 14001 certificates are not considered as substitutes in practice.

Majority of firms operates in agriculture, forestry and fishing (NACE – A, 32% of observations) and manufacturing (NACE - C, 32% of observations). Only one observation is detected from NACE – N (Administrative and support service activities) and NACE - R (Arts, entertainment and recreation).

[9] EPRTR Regulation - Regulation (European Commission) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:033:0001:0017:EN:PDF

Table 3.1 Descriptive statistics

Variable	**No. of observation**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
EMS (EMAS or ISO 14001)	1177	0.14	0.35	0	1
EMAS	1177	0.00	0.06	0	1
ISO 14001	1177	0.14	0.35	0	1
Assets (Ths. CZK)	1177	2674	15569	0.48	311377
Sales (Ths. CZK)	1177	760	10026	0.00	211026
Wages/total assets	1038	0.15	0.23	0.00	4.90
ROE	1174	0.14	1.04	-21.60	10.15
Environmental Performance	1177	250.5	1969	0.00	49333
Industry - NACE - A	1177	0.32	0.47	0	1
Industry - NACE - BCF	1177	0.34	0.47	0	1
Industry - NACE - DE	1177	0.13	0.34	0	1
Industry - NACE - GHI	1177	0.14	0.35	0	1
Industry - NACE - JLMNRS	1177	0.07	0.26	0	1

Note: NACE - A (Agriculture, forestry and fishing); NACE - B, C, F (Mining and quarrying, Manufacturing, Construction), NACE - D, E (Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities), NACE - G, H, I (Wholesale and retail trade; repair of motor vehicles and motorcycles, Transporting and storage, Accommodation and food service activities) and NACE - J, L, M, N, R, S (Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities, Arts, entertainment and recreation, Other services activities).

3.5 Econometric Model

This section describes the econometric model and the variables we use. We study which factors influence firms' decision to implement the EMS.

We measure the firms' decision to adopt EMS by a binary variable *EMS*. The variable is defined as that it takes the value of one, if the firm has an EMS certification, zero otherwise. The firms have to undergone regular audits to maintain the EMS certification or they can quit the system. Majority of firms maintain EMS for the next years but the dropping out was also detected. Due to this reason the logistic regression is used to analyse the data.

As discussed in the literature section, a wide range of both firms' characteristics and external pressures are considered by previous literature as potential factors influencing firms' decision to implement the EMS. We motivate our empirical model by previous literature to put some structure. Therefore, we use the following independent variables to study firms' decision to implement EMS: the firm size (measured as the log of total assets), environmental performance (the calculation is described below), indebtedness (the ratio of debt to total assets), profitability (return on equity - ROE), labour cost and industry classification.

The following logit/probit regression is estimated:

$$P(EMS_{i,\,t}=1) = \Phi(a_i + b*EP_{i,\,t\text{-}1} + c*X_{i,\,t\,\text{-}1} + d*D_{i,\,t\,\text{-}1} + e*FP_{i,\,t\text{-}1} + f*L_{i,\,t\,\text{-}1} + g*I_{i,\,t}) + e_{i,t}$$

where P(EMS i, t=1) is a binary variable indicating whether EMS has been adopted by i-th firm in time t.

$EP_{i,\,t\text{-}1}$ is environmental performance by i-th firm in time t-1.

$X_{i,\,t\,\text{-}1}$ is firm size by i-th firm in time t-1.

$D_{i,\,t\,\text{-}1}$ is indebtedness by i-th firm in time t-1.

$FP_{i,\,t\text{-}1}$ is profitability by i-th firm in time t-1.

$L_{i,\,t\,\text{-}1}$ is labour cost by i-th firm in time t-1.

$I_{i,\,t}$ is industry in which i-th firm operates.

It has been argued that larger firms are more likely to adopt EMS. The main arguments for the adoption of EMS are higher firms´ visibility to public, a lower marginal abatement cost and better financial and personnel resources. Although the empirical evidence support this hypothesis in many studies e.g. Arora and Cason (1995 and 1996) and Khanna and Damond (1999), Alberini and Segerson (2002) emphasize that this evidence is still not conclusive.

Although the impact of environmental performance on the likelihood of EMS adoption has been widely investigated, Arora and Cason (1995), Khanna and Damond (1999) and Alberini and Segerson (2002) point out that the results vary across the studies. But still a majority of studies (e.g. Khanna, 2001) find that poor environmental performance leads to higher participation rates in the EMS. In addition, Alberini and Segerson (2002) emphasize that the difficulties in measuring environmental performance may have an influence on the estimated effect of environmental performance on the EMS implementation.

We measure the environmental performance by the following EP indicator, in which the pollutant emitted amount is normalized according to the reporting threshold (see Horváthová, 2012, who proposed this normalization). Since the harmfulness of each pollutant differs and the relative amount of each pollutant emitted also differs, we do not add total amounts. Instead, we first divide the emitted amount by the reporting threshold, if emissions are higher than the threshold. The reporting thresholds are set up concerning the main impact of the pollutants on human health and on the environment.

The environmental performance for i-th firm in year t is defined as:

$$EP_{i,t} = \sum_{j=1}^{93} \frac{P_{i,j,t}}{RT_{\ j}} \qquad \text{if } P_{i,j,t} \geq RT_j \text{ and 0 otherwise}$$

where $EP_{i,t}$ is an environmental performance of a company

$P_{i,j,t}$ is an absolute amount of emission for pollutant j

RT_j is a reporting threshold for pollutant j

Next, we study the impact of firms´ financial characteristics because the implementation cost of EMS is significant. Clausen et al. (2002) estimate EMAS implementation cost for the companies with more than 500 employees to range between 85.000€ and 322.000€. Once the EMS is adopted, its maintenance entails further costs. The variable indebtedness (the ratio of debt to total assets) is used to test whether less indebted firms have higher probability of EMS implementation. ROE is used to test the effect of firms’ profitability. The more profitable firms have better access to credit and/or can use internal funds to cover the implementation costs. We expect that firms with better financial position have a higher probability of EMS implementation since they are likely to sustain implementation costs.

We also test for the significance of labour cost (wages and salaries/total assets). This is motivated by Bracke et al. (2008), who argue that the higher labour costs may be paid due to more educated personnel and/or to those working in less safe working environment.

Next, we control for the industry effects since other researchers find industry effects to be important factor for the EMS adoption e.g. Arora and Cason (1995, 1996), Hibiki et al. (2003), Videras and Alberini (2000). We use industry classification according to NACE codes[10] . To reduce a number of explanatory variables, we group the NACE codes into the following groups: NACE - A (Agriculture, forestry and fishing); NACE - B, C, F (Mining and quarrying, Manufacturing, Construction), NACE - D, E (Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities), NACE - G, H, I (Wholesale and retail trade; repair of motor vehicles and motorcycles, Transporting and storage, Accommodation and food service activities) and NACE - J, L, M, N, R, S (Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities, Arts, entertainment and recreation, Other services activities).

Since EMS adoption process takes several months (e.g. Hillary (1998) finds that EMAS registration process takes between 6 to 24 months) the explanatory variables, except the industry dummies, are lagged by one year.

3.6 Results

Tables 3.2 and 3.3 show the regression results for various model specifications and independent variables. The results presented in Table 3.2 suggest that the higher firm size is associated with the higher probability of EMS adoption. This result is in line with findings of other studies. For example, Arora and Cason (1995, 1996) studying US firms' participation in EPA´s program 33/50 find similar results. Videras and Alberini (2000) examine participation in the three EPA´s programs and find that

[10] NACE - the Statistical Classification of Economic Activities in the European Community.

larger firms have systematically higher probability of participation in these programs, too. DeCanio and Watkins (1998), Hibiki et al. (2003), Nakamura et al. (2001), Dasgupta et al. (2000) also find the firm size to influence the decision to implement EMS.

The likelihood of EMS adoption increases for more polluting companies. These findings can be due to that environmental certifications can be used as a tool to decrease firms´ environmental impacts. This is in line with Blackman and Guerrero (2012), who find that environmental fines stimulate environmental certification in proceeding three years. In a similar way, Potoski and Prakash (2005) find that the adoption of ISO 14001 leads to improvements in firms' compliance with environmental law. Videras and Alberini (2000) find that the probability of participation in EPA´s voluntary programs is higher for more polluting firms, too. Most studies but not all find that more polluting firms are more likely to participate in ISO 14001 e.g. Potoski and Prakash (2005) and Darnall (2003). Nevertheless, according to Alberini and Segerson (2002) the impact of environmental performance on the likelihood of EMS adoption vary across studies.

The probability of EMS adoption is influenced by the industry in which the company operates, too. In a similar way Arora and Cason (1995, 1996), Hibiki et al. (2003) find that operating industry influences the decision to implement 33/50 program. Arora and Cason (1996) find that the probability of participation in 33/50 program is higher in industries with higher consumer contact. Hibiki et al. (2003) find that firms operating in medicaments, metal, transportation equipment, precision machinery and other manufacturing have less incentive for EMS adoption. Henriques and Sadorsky (1996) find that the probability of formulation of an environmental plan differs across industries, too. They find that firms in service sectors are less likely to formulate an environmental plan. On the contrary we find that the firms operating in service industries implement EMS with higher probability. This finding supports the results of Arora and Cason (1996) who find higher probability of EMS certification in industries with higher consumer contact.

On the other hand, the impact of firms' profitability, indebtedness and labour cost is not statistically significant. The finding that the probability of EMS adoption is not influenced by the labour cost does not correspond to the results of Bracke et al. (2008). Nevertheless, we measure the labour cost somewhat differently. Bracke et al., (2008) use the average cost of employees and average it over 7 year period, while we measure the labour cost as wages plus salaries divided by total assets, since we do not have data on the number of employees.

The results that financial and debt variables do not influence the probability of EMS implementation is consistent with previous research. Similarly, Arora and Cason (1995), Nakamura et al (2001) and Videras and Alberini (2000) find that participation in the EMS programs is not affected with the financial health of the companies. On the other hand, Hibiki et al. (2003) find that firms with higher profitability are more likely to implement ISO 14001. However Cole et al. (2006) find a negative influence of the financial variables on the probability of EMS implementation. In addition, the results of the previous research on the impact of debt variables are mixed, too. For example, Nakamura et al. (2001) and Cole et al. (2006) find that indebtedness negatively influences the EMS implementation decision while Arora and Cason (1995) and Hibiki et al. (2003) find insignificant impact of debt ratio on EMS implementation decision.

To test the stability of the results both logit and probit regression is run. The results of logit regression are summarized in the table 3.2. The results of probit regression are summarized in the table 3.3. The tables indicate that the results of probit and logit regressions are nearly the same.

Table 3.2 Why do firms adopt environmental management systems?
Logistic regression. Dependent variable: EMS (EMAS or ISO 14001)

	[1]	[2]	[3]	[4]
Log of assets	0.36***	0.20**	0.21**	0.25**
	(0.07)	(0.08)	(0.08)	(0.1)
Env. Performance	0.09*	0.09*	0.09*	0.11*
	(0.05)	(0.05)	(0.05)	(0.06)
Debt to total assets			-0.12	-0.23
			(0.2)	(0.3)
ROE	-0.14	-0.19*	-0.19*	-0.15
	(0.09)	(0.11)	(0.11)	(0.16)
Wages/total assets				1.33
				(1.03)
Industry - NACE (A)		-2.90***	-2.89***	-2.80***
		(0.57)	(0.57)	(0.61)
Industry - NACE (BCF)		-1.53***	-1.53***	-1.69***
		(0.39)	(0.39)	(0.44)
Industry - NACE (DE)		-1.36**	-1.34**	-1.65**
		(0.42)	(0.42)	(0.5)
Industry - NACE (GHI)		-1.20**	-1.2**	-1.49**
		(0.44)	(0.44)	(0.5)
Constant	-6.42***	-2.87*	-3.01**	-3.49*
	(0.93)	(1.12)	(1.15)	(1.44)
Number of observations	572	572	572	479
Pseudo R2	0.08	0.14	0.14	0.15
Significance level (Prob>chi2)	0	0	0	0
LR chi2	40.6	73.06	73.28	60.61

Note: Standard errors in parenthesis. *** p<0.01, ** p<0.01, * p<0.1. NACE - A (Agriculture, forestry and fishing); NACE - B, C, F (Mining and quarrying, Manufacturing, Construction), NACE - D, E (Electricity, gas, steam and air conditioning supply, Water supply; sewerage; waste management and remediation activities), NACE - G, H, I (Wholesale and retail trade; repair of motor vehicles and motorcycles, Transporting and storage, Accommodation and food service activities) and NACE - J, L, M, N, R, S (Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities, Arts, entertainment and recreation, Other services activities). The explanatory variables, except the industry dummies, lagged by one year. The regression coefficient on environmental performance divided by 1000.

Table 3.3 Why do firms adopt environmental management systems?
Probit regression. Dependent variable: EMS (EMAS or ISO 14001)

	[1]	[2]	[3]	[4]
Log of assets	0.21***	0.12**	0.12**	0.15**
	(0.04)	(0.04)	(0.04)	(0.06)
Env. Performance	0.05*	0.06*	0.06*	0.07*
	(0.03)	(0.03)	(0.03)	(0.04)
Debt to total assets			0.06	-0.14
			(0.11)	(0.17)
ROE	-0.08	-0.11*	-0.11*	-0.08
	(0.05)	(0.09)	(0.06)	(0.09)
Wages/total assets				0.78
				(0.57)
Industry - NACE (A)		-1.56***	-1.55***	-1.52***
		(0.29)	(0.29)	(0.32)
Industry - NACE (BCF)		-0.91***	-0.91***	-1***
		(0.23)	(0.23)	(0.27)
Industry - NACE (DE)		-0.81**	-0.80**	-0.99**
		(0.25)	(0.25)	(0.3)
Industry - NACE (GHI)		-0.73**	-0.73**	-0.89**
		(0.26)	(0.26)	(0.3)
Constant	-3.77***	-1.71**	-1.78**	-2.13*
	(0.52)	(0.65)	(0.66)	(0.84)
Number of observations	572	572	572	479
Pseudo R2	0.08	0.14	0.14	0.15
Significance level (Prob>chi2)	0	0	0	
LR chi2	42.07	73.38	73.6	61.26

Note: See table 3.2.

3.7 Concluding remarks

We study why firms voluntarily invest in an adoption of environmental management systems (EMS). Most previous studies focus on examining the adoption in developed countries. On the other hand, we examine the adoption of EMS in one of emerging market economies, the Czech Republic. Using the Czech data on both EMAS and ISO 14001, we find that the probability of EMS implementation increases with the firms' size. In addition, our results suggest that more polluting firms exhibit a higher probability of the EMS implementation. The probability of EMS adoption is also influenced by the industry in which the company operates. On the other hand, we fail to find that firms' financial characteristics matter for the adoption of these systems.

3.8 Literature

Alberini; A., Segerson, K., 2002. Assessing Voluntary Programs to Improve Environmental Quality. Environmental and Resource Economics; 22, 157-184.

Arora, S., Cason T. N., 1995. An experiment in voluntary environmental regulation: Participation in EPA's 3350 program, Journal of Environmental Economics and Management 28, 271-286.

Arora, S., Cason, T. N., 1996. Why do firms volunteer to exceed environmental regulations?: Understanding participation in EPA's 33/50 program, Land Economics 72(4), 413-432.

Blackman, A., 2010. Alternative Pollution Control Policies in Developing Countries. Review of Environmental Economics and Policy 4(2): 234-253.

Blackman, A., Guerrero, S., 2012. What Drives Voluntary Eco-Certification in Mexico? Journal of Comparative Economics 40(2): 256-268.

Blanco, E., Borsky, S. 2013. Setting one voluntary standard in a heterogeneous Europe - EMAS, environmental taxes and institutional quality. Preliminary draft.

Bracke, R., Verbeke, T., Dejonckheere V. 2008. What Determines the Decision to Implement EMAS? A European Firm Level Study. Environmental and Resource Economics 41(4): 499-518.

Clausen, J., Keil, M., Jungwirth, M. 2002. The state of EMAS in the EU: literature survey. http://ec.europa.eu/environment/emas/pdf/general/literature_study_020506_en.pdf

Cole, M., Elliott, R., Shimamoto, K. 2006. Globalization, firm-level characteristics and environmental management: a study of Japan. Ecological Economics 59:312-323.

Darnall, N. 2003. Why Firms Certify to ISO 14001: An Institutional and Resource Based View. Academy of Management Proceedings One: A1–A6.

Dasgupta, S., Hettige, H., Wheeler, D., 2000. `What improves environmental compliance? Evidence from Mexican industry', Journal of Environmental Economics and Management 39, 39-66.

DeCanio, S.J., Watkins, W. E., 1998. Investment in energy efficiency: Do the characteristics of firms matter?, Review of Economics and Statistics 80(1), 95-107.

Dragusanu, R., Giovannucci, D., Nunn, N., 2014. The Economics of Fair Trade. Journal of Economic Perspectives, 28(3): 217-36.

European Environmental Agency (2014) http://www.eea.europa.eu/data-and-maps/indicators/number-of-organisations-with-registered/assessment

EPA (2013) http://www.epa.gov/ems/

EU EMAS (2014) http://ec.europa.eu/environment/emas/index_en.htm

Fiorino, D.J., 2006. The new environmental regulation. The MIT Press. 290pp.

Garcia, J.D., Bluffstone, R., Stern, T., 2009. Corporate Environmental Management in Transition Economies: The Case of Central and Eastern Europe. Finance a úvěr-Czech Journal of Economics and Finance, 59 (5), 410-425.

Henriques, I., Sadorsky, P., 1996. The determinants of an environmentally responsible firm: an empirical approach. Journal of Environmental and Economics and Management 30:381-395.

Henriques, I., Sadorsky, P., 2006. The Adoption of Environmental Management Practices in a Transition Economy. Comparative Economic Studies, 48: (641–661).

Hibiki, A., Higashi, M., Matsuda, A., 2003. Determinants of the Firm to Acquire ISO14001 Certificate and Market Valuation of the Certified Firm. Discussion Paper No. 03-06. 21 pp.

Hillary, R., 1998. Pan European Union assessment of EMAS implementation. European Environment 8(6):184–192.

Horváthová, E., 2012. The impact of environmental performance on firm performance: Short-term costs and long-term benefits?, Ecological Economics, 84: 91-97

ISO (2014) http://www.iso.org

Khanna, M,. 2001. Non-mandatory approaches to environmental protection. Journal of economic surveys 15(3): 291-324.

Khanna, M., Damon, L., 1999. EPA’s voluntary 33/50 Program: Impact on toxic releases and economic performance of firms. Journal of Environmental Economics and Management 37, 1-25.

Maxwell, J., Lyon, T., Hacket,t S., 2000. Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism. Journal of Law and Economics 43(2): 583–618.

Nakamura, M., Takahashi, T., Vertinsky, I. 2001. Why Japanese firms choose to certify: a study of managerial responses to environmental issues. Journal of Environmental Economics and Management 42: 23-52.

Nishitani, K. 2009. An empirical study of the initial adoption of ISO 14001 in Japanese manufacturing firms. Ecological Economics 68: 669 – 679.

Potoski, M., Prakash, A., 2005. Green Clubs and Voluntary Governance: ISO 14001 and Firms’ Regulatory Compliance. American Journal of Political Science 49(2), 235-248.

Segerson, K., Miceli, T., 1998. Voluntary Environmental Agreements: Good or Bad News for Environmental Protection? Journal of Environmental Economics and Management 36: 109–30.

Videras J., Alberini, A. 2000. The appeal of voluntary environmental programs: which firms participate and why?. Contemporary Economic Policy 18(4), 449-461.