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The Effect of Corporate Environmental Performance on Financial Outcomes – Profits, Revenues and Costs: Evidence from the Czech Transition Economy

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Abstract:
This empirical study analyzes the effect of corporate environmental performance on financial performance in a transition economy. In particular, it assesses whether good environmental performance affects profits, and if so, in which direction. Then the study decomposes profits into revenues and costs in order to identify the channel(s) of any identified effect of environmental performance on profits. For example, as environmental performance improves, do revenues rise and costs fall so that profits increase? For this assessment, our study analyzes the links from environmental performance to revenues, costs, and profits using an unbalanced panel of Czech firms from the years 1996 to 1998. The empirical results indicate strongly and robustly that better environmental performance improves profitability by driving down costs more than it drives down revenues. The strong reduction in costs is consistent with the substantial regulatory scrutiny exerted by environmental agencies during the sample period in the forms of prevalent monitoring (i.e., inspections) and enforcement and escalating emission charge rates.

Keywords: Czech Republic, environmental protection, pollution, financial performance

Jel codes: D21, G39, Q53

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1. Introduction

Much recent economic analysis, including empirical studies, examines the effect of corporate environmental performance on financial performance (e.g., Konar and Cohen, 2001; Telle, 2006; Elsayed and Paton, 2005). Theoretical insight on this topic posits either a positive relationship or a negative relationship. The traditional perspective views environmental expenditures, whether on end-of-pipe treatment or pollution prevention efforts, as a drain on firms' resources (Palmer et al., 1995; Filbeck and Gorman, 2004). Certainly, firms spend billions of dollars annually when applying for environmental permits, installing mandatory technologies or at least technologies necessary to achieve compliance with pollution limits, and reporting their environmental impacts (Portney and Stavins, 2000; Konar and Cohen, 2001).

On the other hand, more recent theoretical insight posits that pollution prevention and the associated re-evaluation of firms' production processes engenders opportunities for firms to innovate by modifying their production "strategically", such as recycling by-products that would otherwise be discharged into the natural environment (Filbeck and Gorman, 2004). Moreover, this innovation may translate into a competitive advantage for a firm (Porter and van der Linde, 1995). Consistent with this perspective, some firms are moving beyond compliance by voluntarily reducing their pollution to levels below legal limits (Konar and Cohen, 2001; Arora and Cason, 1995). Similarly, some firms are adopting riskier proactive environmental management practices that attempt to modify production processes in order to prevent pollution rather than treat it. While riskier, these pollution prevention programs may effectively reduce pollution, while also lowering costs (McCloskey, 1993; Filbeck and Gorman, 2004).

Several studies analyze empirically the effect of corporate environmental performance on financial performance (e.g., Elsayed and Paton, 2005). To the authors' best knowledge, no previous study examines this relationship outside of the US and Canada, with only two studies of Canada (Laplante and Lanoie, 1994; Lanoie et al., 1998). Thus, previous empirical studies examine only mature market economies. In contrast, our study examines the effect of environmental performance, as measured by air pollutant emissions, on financial performance in the transition economy of the Czech Republic during the years 1996 and 1998.

The context of a transition economy is highly interesting for an assessment of financial performance since all types of firms – state firms, privatized firms, and *de novo* private firms – struggle to organize their financial matters as the economic system evolves. This concern has been even greater in the Czech Republic, along with most transition economies in Central and Eastern Europe, given their desire to enter the European Union (EU).

As with other countries in Central and Eastern Europe, the context of the Czech transition economy is also highly interesting for an assessment of environmental performance. The Czech Republic had a substantially degraded environment in the 1990s; in particular, poor ambient air quality and air pollution were large environmental problems of public concern (World Bank, 1992). In addition to this domestic public concern, the Czech government needed to reduce industrial air pollutant emissions in order to qualify for membership in the EU. (For both of these reasons, our focus on air-related environmental performance seems quite valid.) In response, between 1991 and 1998, the Czech government was tightening air protection policies, especially with a new Clean Air Act. The Czech government was requiring new stationary emission sources to meet stringent emission limits based on the installation of state-of-the-art treatment technologies and forcing existing stationary emission sources initially to meet "currently attainable" emission limits and eventually to meet new source limits (by the end of 1998), all while steadily increasing emission charge rates on all stationary emission sources. In addition to more stringent air protection policies, Czech firms moved into export markets that may have offered new, albeit limited, opportunities to market "green" goods. Consistent with these developments, investment in environmental protection as a percent of gross domestic product (GDP) rose dramatically after 1991, peaking in 1997, and declined substantially after 1998, returning to pre-transition levels by 2000. In keeping with this increased investment, throughout this same period, aggregate air pollutant emissions declined dramatically.[1] Within the 1991 to 1998 period, the years between 1996 and 1998 are especially important because existing pollution sources were modifying their operations in order to comply with the impending new source limits (binding on January 1, 1999) and, to a lesser extent, all pollution sources were facing emission charge rates that had escalated to more meaningful levels. Consistent with this claim, environmental investment was most important during this three-year span, as shown above.

Consequently, Czech firms simultaneously struggled to control their air pollutant emissions and re-organize their financial matters. In this context of major changes, we anticipate that our study is well-positioned to capture any meaningful relationship that might exist between environmental and financial performance. This context contrasts with a mature market economy, where most firms may only marginally modify their environmental management practices with only limited effects on their financial performance. Of course, many prominent cases of substantial change to

[1] During this period, the Czech government offered limited financial assistance from the State Environmental Fund for environmental investment. For example, this source represented only 4 % and 9 % of overall financing into air-related investment in 1996 and 1997, respectively (Czech Ministry of the Environment, 1997, 1998).

environmental management do exist in mature market economies; however, these cases need not represent a substantial portion of the overall economy.[2]

For this reason, the results from this study of a transition economy need not generalize to economies that are neither in transition or developing in general. Nevertheless, the results should generalize to other similar transition economies. The Czech experience with poor ambient air quality, initially high air pollutant emission levels, tightened air protection laws, substantial emission reductions, and pending entry into the EU are highly similar to other countries in Central and Eastern Europe. Thus, our study of the Czech Republic may be viewed as representative of other countries in the Central and Eastern European region during its transition period towards EU accession. In sum, this study cannot serve as the definitive study on the link from environmental performance to financial performance and may not generalize beyond transition economies; still, it represents a useful contribution to a literature packed with studies of mature market economies.

Within the context of a transition economy, our empirical study focuses on two particular research questions First, it assesses whether good environmental performance affects profits, and if so, in which direction. Then the study decomposes profits into revenues and costs in order to identify the channel(s) of any identified effect of environmental performance on profits. For example, as environmental performance improves, do revenues rise and costs fall so that profits increase? For this assessment, our study analyzes the links from environmental performance to profits, along with revenues and costs, using a panel of Czech firms during the 1996 to 1998 period.

[2] While greater variation in the financial and environmental performance factors help to facilitate our empirical analysis, this greater variation may stem (at least partially) from a stronger prevalence of "noise", which reduces our econometric ability to identify meaningful "signals". Nevertheless, our econometric analysis appears to identify them.

The empirical results indicate strongly and robustly that better environmental performance improves profitability by driving down costs more than revenues. The strong reduction in costs is consistent with the substantial regulatory scrutiny exerted by environmental agencies in the forms of prevalent monitoring (i.e., inspections) and enforcement and escalating emission charge rates. In other words, by reducing air pollutant emissions, Czech firms appeared able to lower their overall costs because reduced emissions mitigated the disruption from inspections, avoided regulatory sanctions, and lowered emission charge payments.

2. Related Literature and Theoretical Insight

2.1. Literature of the Link from Environmental Performance to Financial Success

Recent economic analysis explores the link from corporate environmental performance to financial performance. All of these studies analyze firms in mature market economies. Several studies employ regression analysis to examine financial performance. Konar and Cohen (2001) find a significantly positive effect of good environmental performance, as measured by low toxic emissions, on firms' intangible asset values. Similarly, Austin et al. (1999) demonstrate that good environmental performance, as captured by low toxic emissions and hazardous waste corrective actions, positively affect financial rates of return. Moreover, Hart and Ahuja (1996) show that emission reductions prompt better financial performance, based on accounting-based measures. Filbeck and Gorman (2004) also find a positive relationship between financial and environmental performance; to demonstrate this point, they regress three-year holding period returns against environmental penalty magnitudes. Also, Russo and Fouts (1997) show that good environmental ratings, as assigned by the Franklin Research and Development Corporation, positively impact a firm's return on assets (ROA). Khanna and Damon (1999) generate a similar conclusion by examining participants in the EPA's 33/50 program and revealing that better environmental performance, measured by the number of Superfund sites, improves returns on investment. Moreover, Khanna and Damon (1999) demonstrate that participation in the EPA's 33/50 program improves financial performance, including profitability.

More recent studies explore the robustness of results based on different regression strategies. Telle (2006) finds a positive relationship between environmental performance and financial performance using OLS regression yet no relationship using a random effects estimator. Salama (2005) finds no relationship between environmental performance and financial performance using OLS regression yet a positive relationship using robust median regression. Elsayed and Paton (2005) find a strongly significant positive relationship between environmental performance and financial performance using OLS regression based on both cross-sectional and panel data yet only limited evidence of this relationship using panel data estimators.

(Appendix A describes empirical studies employing sample means tests and event-study analyses. See Ambec and Lanoie (2008) for a comprehensive survey of relevant empirical studies.)

Our study draws upon this empirical literature to guide our analysis.

As our primary contribution to the literature, we examine the link from corporate environmental performance to financial performance in a transition economy. As our secondary contribution, our study examines both profits and the decomposition of profits into revenues and costs. While simple in concept, surprisingly no previous study analyzes this decomposition, to the authors' best knowledge. As another contribution, our study examines a panel of firms over a multi-year period using an econometric estimator that relies upon intra-firm variation rather than cross-sectional variation for identification. Use of this estimator avoids the concern that more financially successful firms are the same ones who effectively control their pollution levels. While two recent studies address this concern (Telle, 2006; Elsayed and Paton, 2005), most studies fail to address this concern (e.g., Russo and Fouts, 1997; Hart and Ahuja, 1996; Arora and Cason, 1996; Filbeck and Gorman, 2004; Konar and Cohen, 2001). Consequently, these studies may be incorrectly attributing influence to environmental performance that is based on correlation rather than causation. In other words, these cross-sectional analyses are unable to identify properly the important heterogeneity across firms, while our panel data analysis controls for individual firm characteristics in more detail.

Beyond the empirical guidance displayed above, the cited studies, along with additional studies, provide insight into the theoretical effect of environmental performance on financial performance. Collectively, this theoretical insight suggests that good environmental performance may improve or degrade financial success and that this improvement or degradation may stem from an alteration to revenues, costs, or both.

First, environmental performance may affect revenues. Customers may be willing to pay more for or buy more of environmentally friendly products ("green" products). Thus, a firm is able to increase its revenues by reducing its environmental impact in order to sell "green" products (Klassen and McLaughlin, 1996). Ambec and Lanoie (2008, p. 49) identify this dimension as a differentation strategy "to exploit niches in environmentally conscious market segments". Moreover, a firm may sell green products to customers who would otherwise be indifferent to the firm's environmentally responsible efforts (Konar and Cohen, 2001). In addition, environmentally responsible behavior may improve a firm's overall reputation among customers (McGuire et al., 1988). Lastly, a firm may be able to increase its revenues by using an environmentally friendly technology to establish an industry standard; this establishment provides the firm with an "early-mover advantage" and status as an "industry leader" (Hart and Ahuja, 1996; Klassen and McLaughlin, 1996; Porter and van der Linde, 1995). All of these noted effects are causal, in that better environmental performance directly leads to higher revenues, given a sufficient lag. For example, customers need time to assess the "green" nature of a product before modifying their willingness to pay for it.[3]

Second, environmental performance may affect costs. When firms invest in more efficient production processes, frequently these new technologies are also environmentally friendly: the new production processes require less energy, generate less waste, demand fewer toxic inputs, etc. In addition, better environmental performance may lower the costs of regulatory scrutiny, such as lost productivity due to inspections. Similarly, it should lower the costs associated with regulatory sanctions, third-party lawsuits, and emission charges (Klassen and McLaughlin, 1996). Similar to regulatory scrutiny, better environmental performance may lower the costs imposed by local community pressure, e.g., increased zoning restrictions (Earnhart, 2004; Konar and Cohen, 2001). Related to regulatory sanctions and third-party lawsuits, better environmental performance may reduce financing costs because lenders associate lower financial risk with better environmental management (McGuire et al., 1988). These environmental effects on costs are causal: better environmental performance directly leads to less regulatory scrutiny, fewer sanctions, less community pressure, etc, given a sufficient lag. For example, regulators need time to respond to poor environmental performance with inspections and sanctions, especially since the latter involve

[3] Ambec and Lanoie (2008) state that better environmental performance may facilitate access to certain markets, such as public contracts. This dimension generally involves the third-party certification of particular environmentally friendly management practices (e.g., ISO 14001). Since our analysis focuses on pollution outcomes, we do not explore this link to revenue enhancement.

adjudication; as a related example, emission charges in the Czech Republic are paid in the year following the release of pollutants so that measurement is complete; consistent with the separation in time for both examples, improved environmental performance lowers a firm's future regulatory costs.[4]

In contrast to these enhancements to cost minimization, complex pollution-reducing devices and processes may reduce overall productive efficiency, thus, raising production costs (Bosch et al., 1998). This effect is causal and consistent with the traditional perspective on pollution control, which views efforts to reduce emissions, whether with end-of-pipe treatment or pollution prevention methods, as a real drain on firm resources (Palmer et al., 1995; Filbeck and Gorman, 2004).

Third, environmental performance may affect both revenues and costs. From a more general perspective, investments in environmentally responsible behavior may drag down financial performance because resources are being committed to an ostensibly non-productive use (Cohen et al., 1995). More specifically, environmentally responsible business decisions may limit a firm's strategic alternatives, thus, driving down revenues and driving up costs. For example, a firm may decide not to pursue certain product lines or avoid plant relocations and investment opportunities in certain locations (McGuire et al., 1988).

Consistent with this classification, several studies in the literature take great pains to distinguish conceptually the two relevant pathways from environmental performance to financial performance: (1) the pathway of revenues and (2) the pathway of costs. For example, Figure 2 of Klassen and McLaughlin (1996, p. 1202) represents an excellent schematic for distinguishing

[4] In the case of production processes, the effect of better environmental performance on lower costs is causal when a firm chooses to improve its environmental performance by installing a newly efficient production process.

between “market gains” and “cost savings”. As another example, Figure 1 of Ambec and Lanoie (2008, p. 47) distinguishes between “opportunities for increasing revenues” and “opportunities for reducing cost”. Despite these efforts, no previous empirical study evaluates the two pathways, as noted above. Instead, the previous empirical studies examine either market-based financial performance measures, which cannot discern revenues from costs, or profit-based accounting measures, which evaluate only the difference between revenues and costs. Thus, the present study contributes to the literature by evaluating both profit and its constituent components in order to assess effectively the two noted pathways.

Lastly, we draw upon the noted theoretical insight to interpret our empirical results. In the process, we empirically test the conjectures associated with this theoretical insight.

2.2. Literature of Financial Performance in Central and Eastern Europe

We also draw upon recent economic studies of corporate financial and operational performance in the transition economies of Central and Eastern Europe. None of these studies consider environmental performance as an explanatory variable. Moreover, the prominent economic studies use a surprisingly narrow set of measures to capture corporate financial performance: only accounting-based measures. In contrast to studies of financial performance in the US and Canada, few studies of Central and Eastern Europe consider market-based measures for examining corporate-level financial performance across a variety of firms; this limited use is not surprising given the weakly developed state of most of the stock markets in this region during the 1990s.

We describe the use of financial and operating performance measures by a few of the more prominent studies. Frydman et al. (1999) use revenues and the ratio of labor and material costs to revenues. Both Kocenda and Svejnar (2002) and Pohl et al. (1997) use profitability. Similarly, Claessens and Djankov (1999) use profitability defined as operating profits relative to the sum of fixed assets and inventory. Weiss and Nikitin (2002) use operating profit and value added on either a per worker basis or a per capital unit basis. We utilize these studies to identify meaningful measures of corporate financial performance in the context of a transition economy.

We also utilize these studies to identify control factors in the context of a transition economy. All of these cited studies include only three types of control factors: ownership structure, year indicators, and industrial sector indicators. We include these same factors, in addition to others.

3. Data on Financial and Environmental Performance

3.1. Czech Republic as Study Site

To examine the effect of corporate environmental performance on financial performance, we exploit data on firms in the Czech Republic between 1996 and 1998, which is an excellent site and time period for our study. First, poor ambient air quality was a prominent environmental problem. In response to public concern, Czech government authorities took substantial steps to decrease air emissions dramatically during the period 1991 to 1998 (Czech Ministry of Environment, 1998). In particular, the Czech government was requiring new stationary emission sources to meet stringent emission limits based on the installation of state-of-the-art treatment technologies and forcing existing stationary emission sources initially to meet "currently attainable" emission limits and eventually to meet new source limits by the end of 1998, all while steadily increasing emission charge rates on all stationary emission sources. These steps appear effective: Figure 1 displays a strong downward trend in economy-wide air emissions over this period. Most likely, the post-communist decline in economic activity only partially explains the drop in the early 1990s since the economic decline was not accompanied by a similar drop in energy consumption. As important, firms' pollution control efforts, such as the installation of electrostatic precipitators ("scrubbers"), may also explain much of the reduction (World Bank, 1999). Second, consistent with these pollution control efforts, investment in environmental protection was most important during the period between 1992 and 1998, as shown in Figure 2. As a percentage of Czech gross domestic product (GDP), investment rose dramatically after 1991 from a level of 1.3 % to a peak of 2.5 % in 1997 and tailed off after 1998 back to a pre-transition level of 1.1 % by 2000; in 1990, investment was 1.1. % of GDP. Third, the Czech Republic was attempting to enter the EU during this period and was required to reduce its industrial emissions in order to qualify for membership. The sample period of 1996 to 1998 seems especially important since existing pollution sources' needed to comply with the impending new source limits by the end of 1998 and all pollution sources needed to pay emission charge rates that had escalated to their "full" levels, as identified in environmental legislation.

3.2. Panel Data from Financial Statements, Ownership Files, and Emissions Register

To examine accounting-based financial performance at Czech enterprises, we gather data from three segments of a database provided by the private data vendor Aspekt. Two segments provide information drawn from firms' balance sheets and income statements. The third segment provides information on ownership structure, which we use as a control variable in our regression analysis. We gather balance sheet, income statement data, and ownership data for the years 1996 to 1998.[5] The Aspekt database includes all firms traded on the primary market – Prague Stock Exchange – or secondary market and a majority of the remaining large Czech firms (plus their key

[5] As noted below, our regression analysis incorporates both industry-specific indicators (or firm-specific indicators in the fixed effects estimator) and year indicators. This incorporation sufficiently controls for any variation in prices across firms and/or time. Consequently, we do not convert financial measures from nominal values into real values using a price index or sector-specific price indices.

trading partners). This comprehensive database has been used by previous studies of financial and operational performance in the Czech Republic (e.g., Claessens and Djankov, 1999; Weiss and Nikitin, 2002; Kocenda and Svejnar, 2002; Djankov, 1999).

As an indicator of corporate environmental performance, we choose air pollutants emitted by facilities located in the Czech Republic during the years 1996 and 1998. The included pollutants are carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter, and nitrous oxides (NO_x), which represent the main and most heavily regulated pollutants in the Czech Republic, similar to other industrialized nations. The Czech Hydrometeorological Institute maintains the REZZO-1 database, which records emissions for large, stationary sources, and publicly releases the data on air emissions aggregated to the level of each facility. We further aggregate air emissions across all facilities associated with a single firm, especially since no other facility-level data are available to us. Thus, the analysis links emissions data aggregated to the firm level with other firm-level data, consistent with previous studies of firm-level environmental performance (Konar and Cohen, 1997; Konar and Cohen, 2001; Earnhart and Lizal, 2006; Khanna and Damon, 1999; Khanna et al., 1998; Arora and Cason, 1995). Finally, we add the four pollutants into one composite measure of air emissions, similar to several previous studies of environmental performance (Konar and Cohen, 1997; Konar and Cohen, 2001; Khanna and Damon, 1999; Khanna et al., 1998; Arora and Cason, 1995; Arora and Cason, 1996). This addition is feasible since all four pollutants are measured in tons.[6]

To examine the effect of environmental performance on financial performance, while controlling for ownership structure, we merge the financial, emission, and ownership data sets. In order to generate the largest sample possible and to avoid a sample selection bias due to attrition, we

[6] We are not able to calculate a toxicity-weighted composite since none of the pollutants are toxic.

create an unbalanced panel of firm-year observations for the time period 1996 to 1998. In this merger and creation, we screen for meaningful financial data by applying the following criteria: positive production, positive total assets, and positive fixed assets. (Other important financial measures, such as profits, are difficult to screen because they can truthfully take zero or negative values.) We also restrict our sample to those observations with non-missing data for the variables used in our regression analysis.[7] We consider three financial performance measures – profits, sales, and costs; each retained observation must possess non-missing data for all three measures. (We choose not to examine a variety of samples based on data availability for each financial performance measure; by considering a single sample, we avoid sample compositional biases when comparing results across the various financial performance measures. The same concern and approach applies to our use of various firm size measures.) This merger, screening, and set of restrictions generates a combined unbalanced panel of 429 firms with 1,044 observations for the years 1996 to 1998.[8,9]

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[7] Non-missing data for emissions are available for either all four pollutants or none.

[8] The overlap between the financial data set and the air emissions data set is limited. Yet, the limited overlap does not indicate a problem with the data. Instead, it may simply indicate that firms included in the Aspekt database do not own large stationary air emission sources. In this way, the Aspekt database need not completely represent large stationary air polluters. Therefore, our results may not generalize to all or most large stationary air polluters. The opposite concern is not relevant. The REZZO-1 database is fully comprehensive of all large polluters.

[9] The restriction of non-missing data binds strongly for ownership data because we lack these data for many firm-year observations. (Ownership data for years prior to 1996 are especially scarce, which explains our focus on the period 1996 to 1998.) The incomplete recording of ownership data during the chosen sample period raises a concern about selection bias. We address this concern by implementing a Heckman two-step sample selection procedure (Heckman, 1979). As the first step, we use a probit model to estimate the probability of ownership data being recorded. As regresors in this model, we include current corporate financial characteristics, namely, total assets, fixed assets, the log of fixed assets, fixed assets squared, production, production squared, the log of production, profit, and the log of the absolute value of profit times the sign of the profit. In addition, we include year and industrial indicator variables. The probit model predicts correctly the recording of ownership data at a success rate of 83 %. Based on the coefficient estimates generated by the first stage of this procedure, we generate an inverse Mills ratio for each firm in each time period. By including this variable as a regressor in the estimation of financial performance, we

3.3. Descriptive Statistics

Table 1 presents a statistical summary of the relevant firm data.[10] As shown in Table 1.a, our data are sufficiently spread across the three years of our time frame. Table 1.b. summarizes our data on air pollutant emissions. Our data set contains much variation for emissions, which facilitates our analysis. Table 1.b also summarizes the ownership shares held by certain types of investors: (1) state, (2) investment funds, (3) citizens, (4) portfolio companies, (5) bank: direct ownership, (6) strategic investors (e.g., other companies), and (7) foreign investors. We also incorporate a variable to capture the concentration of ownership as measured by the stockholding share of the single largest shareholder (Kocenda and Svejnar, 2002).

Table 1.d indicates the distribution of firms by industrial classification, while Table 1.c summarizes the key financial variables used in our study: profits, operating profits, sales (or revenues), costs, total assets, and equity. As demonstrated by the standard deviation measures, our data set contains much variation in these financial measures.

Profits, operating profits, sales, and costs represent measures of accounting-based financial performance. In particular, profits and operating profits represent two measures of profitability. Operating profits equal the difference between sales and the combination of costs of goods sold and operating expenses, such as depreciation. Profits equal the difference between operating profits and other income and expenses, such as interest payments, extraordinary gains, and taxes. Interestingly, profits and operating profits are not extremely correlated given a correlation coefficient (ρ) equal to

control for any potential sample selection bias.

[10] The sampled firms generated 9.5 %, 7.9 %, and 7.3 % of the Czech economy-wide amount of economic activity, as measured by value added, in 1996, 1997, and 1998, respectively.

0.709, which is statistically significant (p=0.0001). Since the two profitability measures are similar but sufficiently different, as a robustness check, we examine both profits and operating profits. For the purposes of this study, costs represent the difference between sales and profits. Consequently, the measure of costs is comprehensive in that it includes all types of costs: both standard costs and environmental costs, both operating costs and investment costs.[11] This point notwithstanding, the measured costs do not represent "full" costs but rather full costs net of other income since profits are based not on sales alone but the sum of sales and other income.

Total assets and equity represent measures of firm size. While total assets and equity capture distinctively different aspects of a firm's financial structure, the two measures are strongly correlated ($\rho = 0.939$) and significantly correlated (p=0.0001). Thus, both measures are most likely capturing similar information about a firm's size. Yet, as a check for robustness, we consider both measures.

4. Statistical Analysis of Financial Performance

4.1. Econometric Framework

In this section, we use the described data to explore the link from environmental to financial performance at Czech firms in 1996 to 1998. We estimate the relationship between environmental performance, as measured by the absolute level of air pollutant emissions, and financial performance, as measured by profits, sales, and costs. Consistent with several previous studies (Konar and Cohen, 2001; Filbeck and Gorman, 2004; Cohen et al., 1995; Austin et al., 1999; Hart and Ahuja, 1996), we use lagged environmental performance as the proper regressor. (To accommodate this lag, we also gather emissions data for 1995.) The lagging of environmental performance is appropriate since

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[11] We do not possess data disaggregated between standard costs and environmental costs and we do not possess data disaggregated between environmental operating costs and environmental investment costs.

economic agents need to time to translate any reduction in emissions into an alteration of revenues and/or costs and environmental authorities need time to respond to poor environmental performance. As an example of the first dimension, lenders need time to adjust their calculations of environmental risk; as an example of the second dimension, Czech authorities demand payment for emission charges in the year following the release of the pollutants Thus, environmental performance and financial performance are separated in time. Given this separation, lagged environmental performance appears predetermined with respect to current financial performance.[12]

To estimate the influence of environmental performance on financial performance, we regress each type of financial performance on lagged air pollutant emissions. To construct the econometric models, we define the following notation. We consider three dependent variables. As the primary dependent variable, π_{it} denotes the profits generated by firm *i* in time period *t*. Unless otherwise indicated, π_{it} denotes overall profits as opposed to operating profits. As the secondary dependent variables, s_{it} denotes the sales generated by firm *i* in time period *t* and c_{it} denotes the costs born by firm *i* in time period *t*.

The analysis seeks first to examine the effect of each explanatory factor on profits and then to decompose each factor's effect on profits into the factor's separate effect on revenues and separate effect on costs. Estimating profits and then separately estimating revenues and costs generates this decomposition. Fortunately, after estimating profits, we do not need to estimate both of the remaining dependent variables. By definition, profits equal the difference between revenues and costs. In this empirical application, we use the same explanatory variables to estimate each

[12] Given this separation in time, no correction for endogeneity seems necessary unless serial correlation exists, which would be very difficult to detect in our three-year sample period.

dependent variable. Thus, as long as the regressor set for estimating each dependent variable is identical (or a subset of the other two sets), we only need to estimate one of the two remaining dependent variables in order to generate the desired decomposition.[13] Arbitrarily, we choose to estimate costs. Each coefficient that could be generated by estimation of revenues is recoverable as a simple linear combination of the coefficients generated for profits and costs; we elaborate below.

We incorporate various explanatory variables into our estimation of profits and costs. As the primary explanatory variable, $p_{i,t-1}$ denotes the amount of pollution emitted by firm *i* in the preceding time period *t-1* (i.e., lagged emissions). We also include financially-related factors as explanatory variables. Profits and costs most likely depend on the level of production, which is denoted as y_{it}. As production rises, one would expect costs to rise. Since production is clearly expected to affect costs, by extension, production is expected to affect profits.[14] Profits and costs may also depend on firm size, denoted as a_{it}. Unless otherwise indicated, firm size is captured by total assets. This set of financially-related regressors may seem limited relative to the regressor sets used by comparable studies of environmental and financial performance in mature market economies. These studies

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[13] By construction, the error terms of one equation are orthogonal to regressors of the other two equations.

[14] Two aspects surrounding production deserve elaboration. First, production is measured in value terms, which allows the analysis to compare across firms and across time within a given firm. As noted below, our regression analysis incorporates both industry-specific indicators (or firm-specific indicators in the fixed effects estimator) and year indicators. This incorporation sufficiently controls for any variation in prices across firms and/or time that may otherwise complicate the use of production value as a regressor. Second, for our regression analysis, we assume that production is pre-determined with respect to costs and profits. Consistent with this general assumption, we specifically assume that the firm is a price-taker, even in those cases when it markets a product of higher environmental quality. Similarly, we assume that the firm is demand-constrained in each separate product, with a clear distinction between a product of higher environmental quality and one of lower environmental quality. Fortunately, identifying the relationship between production and profits, as well as costs, does not prove critical for the task at hand. The reported results regarding the effect of environmental performance on financial performance are fully robust to the exclusion of the production factor and a one-year lagging of the production factor.

include additional regressors, such as advertising expenditures and research and development expenditures. We do not include these types of factors as regressors for two reasons. First, as noted in Section 2, previous studies of corporate financial performance in transition economies do not include these types of factors. Second, data on these factors are not recorded systematically, if at all, in our database.

Our analysis incorporates additional regressors. Specifically, we include various regressors that capture ownership structure. First, we include a regressor for each ownership type, collectively denoted as W_{it}. We establish "dispersed private investors" as the omitted category. These investors hold less than 10% of a given company and never publicly announce their holdings. Data on these investors' shares are not available; instead, we measure their presence indirectly. Second, we include a measure of concentration, as captured by the ownership share held by the single largest shareholder and denoted as L_t. To control for variation over time with respect to economy-wide trends and the legal framework controlling air emissions, we also include individual year indicators, collectively denoted as vector T_t. To control for sector-specific variation, we include industry indicator variables, collectively denoted as vector X_i. The omitted industrial category includes "manufacturing: other" and "other: overall" sectors; see Table 1.d. Given this notation, we formulate the following regression system:

$$\pi_{it} = \alpha^{\pi} + \beta^{\pi}\, p_{i,t-1} + \gamma^{\pi}\, y_{it} + \kappa^{\pi}\, a_{it} + \omega^{\pi}\, W_{it} + \eta^{\pi}\, L_{it} + \Psi^{\pi}\, T_{it} + \varsigma^{\pi}\, X_{it} + \upsilon_{it}\,, \quad (1)$$

$$c_{it} = \alpha^{c} + \beta^{c}\, p_{i,t-1} + \gamma^{c}\, y_{it} + \kappa^{c}\, a_{it} + \omega^{c}\, W_{it} + \eta^{c}\, L_{it} + \Psi^{c}\, T_{it} + \varsigma^{c}\, X_{it} + \nu_{it}\,, \quad (2)$$

where υ_{it} and ν_{it} denote the error terms associated with profits and costs, respectively.[15] Please note

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[15] We consider neither a semilog nor log-linear specification because profits (and operating profits) cannot be log-transformed since they take zero values.

the use of superscripts to distinguish the coefficients shown in the two equations: "π" denotes profits and "c" denotes costs. We estimate each equation separately; joint estimation of the two equations within a seemingly unrelated regression framework generates identical results since the two regressor sets are identical.

To control properly for firm-specific effects, we estimate equations (1) and (2) using standard panel estimators: pooled OLS, fixed effects, and random effects. We use standard tests to assess these estimators. When the F-test indicates significant firm-specific effects, the fixed effects estimator dominates pooled OLS. Since this dominance always holds, we do not report the pooled OLS estimates; instead, we only report the F-test statistics, as shown in Tables 2 and 3. We use the Hausman test of random effects to evaluate whether the random effects estimates are consistent. Since the random effects estimates appear inconsistent based on the Hausman test statistics (see Table 2), we do not report these estimates. The fixed effects estimates are consistent by assumption.

Use of a fixed effects estimator has an additional advantage. By including firm-specific intercept terms, the fixed effects estimator controls comprehensively for time-invariant factors associated with specific firms. Thus, the estimator controls for the possibility that companies who are better in terms of both environmental and financial matters due to some common (time-invariant) factor, such as a highly effective corporate governance structure. Rather than using cross-sectional variation, which is vulnerable to this concern, the fixed effects estimator utilizes intra-firm variation.

4.2. Estimation Results

Table 2.a presents the regression results based on the estimation of equations (1) and (2). In this sub-section, we report and interpret briefly the estimation results relating to environmental performance, while interpreting them more deeply in the subsequent sub-section. We merely report

the other estimation results. We first examine the results relating to profits, as shown in the left column of Table 2.a. Production strongly and positively affects profits. Firm size does not significantly affect profits. Ownership also proves insignificant, as reported in Appendix B. (We do not report sectoral coefficients since the fixed effects estimator subsumes the sectoral effects into its firm-specific fixed effects because sector does not vary over time for a specific firm.) Most important, higher lagged air pollutant emissions significantly lower profits, as shown in Table 2.a. Thus, better environmental performance appears linked with improved profitability.

We demonstrate the robustness of this conclusion by examining the effect of environmental performance on profits using alternative econometric specifications. In all cases, the estimated effect of environmental performance is highly robust to the alternative specifications. While we estimate several specifications, for brevity's sake, we report the full regression results for only three specifications (see Table 3). For the remaining specifications, we mostly report only the p-value of the environmental performance coefficient. First, we modify the effect of firm size on financial performance. To capture any nonlinearities associated with firm size, we add a squared term of firm size (a_{it}^2). As shown in Table 3, this specification generates an environmental performance coefficient that is very similar in terms of sign, magnitude, and significance as the coefficient reported in Table 2.a. Inclusion of the squared firm size measure causes both the linear and the squared firm size coefficients to become statistically significant. Specifically, profits rise with firm size but at a declining rate. As an additional specification, we replace total assets with equity, as the measure of firm size. This change in firm size measure does not meaningfully alter the sign, magnitude (β^{π} = -13.32), and significance (p=0.0001) of the estimated environmental performance coefficient. The addition of squared equity as a regressor does not change this preceding conclusion.[16] Two previous studies of financial performance in Central and Eastern Europe use alternative firm size measures as replacements for total assets: sum of fixed assets and inventory (Claessens and Djankov, 1999) and depreciation (Weiss and Nikitin , 2002). Use of these alternative firm size measures again generates highly similar coefficient estimates in terms of sign, magnitude, and significance (p=0.0001).

Second, we assess the robustness of the profits-related result by modifying the production regressor. In one alternative specification, we simply drop this regressor; in a second specification, we lag the regressor; in a third specification, we add a squared term of production (y_{it}^2). Regardless, the estimated effect of environmental performance remains strongly and significantly negative (p=0.0001). Results for the third specification are displayed in Table 3. As shown, profits rise in production but at a declining rate since the coefficient on the squared production term is significantly negative.

Third, we modify the measure of profitability by replacing overall profits with operating profits. This replacement generates a highly significant negative coefficient for lagged environmental performance: $\beta^{\pi} = -10.92$ (p=0.0001). Thus, better environmental performance improves operating profitability, as well as overall profitability. This conclusion is strongly robust to the particular measure of firm size included as a regressor. As shown in Table 3, use of equity as the firm size measure also generates a highly significant negative effect (p=0.0001) for lagged environmental performance. (We report the full regression results for this specification since the use of equity generates a significant coefficient for firm size, while use of total assets generates an

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[16] Estimation of the environmental performance coefficient is also robust to the inclusion of a debt to equity regressor, which does not prove to be statistically significant.

insignificant firm size coefficient.) Use of fixed assets plus inventory or depreciation as the firm size measure generates highly similar coefficient estimates for lagged environmental performance in terms of sign, magnitude, and significance (p=0.0001).

We next seek to decompose the effect of environmental performance on profits into its constituent components. Given that better environmental performance seems to raise profits, does this increase in profits stem from the combination of greater revenues and lower costs or the combination of lower revenues and even lower costs? In order to answer this question, we assess the cost-related estimation results shown in the rightmost column of Table 2.a. (Similar to profits, production strongly and positively affects costs, yet neither firm size nor ownership proves significant; the last set of results is shown in Appendix B). In particular, we interpret the cost-related coefficient for environmental performance. For the purpose of decomposing the effect of environmental performance, we also interpret the relevant sales-related coefficient (i.e., effect of lagged environmental performance on sales). To recover this latter coefficient, we subtract the cost-related coefficient for environmental performance (β^c) from the profit-related coefficient for environmental performance (β^π):

$$\beta^s = \beta^\pi - \beta^c , \quad (3)$$

where "s" denotes sales. The resulting coefficient is shown in Table 2.b.

As shown in Table 2, environmental performance negatively affects both sales and costs. Higher lagged air pollutant emissions significantly raise sales (p=0.062), as shown in Table 2.b. Thus, better environmental performance appears to reduce revenues. Perhaps, environmentally responsible business decisions limit firms' strategic alternatives, forcing firms to forego revenue-boosting products. In contrast, better environmental performance appears linked with reduced costs.

As shown in Table 2.a, higher lagged air pollutant emissions significantly raise costs. Many reasons potentially explain this outcome, such as increased regulatory scrutiny. In the next sub-section, we assess which of these reasons seems the most plausible. Both reported conclusions are fully robust to the use of equity as the firm size measure in lieu of total assets and to the inclusion of a squared production term.[17]

Considering jointly the effects of environmental performance on profits, sales, and costs, we draw the following general conclusion. While more responsible environmental management may limit firms' abilities to exploit revenue-enhancing projects, apparently better environmental management more than compensates for these missed opportunities by driving down costs via reduced regulatory scrutiny, dampened community pressure, etc. The next sub-section interprets the full set of results, which helps to assess which reason(s) most likely drive(s) these results.

4.3. Interpretation of Results and Implications

Lastly, we interpret these results using the literature's theoretical insight, while assessing the empirical evidence for any related conjectures. We do not claim that any of our results are able to establish a causal link. First, our results indicate that better environmental performance appears to lower revenues. This finding provides support for the conjecture that the implementation of better environmental management practices limit firms' abilities to pursue revenue-enhancing projects (McGuire et al., 1988). More specifically, tighter air emission limits and/or higher emission charge rates may have possibly constrained Czech firms' abilities to produce higher quality products. Yet,

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[17] To explore further the positive effect of lagged emissions on sales, our analysis could interact lagged emissions with sectoral indicators in order to assess whether revenue potential is constrained differently across different sectors. However, this exploration is highly complicated within fixed effects estimation given the presence of many firm-specific indicators that, in essence, replace the sectoral indicators.

we acknowledge that the estimated effect of environmental performance on sales, albeit robust to various specifications, is only significant at the 6 % level. Nevertheless, with greater confidence, the noted findings reject, based on a one-tailed test (p=0.031), the conjectures that better environmental management (1) allows firms to sell "green" goods at a higher price or in greater quantity, (2) improves a firm's overall reputation among customers, and (3) provides the firm with an "early-mover" advantage and status as an "industry leader". This apparent rejection need not surprise us given that Czech firms were probably not well situated during the sample period to deliver "green" products or establish themselves as "industry leaders".[18]

Second, our results indicate that better environmental performance appears to lower costs. This finding is consistent with several theoretical conjectures. First, this finding supports the conjecture that implementation of a more efficient production technology, which reduces air pollutant emissions, also lowers production costs.[19] Alternatively, this finding supports the conjecture that reduced air emissions lead to less regulatory scrutiny, which reduces the costs stemming from the distraction of inspectors and lawyers. Yet again, this finding supports the conjecture that better environmental performance lowers the costs associated with regulatory sanctions, emission charges, third-party suits, and community pressure.

All of these interpretations are plausible for the Czech transition economy and consistent with

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[18] While the Czech Ministry of the Environment established the National Eco-Labeling Program in 1994, this program operated at a low level prior to 2000 (Czech Ministry of Environment, 2004).

[19] Use of the fixed effects estimator clarifies our interpretation of the estimated effect of environmental performance on costs. Given the examination of intra-firm variation, the estimated coefficient captures the connection between a change in a firm's emissions relative to the firm's average emission level and a change in the firm's costs relative to the firm's average cost level. This connection helps the analysis to focus on the installation of <u>new</u> technologies.

other available evidence. Certainly, Czech firms invested into new production technologies over this period (Lizal and Svejnar, 2002b). However, pollution prevention stemming from the installation of better and cleaner production processes was not prevalent during the sample period. Instead, most Czech facilities reportedly reduced emissions in the old-fashioned way: they installed end-of-pipe treatment technologies. Thus, the role of new production technologies appears limited. In contrast, the role of regulatory scrutiny seems larger. Unlike in Communist times, the Czech Inspection, which is responsible for monitoring for and enforcing against non-compliance with air protection laws, performed many inspections and imposed many fines during the sample period. For example, in 1997, the Czech Inspection performed 13,455 inspections and imposed 1,952 fines, in addition to closing 36 facilities due to noncompliance, as reported in the agency's annual yearbook. Moreover, substantive emission charges were imposed during the sample period. Similar to the cost of regulatory scrutiny, sanctions, and charges, local community pressure was tangible in this period, as expressed through numerous citizen complaints, which are filed with the Czech Inspection (Earnhart, 2000). For example, in 1997, the Czech Inspection received over 700 citizen complaints. Unlike regulatory and commmunity pressure, the threat of third-party lawsuits was trivial in the Czech Republic during this period (Earnhart, 1998).

As yet another interpretation of the negative effect on costs, the noted finding supports the conjecture that better environmental performance lowers financing costs. While possible, this interpretation is not supported by any corroborating evidence.

Based on this discussion, of the supported conjectures, the most plausible is the combination of regulatory and community pressure: reductions in air emissions lowered Czech firms' costs by reducing regulatory scrutiny, emission charges, and community pressure, while eliminating the imposition of regulatory sanctions.

In contrast, the noted finding rejects the conjecture that complex pollution-reducing devices and processes reduce overall productive efficiency, which implies an increase in costs.

Third, by considering the effects of environmental performance on profits, the results of our study indicate that better environmental performance appears to improve profitability by driving costs down without increasing revenues or perhaps weakly decreasing revenues. A strong decrease in costs is consistent with the meaningful benefits of reducing the otherwise substantial regulatory and community pressure. On the other side of the ledger, a weak or negligible decrease in revenues is consistent with the traditional end-of-pipe approach to pollution control taken by most Czech firms. Use of these end-of-pipe treatment technologies most likely did not constrain the production of revenue-enhancing production to a great extent.

5. Summary

This paper examines the link from corporate environmental performance to financial performance. In particular, we assess whether better environmental performance affects profits, and if true, through which channel: revenues, costs, or both. Based on our analysis of Czech firms in the years 1996 to 1998, we conclude that good environmental performance, in the form of lower air pollutant emissions, appears to improve profitability by strongly lowering costs yet perhaps weakly decreasing revenues. This conclusion is highly robust to many alternative specifications.

Given the transitional nature of the Czech economy, our empirical results need not generalize to other economies, especially mature market economies. To assess this point, as ongoing research, we are examining the latter period of the Czech transition, specifically, the period between 1999 and 2004, when the country entered the EU. By examining the expanded period from 1996 to 2004 and comparing the two sub-periods, we will be able to assess whether the evolution towards a market-based economy alters the relationship between environmental and financial performance.

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Table 1
Descriptive Statistics

Table 1.a. Year Distribution

Year	Frequency	Percent
1996	372	35.63
1997	357	34.20
1998	315	30.17
Total	1,044	100.00

Table 1.b. Means and Standard Deviations of Production, Ownership, and Emission Variables

Variable	Mean	Std. Deviation
Production Value (000s CZK)	1,201,078	2,646,672
Emissions Total (tons)	866	3,728
State Ownership share (%)	5.69	15.73
Strategic Investor Ownership share (%)	28.40	30.33
Individual Citizens Ownership share (%)	4.92	15.22
Bank Ownership share (%)	1.00	5.62
Portfolio Company Ownership share (%)	1.97	8.44
Investment Funds Ownership share (%)	13.51	20.51
Foreign Ownership share (%)	7.16	19.84
Concentration: Single Largest Shareholder (%)	44.76	21.62

Note: CZK = Czech Crowns

1.c. Means and Standard Deviations: Financial Performance and Firm Size

Variable	Mean	Std. Deviation
Profits (000s CZK)	- 6,914	194,909
Operating Profits (000s CZK)	60,751	249,785
Costs (000s CZK)	1,238,092	2,717,239
Sales (000s CZK)	1,231,178	2,553,454
Total Assets (000s CZK)	1,546,258	3,183,106
Equity (000s CZK)	776,521	1,659,270

Note: CZK = Czech Crowns

Table 1.d. Distribution According To Industrial Classification

Industry	Obs.	Percent
Agriculture, Hunting, Forestry, Fisheries	8	0.79
Mining and Quarrying	13	1.23
Manufacturing of Food Products, Beverages, and Tobacco	165	15.76
Manufacturing of Textiles, Textile Products, Leather, and Leather Products	85	8.10
Manufacturing of Wood, Wood Products, Pulp, Paper, and Paper Products and Publishing and Printing	36	3.43
Manufacturing of Coke and Refined Petroleum	4	0.35
Manufacturing of Chemicals, Chemical Products, and Synthetic Fibers	46	4.40
Manufacturing of Rubber and Plastic Products	18	1.76
Manufacturing of Other Non-Metallic Mineral Products	80	7.66
Manufacturing of Basic Metals and Fabricated Metal Products	135	12.94
Manufacturing of Machinery and Equipment n.e.c.	141	13.53
Manufacturing of Electrical and Optical Equipment	41	3.96
Manufacturing of Transport Equipment	73	7.04
Manufacturing: Other	32	3.08
Electricity, Gas, and Water Supply	53	5.11
Construction	49	4.67
Wholesale and Retail Trade and Repair of Motor Vehicles	3	0.26
Hotels and Restaurants	8	0.79
Transport, Postal Service, Storage, and Telecommunications	1	0.09
Finance, Real Estate, Rentals, Business, Research, Public Administration	30	2.90
Education, Health, and Veterinary Services	11	1.06
Other Public and Social Services	5	0.44
Other: Overall	7	0.65
Total	1,044	100.00

Table 2

Fixed Effects Estimation of Financial Performance Measures

Table 2.a. Estimation of Costs and Profits

Variable [a]	Profits		Costs	
Lagged Pollutant Emissions	- 15.146	***	23.609	***
	(3.713)		(6.008)	
Production Value (000 CZK)	0.0717	***	0.8381	***
	(0.0177)		(0.0286)	
Total Assets (000 CZK)	0.0048		0.0439	
	(0.0169)		(0.0273)	
1997	1,620,403	***	- 4,383,064	***
	(649,367)		(1,050,596)	
1998	1,547,097	***	- 4,182,951	***
	(622,473)		(1,007,084)	
No. of Firms / No. of Obs	429 / 1044		429 / 1044	
F-Test for Fixed Effects	3.90		21.47	
[significance level]	[0.0001]		[0.0001]	
Hausman Test: Random Effects	35.47		192.12	
[significance level]	[0.0013]		[0.0001]	
Adjusted R^2	0.7170		0.8957	

Standard errors are noted inside parentheses; p-values are noted inside square brackets.
*, **, and *** indicate statistical significance at the 10 %, 5 %, and 1 % levels, respectively.
[a] Each regression also includes 429 firm-specific indicators, seven ownership share factors, an ownership concentration factor, and an inverse Mills ratio for ownership data reporting (as described in footnote # 7). Estimation results relating to ownership and the inverse Mills ratio are shown in Appendix B.

Table 2.b. Effect of Lagged Pollutant Emissions on Sales:
Coefficient Recovered from Estimation Results for Costs and Profits

Variable	Sales	
Lagged Pollutant Emissions	8.463	*
	(4.532)	

Standard errors are noted inside parentheses.
*, **, and *** indicate statistical significance at the 10 %, 5 %, and 1 % levels, respectively.

Table 3

Fixed Effects Estimation of Profitability: Alternative Specifications

Variable [a]	Add Firm Size ^{2}		Add Production ^{2}		Dependent = Operating Profits, Firm Size = Equity	
Lagged Pollutant Emissions	- 14.630 (3.593)	***	- 15.122 (3.653)	***	- 9.735 (2.643)	***
Production (000 CZK)	0.1185 (0.0185)	***	0.1571 (0.0254)	***	0.1105 (0.0106)	***
Production ^{2} (000,000 CZK)	N/A		- 3.42 E-9 (0.74 E-9)	***	N/A	
Total Assets (000 CZK)	0.0914 (0.0209)	***	0.0307 (0.0175)	*	N/A	
Total Assets ^{2} (000,000 CZK)	- 3.73 E-9 (0.56 E-9)	***	N/A		N/A	
Equity (000 CZK)	N/A		N/A		0.2105 (0.0228)	***
No. of Firms / No. of Obs	429 / 1044		429 / 1044		429 / 1044	
F-Test for Fixed Effects [significance level]	4.18 [0.0001]		4.06 [0.0001]		10.63 [0.0001]	
Adjusted R^2	0.7365		0.7267		0.9134	

Standard errors are noted inside parentheses; p-values are noted inside square brackets.
*, **, and *** indicate statistical significance at the 10 %, 5 %, and 1 % levels, respectively.
[a] Each regression also includes 429 firm-specific indicators, two year-specific indicators, seven ownership share factors, an ownership concentration factor, and an inverse Mills ratio for ownership data reporting (which is described in footnote # 9).

Figure 1: Air Pollutant Emissions in Czech Republic

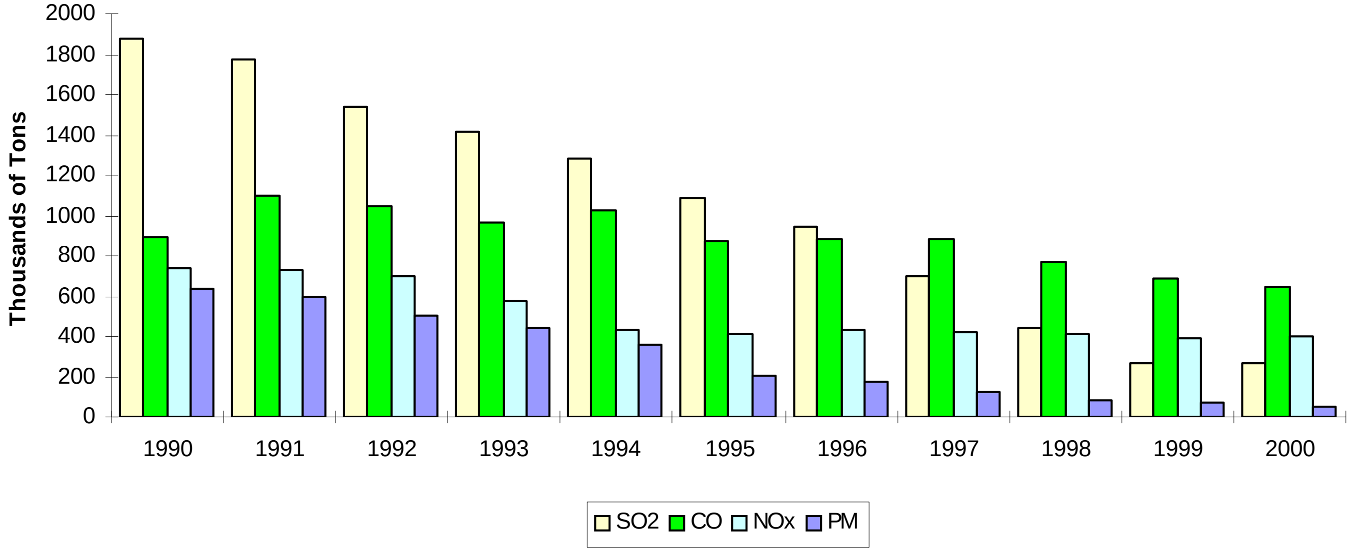
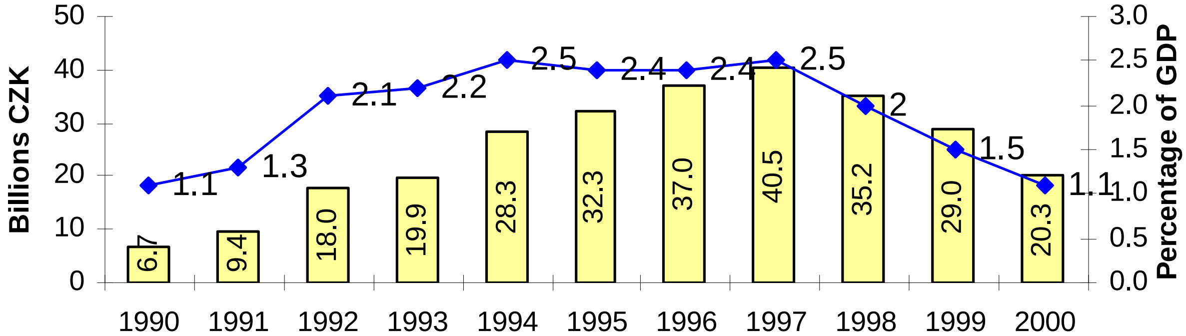


Figure 2: Investment in Environmental Protection



Source: Czech Statistical Office, Czech Ministry of Environment

Appendix A: Other Related Empirical Studies

This appendix discusses empirical studies employing sample means tests and event-study analyses. Three previous empirical studies use sample means tests to examine the effect of environmental performance on financial performance. First, Cohen et al. (1995) examine both accounting-based measures of financial performance (e.g., return on assets) and market-based measures of financial performance (e.g., risk-adjusted shareholder total return). Their study divides a sample of US firms into two "portfolios" according to whether each firm is above or below its industry median for one of nine environmental performance measures. Then they test the differences in financial performance mean values across the two sub-samples. Similarly, Austin et al. (1999) divide firms into "green" and "brown" categories according to their lagged environmental performance. Consistent with these two studies, Gottsman and Kessler (1998) compare the financial returns to the S&P 500 against three sub-samples based on four measures of environmental performance. In particular, they divide firms into the top 75%, top 50%, and top 25% of environmental performers across all industries.

Additional empirical studies use event-study analysis to examine the effect of environmental events on stock value. Laplante and Lanoie (1994) use the CAPM version of event-study analysis. Bosch et al. (1998) use Dodd and Warner's (1983) version of event-study analysis to explore the effect of federal environmental enforcement on stockholder wealth. They show that the stock market reacts negatively upon learning that a given firm has been targeted for enforcement. Muoghalu et al. (1990) also use Dodd and Warner's (1983) version of event-study analysis. Lanoie et al. (1998) use a method akin to event-study analysis to analyze how investors react to the release of public information regarding the environmental performance of specific facilities, including the deliberate release by regulators, as measured by fluctuations on the stock market. Klassen and McLaughlin (1996) use the Efficient Market Theory version of event-study analysis to show that signals of strong environmental management, as measured by environmental performance awards, increase firms' equity returns, and signals of weak environmental management, as measured by environmental "crises", lower equity returns. Hamilton (1995) uses Dodd and Warner's (1983) version of event-study analysis to examine firms listed in the Environmental Protection Agency (EPA)'s Toxic Release Inventory (TRI) database to determine the effect of that data's release on stock returns for those firms. In addition to their event-study analysis, both Klassen and McLaughlin (1996) and Hamilton (1995) perform regression analysis. In particular, Hamilton (1995) performs cross-section analysis of the abnormal returns on the day of TRI data release. Konar and Cohen (1997) also use event-study analysis to examine investors' reactions to the release of TRI data.

Appendix B

Effects of Ownership and Inverse Mills Ratio on Financial Performance
Supplement to Table 2.a

Variable	Profits		Costs	
State Ownership share (%)	226.7		- 240.7	
	(816.2)		(1,320.5)	
Strategic Investor Ownership share (%)	- 765.6		393.6	
	(607.7)		(983.2)	
Individual Citizens Ownership share (%)	- 1,143.4		311.0	
	(1,237.6)		(2,002.3)	
Bank Ownership share (%)	- 987.4		- 228.0	
	(1,006.7)		(1,628.8)	
Portfolio Company Ownership share (%)	- 550.7		- 154.8	
	(847.3)		(1,370.8)	
Investment Funds Ownership share (%)	- 674.4		- 83.1	
	(608.4)		(984.4)	
Foreign Ownership share (%)	- 480.1		- 317.8	
	(800.4)		(1,294.9)	
Concentration: Single Largest Shareholder (%)	- 34.4		613.0	
	(638.2)		(1,032.6)	
Inverse Mills Ratio for	686,429	***	-1,855,216	***
Ownership Data Reporting [a]	(264,422)		(427,802)	

Standard errors are noted inside parentheses.
*, **, and *** indicate statistical significance at the 10 %, 5 %, and 1 % levels, respectively.
[a] The inverse Mills ratio for ownership data reporting is described in footnote # 9.