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# Does Better Environmental Performance Affect Revenues, Cost, or Both? Evidence From a Transition Economy

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# Does Better Environmental Performance Affect Revenues, Costs, or Both? Evidence from a Transition Economy

**Abstract:** This study analyzes the effect of corporate environmental performance on financial performance in a transition economy. In particular, it assesses whether good environmental performance affects revenues, costs, or both, and if so, in which directions. As environmental performance improves, do revenues rise and costs fall so that profits unambiguously increase? Or vice versa? If both revenues and costs rise (or fall), does better environmental performance improve or undermine profitability? To answer these questions, 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 analytical results indicate strongly that better environmental performance improves profitability by driving down costs more than it drives down revenues, consistent with the substantial regulatory scrutiny exerted by environmental agencies and the primary pollution control approach implemented by firms during the sample period.

**JEL codes:** D21, G39, Q53

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

## Non-Technical Summary

This paper analyzes the effect of corporate environmental performance on financial performance in a transition economy. 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. 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.

Several studies analyze empirically the effect of corporate environmental performance on financial performance but only in 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 between 1996 and 1998. The context of a transition economy is highly interesting for an assessment of financial performance for obvious reasons. Firms in transition economies are struggling to restructure themselves within a new market-based system. *De novo* private firms struggle to establish themselves as the economic system evolves. State-owned firms struggle to compete against potentially more nimble private competitors. Privatized firms (i.e., previously state-owned) face the extra challenge of reformulating their corporate management practices to fit a new economic paradigm. The importance of corporate restructuring and financial management is even greater in most of the transition economies in Central and Eastern Europe, including the Czech Republic, given the desire to enter the European Union.

As with many of other countries in Central and Eastern Europe, the context of the Czech

transition economy is also highly interesting for an assessment of environmental performance. During and following the collapse of communism in the Czech Republic, environmental protection issues were prominent. In addition to domestic concerns, the Czech government needed to reduce industrial air pollutant emissions to qualify for membership in the EU. Between 1991 and 1998, the country's government tightened air protection with a new Clean Air Act and steadily increased emission charge rates on all stationary emission sources. Thus, Czech firms simultaneously struggled to control their air pollutant emissions and re-organize their financial matters.

Overall, our study of the Czech Republic may be viewed as representative of other countries in the Central and Eastern European region during their transition periods towards EU accession.

Within the context of a transition economy, our study focuses on a particular research question. It assesses whether good environmental performance affects revenues, costs, or both, and if so, in which directions. As environmental performance improves, do revenues rise or fall? Do costs rise or fall? Do revenues rise and costs fall so that profits unambiguously increase? Or do revenues fall and costs rise so that profits unambiguously decrease? If both revenues and costs rise (or fall), does better environmental performance improve or undermine profitability? To answer these questions, this 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 analytical results indicate strongly and robustly that better environmental performance improves profitability by driving down costs more than it drives down revenues, consistent with the substantial regulatory scrutiny exerted by Czech environmental agencies and the primary pollution control approach implemented by Czech firms during the sample period.

## 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; Khanna and Damon, 1999). 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). For example, in 1994, U.S. firms spent more than $ 120 billion to comply with environmental laws, in addition to several more billions spent on associated research and development (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). In some cases, this overcompliance is associated with a government-sponsored voluntary program. For example, more than 1,200 firms participated in the EPA's 33/50 program, agreeing to reduce voluntarily their emissions of certain chemicals by 33 % by 1988 and by 50 % by 1995 (Arora and Cason, 1995). Similar to voluntary

overcompliance or as part of these efforts to overcomply, 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. For example, by implementing a rigorous pollution prevention program, 3M reported reducing its air pollutant emissions by 125,000 tons between 1975-1990, while saving more than $ 1 billion in costs (McCloskey, 1993).

Several studies analyze empirically the effect of corporate environmental performance on financial performance (e.g., Khanna and Damon, 1999). 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 for obvious reasons. Firms in transition economies are struggling to restructure themselves within a new market-based system. *De novo* private firms struggle to establish themselves as the economic system evolves. State-owned firms struggle to compete against potentially more nimble private competitors. Privatized firms (i.e., previously state-owned firms) face the extra challenge of reformulating their corporate management practices to fit an entirely new economic paradigm. The importance of corporate restructuring and financial management is even greater in most of the transition economies in Central and Eastern Europe, including the Czech Republic, given the desire to enter the European Union (EU). [While the Czech Republic entered

the EU in 2004, the accession process began in the mid-1990s.]

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. During and following the collapse of communism in the Czech Republic, environmental protection issues were prominent. 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 to public concern and in anticipation of the Czech Republic's entrance into the EU, between 1991 and 1998, the country's government was tightening air protection with a new Clean Air Act and its subsequent clarifying decrees. 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 the escalating protection policies and new marketing opportunities, investment in environmental protection as a percent of gross domestic product (GDP) rose dramatically after 1991, peaking in 1996, 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.

Thus, Czech firms substantially increased their investment into environmental protection and produced dramatic pollution reductions.[1]

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 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 is highly similar to other countries in Central and Eastern Europe, such as Hungary and Poland.[3] 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

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[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).

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

[3] Details on this comparison are available upon request.

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 study focuses on a particular research question. It assesses whether good environmental performance affects revenues, costs, or both, and if so, in which directions. As environmental performance improves, do revenues rise or fall? Do costs rise or fall? Do revenues rise and costs fall so that profits unambiguously increase? Or do revenues fall and costs rise so that profits unambiguously decrease? If both revenues and costs rise (or fall), does better environmental performance improve or undermine profitability? To answer these questions, this study analyzes the links from environmental performance to revenues, costs, and profits using a panel of Czech firms. The analytical results indicate strongly and robustly that better environmental performance improves profitability by driving down costs more than revenues.

This paper explores the effect of environmental performance within the following format. The next section summarizes the related literature. Section 3 describes the database on corporate financial performance and air pollutant emissions. Section 4 estimates and interprets the effect of corporate environmental performance on financial performance. The final section concludes.

## 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. Four studies employ regression analysis to examine a sample of firms from the Standard & Poor 500 using

environmental data from the Investor Responsibility Research Center (IRRC) Corporate Environmental Profiles Directory. First, Konar and Cohen (2001) find a significantly positive effect of good environmental performance, as measured by toxic emissions, on firms' intangible asset values. Similarly, Austin et al. (1999) demonstrate that good environmental performance, as captured by certain measures (e.g., toxic emissions and hazardous waste corrective actions), positively affect financial rates of return. Consistent with the two noted studies, Hart and Ahuja (1996) show that emission reductions prompt better financial performance, based on accounting-based measures, within a two-year window. 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.

Three additional studies generate similar conclusions in general by also employing regression analysis to examine financial performance. Russo and Fouts (1997) demonstrate 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, at least measured by the number of Superfund sites, improves return on investment and sales-adjusted excess market value.[4] In addition, the authors show that participation in the 33/50 program improves sales-adjusted excess market value. Similar to Khanna and Damon (1999), Arora and Cason (1996) demonstrate that participation in the EPA's 33/50 program slightly increases profits.

In addition to regression analysis, which our study employs, three studies use sample means

[4] Sales-adjusted excess market value equals actual market value less the book value of assets.

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.[5]

Our study draws upon this empirical literature to guide our analysis. Since all of the noted

[5] Additional 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. His results indicate that stockholders in firms reporting TRI pollution figures experienced negatively abnormal returns upon the first release of the information. 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, measured in dollars, 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. Then they expand on Hamilton (1995) by showing that the abnormal returns generated by the TRI data release were important enough to affect future corporate environmental performance.

studies examine mature market economies, our study contributes to the literature by examining the link from corporate environmental performance to financial performance in a transition economy.

As a second 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. Use of this estimator avoids the concern that more financially successful firms are the same ones who effectively control their pollution levels. Several of the previous studies fail to address this concern (e.g., Russo and Fouts, 1997; Hart and Ahuja, 1996; Arora and Cason, 1996). 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 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). Conversely, firms may experience lower revenues when their products are deemed "brown" because the firms' environmental record is poor. Within the realm of "green" marketing, 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.

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 may lower the costs associated with regulatory sanctions and third-party lawsuits (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.[6] For example, regulators needs time to respond to poor environmental performance with inspections and sanctions; consistent with this separation in time, improved environmental performance will lower a firm's future regulatory costs.

Better environmental performance may also reduce labor costs. Pollution-reduction investments may lower three types of emissions: (1) "external emissions", which are directly discharged from the factory into the external environment, (2) "internal emissions", which are created and remain within a factory's working environment, and (3) "internal/external emissions", which are created within a factory's working environmental but are eventually discharged into the external environment. (These internal/external emissions are important when a facility's primary emission sources are diffuse within the factory; wood chip dust represents a good example of these so called "fugitive emissions".) Often, if a factory wishes to lower its overall discharges into the external environment, it must reduce internal/external emissions. Reductions in internal/external emissions improve working conditions, which increases labor productivity (lowering labor costs) and decreases worker's compensation claims and litigation costs (Porter and van der Linde, 1995). Thus, efforts to improve environmental performance – lower discharges into the external environment – directly lead to lower costs, due to better working conditions. Still, this causal link exists with a lag since the human body does not respond immediately to improved indoor ambient air quality and the compensation claims process is time-consuming.

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[6] The installation of a newly efficient process may be a notable exception since installation generates two outcomes: (1) lower costs, and (2) better environmental performance. In this case, better environmental performance need not cause lower costs. Instead, a link may simply exist between the two elements because they stem from the same underlying cause. However, the effect of environmental performance on lower costs may be viewed as causal when a firm chooses to improve its environmental performance by installing a newly efficient production process. In this case, the choice to improve environmental performance leads to lower costs.

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 between "market gains" and "cost savings". Despite these efforts, no previous empirical study evaluates the two pathways, to the authors' best knowledge. 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.

**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. In particular, they consider only accounting-based measures of financial performance. In contrast to studies of financial performance in the US and Canada, few studies of the Central and Eastern European region 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. Claessens and Djankov (1999) include a dummy variable for the first phase of privatization in the Czech Republic, which does not relate to air pollution

controls. Multi-country studies also include country-specific indicators (e.g., Frydman et al., 1999). We include the same relevant control factors as these cited studies, in addition to other factors.

## 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 and effective steps to decrease air emissions dramatically during the period 1991 to 1998 (Czech Ministry of Environment, 1998). Figure 1 displays the trend of economy-wide air emissions over this period. Perhaps, the post-communist decline in economic activity partially explains the drop in the early 1990s. This output decline notwithstanding, firms' pollution control efforts, such as the installation of electrostatic precipitators ("scrubbers") and fuel switching may also explain much of the reduction in air pollutant emissions (World Bank, 1999). Second, consistent with this focus on 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.[7]

[7] Further details on country-wide emissions, Czech air regulations, and environmental issues related to EU accession are available upon request.

### 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, such as assets, and information taken from firms' income statements, such as profits.[8] The third segment provides information on ownership structure, which we use as a control variable in our multivariate regression analysis. We gather balance sheet and income statement data and ownership data for the years 1996 to 1998. The Aspekt database includes all firms traded on the primary market – Prague Stock Exchange – or secondary market [e.g., *"Registrační místo system"* (RMS)] and a majority of the remaining large Czech firms (plus their key 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 1995 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. While the REZZO-1 database records emissions at individual units of individual facilities, the Czech Hydrometeorological Institute aggregates the air emissions to the level of each facility before public release of the data. We further

[8] These financial data are not adjusted for inflation. Instead, our analysis includes year indicators as regressors in the regression analysis.

aggregate air emissions across all facilities associated with a single firm, especially since no other facility-level data are available to us.[9] 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 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).

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 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 financial, ownership, and emission variables used in our analysis.[10] We consider three financial performance measures; each retained observation must possess non-missing data for all three measures. (We choose not to examine a variety of samples based on the availability of data for each financial

[9] While the Czech Hydrometeorological Institute gathers additional information on some facilities, these data are not systematically recorded.

[10] In the case of emissions, non-missing data are available for either all four pollutants or none.

performance measure; by considering a single sample, we avoid sample compositional biases when comparing results across the various financial performance measures. The same concern applies to our use of various measures of firm size; again, we avoid compositional biases by considering a single sample.) 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. (In this process, missing values, not inconsistent values, cause most of the reduction in sample size.)[11]

### 3.3. Descriptive Statistics

Table 1 presents a statistical summary of the relevant firm data. 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 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), (7) foreign investors, and (8) dispersed private investors, which

[11] Two features of this merger deserve elaboration. First, 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.

Second, 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. In addition, data on ownership prior to 1996 mostly exist for firms that were privatized under the Czech citizen voucher program; thus, use of these data most likely would introduce sample selection bias.) 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). Based on 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 control for any potential sample selection bias. (Complete details are available upon request.)

are not included in the table.[12] 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 ($\rho$) equal to 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, they do not capture full costs but full costs net of other income; i.e., [cost of goods sold + operating costs + other costs] - other income.

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[12] Two of these ownership forms deserve elaboration. First, portfolio companies are similar to strategic investors in that another company invests in the identified company; however, the rationale for the investment ranges widely. Second, the category of dispersed investors includes investors who hold less than 10% of a given company and never publicly announced their holdings. Since data on these shares are not available, we cannot measure the presence of dispersed investors directly. Instead, we establish it as the omitted category in our regression analysis. As a benchmark, these investors clearly represent less interested, non-strategic investors since they hold such a small share of the particular company.

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 sales, costs, and profits. 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. The lagging of environmental performance is appropriate since economic agents need to time to translate any reduction in emissions into an alteration of revenues and/or costs, as noted in sub-section 2.1. For example, consumers need time to view a product as "green"; as another example, lenders need time to adjust their calculations of environmental risk. Thus, environmental performance and financial performance are separated in time. Given this separation, lagged environmental performance is clearly predetermined with respect to current financial performance. In essence, the analysis estimates the effect of environmental performance on future financial performance.

To estimate the influence of environmental performance on financial performance, we regress each type of financial performance on lagged air pollutant emissions plus other control factors. To construct the econometric models associated with financial performance, we define the following

notation. We consider three dependent variables. As the first dependent variable, $s_{it}$ denotes the sales generated by firm *i* in time period *t*. As the second dependent variable, $c_{it}$ denotes the costs born by firm *i* in time period *t*. Finally, $\pi_{it}$ denotes the profits generated by firm *i* in time period *t*. Unless otherwise indicated, $\pi_{it}$ denotes overall profits as opposed to operating profits.

The analysis seeks to decompose the effect of each explanatory factor on profits into the factor's separate effect on revenues and separate effect on costs. Estimation of profits unto itself does not provide this decomposition. Estimating revenues and costs separately, along with estimation of profits, would generate this decomposition. Fortunately, we do not need to estimate all three dependent variables. By definition, profits equal the difference between revenues and costs. Thus, we only need to estimate two of the three dependent variables in order to generate the desired decomposition. Each coefficient that could be generated by estimation of the omitted dependent variable is recoverable as a simple linear combination of the coefficients generated for the two estimated dependent variables. Arbitrarily, we choose to estimate costs and profits. Based on the coefficients generated by the estimation of costs and profits, we recover the estimated coefficients for revenues. For each regressor, the sales-related coefficient equals the difference between the profit-related coefficient and the cost-related coefficient; we elaborate below.

We incorporate various explanatory variables into our estimation of costs and profits. 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. Costs and profits 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.[13] Costs and profits 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 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 except "dispersed investors". Collectively, we denote these ownership variables as $W_{it}$. Second, we include a measure of concentration, as captured by the ownership share held by the single largest shareholder and denoted as $L_t$. By including these ownership-related regressors, we control for ownership structure, consistent with most studies of transition economies. However, we neither report nor

[13] 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 analysis incorporates both industry-specific indicators (or firm-specific indicators in the fixed effects model) 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 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 costs and profits 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.

interpret the associated estimation results since ownership is not the focus of our study and the coefficients prove insignificant. 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 also include industry indicator variables, collectively denoted as vector $X_i$. (The omitted industrial category includes "manufacturing: other" and "other: overall" sectors, which are both listed in Table 1.d.) The fixed effects model, described below, subsumes these sectoral effects into its firm-specific fixed effects since sector does not vary over time for a specific firm.

Given this notation, we formulate the following regression system:

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

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

where $\nu_{it}$ and $\upsilon_{it}$ denote the error terms associated with costs and profits, respectively.[14] Please note the use of superscripts to distinguish the coefficients shown in the two equations: "c" denotes costs and "$\pi$" denotes profits. We estimate each equation separately; joint estimation of the two equations within a seemingly unrelated regresssion framework generates identical results since the two regressor sets are the same.

To control properly for firm-specific effects, we estimate equations (1) and (2) using standard panel methods: pooled OLS, fixed effects method, and random effects method. We use standard tests to assess these methods. 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

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

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 are always inconsistent based on the Hausman test statistics, we do not report these estimates.[15] The fixed effects estimates are consistent by assumption of the model.

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. First, production strongly and positively affects costs and profits. Firm size does not significantly affect either costs or profits.

Second, we examine the estimated coefficients for lagged environmental performance. To recover the sales-related coefficient for environmental performance (i.e., effect of lagged environmental performance on sales), we subtract the cost-related coefficient for environmental performance ($\beta^c$) from the profit-related coefficient for environmental performance ($\beta^\pi$):

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

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

In this sub-section, we report and interpret briefly the estimation results relating to

[15] Hausman test statistics are available upon request.

environmental performance, while interpreting them more deeply in the subsequent sub-section. As shown in Table 2.b, higher lagged air pollutant emissions significantly raise sales (p=0.062). 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 the first column of Table 2.a, higher lagged air pollutant emissions significantly raise costs. Many reasons potentially explain this outcome, such as diminished 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.[16]

If better environmental performance lowers revenues and costs, one question remains: does better environmental performance raise or lower the difference between revenues and costs, i.e., profits? As shown in the second column of Table 2.a, higher lagged air pollutant emissions significantly lower profits. Thus, better environmental performance appears linked with improved profitability. 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; this interpretation helps to assess which reason (or reasons) most likely drives (or drive) these results.

We demonstrate the robustness of this last conclusion by examining the effect of environmental performance on profitability using alternative econometric specifications. We focus

[16] Details on these results are available upon request.

on profitability because it is the most comprehensive financial performance measure from the set of three: sales, costs, and profits. In all cases, the estimated effect of environmental performance on profitability is highly robust to the alternative specifications and does not differ qualitatively across the alternative specifications. While we estimate several alternative specifications, which are described below, for the sake of space and the reader's burden, we report the full regression results for only three alternative specifications, which are shown in Table 3. For the remaining specifications, we merely report the p-value of the coefficient associated with environmental performance. 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 the first column of Table 3, this alternative specification generates an environmental performance coefficient that is very similar in terms of sign, magnitude, and significance as the coefficient reported in Table 2. 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 ($\beta^{\pi} = -13.32$), 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.[17] Two previous studies of financial performance in Central and Eastern Europe use alternative measures of firm size. Claessens and Djankov (1999) use the sum of fixed assets and inventory as a replacement for total assets. Similarly, Weiss and Nikitin (2002) replace total assets

[17] 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.

with depreciation, which serves as a proxy for units of capital. Use of these alternative firm size measures again generate highly similar coefficient estimates in terms of sign, magnitude, and significance (p=0.0001 in both cases).

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 in all cases). Results for the third specification are displayed in the second column of 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: $\beta^{\pi} = -10.92$ and $p = 0.0001$. 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 the third column of Table 3, use of equity as the firm size measure also generates a highly significant negative effect (p=0.0001) for lagged environmental performance on operating profits. (We report the full regression results for this particular specification since the use of equity as a firm size measure generates a significant coefficient for firm size as opposed to the use of total assets, which generates an insignificant coefficient for firm size.) Use of the sum of fixed assets and inventory or depreciation as the firm size measure generates highly similar coefficient estimates in terms of sign, magnitude, and significance (p=0.0001 in both cases).

### 4.3. Interpretation of Results and Implications

Lastly, we interpret these results in light of the preceding literature, while attempting to identify important implications. First, the results of our study 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. More specifically, tighter air emission limits and/or higher emission charge rates may have possibly constrained Czech firms' abilities to produce higher quality products. Conversely, the noted finding rejects the conjectures that better environmental management (1) allows firms to sell "green" goods at a higher price or in greater quantity, (2) prompts customers who are otherwise indifferent to environmentally responsible efforts to buy "green" goods, (3) improves a firm's overall reputation among customers, and (4) provides the firm with an "early-mover" advantage and status as an "industry leader" (given that the better management practice establishes an industry standard). 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]

Overall, this finding implies that Czech firms should cautiously improve environmental management practices if corporate management keys on any decline in revenues, independent of any change in profits (which seem to benefit from better environmental management), as an indicator

[18] According to Czech Ministry of Environment (2004), 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. Starting in 2000, the Czech government began to support the sale of eco-labeled products by granting them preference in the purchasing orders from the state administration. In the same year, the national program entered the Global Eco-Labeling Network. By 2004, the program had awarded the eco-label to 310 products, involving 169 licenses for 82 companies; moreover, the Czech government had integrated its national program into the multinational programs of the OECD and EU.

of the need to cut costs. In other words, management may observe weakened revenues in the preceding period and attempt to address this issue by cutting costs in the current period. In this case, management would be over-reacting because the diminished revenues are associated with an even stronger reduction in costs so that profits actually rise.

Second, the results of our study indicate that better environmental performance appears to lower costs. This finding is consistent with several conjectures, which are described in sub-section 2.1. 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 lower 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, third-party suits, and community pressure.

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

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[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.

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. Similar to the cost of regulatory scrutiny and regulatory sanctions, 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 plausible for the Czech Republic during the sample period given the lack of any corroborating evidence. Lastly, the noted finding supports the conjecture that better environmental performance lowers labor costs by improving work conditions with reductions in internal/external or fugitive emissions. As explained in sub-section 2.1, improved work conditions increase labor productivity and/or decrease workers' compensation claims and litigation costs. Given the rather filthy conditions in some Czech firms during the sample period, a meaningful increase in labor productivity seems quite plausible. Consistent with this claim, labor productivity improved dramatically over the sample period (Kocenda and Svejnar, 2002). However, we are aware of no study that connects reductions in fugitive emissions to improved labor productivity in the Czech Republic. Thus, this claimed connection remains unsubstantiated. Unlike the potential importance of labor productivity increases, any reduction in workers' compensation claims and litigation costs

was most likely mitigated by the government's comprehensive coverage of medical services and the general absence of litigation over "environmental" matters (Earnhart, 1998).

Based on this discussion, of the supported conjectures (i.e., interpretations), the most plausible is the combination of regulatory and community pressure: reductions in air emissions lowered Czech firms' costs by removing regulatory scrutiny and community pressure and 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, the results of our study indicate that better environmental performance appears to improve profitability by driving costs down more than revenues. Profits represent the simple difference between revenues and costs. Above we interpret the findings for revenues and costs separately. Thus, the remaining issue concerns the relative magnitudes of the effects on these two profit components. The decline in costs exceeds the decline in revenues. A greater decrease in costs is consistent with the meaningful benefits of reducing the otherwise substantial regulatory scrutiny or at least reducing the uncertainty associated with possible regulatory scrutiny. As evidence of this substantial regulatory scrutiny, several facilities were actually shut down in the Czech Republic due to noncompliance. The benefits of reduced community pressure further substantiate the greater decrease in costs, relative to the decline in revenues.

On the other side of the ledger, a lesser 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. This point notwithstanding, better environmental management, in some form, not

necessarily end-of-pipe treatment, apparently constrained revenue enhancement to a significant extent.

In sum, better environmental management appears linked to improved profitability and the most likely cause is reduced regulatory and community pressure.

**5. Summary**

This paper examines the link from corporate environmental performance to financial performance. In particular, we assess whether better environmental performance alters sales, revenues, 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 undermine future revenues, while lowering costs to a greater extent, thus, improving profitability. This conclusion is highly robust to many alternative specifications.

As noted in the introduction, given the transitional nature of the Czech economy, the results of this study 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.

**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] | Costs | | Profits | |
|---|---|---|---|---|
| Lagged Pollutant Emissions | 23.609 | *** | - 15.146 | *** |
| | (6.008) | | (3.713) | |
| Production Value (000 CZK) | 0.8381 | *** | 0.0717 | *** |
| | (0.0286) | | (0.0177) | |
| Total Assets (000 CZK) | 0.0439 | | 0.0048 | |
| | (0.0273) | | (0.0169) | |
| 1997 | - 4,383,064 | *** | 1,620,403 | *** |
| | (1,050,596) | | (649,367) | |
| 1998 | - 4,182,951 | *** | 1,547,097 | *** |
| | (1,007,084) | | (622,473) | |
| No. of Firms / No. of Obs | 429 / 1044 | | 429 / 1044 | |
| F-Test for Fixed Effects | 21.47 | | 3.90 | |
| [significance level] | [0.0001] | | [0.0001] | |
| Adjusted $R^2$ | 0.9957 | | 0.7170 | |

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.

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<br>(3.593) | *** | - 15.122<br>(3.653) | *** | - 9.735<br>(2.643) | *** |
| Production (000 CZK) | 0.1185<br>(0.0185) | *** | 0.1571<br>(0.0254) | *** | 0.1105<br>(0.0106) | *** |
| Production$^2$ (000,000 CZK) | N/A | | - 3.42 E-9<br>(0.74 E-9) | *** | N/A | |
| Total Assets (000 CZK) | 0.0914<br>(0.0209) | *** | 0.0307<br>(0.0175) | * | N/A | |
| Total Assets$^2$ (000,000 CZK) | - 3.73 E-9<br>(0.56 E-9) | *** | N/A | | N/A | |
| Equity (000 CZK) | N/A | | N/A | | 0.2105<br>(0.0228) | *** |
| No. of Firms / No. of Obs | 429 / 1044 | | 429 / 1044 | | 429 / 1044 | |
| F-Test for Fixed Effects<br>[significance level] | 4.18<br>[0.0001] | | 4.06<br>[0.0001] | | 10.63<br>[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.

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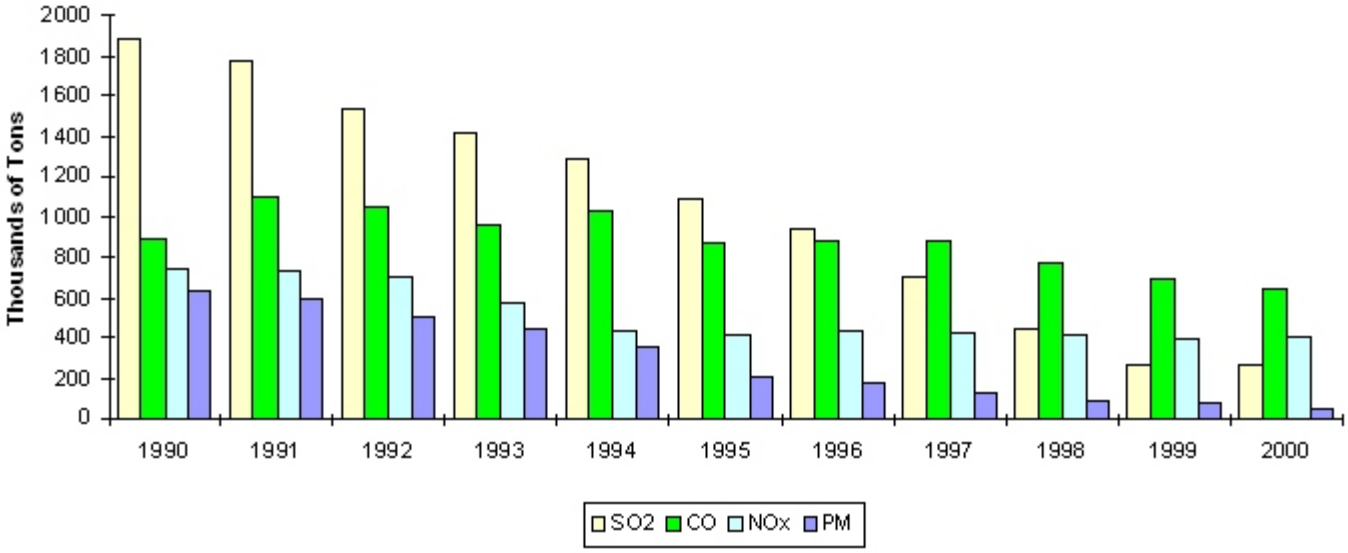
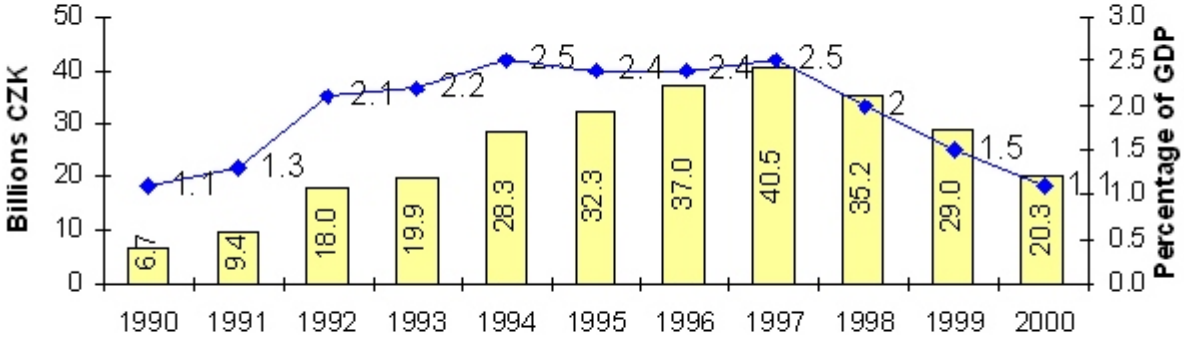
**Figure 1: Air Pollutant Emissions in Czech Republic**



## Figure 2: Investment in Environmental Protection




Source: Czech Statistical Office, Czech Ministry of Environment

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