Comparative Economic Studies, 2006, 48, (619–640)

www.palgrave-journals.com/ces

Explaining Environmental Management in Central and Eastern Europe

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The paper analyses the adoption of various environmental management systems (EMSs) by industrial firms in Central and Eastern Europe approximately 8 years after economic transitions began. Of special interest are the effects of privatisation, export orientation, public pressure and environmental regulation on adoption. Using logit regression models, it is found that several transition and environmental regulatory factors spur EMS adoption. Better environmental regulatory systems and anticipation of more stringent future regulation appear to encourage EMS. Public information regarding firms' pollution emissions, foreign direct investment and export dependency also appear to be important, but there is no evidence that firm ownership is related to EMS adoption.
Comparative Economic Studies (2006) **48,** 619–640. doi:10.1057/palgrave.ces.8100184

Keywords: environmental management, central and Eastern Europe, economic transition

JEL Classifications: p26, Q58, Q55

INTRODUCTION

Late in the 20th century, a historic series of events caused the downfall of the economic system of planning that characterised the Soviet Union and Central and Eastern Europe (CEE) for as much as 70 years. We examine the environmental behaviour of industrial firms approximately 8 years after this collapse. The main aim of the paper is to understand the economic and social transition factors that spurred environmental management systems (EMSs) that are believed to have contributed to the generally positive environmental

changes that have been observed in the region. Because the transitions in CEE countries have been so large and dramatic, understanding what factors spur adoption of EMSs could yield important lessons for other countries, many of which are undergoing some degree of transition away from reliance on governments to allocate economic resources.

Bulgaria, Hungary, Lithuania, Poland, Romania and Slovakia are examined in this paper. In all these countries, the transitions began during 1989–1991 and in 1998, which is when our data were collected, all were associate members of the European Union (EU). Hungary, Lithuania, Poland and Slovakia were admitted to the EU in 2004 and the remaining two countries are associate members. We particularly look at the effects of privatisation, export orientation, public pressure and environmental regulation on environmental behaviour in industrial firms that are likely to have serious pollution problems. EAP Task Force (1998) notes that nonferrous metallurgy, iron and steel, pulp and paper and chemicals may have particularly dramatic effects on human health. We focus on enterprises in these sectors, as well as energy and mining firms.

The following section reviews the relevant literature on the relationship between the transitions to market economies and environmental outcomes. The section also reviews the literature on adoption of EMSs. The further section discusses the data and empirical approach. The penultimate section presents the results and the last section concludes.

ENVIRONMENT, TRANSITION AND ADOPTION OF EMSs

Some proponents of the planned economic systems in CEE countries believed there would be less pollution in economies not driven by the profit motive, because planners would (or at least could) take into account all costs and benefits. In fact, the opposite appears to have been a closer description, because prior to the economic transitions, CEE countries were known for severe pollution (Åhlander, 1994; Environment for Europe, 1994; Hughes, 1991; Wilczynski, 1990; Carter and Turnock, 1993; Chandler, 2000, p. 23).

Under central planning, the well-known bias towards heavy industry combined with a lack of incentives to economise on inputs created considerable waste and pollution (Hughes, 1991; Chandler, 2000, p.139; Carter and Turnock, 1993, p.4). As a consequence, CEE countries emitted much more pollution per unit of GDP and per person than OECD countries. The planned economies in Europe, for example, averaged 13 times more particulates per capita than the EU and three times more wastewater

emissions in 1980. SO_2 emissions per capita were on average twice that of the EU (EAP Task Force, 1998; Wilczynski, 1990).

The economic transitions in CEE countries greatly reduced stationary source air and water pollution. For example, in the Slovak Republic emissions of particulate matter (an important air pollutant) by stationary sources declined 80% during the 8 years between 1990 and 1997. SO_2 emissions fell by over 60% and NO_x declined 45% during 1990–1997 (Ministry of Environment of the Slovak Republic, 1998). The story is the same for water pollution. In Lithuania, for example, industrial emissions of chrome and copper declined by 65%–70% during 1989–1994 alone. Biological oxygen demand in surface waters fell by about 90% during the 1990s (Ministry of Environment of Lithuania, 2001).

Hypotheses abound regarding the causes of these improvements, but little empirical work – particularly at the firm level – has been done to identify the most important factors. Perhaps, the most often noted change that is believed to have contributed to improved environmental quality is the large decline in industrial output (Hughes and Lovei, 1999). This explanation alone is probably insufficient since there are many other factors that may have contributed to improved performance. For example, improved environmental performance is likely to be related to adoption and implementation of EMSs, which may be spurred by a variety of transition factors, and could include development of environmental plans, establishment of environmental departments, adoption of environmental audit, waste minimisation and pollution prevention programmes and more frequent monitoring of air and water pollution emissions. Anton, Deltas and Khanna (2004), for example, find that firms with more comprehensive EMSs had lower toxic releases per unit of sales. Newbold (2006) finds that adoption of EMSs in the Chilean mining sector improves firms' environmental performance. Nash and Ehrenfeld (2001) note several examples where adoption of EMSs likely improved environmental performance in US firms. King and Lenox (2001) find that firms with ISO 9001 certification had better environmental performance than other firms.

The use of EMSs is widespread and they have been adopted for a variety of reasons. McKinsey and Company (1991) find that 79% of respondents to a survey of 400 senior managers of international firms reported they utilised such methods. Some of these programmes are very formal and follow rules specified by outside organisations. One example is the set of measures required for International Standards Organisation 14000 series certification. ISO 14001 focuses primarily on environmental practices and includes the elements of environmental planning, monitoring and assessment. In addition to being potentially useful tools for management, ISO 14001 certification can

send consumers important signals about firm-level production processes and therefore offer real public relations value (Boiral and Sala, 1998; Clapp, 2001). Bellesi *et al*. (2005), for example, find that EU importers put great weight on ISO 14001 certification in choosing export partners. King and Lenox (2001) suggest that cost savings are also important, because of their finding that US firms with ISO 140001 certification tended to also have ISO 9001 certification, which deals with product quality.

A number of authors have analysed the adoption of EMSs outside the ISO context. Henriques and Sadorsky (1996) find the factors behind the existence of environmental plans in Canadian firms are type of sector, ownership structure and the existence of outside pressure from consumers, investors, community or government. These findings are consistent with those of Benito and Benito (2005), who see demand-side benefits as key drivers of better environmental behaviour. They also note that firms use EMSs for more effective regulatory compliance and cost savings. Khanna and Anton (2002) find that fear of liabilities, public pressure and threats of high-cost regulation cause firms to adopt EMSs. They also note that solid regulatory regimens underlie incentives. Anton *et al*. (2004) find that market pressures from consumers, investors and competitors prompt adoption.

Several papers also find that public disclosure of information on firm pollution can stimulate better environmental outcomes and behaviour, potentially including adoption of EMSs (Sterner, 2003). Konar and Cohen (1997) find that firms with adverse disclosures publicised in the USEPA Toxics Release Inventory had bigger declines in toxic emissions than other firms. In an evaluation of the USEPA 33/50 Program, Arora and Cason (1996) found that competitiveness was likely an important motivator for participation and reductions achieved did not substitute for other measures. Wang (2000) shows, in an econometric study, that both formal regulation and community pressure lead to water pollution reduction in China.

There are, however, so many more changes occurring in CEE countries than is typically captured in the study settings analysed. This changing environment offers the opportunity to look at the fundamental drivers of EMS adoption. For example, in CEE countries, the creation of functioning markets, facilitated by privatisation, dramatically increased competitive pressures and incentives for efficiency. Brown *et al*. (2006) find, for example, that privatisation of manufacturing firms is associated with 15%–50% increases in productivity in Romania and 8%–28% in Hungary.

Another outcome of the transition was the development of international commercial contacts, such as foreign direct investment (FDI) and trade with high-income market economies. CEE countries experienced significant FDI during the transition, with an estimated $70 billion flowing into the region in

the 1990s. Hungary, for example, received over $16 billion in foreign investment during the decade, with annual investment averaging 4%–5% of GDP. FDI could have important environmental implications. As noted by Klavens and Zamparutti (1995) and Environment for Europe (1994), in a survey of 1,000 potential foreign corporate investors, over three-quarters said they utilised corporate or headquarter country environmental management standards when they were stricter than those in their countries of investment. FDI could therefore bring with it EMSs. Relatively little literature exists on the relationship between country of ownership and environmental behaviour. Collins and Harris (2002) analyse a sample of UK metal manufacturing plants and find that foreign-owned plants were more likely to invest in pollution abatement and invested more than plants that were purely domestic.

CEE firms also dramatically increased their foreign trade. Growth in total export earnings averaged almost 9% during 1993–98, with the share of exports to the West increasing to 67% by 1999. These results suggest that CEE countries were increasingly looking outward and westward for markets (World Bank, 2000). Increased trade with western countries could also spur adoption of EMSs. Quality standards are often higher in western markets and those standards can typically only be met using improved technologies mediated by EMSs (Andonova, 2003). Consumers in Western Europe and other high-income countries often prefer products manufactured using environmentally benign methods, but have little direct information on these processes. Firms with higher foreign trade shares may therefore adopt EMSs to signal that green production methods were used (Bellesi *et al.*, 2005).

The creation of civil societies and increased environmental information may also have important, positive effects on adoption of EMSs. We know from the literature on voluntary environmental agreements and environmental information that increasing the availability of public information on the environmental performance of firms can affect firms' behaviour. This literature is especially relevant for CEE countries, because prior to 1989, there was very little public information available about firms' pollution. Environmental impact assessment results are now generally public and most countries enforce the public's right to know about activities that damage the environment. Prior to the transition, there were also very few non-governmental environmental advocacy groups to help translate public information into community pressure. By 1997, however, the Regional Environment Center headquartered in Budapest had identified 3,000 environmental NGOs working for improved environmental quality in the CEE region.

Improved civil society is complemented by improved environmental policies. Ministries of environment were established during the first half of

the 1990s where they did not previously exist, environmental inspectorates were strengthened and the generally adversarial relationships between regulator and regulated that are familiar in the West were established in most countries. Ambient and emissions monitoring systems were also put in place or strengthened. Pollution charge systems were also improved, offering incentives for better performance (Bluffstone and Larson, 1997).

EMPIRICAL APPROACH AND DATA

In 1998, the Harvard Institute for International Development at Harvard University conducted a survey of 2,393 firms in Bulgaria (404 firms), Hungary (379 firms), Lithuania (366 firms), Poland (536 firms), Romania (654 firms) and Slovakia (54 firms), which provide the data used in this paper. These countries represent a wide variety of cultures and transition experiences, with Hungary and Poland considered the most advanced in terms of private sector development, followed by Lithuania and Slovakia and then Romania and Bulgaria.

The data were gathered by professional research firms or institutes that either had substantial experience in environmental economics research or specialised in survey implementation. The sample was stratified to include only firms operating in industries that are generally highly polluting and therefore are likely to face environmental management challenges. The four sectors examined in the present study are animal raising, mining, electric power and manufacturing. A list of industry sectors is provided in Table 1. The survey responses included data focusing on general firm characteristics, environmental management, environmental expenditures, environmental performance, regulatory enforcement, public awareness and community pressure. We examine the firm-level environmental management measures listed below, all of which were reported in 1998:

- Adoption of environmental audit, waste minimisation and pollution prevention programmes, which are programmes in which firms examine their production operations to reduce waste and pollution;
- establishment of environmental departments in firms;
- development of environmental plans by firms to improve environmental performance;
- ISO 14001 certification being sought or achieved;
- use of on-site wastewater treatment plants;
- existence of internal water and air pollution monitoring systems.

As shown in Table 2, over 40% of the firms reported internal environmental audit, waste minimisation or pollution prevention (AWM&PP) programmes.

Table 1: Sample size at NASIC three-digit level

Industry	Number of firms
Animal raising	56
Other agriculture	81
Oil and gas extraction	22
Mining	77
Electric power generation	84
Other utilities	1
Food manufacturing	264
Beverage and tobacco production	85
Textile mills	83
Textile product manufacturing	34
Apparel manufacturing	199
Leather goods production	102
Wood products	49
Paper manufacturing	48
Printing	17
Petroleum products	24
Chemical manufacturing	211
Plastics and rubber manufacturing	73
Nonmetallic mineral products	156
Primary metal manufacturing	80
Metal fabrication	113
Machinery manufacturing	192
Computer and electronic manufacturing	40
Electrical equipment and appliance production	85
Transportation equipment manufacturing	106
Furniture and related products	40
Miscellaneous manufacturing	62
Industry not reported	9
Total	2,393

Table 2: Summary of EMS adoption by sample firms

Country	Percent of firms adopting				
	AWM&PPP (%)	Environmental departments (%)	Environmental plans (%)	ISO 14001 certification (%)	On-site waste-water treatment (%)
Bulgaria	51.2	61.3	39.1	18.1	52.0
Hungary	42.7	16.9	36.2	16.0	19.1
Lithuania	65.0	17.4	31.9	18.0	34.5
Poland	63.2	30.0	50	15.2	29.4
Romania	75.4	82	48.5	49.5	30.1
Slovakia	52.8	30.2	38.5	35.2	32.0
Full sample	61.1	45.3	42.5	26.0	33

Table 3: Frequency of pollution monitoring by firms in 1998

Frequency	Water pollution (n=2328)		Air pollution (n=2312)	
	Number of firms	% of firms	Number of firms	% of firms
No monitoring	821	35.7	1010	43.7
Annually	250	10.7	742	32.1
Quarterly	212	9.1	184	8.0
Monthly	420	18.0	189	8.2
Weekly	259	11.1	51	2.2
Daily	203	8.7	60	2.6
More frequently than daily	163	7.0	76	3.3

Existence of environmental departments varied across countries, with only 17% of Hungarian firms having such institutions and 82% of Romanian firms having formal environmental departments. One-third to one-half of firms reported having environmental plans in place. In most countries, 15%–20% of firms reported taking steps toward ISO 14001 series certification, with participation in Romania and Slovakia higher. With the exception of Hungary, at least 30% of firms in each country had on-site wastewater treatment.

Internal emissions monitoring is a key element of any EMS, because it provides the basic information necessary for EMS operation. As shown in Table 3, most firms monitored their water pollution emissions quarterly or annually, but over one-third did not monitor water pollution emissions at all. Air pollution monitoring was even more problematic, with over 40% having no monitoring. In the analysis to follow, we examine the existence rather than frequency of internal monitoring, because so many firms do not monitor at all.

Table 4 lists the independent variables used in regressions and our reasons for including them. Of special interest are those focusing on economic transition, such as output, private sector ownership, FDI, exports, environmental regulatory measures and public information. We now discuss our independent variables in turn, including key descriptive statistics.

Firms with more output are larger and therefore may have more capacity to absorb fixed costs associated with EMSs. We therefore expect more output encourages EMS adoption. We do not have reliable output data for Bulgaria and Lithuania and therefore use 1997 employment as a proxy. For change in output, which takes account of the dynamics that occurred during the transition itself, we proxy with the ratio of 1997–1990 employment. Although the correlation between output and employment is reasonably high ($\rho = 0.48$), we recognise that in the CEE context change in employment is

Table 4: Descriptive statistics for independent variables and reason for including

Independent variable	Mean	Std. Dev.	Expected relationship with EMS and reason for including
Average age of most capital utilised by firm	21.8	15.3	(+/−) Proxy for capital vintage – conditioning variable
Total firm employment in 1997	662.8	1,324	(+) Proxy for firm size – conditioning variable
Ratio 1997 to 1990 firm employment	1.17	2.7	(+) Proxy for output change 1990–1997. Test hypothesis that output declines discourage environmental management
Private foreign ownership share[a]	9.4	25.6	(+) Test hypothesis that FDI encourages adoption of EMS
Government ownership share[a]	32.2	39.5	(−) Test hypothesis that government ownership discourages EMS adoption
% Main product that was exported in 1997	28.0	35.2	(+) Test hypothesis that higher export intensities encourage adoption of EMS
% Total exports that went to EU in 1997	34.3	42.7	(+) Test hypothesis that greater Western European focus encourages environmental management
Average number of wastewater inspections per year by regulators	3.70	3.82	(+) Test hypothesis that more frequent monitoring by regulators encourages EMS adoption
Average number of air pollution inspections per year by regulators	3.65	4.02	(+) Test hypothesis that more frequent monitoring by regulators encourages environmental management
Firm self-reports pollution emissions (dummy)	0.58	0.49	(+) Test whether adopting pollution reporting system used in the West encourages EMS
Inspector visits are announced (dummy)	0.19	0.39	(−) Test hypothesis that more stringent enforcement encourages adoption of EMS
Firm has pollution permits for some or all facilities	0.69	0.46	(+) Test whether existence of permits affects EMS adoption
Public is informed about pollution emissions (dummy)	0.24	0.43	(+) Test hypothesis that public information and pressure encourages adoption of EMS
Importance for motivating improved environmental management in 1997 (Likert scale 0=no effect; 5=max effect)			
Importance of foreign market pressures	2.3	2.0	(+) Test hypothesis that more export focus encourages adoption of EMS
Importance of pressure from suppliers and investors	2.3	1.9	(+) Test whether non-customer pressures are important drivers of EMS use
Importance of expected future regulations	2.7	1.9	(+) Test whether firms are trying to be pro-active when they adopt EMSs
Importance of reducing energy/material use	2.6	1.9	(+) Test whether cost pressures spur EMSs.
Importance of pressure from civic groups	1.7	1.6	(+) Test hypothesis that public information and pressure encourages adoption of EMSs
Importance of public incentives like loans, grants, etc	1.9	1.9	(+) Test whether public subsidies encourage EMS use

[a] Default ownership form is private domestic.

an imperfect proxy for change in output, because changes in employment are likely to also imply changes in efficiency. We therefore cannot draw inferences about the effect of changing output on adoption of EMSs from this variable, but we believe including employment and change in employment adequately conditions for both level and changes in output. Table 5 shows that on average firms in the sample had high levels of employment, but across the board 1990–1997 declines were large.

Most firms in the sample had mixed ownership structures made up of domestic private, government and foreign owners. We include in our regressions percentage of private, foreign and government ownership, with private domestic as the omitted variable. We see in Figure 1 that ownership structures varied somewhat across countries, with an average firm in Hungary largely being owned by private domestic investors with significant foreign participation. In most other countries, foreigners held relatively small shares and in Bulgaria and Romania government ownership was very significant.

To examine the importance of international exposure, we use both objective and subjective variables. Exports are measured as the percentages of firms' main products that were exported in 1997, as well as the portion of total exports that went to the EU. Managers also provided Likert-scale rankings (0–5, with 5 being the highest) for the importance of environmental norms and standards for selling goods in foreign markets as a motivator of improved environmental management. A similar Likert-scale variable focusing on requirements by suppliers and investors is also included. As shown in Table 6, firms in all countries increased their export shares and for countries that had limited shares in 1990, increases were quite dramatic. For example, on average Slovak firms increased their export share over 200% in 8 years. Lithuanian and Romanian firms increased their export shares by over 50%. Further, the composition of export destinations changed during the 1990s, with higher shares going to EU markets.

Table 5: Average firm employment in 1990 and 1997

Country	1990	1997
Bulgaria	1,120	761
Hungary	327	267
Lithuania	703	292
Poland	869	556
Romania	1,830	1,325
Slovakia	1674	612
Full sample	1,070	700

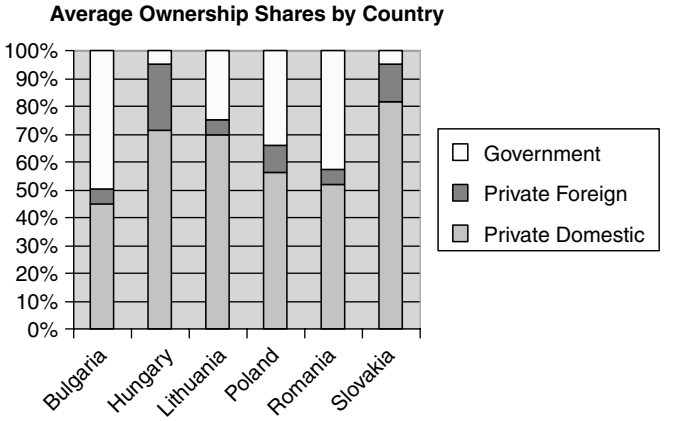

Figure 1: Average ownership shares by country.

Table 6: Average % of firms' main products exported and % of exports destined for the EU

Country	Average % of main product exported		% of exports destined for the EU	
	1990	1997	1990	1997
Bulgaria	18	33	16	30
Hungary	63	64	41	46
Lithuania	15	25	19	24
Poland	16	23	34	38
Romania	7	11	8	10
Slovakia	9	32	26	31
Overall sample	19	28	21	28

As found by Khanna and Anton (2002), more stringent environmental regulation and enforcement may also spur adoption of EMSs, particularly if firms face fines or other penalties for noncompliance. A vector of variables captures various aspects of monitoring and enforcement. The frequency of air and water pollution monitoring by regulatory agencies is the first such variable. We see from Table 7 that on average firms were monitored by regulatory authorities about every 5 months. Poland had essentially annual monitoring of water emissions and semi-annual for air pollution. No Polish firms reported going unchecked, which was not true for Bulgarian, Romanian and Slovak firms. Hungary, Poland and Romania put more emphasis on air pollution, with the other countries focusing on water protection.

Table 7: Monitoring of emissions by various regulatory authorities

Country	Water pollution		Air pollution	
	Average frequency of monitoring for firms that are monitored (months)	% Firms that are not monitored by regulators (%)	Average frequency of monitoring for firms that are monitored (months)	% Firms that are NOT monitored by regulators (%)
Bulgaria	7.49	25.3	9.09	43.9
Hungary	3.04	No data	1.59	No data
Lithuania	3.14	1.1	7.97	2.1
Poland	10.63	0.0	6.27	0.0
Romania	2.69	14.4	2.44	21.2
Slovakia	3.79	54.8	4.39	43.9
Full sample	5.4	21.1	5.16	25.9

Also included in our models is a dummy variable to indicate whether inspectors' visits are announced in advance. If visits are announced, inspectors are less likely to catch ongoing violations, because managers may have time to temporarily remedy problems before inspections take place. In the sample, 18.5% of respondents reported that environmental inspections were generally announced, but the figure varied from 10% or less in Bulgaria and Poland to 45% in Slovakia. Even major firms may not ave formal environmental permits for all or part of their facilities, yet we know permits are critical for environmental monitoring and enforcement. To capture this potentially important aspect of environmental policy, we include a dummy variable for whether some or all facilities have permits.

To be effective, monitoring and enforcement must be realistic. Regulatory capacity in CEE countries is quite limited and therefore self-reporting of emissions (typically enforced with spot checks by inspectors), which is the norm in developed countries, rather than relying wholly on inspections for monitoring, is likely to be most appropriate. In the overall sample, 58.4% of firms self-reported their emissions and the percentage was as high as 75% in Lithuania and as low as 46.3% in Hungary. A dummy variable is used to capture whether firm management self-reported its emissions to regulatory agencies in 1997.

The impacts of public information and open civil societies on firm environmental management are captured by two variables. A dummy variable indicates whether as of 1998 the firm or government agencies informed the public about pollution emissions by firms. In the full sample,

24% of firms say the public is informed about pollution emissions. In Romania, 47% of firms said their emissions were public, but in Hungary and Poland this was true for only 5% and 8% of firms. The second variable is a Likert-scale ranking for the importance of public pressure by environmental organisations and local communities as motivators of improved environmental management. This variable therefore focuses on managers' perceptions of the importance of public pressure. Managers report fairly modest effects on average (1.65 out of possible 5), although much stronger impacts seem to exist in Poland and Romania.

In addition to our policy variables, we include country dummies (Poland is the default) to adjust for country-specific factors not captured by transition variables. We also include dummies for all industries in Table 1, except animal raising, which is incorporated into the constant term. These dummies adjust for industry-specific effects. The variable 'Year in which Most Capital was Built' conditions for the age of equipment and indirectly for capital quality. To capture other motivators of better environmental management that do not fit within these categories, also included in regressions are Likert-scale rankings focusing on manager perceptions of the importance of reducing the cost of energy and material inputs and public subsidies, such as loans, grants and tax exemptions, as motivators for improved environmental performance.

RESULTS

Tables 8–10 present our econometric results from our model of EMS adoption. All dependent variables are binomial and were therefore estimated using logit. All models included the same explanatory variables, including 24 industry dummies. In the interest of brevity and because we do not focus on industry-specific differences in behaviour, industry effects are suppressed in the tables. The full set of parameter results is, however, available from the authors.

We see in Table 8 that the signs of statistically significant variables are in general as expected, with four variables estimated to be positively and significantly correlated with both the existence of audit, waste minimisation and pollution prevention (AWM&PP) programmes and environmental departments. Larger firms (as measured by total employment in 1997) are more likely to have both programmes, as are those that have formal permits and self-report emissions. Firms subject to more frequent air pollution monitoring by regulators were more likely to have AWM&PP programmes. Marginal effects of formal permits and self-reported emissions are very large,

Table 8: Logit models of existence of environmental programmes and facilities

	Internal audit, pollution prevention/waste minimisation programmes		Environmental department	
	Coefficient	Marginal effect	Coefficient	Marginal effect
Constant	−1.715***	−0.3753	−2.771***	−0.6139
Bulgaria dummy	−1.083***	−0.2460	1.6070***	0.3128
Hungary dummy	−0.7695*	−0.1806	0.0166	0.0037
Lithuania dummy	−0.5213	−0.1210	−0.2351	−0.0536
Romania dummy	−0.6685*	−0.1504	2.1243***	0.3966
Slovakia dummy	−1.3822	−0.3322	0.6080	0.1190
Private foreign ownership share	0.0012	0.0003	0.0009	0.0002
Government ownership share	0.0009	0.0002	0.0027	0.0006
Total employment in 1997	0.0004***	0.0001	0.0011***	0.0002
Ratio of employees from 1997 to 1990	0.0185	0.0041	−0.2838**	−0.0629
Year in which most capital was built	0.0028	0.0006	0.0016	0.0004
% Main product that was exported in 1997	−0.0042	−0.0009	0.0020	0.0004
% Total exports that went to EU in 1997	−0.0034	−0.0008	0.0012	0.0003
Average number of wastewater inspections per year by regulators	0.0323	0.0071	0.0333	0.0074
Average number of air quality inspections per year by regulators	0.0382*	0.0084	0.0038	0.0008
Inspector visits are announced	0.2385	0.0508	0.1781	0.0387
Firm self-reports pollution emissions	0.8158***	0.1829	0.4096**	0.0921
Firm has permits for some or all facilities	0.4934**	0.1131	0.4163**	0.0959
Public is informed about firm's pollution	0.6251***	0.1297	0.4971***	0.1059
Importance of foreign market pressures	0.2046***	0.0448	0.1165*	0.0258
Importance of pressure from suppliers and investors	−0.0057	−0.0013	0.0095	0.0021
Importance of expected future regulations	0.0974*	0.0213	0.0200	0.0044
Importance of reducing energy and material use	−0.0802	−0.0175	0.0241	0.0053
Importance of pressure from civic groups	0.0084	0.0019	0.1203*	0.0266
Importance of public incentives like loans, grants, etc	−0.0065	−0.0014	0.0144	0.0032
Number of observations		1055		1065
% Correct predictions		74.88%		78.59%
Pseudo-R^2		0.22		0.31
Mean of dependent variable		0.630		0.59

*, ** and *** indicate significance at least at the 10%, 5% and 1% levels. See Table 4 for variable definitions.
Industry dummy results are suppressed, but available from the authors.

with firms experiencing these policies having 9%–18% higher probabilities of adoption. These effects are 15%–30% of means. Better environmental management may lead regulators to allow a greater degree of self-reporting, but it is also true that with limited regulatory monitoring capability,

Table 9: Logit models of existence of various environmental management tools

	Environmental plan		ISO 14001 certification		Wastewater treatment on-site	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Constant	−1.495***	−0.3712	−3.635***	−0.6411	−2.053***	−0.4725
Bulgaria dummy	−1.373***	−0.3188	0.1195	0.0213	0.6650*	0.1561
Hungary dummy	−0.8353**	−0.1953	0.2851	0.0530	−0.1505	−0.0341
Lithuania dummy	−1.391***	−0.2989	0.0299	0.0053	−0.5253	−0.1127
Romania dummy	−1.136***	−0.2689	1.1323***	0.2168	−0.5892*	−0.1307
Slovakia dummy	−0.6508	−0.1521	1.3857	0.3132	1.4638	0.3489
Private foreign ownership share	0.0070**	0.0018	0.0027	0.0005	0.0088**	0.0020
Government ownership share	0.0037*	0.0009	0.0006	0.0001	0.0035	0.0008
Total employment in 1997	0.0003***	0.0001	0.0002***	0.0000	0.0004***	0.0001
Ratio of employees from 1997 to 1990	−0.0269	−0.0067	−0.0767	−0.0135	−0.240**	−0.0554
Year in which most capital was built	0.0102*	0.0025	0.0039	0.0007	0.0047	0.0011
% Main product that was exported in 1997	0.0070**	0.0017	−0.0037	−0.0007	0.0010	0.0002
% Total exports that went to EU in 1997	−0.0006	−0.0002	−0.0013	−0.0002	−0.0006	−0.0001
Average number of wastewater inspections per year by regulators	0.0226	0.0056	0.0355	0.0063	0.086***	0.0198
Average number of air quality inspections per year by regulators	0.0322	0.0080	0.0037	0.0007	−0.0184	−0.0042
Inspector visits are announced	−0.1354	−0.0335	0.1041	0.0187	0.0470	0.0109
Firm self-reports pollution emissions	0.5904***	0.1444	0.6300***	0.1064	0.7244***	0.1606
Firm has permits for some or all facilities	0.1792	0.0442	0.2607	0.0439	0.3376	0.0750
Public is informed about firm's pollution	0.466***	0.1158	0.483***	0.0895	0.1265	0.0293
Importance of foreign market pressures	−0.0783	−0.0194	0.1006*	0.0177	−0.0075	−0.0017
Importance of pressure from suppliers and investors	−0.0053	−0.0013	0.0250	0.0044	−0.1409**	−0.0324
Importance of expected future regulations	0.1551***	0.0385	0.0302	0.0053	0.0689	0.0158
Importance of reducing energy and material use	0.0689	0.0171	0.1202**	0.0212	0.1247**	0.0287
Importance of pressure from civic groups	−0.0370	−0.0092	0.0849	0.0150	−0.1281**	−0.0295
Importance of public incentives like loans, grants, etc	0.0605	0.0150	−0.1205**	−0.0213	0.0652	0.0150
Number of observations	1059		1049		1023	
% Correct predictions	71.34%		76.36%		73.51%	
Pseudo-R^2	0.191		0.192		0.190	
Mean of dependent variable	0.461		0.286		0.387	

*, ** and *** indicate significance at least at the 10%, 5% and 1% levels. See Table 4 for variable definitions.
Industry dummy results are suppressed, but available from the authors.

Table 10: Logit models of existence of internal air and water pollution monitoring

	Water pollution		Air pollution	
	Coefficient	Marginal effect	Coeffivient	Marginal effect
Constant	−0.7289	−0.0819	−1.0853*	−0.2559
Bulgaria dummy	−2.462***	−0.3734	−2.668***	−0.5828
Hungary dummy	−4.225***	−0.7732	−1.834***	−0.4261
Lithuania dummy	−0.6133	−0.0821	−1.0229**	−0.2499
Romania dummy	−0.6980	−0.0855	−1.0197**	−0.2435
Slovakia dummy	−3.6649**	−0.7233	−0.6361	−0.1566
Private foreign ownership share	0.0046	0.0005	0.0003	0.0001
Government ownership share	−0.0063**	−0.0007	−0.0005	−0.0001
Total employment in 1997	0.0014***	0.0002	0.0002**	0.0001
Ratio of employees from 1997 to 1990	−0.469***	−0.0527	−0.0524	−0.0124
Year in which most capital was built	0.0015	0.0002	0.0026	0.0006
% Main product that was exported in 1997	0.0028	0.0003	0.0022	0.0005
% Total exports that went to EU in 1997	−0.0030	−0.0003	−0.0051*	−0.0012
Average number of wastewater inspections per year by regulators	0.1929***	0.0217	0.0114	0.0027
Average number of air quality inspections per year by regulators	−0.0158	−0.0018	0.1434***	0.0338
Inspector visits are announced	0.1449	0.0158	0.0396	0.0093
Firm self-reports pollution emissions	0.9377***	0.1161	0.8215***	0.1957
Firm has permits for some or all facilities	0.4120	0.0511	0.5162**	0.1252
Public is informed about firm's pollution	1.0598***	0.1029	0.7255***	0.1630
Importance of foreign market pressures	−0.0377	−0.0042	0.0416	0.0098
Importance of pressure from suppliers and investors	−0.0176	−0.0020	−0.0663	−0.0156
Importance of expected future regulations	0.2887***	0.0324	0.0230	0.0054
Importance of reducing energy and material use	−0.0583	−0.0066	0.1132**	0.0267
Importance of pressure from civic groups	−0.1670**	−0.0188	−0.0628	−0.0148
Importance of public incentives like loans, grants, etc	0.0734	0.0083	0.0463	0.0109
Number of observations	1065		1065	
% Correct predictions	86.10%		78.22%	
Pseudo-R^2	0.45		0.310	
Mean of dependent variable	0.70		0.581	

*, ** and *** indicate significance at least at the 10%, 5% and 1% levels. See table 13 for full variable definitions.
Industry dummy results are suppressed, but available from the authors.

self-reporting is the preferred method in developed as well as CEE countries. We do not, however, know which way the causality runs.

Public information also appears to be empirically important. If the public is informed about firms' pollution emissions, the probability of having AWM&PP programmes is estimated to increase by 13%, which is 21% of the

mean. Public information is also estimated to increase by 11% the probability firms have environmental departments, which is 18% of the mean. This result is supported by the Likert-scale variable focusing on the importance of public pressure, which is positively correlated with the existence of an environmental department.

Foreign market pressures are also estimated to be positively correlated with adoption of AWM&PP programmes and establishment of environmental departments. Marginal effects are 4%–7% of means, suggesting that international demand effects are important factors.

In the environmental department equation, we find the ratio of employees in 1997–1990 negatively correlated with the existence of an environmental department. This indicates that firms that shed employees over time were more likely to have such institutions, which suggests that efficiency may be an important driver of this aspect of EMS. Compared with means, firms that *reduced* their employment by 1.0% were estimated to have a 10% higher probability of having an environmental department. Firms located in all countries were estimated to be less likely to have AWM&PP programmes than Poland, but Bulgarian and Romanian firms were more likely than Poland to have environmental departments.

The use of environmental planning, on-site wastewater treatment and ISO 14000 series certification are now considered, with results presented in Table 9. In Table 9, we see some important commonalities with results presented in Table 8 for other EMS adoption decisions. For example, scale is also a factor in adoption of the three EMS measures reported in Table 9 and firms that self-report emissions are again more likely to adopt all measures. Marginal effects of self-reporting are particularly large at 30%–45% of mean values. Public information about firm emissions is estimated to be an important driver of environmental planning and ISO 14001 certification, with marginal effects 25%–30% of means.

Perhaps, the most important difference with our previous results is that the Likert-scale variable focusing on the need to reduce energy and materials is positively and significantly correlated with ISO 14001 certification and on-site wastewater treatment, whereas in Table 8 it was insignificant. Marginal effects associated with increases of one Likert category are about 7% of means, which implies that firms in part adopt these EMSs to increase their profits. Another difference is that, consistent with Khanna and Anton (2002), expectation of future regulation is estimated to be a driver of environmental plan adoption.

Foreign private investment is estimated to be associated with increased adoption of environmental plans and on-site wastewater treatment, with a 10% increase in ownership share increasing the probability of adoption by

approximately 2% (4%–5% of means). It seems likely that it is the foreign aspect rather than privatisation driving this result, however, because an increase in government ownership share is also positively correlated with the existence of environmental plans. Firms that perceived pressure from foreign markets to upgrade EMSs were more likely to seek ISO 14001 certifications. This effect is consistent with our hypothesis and results presented in Table 8. Polish firms are more likely than all other countries' firms to have environmental plans in place, but are less likely than Romanian firms to be seeking ISO 14001 certification.

In Table 10, which presents the determinants of internal air and water pollution monitoring, scale is again important, with larger firms more likely to monitor air and water pollution. Self-reporting is again also seen to be positively correlated with better management. We, of course, cannot be sure of the direction of causality, but firms that report their own emissions to government regulators are 12%–20% more likely to monitor air and water emissions than those that only report when checked by authorities. This represents 16%–34% increases above mean probabilities. Public information about pollution emissions also has major effects. At the 1% significance level, public information is estimated to increase the probability of internal monitoring by 10%–16%, which is 15%–28% of mean values.

Inspections by regulators are estimated to be important drivers of internal monitoring. Increasing inspections by one time per year is estimated to increase the probability of internal firm monitoring by 2%–3%. Firms for which expected future environmental regulations were important were more likely to have internal water pollution monitoring. The need to reduce energy and material use, however, appears to spur air pollution monitoring. This result suggests that the need to control energy costs is linked with air pollution management. Marginal effects in both cases were roughly 4%–5% of means. Also, positively correlated with air pollution monitoring was having formal permits for facilities.

The ratio of 1997–1990 employment is negatively associated with internal water pollution monitoring, suggesting again that efficiency is correlated with better EMS. This effect is estimated to be large, with a 1% decline in employment correlated with an increase in the probability of internal monitoring of 7%. Government ownership is negatively associated with internal water pollution monitoring, but marginal effects are small. Polish firms are again systematically more likely to adopt EMS components. Except for three country dummies that had coefficient estimates not significantly different from zero, Polish firms are more likely to engage in air and water pollution monitoring.

CONCLUSIONS

This paper tested some hypotheses from the literature related to adoption of key EMS elements. The particular contribution is that these issues are examined within the context of the economic and political transitions in CEE countries. The literature suggests that privatisation, FDI, exports to western countries, better public administration, including environmental regulatory monitoring and enforcement, and expanded civil society may be important drivers of better environmental management.

Our findings generally support the literature, although we do not find that privatisation *per se* is associated with EMS adoption. Better environmental regulatory systems, including self-reporting of emissions by firms and in some models formal permits and pollution monitoring by environmental regulators, are important for adoption of EMSs. Expectation of future regulations is estimated to be a significant driver of AWM&PP programmes, environmental planning and water pollution monitoring. Self-reporting has large marginal effects in a variety of cases, which suggests that what some might view as an administrative detail could have major environmental implications. Simply putting the burden for calculating, recording and reporting pollution on firms appears to spur more advanced environmental measures, although as we have emphasised, the actual mechanisms involved or even the direction of causality is not known for sure. The importance of self-reporting should be an area for future economic research.

Making information about pollution discharges available to the public appears to create a wide variety of empirically important and statistically significant incentives for adopting virtually all environmental management measures. We expect that firms are responding to public pressure generated by the availability of information, suggesting that improved civil societies are an important factor in EMS adoption. Of course, the effectiveness of the environmental management measures adopted is unknown and it is possible they are in reality 'greenwash'. Given the short time in which public information and civic participation have developed, though, it is notable that they affect firm behaviour at all.

We also find evidence that FDI is associated with the use of select environmental management methods. Of special interest is the strong relationship with environmental planning, suggesting that Western strategic planning methods could potentially be paying environmental dividends in CEE countries. Consistent with the results of Andonova (2003), we find that firms which perceived strong pressures from foreign markets to comply with environmental norms were indeed more likely to adopt a number of EMSs. Firms subject to such pressures were more likely to have environmental

departments, be seeking ISO 14001 certification and have AWM&PP programmes in place. These results suggest that export-driven firms are more likely to adopt EMS measures. This finding is consistent with those of Bellesi *et al*. (2005).

That air pollution monitoring, ISO 14001 certification and wastewater treatment are positively associated with the need to reduce energy use and material waste suggests that cost pressures associated with the economic transition itself stimulated closer attention to production processes. That efficiency and EMS adoption are related is also supported by the result that while firms with more employees (ie larger firms) were more likely to have instituted all environmental management measures, *reductions* in employment during the 1990s (ie increases in efficiency) were associated with a number of EMS components. In this regard, economic efficiency and EMS adoption appear to have some complementarities.

These results suggest that a variety of factors are driving the adoption of respected environmental management techniques. An important methodological issue is that we treat the various measures of environmental behaviour here as independent of each other. In reality, they are likely to be substitutes or complements, which would make the analysis substantially more complicated. This is left to future research as is examining the relationship between transition factors and emissions of key industrial pollutants.

Acknowledgements
We thank Dietrich Earnhart, Irene Henriques and Perry Sadorsky for helpful comments on drafts of this paper and Theo Panayotou for his leadership while Bluffstone was at the Harvard Institute for International Development. We also thank the Swedish international development cooperation agency, Sida, for financing the analysis that led to this paper and USAID for supporting the data collection. Finally, we acknowledge the contributions of the researchers at Bulgarian Industrial Association (Bulgaria), TARKI (Hungary), Environmental Policy Center (Lithuania), Institute of Economics, Polish Academy of Sciences (Poland), CESEP (Romania) and Incoma (Slovakia), which collected the data used in this paper.

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