Effects of ownership and financial performance on corporate environmental performance

Dietrich Earnhart\textsuperscript{a,b,*}, Lubomir Lizal\textsuperscript{b,c,d}

\textsuperscript{a} 213 Summerfield Hall, University of Kansas, Lawrence, KS 66045, USA
\textsuperscript{b} William Davidson Institute (WDI), University of Michigan, Ann Arbor, MI 48109, USA
\textsuperscript{c} CERGE-EI (joint workplace of Charles University and the Academy of Sciences of the Czech Republic), Prague, Czech Republic 111 21
\textsuperscript{d} Centre for Economic Policy Research, London, EC1V 7RR, UK

Received 8 October 2003; revised 4 November 2005
Available online 7 February 2006

Earnhart, Dietrich, and Lizal, Lubomir—Effects of ownership and financial performance on corporate environmental performance

This paper analyzes the effects of ownership structure on corporate environmental performance and examines the relationship between financial performance and environmental performance in a transition economy. Using an unbalanced panel of Czech firms from 1993 to 1998, we consider state ownership and contrast concentrated with diffuse forms of private ownership. Additionally, we investigate whether successful financial performance begets or undermines good environmental performance. \textit{Journal of Comparative Economics} 34 (1) (2006) 111–129. 213 Summerfield Hall, University of Kansas, Lawrence, KS 66045, USA; William Davidson Institute (WDI), University of Michigan, Ann Arbor, MI 48109, USA; CERGE-EI (joint workplace of Charles University and the Academy of Sciences of the Czech Republic), Prague, Czech Republic 111 21; Centre for Economic Policy Research, London, EC1V 7RR, UK.

© 2005 Association for Comparative Economic Studies. Published by Elsevier Inc. All rights reserved.

\textit{JEL classification:} D21; G39; Q25; D62

\textit{Keywords:} Czech Republic; Environmental protection; Pollution; Ownership; Financial performance

\begin{itemize}
\item We acknowledge the financial support of a COBASE grant from the National Research Council.
\item * Corresponding author. Fax: 785 864 5270.
\item E-mail address: Earnhart@ku.edu (D. Earnhart).
\end{itemize}

0147-5967/$ – see front matter © 2005 Association for Comparative Economic Studies. Published by Elsevier Inc. All rights reserved.
doi:10.1016/j.jce.2005.11.007
1. Introduction

Frydman et al. (1999), Djankov (1999), and Claessens and Djankov (1999) investigate the effects of different ownership structures on standard measures of corporate financial performance, such as revenue and capital investment, in the transition economies of Central and Eastern Europe. In this paper, we estimate the effects of different ownership structures on corporate environmental performance, measured by air pollutant emissions, in the transition economy of the Czech Republic from 1993 to 1998.\(^1\) Similar to previous studies on ownership, we focus on the impact of privatization by comparing state and private ownership. Alchian (1965) and De Alessi (1995) argue that ownership structure affects the incentives to pursue value-maximizing strategies and that private ownership provides strong incentives to exploit revenue-enhancing and cost-reducing options. For our purpose, revenue-enhancing options such as the sale of marketable permits are not related to environmental performance; thus, we focus on cost-reducing options. However, cost-reducing options may increase or decrease emissions because costs are incurred by both emissions fees and emission reductions. If private ownership promotes cutting emission-related costs, relative to state ownership, private ownership leads to a decrease in emissions. Conversely, if private ownership promotes cutting reduction-related costs, private ownership leads to an increase in emissions. In our empirical analysis, we test these two competing effects.

To investigate variation across different types of private ownership, we distinguish between concentrated ownership, e.g., the presence of a strategic investor, and diffuse ownership, e.g., the predominance of investment funds. More concentrated ownership may improve the owners’ ability to control the firm’s costs, including environmentally-related costs, by enhancing its monitoring of management. However, more concentrated ownership may also thwart a manager’s ability to control costs by reducing incentives to acquire information. If the improvement in the owner’s ability to monitor management is dominant, greater ownership concentration results in better cost control. Conversely, if the decrease in managerial incentives is dominant, greater ownership concentration leads to less cost control. In addition, we investigate the link between financial performance, measured by profitability, and environmental performance. If firms face liquidity constraints, successful financial performance should be associated with good environmental performance. In our empirical analysis, we test these hypotheses.

In the next section, we survey the related economic literature and develop a simple conceptual framework. Section 3 contains a description of the database, focusing on corporate financial performance, ownership structure, and air pollutant emissions. In Section 4, we estimate and interpret the effects of ownership and financial performance on corporate environmental performance. The final section concludes with policy and research implications.

2. Related economic literature

Recent studies estimate the effects of different ownership structures on standard measures of corporate financial performance in the transition economies of Central and Eastern Europe (CEE). Frydman et al. (1999) compare the performance of privatized and state firms in CEE by examining growth rates of key financial indicators, namely, sales revenues, employment, labor

---

\(^1\) Earnhart (1997, 2000a, 2000b) also examine environmental issues in the Czech Republic but focus on government regulatory decisions rather than firm performance.
productivity, and labor and material costs relative to revenues. They find that privatization has different effects on financial performance depending on the type of controlling owner. In particular, outsiders generate significant performance improvements, while insiders do not. Claessens and Djankov (1999) explore the relationship between the composition of ownership and corporate financial performance in the Czech Republic between 1992 and 1997. They find that more concentrated ownership leads to higher profitability and greater labor productivity. Kocenda and Svejnar (2002) analyze Czech corporate financial performance and show that private domestic and foreign majority owners, as well as significant minority owners, increase profitability relative to state-owned firms. However, contrary to Claessens and Djankov (1999), these authors find that firms with dispersed ownership generate even higher profits than firms with more concentrated ownership. Megginson and Netter (2001) provide a comprehensive survey of several other empirical studies on privatization.

Only one previous study examines the effects of ownership structure on corporate environmental performance in CEE. Bluffstone (1999) estimates the effect of state ownership on firm-level air pollutant emission levels in Lithuania. However, ownership structure is used only as a control factor in his econometric model so that he does not interpret its estimated effect. Other studies explore links between financial and environmental performance for firms in mature market economies. The first set of studies examines only the link from environmental performance to financial performance. By examining a firm’s market value, Konar and Cohen (2001) demonstrate that bad environmental performance is negatively correlated with market value. Gottsman and Kessler (1998) divide the companies in the S & P 500 into three sub-samples based on four measures of environmental performance and find no statistically significant differences in financial returns among the three categories of environmental performers. Bosch et al. (1998) consider the effect of federal environmental enforcement, which represents one measure of environmental performance, on stockholder wealth. These authors show that the stock market reacts negatively upon learning that a given firm has been targeted for enforcement. Klassen and McLaughlin (1996) find that signals of strong environmental management, measured by environmental performance awards, increase returns to equity, while signals of weak environmental management, measured by environmental crises, decrease returns to equity. Finally, Austin et al. (1999) explore the interrelationships between financial performance and environmental performance to identify the causal relationship between the two. Although these authors provide evidence of a relationship between environmental and financial performance, they cannot identify the direction of causality.

To explore these issues, we develop a simple model of corporate environmental decision-making in three stages. In the first stage, we assume that each private firm is owned and operated by the same entity; hence, ownership and control are not separated. In this stage, we focus on the distinction between private and state ownership. In the second stage, we allow for separation of ownership and control in private firms. In the third stage, we examine the impact of liquidity constraints, which limit the firm’s ability to invest in projects intended to improve both financial and environmental outcomes.

Starting with the restriction that each private firm is owner-operated, we assume that firms maximize profits. Since environmentally-related revenues, e.g., marketable permits, did not exist during the sample period in the Czech Republic, firms minimize two categories of environmental costs. First, increases in emissions generate costs due to emission charges and induce regulatory authorities to impose costly penalties. Emissions may also be associated with higher costs due to inefficient use of inputs. Second, reductions in emissions incur treatment costs. We assume that the private firm minimizes the sum of emission costs and reduction costs. Let $p$ represent
the level of emissions, which is not stochastic. $ME(p)$ represents marginal emission costs, which are increasing in emissions. Let $MA(p)$ represent marginal reduction costs, which are decreasing in emissions because they are increasing in emission reductions. Denote $p^*$ the cost-minimizing level of emissions, where $ME(p) = MA(p)$.

In contrast to private firms, we assume that state firms do not minimize total costs and that the level of emissions generated by a state firm, denoted as $p^s$, may be greater or less than $p^*$. We consider two testable hypotheses that follow from this framework.

(H1a) If reduction costs are excessively high under state ownership so that $ME(p^s) < MA(p^s)$, private ownership will reduce emission-reduction costs and increase emissions, relative to state ownership.

(H1b) If emission costs are excessively high under state ownership so that $ME(p^s) > MA(p^s)$, private ownership will reduce emission costs and raise emissions, relative to state ownership.\(^2\)

In the second stage, we drop the assumption of owner-operated private firms. Although we continue to assume that private owners maximize profits, the distinction between owners and managers introduces agency problems that may prevent the achievement of this objective.

Ownership concentration is denoted $C$, where $C \in [0, 100]$; it affects incentives and the ability to pursue cost-reducing options by two countervailing effects. On one hand, greater ownership concentration may improve an owner’s ability to control costs. Shleifer and Vishny (1997) argue that ownership concentration results in better monitoring of managers, who might otherwise pursue their own goals. Similarly, Admati et al. (1994) argue that minor shareholders may free ride on the decision process of corporate governance and undermine firm performance. Hence, we take $N(C)$ to represent the improvement in the owner’s ability to control costs and assume that $N(C)$ is increasing in $C$, i.e., $N'(C) > 0$, at a constant or declining rate, i.e., $N''(C) \leq 0$. On the other hand, concentrated ownership may undermine a manager’s ability to control costs. Aghion and Tirole (1997) argue that highly uncertain business conditions require managerial initiative and that incentives to acquire information may be reduced by concentrated ownership.

In addition, Bolton and von Thadden (1998) claim that dispersed ownership may be optimal if shareholders can block unwanted but necessary restructuring. Let $I(C)$ represent the reduction in the manager’s ability to control costs and assume that $I(C)$ is rising in $C$, i.e., $I'(C) > 0$, at a constant or increasing rate, i.e., $I''(C) \geq 0$.

The profit-maximizing private firm adjusts $C$ until $N'(C) = I'(C)$, denoted $C^*$. However, the current level of concentration, denoted $C_0$, may be above or below $C^*$. Thus, no testable hypotheses regarding the effect of ownership concentration follow without further qualification. If $C_0 < C^*$, greater concentration improves the firm’s ability to control costs. Conversely, if $C_0 > C^*$, greater concentration undermines the firm’s ability to control costs. Taken together

\(^2\) This simple conceptual framework disregards aspects that influence the relationship between ownership type and environmental performance. First, state-owned firms may be less inclined to control emissions if state regulators are reluctant to impose fees, charges, and penalties on them. Alternatively, state-owned firms may be pressured by state regulators to achieve better environmental performance. Thus, the relationship between ownership type and regulatory pressure is ambiguous. Second, preferences for better environmental stewardship, independent of cost concerns, may differ by ownership structure. The state may express a greater concern for the environment than private owners. Concerning both issues, we assume that any potential difference in regulatory pressure or preferences is sufficiently small relative to the incentives to pursue cost-reducing strategies so that it does not change the proposed relationship.
with the two competing hypotheses from the first stage, these conditions imply the following two hypotheses.

**(H2a)** Greater private ownership concentration raises emissions if:

(i) \( C_0 < C^* \) and \( ME(p^*) < MA(p^*) \), or 

(ii) \( C_0 > C^* \) and \( ME(p^*) > MA(p^*) \).

**(H2b)** Greater private ownership concentration lowers emissions if:

(i) \( C_0 < C^* \) and \( ME(p^*) > MA(p^*) \), or 

(ii) \( C_0 > C^* \) and \( ME(p^*) < MA(p^*) \).

In the third stage, we expand the conceptual framework to include a liquidity constraint in order to examine the effect of profitability on environmental performance. For ease of exposition, we assume that each firm is operated by its owner. In this case, \( p^* \) represents the cost-minimizing emissions level chosen by the firm’s owner-operator. However, a firm may not possess sufficient internal funds to invest in the equipment and personnel needed to obtain the desired level of emissions. Internal financial resources are more important in a transition economy than in a mature market economy, as Lizal and Svejnar (2002a, 2002b) demonstrate. In particular, internal financing was crucial in the Czech Republic during the analyzed period because Czech firms faced various liquidity constraints. The transition caused a significant reduction in government subsidies, yet capital markets were undeveloped. Thus, the only source of external financing was bank credit, whose availability depended on past and current profitability. Alternatively, firms could have used internal resources formed from retained profits. Regardless, Czech firms faced a liquidity constraint tied directly to profits. Hence, the level of profits, denoted \( \pi \), represents the limit on internal funds available to achieve the desired level of emissions. Given such a liquidity constraint, the firm may be able to fund only a portion of its desired investment in equipment and personnel. Asymmetrically, the liquidity constraint does not prevent increases in emissions because the firm can discontinue investment and maintenance of emission-reducing activities. Hence, we assume that the funded portion of emission-reduction investments lowers emissions to a level denoted \( p_L(\pi) \), which exceeds \( p^* \). This constrained level depends negatively on the level of profits, i.e., \( p_L'(\pi) < 0 \). As profits increase, the liquidity constraint becomes less binding and the level of emissions falls. Since investment in new capital equipment may lower pollution by using energy inputs more efficiently, the effect of a liquidity constraint on emissions may not be limited to investment projects inspired by pollution reduction. Therefore, we state the final testable hypothesis:

**(H3)** Greater profitability improves environmental performance by allowing a Czech firm to generate internal financial resources that may be used for emission-reducing investments.

3. **Data on financial and environmental performance and ownership structure**

To examine the effect of ownership structure and explore the link between financial and environmental performance, we use firm data from the Czech Republic between 1993 and 1998. This transition economy exhibits an interesting pattern of ownership structures due to the various privatization methods, especially the extensive use of vouchers. In addition, although most
Czech enterprises have been privatized, some key sectors in our sample remain state-controlled, e.g., most utilities, especially energy utilities. Therefore, we can examine the different behavior of state-owned firms and privatized firms for the entire sample period. However, even when state-owned enterprises are privatized, the state maintains significant influence. Kocenda (1999) shows that the state is able to influence over 76% of the assets held by privatized Czech firms. Since we measure the share of state ownership, we capture the state’s influence over privatized firms. The time period from 1993 to 1998 represents most of the initial Czech post-privatization experience during which the ownership structure is more likely to be exogenous. Over time, each firm will identify and achieve the ownership structure best suited for its operation. Several previous studies examine the effect of ownership on standard measures of corporate financial performance in the Czech Republic, e.g., Claessens and Djankov (1999). Hence, we compare our results on environmentally-related corporate performance to their results on standard performance measures.

The Czech Republic has a substantially degraded environment; in particular, poor ambient air quality and air pollution is a large environmental problem, as World Bank (1992) attests. In response to public concern, the Czech government took strong steps to reduce air emissions substantially from 1991 to 1998, as documented by Czech Ministry of Environment (1998). Figure 1 displays the declining trend of air emissions over two decades. An overall decline in economic activity, with its resulting reduction in domestic energy demand, explains part of the decline in the early 1990s. However, pollution control laws, e.g., the 1991 Czech National Air Act, and pollution control efforts by firms, such as installation of electrostatic precipitators and fuel switching, explain much of the decline in the 1990s, according to World Bank (1999). Moreover, the Czech government was seeking to enter the European Union (EU) during this period so that industrial emissions had to be reduced to qualify for membership.

To examine financial performance and ownership structure, we use two segments of a database provided by the private vendor Aspekt. One segment provides information drawn from balance sheets, e.g., asset levels, and information taken from income statements, e.g., profits, from 1993 to 1999. The second segment provides information on ownership structure from 1994 to 1999. The Aspekt database includes all firms traded on the Prague Stock Exchange, firms registered for trading on the RMS (Registrační místo system) secondary market, and a majority of the remaining large Czech firms, including the key trading partners of these large firms.

As an indicator of corporate environmental performance, we chose air pollutants emitted by facilities located in the Czech Republic during the years 1982 and 1998. The included pollutants are carbon monoxide (CO), sulfur dioxide (SO2), particulate matter, and nitrous oxides (NOx), which represent the main and most heavily regulated pollutants in the Czech Republic. The Czech Hydrometeorological Institute maintains the REZZO-1 database, which records emissions for large, stationary sources, and the REZZO-2 database, which records emissions for medium-sized, stationary sources. We use the REZZO-1 database because it overlaps considerably with

---

3 The state uses three means of influence: primary ownership, the veto power of golden shares, and secondary ownership, i.e., the firm is owned by a state-controlled firm.
4 Nitrous oxide (NOx) emissions do not demonstrate as strong a downward trend due to the rapid rise in automobile ownership and use.
5 Further details on country-wide emissions, Czech air regulations, and environmental issues related to EU accession are available upon request.
6 Claessens and Djankov (1999), Weiss and Nikitin (2002), Kocenda and Svejnar (2002), and Djankov (1999) have used this comprehensive database to study ownership effects.
Fig. 1. Air pollutant emissions in Czech Republic.
the financial and ownership data. Although this database records emissions at individual units of individual facilities, the Czech Hydrometeorological Institute aggregates air emissions to the level of each facility before releasing the data. We aggregate air emissions further across all facilities associated with a single firm. Finally, we add the four pollutants into one composite measure of air emissions, following previous studies of environmental performance by Konar and Cohen (1997, 2001), Khanna and Damon (1999), Khanna et al. (1998), Arora and Cason (1995, 1996).7

To generate the largest sample possible and to avoid sample selection bias due to attrition, we create an unbalanced panel of firm-year observations from 1993 to 1998. First, we merge the data from balance sheets and income statements into a financial data for 1993 to 1999 having approximately 37,600 observations representing roughly 10,000 firms. Second, we add air emissions data that cover the period from 1993 to 1998 having approximately 9700 observations. Hence, the overlap between the financial data set and the air emissions data set is limited, with only 4688 observations in common.8 Third, we eliminate all observations that do not have positive production, measured in Czech Crowns, positive total assets, and positive fixed assets. We also restrict our sample to those observations with non-missing data for key financial and emission variables. This screening and restriction generates an unbalanced panel of 2628 observations from 1993 to 1998.9

Our ownership information covers the years from 1993 to 1999 with roughly 15,800 observations representing about 5800 firms. Merging the financial, emission, and ownership data sets generates an unbalanced panel of 463 firms with 1127 observations from 1993 to 1998.10 However, we lack ownership data for many firm-year observations, in particular, from 1993 to 1995. The ownership data come from four sources. First, the Prague Stock Exchange (PSE) maintains a Register of Shares for all listed companies, in which all stakes above 10% are published.11 Second, companies provide ownership data in annual reports and in reports to stockholders as required by the relevant stock exchange or court of registry. Third, the data vendor sends questionnaires to firms requesting ownership information. Fourth, the data vendor also uses published materials, e.g., newspaper articles, to extract this information. Although the first two sources may not generate selection bias, the last two sources are likely to do so. We address this issue by implementing a Heckman two-step sample selection procedure.

Panel A of Table 1 indicates that our data are spread sufficiently across the six years and panel B presents the summary statistics regarding firm characteristics.12 The standard deviations

---

7 Estimation using individual pollutants generates similar results that are less significant in some cases than the results presented. We also calculate an alternative measure of composite air emissions by weighting each individual pollutant by the relevant emission charge imposed by the Czech Ministry of the Environment. This alternative measure equals the sum of emission charges paid by each firm. Estimation using this alternative measure generates results that are similar to those presented.
8 While unfortunate, this limited overlap does not represent a problem with the data. Instead, it indicates that firms included in the Aspekt database own medium, rather than large, stationary air emission sources or own facilities that are not required to measure air emissions because they are non-existent or extremely low. Hence, the Aspekt database does not represent large stationary air polluters completely. Therefore, our results may not generalize to large stationary air polluters. However, the REZZO-1 database includes all large polluters.
9 Missing values, not inconsistent values, cause most of the reduction in sample size. The final sample size is comparable to that in other studies using Czech data, e.g., Kocenda and Svejnar (2002).
10 We do not have emissions data for 1999.
11 Investment funds, portfolio investors, and the state often publish the composition of their portfolios so that some information on smaller holdings is available.
12 Industrial classification is not reported but is available upon request.
Table 1
Descriptive statistics

A. Distribution across years

<table>
<thead>
<tr>
<th>Year</th>
<th>Freq.</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>353</td>
<td>13.43</td>
</tr>
<tr>
<td>1994</td>
<td>467</td>
<td>17.77</td>
</tr>
<tr>
<td>1995</td>
<td>468</td>
<td>17.81</td>
</tr>
<tr>
<td>1996</td>
<td>484</td>
<td>18.42</td>
</tr>
<tr>
<td>1997</td>
<td>457</td>
<td>17.39</td>
</tr>
<tr>
<td>1998</td>
<td>399</td>
<td>15.18</td>
</tr>
<tr>
<td>Total</td>
<td>2628</td>
<td>100</td>
</tr>
</tbody>
</table>

B. Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th># of obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed assets (000s CZK)</td>
<td>2628</td>
<td>886,875</td>
<td>2,193,577</td>
</tr>
<tr>
<td>Profit (000s CZK)</td>
<td>2625</td>
<td>−179</td>
<td>236,383</td>
</tr>
<tr>
<td>Production value (000s CZK)</td>
<td>2628</td>
<td>1,222,220</td>
<td>3,559,092</td>
</tr>
<tr>
<td>Emissions total (tons)</td>
<td>2628</td>
<td>963</td>
<td>4063</td>
</tr>
<tr>
<td>Emissions of carbon monoxide [CO] (tons)</td>
<td>2628</td>
<td>127</td>
<td>1189</td>
</tr>
<tr>
<td>Emissions of sulfur dioxide [SO2] (tons)</td>
<td>2628</td>
<td>515</td>
<td>2440</td>
</tr>
<tr>
<td>Emissions of particulate matter [PM] (tons)</td>
<td>2628</td>
<td>121</td>
<td>621</td>
</tr>
<tr>
<td>Emissions of nitrous oxides [NOx] (tons)</td>
<td>2628</td>
<td>200</td>
<td>849</td>
</tr>
<tr>
<td>State ownership share (%)</td>
<td>1168</td>
<td>6.14</td>
<td>16.65</td>
</tr>
<tr>
<td>Strategic investor ownership share (%)</td>
<td>1168</td>
<td>27.77</td>
<td>30.41</td>
</tr>
<tr>
<td>Individual citizens ownership share (%)</td>
<td>1168</td>
<td>5.72</td>
<td>16.88</td>
</tr>
<tr>
<td>Bank ownership share (%)</td>
<td>1168</td>
<td>0.99</td>
<td>5.70</td>
</tr>
<tr>
<td>Portfolio company ownership share (%)</td>
<td>1168</td>
<td>2.17</td>
<td>9.02</td>
</tr>
<tr>
<td>Investment funds ownership share (%)</td>
<td>1168</td>
<td>12.80</td>
<td>20.12</td>
</tr>
<tr>
<td>Foreign ownership share (%)</td>
<td>1168</td>
<td>7.61</td>
<td>20.64</td>
</tr>
<tr>
<td>Concentration: single largest shareholder (%)</td>
<td>1168</td>
<td>45.34</td>
<td>22.22</td>
</tr>
</tbody>
</table>

Note. The abbreviation CZK refers to Czech Crowns.

of financial measures indicate considerable variation as do those for measures of air emissions. The ownership variables consist of eight categories, namely, state, strategic investors, individual citizens, direct bank ownership, portfolio companies, investment funds, foreign investors, and dispersed private investors, which is excluded from the table. The excluded ownership category consists of investors who hold less than 10% of a given company so that their holdings are never publicly disclosed.13 Because data on these shareholdings are not available, we consider this group to be the omitted category in our regression analysis.

As panel B of Table 1 indicates, although the state retains a sizeable residual claim in the average firm, strategic investors hold the dominant stake. We classify strategic and foreign investors as concentrated private owners and banks, investment funds, citizens, and dispersed investors as diffuse private owners for the following reasons. First, banks in the Czech Republic play only a small direct role in the operation of Czech firms according to Hanousek et al. (2002), in contrast to the larger role played by banks in other European countries, e.g., Germany. Second, Czech legislation prohibited investment funds from owning more than 20% of any particular company during the sample period. Third, citizens differ from business entities so that we consider them as

13 This category also contains some holdings by investment funds, portfolio companies, and the state.
a separate ownership category. Lastly, portfolio companies are not classified because, although they are similar to strategic investors, their rationale for investment ranges from hedging to improvement in governance to asset stripping. Moreover, the holdings of portfolio companies range from dispersed to substantially concentrated given their different investment motives.

In addition to ownership shares, we include an additional variable to capture the concentration of ownership as measured by the share of the single largest shareholder following Kocenda and Svejnar (2002). Ownership structure varies substantially by industrial sector. For example, the electricity, mining, and oil refining sectors are heavily state-controlled, while the rubber and plastic sector has no state presence. Within any given sector, certain investor categories are represented only weakly if at all. Since our analysis controls for industry-specific effects, the statistical significance of the marginal effects of ownership structure may be difficult to establish.

4. Econometric analysis of environmental performance

We estimate the relationship between environmental performance and key explanatory variables using standard unbalanced panel analysis. When examining the link from financial to environmental performance, we do not use current financial performance because contemporaneous financial and environmental performance are likely to be determined jointly. Instead, we use lagged financial performance, which is considered as predetermined, following Lizal and Svejnar (2002a, 2002b). In general, lagging financial performance avoids any endogeneity problem, as Austin et al. (1999) argue. However, if the error term associated with environmental performance includes a time-invariant component, endogeneity remains a problem unless a fixed effects model is used. Moreover, lagging financial performance is appropriate because of the expected lag between accessing financial resources and investing in technologies to reduce air emissions.

We estimate environmental performance using both absolute emissions and emissions divided by the production level, denoted relative emissions. Czech government regulators impose both quantity-based limits, e.g., tons per month, and concentration-based limits, e.g., grams of pollutant per liter of air. Quantity-based limits relate directly to absolute emissions, while concentration-based limits can be approximated by relative emissions if the level of production is proportional to the volume of air flowing from a facility's smokestacks. If the main issue is environmental protection, absolute emissions is the proper measure because environmental degradation depends on the mass of pollutants not on its ratio to production. However, relative emissions may capture better the environmental policy of a given firm. A firm with high absolute emissions and high production may be more environmentally friendly than a firm with lower absolute emissions but very small production. In addition, relative emissions permit a determination of economies of scale in pollution control because increases in the production level should lower relative emissions in the presence of such scale economies.

The dependent variable, denoted $p_{ii,t}$, is the amount of pollution emitted by firm $i$ in time period $t$. The profits generated by firm $i$ in the preceding time period $t - 1$, denoted $\pi_{i,t-1}$, is a primary explanatory variable. Including the lagged dependent variable as a regressor would capture any potential dynamics in the evolution of environmental performance over time, as Magat and Viscusi (1990) discuss. However, any other benefits are small com-

---

14 We also used the share of five largest shareholders as an alternative concentration measure and found similar or less significant results. Data on the Herfindahl index of shareholding are not precise enough due to the design of the Aspekt database.

15 Including the lagged dependent variable as a regressor would capture any potential dynamics in the evolution of environmental performance over time, as Magat and Viscusi (1990) discuss. However, any other benefits are small com-
production, denoted $y_{it}$. To capture the effect of firm size, we include fixed assets, denoted $a_{it}$. To control for variation over time with respect to economy-wide trends and the legal framework regulating air emissions, we include a vector of individual year indicators, denoted $T_{it}$. To control for sector-specific variation, we include a vector of industry indicator variables, denoted $X_{it}$. To estimate the effects of ownership structure, we employ a synchronic approach that controls for macroeconomic or sectoral conditions by examining various firms under similar circumstances. Hence, we compare across firms and include year and industrial indicator variables.

Before incorporating ownership effects into the estimation of corporate environmental performance, we address the incomplete recording of ownership structure data by the data vendor. Although the decision to record ownership data is not likely to bias our results, we implement the standard Heckman two-step procedure to correct for any potential sample selection bias (Heckman, 1979). As the first step, we use a probit model to estimate the probability of ownership data being recorded. As regressors 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 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, we generate an inverse Mills ratio for each firm $i$ in time period $t$, denoted $\lambda_{it}$. By including this variable as a regressor in the estimation of corporate environmental performance, we control for any potential sample selection bias.

To estimate the effects of ownership structures on environmental performance, we include a regressor for each ownership type, with dispersed investors as the omitted category, and denote this group of ownership variables $W_{it}$. In addition, we include the ownership share held by the single largest shareholder, denoted $C_{it}$, as a measure of concentration. Given this notation, we formulate the following two baseline econometric models.

$$
\begin{align*}
  p_{it} &= \alpha a_{it} + \gamma y_{it} + \beta \pi_{i,t-1} + \omega W_{it} + \rho C_{it} + \Psi T_{it} + \xi X_{it} + \mu \lambda_{it} + e_{it}, \\
  (p/y)_{it} &= \delta a_{it} + \eta y_{it} + \theta \pi_{i,t-1} + \sigma W_{it} + \varphi C_{it} + \kappa T_{it} + \beta X_{it} + \tau \lambda_{it} + u_{it},
\end{align*}
$$

where $e_{it}$ and $u_{it}$ denote the respective error terms.

In each specification, the error term is likely to be heteroskedastic. Hence, we assume that the heteroskedasticity depends only on fixed assets so that $\sigma_{it} = \sigma \cdot a_{it}$, where $\sigma_{it}$ represents

pared to the considerable increase in complexity and potential bias associated with econometric methods incorporating the lagged dependent variable as a regressor, as Anderson and Hsiao (1982), Arellano and Bond (1991), Bun and Kiviet (1999), and Harris and Matyas (2000) discuss. Therefore, we do not include the lagged dependent variable as a regressor.

Unfortunately, this approach may be subject to selection bias because caused the state may privatize only better firms, as Frydman et al. (1999) and Gupta et al. (2000) argue. Such a selection process would mostly depend on financial characteristics, but environmental characteristics may play a role. This selection bias would exaggerate the positive effect of privatization in that environmentally cleaner facilities would be privatized. In the Czech Republic, investors’ concerns focus on the legal responsibility to remediate or clean up on-site contamination caused by previous wastewater discharges and hazardous waste disposal, as Earnhart (2004) documents. By 1993, these concerns were addressed by a government policy to relieve investors of practically all past legal responsibilities. Current, on-going air emissions are likely to be less important, but investors are most likely to focus on absolute emissions not relative emissions if they have such concerns. Hence, using relative emissions avoids the selection bias. In addition, the fixed-effects estimator should control for any non-random selection with respect to privatization, as Frydman et al. (1999) discuss.

The complete estimation results are available upon request.

We assume that ownership structure is exogenous to environmental performance.
the standard error associated with the residual term $e_{it}$ or $u_{it}$. To increase the efficiency of the estimates when correcting for heteroskedasticity, we multiply Eqs. (1) and (2) by the inverse of fixed assets, i.e., $1/a_{it}$, as suggested by Greene (1997). We do not apply this scaling to the ownership regressors because they are scaled by the book value of the firm. In addition, this scaling is not applied to year and sectoral indicators, which serve only as intercept shift factors. The scaled equations are:

$$
(p/a)_{it} = \alpha + \gamma (y/a)_{it} + \beta (\pi_{i,t-1}/a_{it}) + \omega W_{it} + \rho C_{it} + \Psi T_{it} + \zeta X_{it} + \mu \lambda_{it} + \varepsilon_{it},
$$

(3)

$$
[(p/y)/a]_{it} = \delta + \eta (y/a)_{it} + \theta (\pi_{i,t-1}/a_{it}) + \sigma W_{it} + \varphi C_{it} + \kappa T_{it} + \beta X_{it} + \tau \lambda_{it} + \psi_{it},
$$

(4)

where $\varepsilon_{it}$ and $\psi_{it}$ are the corrected error terms. Even though this correction for heteroskedasticity causes the Lagrange multiplier (LM) heteroskedasticity test statistic to decrease dramatically for each specification, tests indicate the continuing presence of heteroskedasticity. Hence, we apply a White correction procedure and report heteroskedastic-consistent standard errors.

To control for firm-specific effects, we estimate Eqs. (3) and (4) using standard panel methods, namely, pooled ordinary least squares (OLS), between-group estimation, a fixed-effects method, and a random-effects method. If the $F$-test indicates significant firm-specific effects, the fixed-effects estimator dominates the pooled OLS one. Because we find this to be true in all cases, we do not report the pooled-OLS estimates. We use the Hausman test to evaluate whether the random-effects estimates are consistent. If so, the random-effects estimator is preferable to the fixed-effects estimator. If not, the fixed-effects estimator is preferable since it is consistent. We report the between-group estimator only to contrast across-firm effects with the within-firm effects generated by the fixed-effects estimator.

Table 2 presents the estimation results using absolute emissions as the dependent variable and Table 3 reports the results using relative emissions as the dependent variable. Based on the Hausman test for random effects, the fixed-effects estimator dominates the random-effects estimator in Table 2, but the random-effects estimator dominates the fixed-effects estimator in Table 3. In addition, the significant coefficient associated with the inverse Mills ratio indicates that the Heckman two-step method is needed to correct for selection bias in both specifications. Moreover, higher production increases absolute and relative emissions significantly, which implies that the average firm faces diseconomies to scale in pollution control. Finally, for both specifications, lagged financial performance is negative significantly, indicating that stronger financial performance leads to better future environmental performance, i.e., lower emissions.

20 The specification of the functional form for heteroskedasticity in Park (1966) and $J$-tests for non-nested models in Davidson and MacKinnon (1981) indicate that heteroskedasticity depends on fixed assets and does not depend on production. Test results from a nested specification that generalizes Park’s model to two potential sources of heteroskedasticity reject the notion that heteroskedasticity depends on production and fixed assets in favor of a simplified model that includes only fixed assets. Our analysis uses residuals drawn from both a fixed-effects estimator and a random-effects estimator. Full details are available upon request.

21 Ownership shares are ratios of the book value of shares owned by a particular owner to the book value of all shares. Ownership concentration is a ratio involving the book value of shares owned by a specific investor.

22 In Eq. (3), emissions are expressed as kilograms per 1000 CZK of production. In Eq. (4), emissions are expressed as milligrams per 1,000,000 CZK of production, i.e., mg/(1000 CZK)^2.

23 The between-group estimator calculates the mean value of the dependent and independent variables for each firm and takes these mean values for the estimation. In the fixed-effects estimation, the intercept terms are specific to each firm $i$, i.e., $\alpha_i$ and $\delta_i$. 
Since we control for ownership structure, the effect of financial performance captures variation in profitability that is orthogonal to variation in ownership structure. This result suggests that the generation of internal financial resources in the face of a liquidity constraint allows firms to control their emissions better, which is consistent with hypothesis (H3). This conclusion is robust to an increase in sample size by including observations that lack only ownership information. Regardless of sample size, lagged financial performance has a positive effect on current environmental performance.

The effect of financial performance on emissions may differ across firms and within a particular firm. The financial performance coefficient based on the between-group estimator captures
the effect of financial performance across firms since this estimator includes only cross-sectional variation. In contrast, the financial performance coefficient based on the fixed-effects estimator captures the effect of financial performance within a firm since this estimator includes only time variation. By comparing the estimated significance of these two financial performance coefficients, we conclude that the effect of financial performance across firms is relatively more important than the effect of financial performance within a firm. The financial performance coefficient in the between-group estimation is statistically significant at better than 1% for both specifications, while the same coefficient in the fixed-effects estimation is statistically significant only at the 10 and 5% levels in Tables 2 and 3, respectively. In addition, the financial coefficient is larger in absolute terms in the between-group estimation for both specifications. Even though

---

Table 3
Environmental performance: relative emissions

<table>
<thead>
<tr>
<th></th>
<th>Between group</th>
<th>Fixed effects</th>
<th>Random effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production / Assets</td>
<td>2.0123**</td>
<td>0.9762**</td>
<td>1.3288**</td>
</tr>
<tr>
<td></td>
<td>(0.3528)</td>
<td>(0.3999)</td>
<td>(0.1416)</td>
</tr>
<tr>
<td>Lagged profits / Assets</td>
<td>−50.5278***</td>
<td>−3.3384**</td>
<td>−4.5155***</td>
</tr>
<tr>
<td></td>
<td>(6.4676)</td>
<td>(1.6365)</td>
<td>(0.6931)</td>
</tr>
<tr>
<td>State ownership (%)</td>
<td>−0.0691</td>
<td>−0.0138</td>
<td>−0.0185</td>
</tr>
<tr>
<td></td>
<td>(0.1225)</td>
<td>(0.0115)</td>
<td>(0.0181)</td>
</tr>
<tr>
<td>Investment fund ownership (%)</td>
<td>−0.0909</td>
<td>−0.0025</td>
<td>−0.0050</td>
</tr>
<tr>
<td></td>
<td>(0.1015)</td>
<td>(0.0102)</td>
<td>(0.0134)</td>
</tr>
<tr>
<td>Bank ownership (%)</td>
<td>0.0526</td>
<td>−0.0221</td>
<td>−0.0294</td>
</tr>
<tr>
<td></td>
<td>(0.2902)</td>
<td>(0.0140)</td>
<td>(0.0277)</td>
</tr>
<tr>
<td>Portfolio company owner (%)</td>
<td>0.2544</td>
<td>−0.0055</td>
<td>0.0027</td>
</tr>
<tr>
<td></td>
<td>(0.1813)</td>
<td>(0.0148)</td>
<td>(0.0215)</td>
</tr>
<tr>
<td>Citizen ownership (%)</td>
<td>0.1426</td>
<td>−0.0113</td>
<td>−0.0005</td>
</tr>
<tr>
<td></td>
<td>(0.1091)</td>
<td>(0.0135)</td>
<td>(0.0180)</td>
</tr>
<tr>
<td>Strategic investor ownership (%)</td>
<td>−0.0988</td>
<td>−0.0003</td>
<td>−0.0035</td>
</tr>
<tr>
<td></td>
<td>(0.1012)</td>
<td>(0.0118)</td>
<td>(0.0134)</td>
</tr>
<tr>
<td>Foreign investor ownership (%)</td>
<td>−0.0074</td>
<td>−0.0017</td>
<td>−0.0022</td>
</tr>
<tr>
<td></td>
<td>(0.1158)</td>
<td>(0.0136)</td>
<td>(0.0175)</td>
</tr>
<tr>
<td>Concentration: largest shareholder</td>
<td>0.0961</td>
<td>−0.0021</td>
<td>0.0002</td>
</tr>
<tr>
<td></td>
<td>(0.0975)</td>
<td>(0.0124)</td>
<td>(0.0139)</td>
</tr>
<tr>
<td>Inverse Mills ratio</td>
<td>12.7144***</td>
<td>8.3311***</td>
<td>12.1006***</td>
</tr>
<tr>
<td></td>
<td>(4.5834)</td>
<td>(4.1570)</td>
<td>(1.237)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.229</td>
<td>0.973</td>
<td>0.112</td>
</tr>
<tr>
<td>LM heteroskedasticity test</td>
<td>89.607</td>
<td>0.202</td>
<td>7.282</td>
</tr>
<tr>
<td>[significance level]</td>
<td>[0.000]</td>
<td>[0.964]</td>
<td>[0.007]</td>
</tr>
<tr>
<td>Joint test of ownership significance $X^2$ (7)</td>
<td>2.424</td>
<td>2.311</td>
<td>2.552</td>
</tr>
<tr>
<td>[significance level]</td>
<td>[0.932]</td>
<td>[0.940]</td>
<td>[0.923]</td>
</tr>
</tbody>
</table>

Notes. (1) The standard errors are in parentheses; the $p$-values are in square brackets. (2) Each regression also includes an intercept term, year indicators, and sectoral indicators, with the exception of the fixed-effects regression, which includes firm-specific intercepts rather than sectoral indicators.

** Statistical significance at the 5%.
*** Idem, 1%.
the between-firm effects are larger, we focus on the within-firm effects from the fixed-effects estimation to assess a particular firm’s sensitivity to changes in the availability of internal financial resources.

Although these estimation results establish a link between profits and emissions, they do not address indicate the direction of causality. To address this issue, we use Granger-causality tests based on the estimation of the following two equations:

\[
\pi_t = \alpha_0 + \sum_{i=1}^{k_1} \alpha_i \pi_{t-i} + \sum_{i=1}^{k_2} \beta_i p_{t-i} + \varepsilon_t, \quad \text{and} \quad (5)
\]

\[
p_t = \gamma_0 + \sum_{i=1}^{k_3} \gamma_i \pi_{t-i} + \sum_{i=1}^{k_4} \delta_i p_{t-i} + \nu_t, \quad (6)
\]

where \( t \) and \( t - i \) denote the current and lagged values of \( \pi \) and \( p \). Due to the limited time span, we use lags of only one or two periods, i.e., \( k_1 = k_2 = k_3 = k_4 = \{1, 2\} \), so that we do not use the information criterion to search for values of \( k_i \).

If the estimates of \( \beta_i \) are jointly insignificant, emissions do not Granger-cause profits; if the estimates of \( \gamma_i \) are jointly insignificant, profits do not Granger-cause emissions. Based on this criterion, we find that emissions never Granger-cause profits. However, profits may Granger-cause emissions. When the estimation includes two lagged periods of profits and one lagged period of emissions, i.e., \( k_3 = 2 \) and \( k_4 = 1 \), the \( p \)-value is 0.085. For two other combinations of lagged values, the \( p \)-value is below 0.20. Hence, we find no evidence of a causal link from emissions to profits but some indication that profits Granger-cause emissions.

Regarding ownership effects, the results in both Tables 2 and 3 indicate that non-dispersed private investors do not affect environmental performance in a statistically significantly different way than do dispersed private investors. Although individual private ownership effects are statistically significant at better than 5% for the random-effects estimation using absolute emissions, the Hausman tests rejects the consistency of the random-effects estimator. Moreover, taken as a group, the types of private ownership do not have a statistically significant impact. The log-likelihood ratio test statistic equals 8.97 and 2.55 for absolute and relative emissions, respectively, based on the appropriate estimation in each case. These values are not statistically significant having \( p \)-values of 0.255 and 0.923, respectively. Hence, we conclude that non-dispersed private investors do not affect environmental performance differently from dispersed private investors.

To assess the robustness of these findings, we define a new joint category of financial institutions consisting of portfolio companies, investment funds, and banks. Taking this joint category, we find that financial institution ownership does not significantly affect environmental performance, relative to dispersed ownership. In addition, we include domestic non-dispersed private investors in the omitted category so that state ownership and foreign ownership remain as the

---

24 The presence of lagged values of the dependent variable on the right-hand side of Eqs. (5) and (6) in a dynamic panel data framework may lead to inconsistent parameter estimates unless the time dimension of the panel is very large, as Nerlove (1967), Nickell (1981), and Keane and Runkle (1992) discuss. However, simulation results in Judson and Owen (1999) show that these biases are concentrated almost entirely in the coefficient on the lagged dependent variables, while biases in the coefficients of the independent variables are relatively small. Thus, we ignore such possible biases. Moreover, Anderson and Hsiao (1981) and Kiviet (1995) show that any method for correcting these biases results in a significant loss of efficiency, which reduces our ability to assess the causal relationships. Furthermore, any corrections would be complicated greatly by the unbalanced nature of our panel.

25 The results of the full Granger-causality test are available upon request.
only two individual ownership regressors. Using the combined classification of domestic private ownership, we find that foreign ownership has no statistically significantly differential effect on environmental performance. From Table 2, state ownership lowers absolute emissions significantly relative to dispersed private investors based on the fixed-effects estimation. Hence, we test for differences between the various non-dispersed private ownership categories and state ownership and find two significant differences, namely, state vs. investment funds with a \( p \)-value of 0.012, and state vs. strategic investors with a \( p \)-value of 0.059. Hence, we conclude that state ownership lowers emissions more than does ownership by an investment fund or a strategic investor. These results are consistent with hypothesis \((H1a)\), namely certain private investors may reduce costs by allowing emissions to increase. However, they reject hypothesis \((H1b)\), namely private investors reduce costs by lowering emissions.

When we compare two types of concentrated ownership, namely strategic investors and foreign investors, separately to the diffuse forms of investment funds, individual citizens, and banks, we find no significant differences regardless of the specification used. Hence, we conclude that the effects of private ownership do not differ across types. However, as Table 2 reports, greater ownership concentration measured by the single largest shareholder leads to better environmental performance with respect to absolute emissions in the preferred fixed-effects estimation. This result suggests that taking the single largest shareholder, rather than individual categories, may provide a better measure of ownership control. Hence, the result is consistent with the hypothesis that a manager’s improved ability to control costs is more important than an owner’s improved ability to control costs, as specified in hypothesis \((H2b)\), conditional on the premise that private ownership raises emissions. Condition (ii) of hypothesis \((H2b)\) is supported by the evidence that private ownership in the form of dispersed investors, investment firms, and strategic investors increases emissions relative to state ownership.

To contrast more sharply state ownership from private ownership, we eliminate the regressors for non-dispersed private investors because this group had no statistically discernible effect on environmental performance. The resulting estimation results are shown in Table 4 for absolute emissions and relative emissions. Based on the Hausman test, the random-effects estimator dominates the fixed-effects estimator in both cases, although the test statistic is close to the 10% critical value for absolute emissions. Since the fixed-effects estimator dominates the random-effects estimator in the previous regressions for absolute emissions, we consider both sets of estimates for absolute emissions. Based on the fixed-effects estimates, greater state ownership leads to a reduction in emissions in both specifications. These results confirm our conclusion that private ownership reduces costs by letting emissions rise, which is consistent with hypothesis \((H1a)\), for relative emissions as well as absolute emissions. However, the random-effects estimates indicate no difference between state and private ownership so that this conclusion rests on the estimation procedure chosen. Since the Hausman test almost rejects the consistency of the random-effects estimates for absolute emissions, the significantly negative effect of state ownership in the fixed-effects estimation leads us to conclude that private ownership increases absolute emissions relative to state ownership.

5. Conclusion

Our analysis of Czech firms from 1993 to 1998 provides evidence that successful financial performance improves future environmental performance, which is consistent with the hypothesis that a liquidity constraint may be limiting investment in activities that directly or indirectly lower emissions. Moreover, we conclude that increased state ownership actually improves en-
Table 4
State vs. private ownership

<table>
<thead>
<tr>
<th></th>
<th>Absolute emissions</th>
<th></th>
<th>Relative emissions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed effects</td>
<td>Random effects</td>
<td>Fixed effects</td>
<td>Random effects</td>
</tr>
<tr>
<td>Production / Assets</td>
<td>0.494***</td>
<td>0.308***</td>
<td>0.963**</td>
<td>1.328***</td>
</tr>
<tr>
<td></td>
<td>(0.154)</td>
<td>(0.015)</td>
<td>(0.395)</td>
<td>(0.140)</td>
</tr>
<tr>
<td>Lagged profits / Assets</td>
<td>−0.701*</td>
<td>−1.016***</td>
<td>−3.33**</td>
<td>−4.49***</td>
</tr>
<tr>
<td></td>
<td>(0.425)</td>
<td>(0.148)</td>
<td>(1.63)</td>
<td>(0.689)</td>
</tr>
<tr>
<td>State ownership (%)</td>
<td>−0.0048**</td>
<td>−0.0018</td>
<td>−0.0210*</td>
<td>−0.0145</td>
</tr>
<tr>
<td></td>
<td>(0.0020)</td>
<td>(0.0027)</td>
<td>(0.0062)</td>
<td>(0.0139)</td>
</tr>
<tr>
<td>Concentration:</td>
<td>−0.0045*</td>
<td>−0.0012</td>
<td>−0.0013</td>
<td>−0.0014</td>
</tr>
<tr>
<td>largest shareholder</td>
<td>(0.0025)</td>
<td>(0.0019)</td>
<td>(0.0066)</td>
<td>(0.0101)</td>
</tr>
<tr>
<td>Inverse Mills ratio</td>
<td>1.108**</td>
<td>0.731***</td>
<td>8.25**</td>
<td>11.98***</td>
</tr>
<tr>
<td></td>
<td>(0.444)</td>
<td>(0.162)</td>
<td>(4.09)</td>
<td>(1.22)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.786</td>
<td>0.48</td>
<td>0.974</td>
<td>0.116</td>
</tr>
<tr>
<td>LM heteroskedasticity test</td>
<td>73.98</td>
<td>7.830</td>
<td>0.002</td>
<td>7.07</td>
</tr>
<tr>
<td>[significance level]</td>
<td>[0.000]</td>
<td>[0.005]</td>
<td>[0.964]</td>
<td>[0.008]</td>
</tr>
<tr>
<td>$F$-test of individual effects</td>
<td>6.52</td>
<td>78.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[significance level]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hausman fixed vs. random</td>
<td>10.18</td>
<td>1.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[significance level]</td>
<td>[0.117]</td>
<td>[0.888]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of firms / No. of observations</td>
<td>463 / 1127</td>
<td>463 / 1127</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. (1) The standard errors are in parentheses; the $p$-values are in square brackets. (2) Each regression also includes an intercept term, year indicators, and sectoral indicators, with the exception of the fixed-effects regression, which includes firm-specific intercepts rather than sectoral indicators.

* Statistical significance at the 10%.
** Idem, 5%.
*** Idem, 1%.

Environmental performance relative to all other ownership types, even though the state is more likely to have retained ownership in high-polluting industries. During the Czech privatization of the early nineties, the state retained a significant portion of assets in strategic firms, which include many large state-owned enterprises in heavy industry. According to World Bank (1992), heavy industry emits above average pollution. Finally, we conclude that more concentrated ownership, as measured by the single largest shareholder, improves environmental performance, in the Czech Republic. Our results highlight the importance of using multiple measures of environmental performance because the last effect is found for absolute emissions but not relative emissions.

Given that Czech environmental protection agencies are seeking to reduce air pollutant emissions, our results have policy implications. First, since liquidity constraints limit investment in pollution reduction, subsidizing investments in these technologies is beneficial. Second, since state ownership lowers air pollutant emissions relative to private ownership, air protection policies designed to induce better environmental performance should consider each firm’s ownership type. Such policies include providing firms with technical assistance, monitoring firms for poor environmental performance, and prodding firms toward better environmental performance by enforcement actions. If privately-owned firms lack the motivation to improve their environmental record, regulators should focus on monitoring and stronger enforcement practices. If state firms are sufficiently motivated to reduce emissions, technical assistance is the appropriate policy. Third, given that the connection between greater ownership concentration and better environment-
tal performance is driven by a firm’s ability to manage its operation, environmental protection agencies may wish to provide more technical assistance to firms with more diffuse ownership and monitor more closely and enforce more stringent policies against firms with more concentrated ownership. Although the last policy prescription may seem counter-intuitive, attempting to prod diffusely owned firms lacking the means to improve environmental performance is fruitless but regulating firms with concentrated ownership that possess these means more stringently is useful.

References


