Springer

Dear Author,

Here are the proofs of your article.

- You can submit your corrections **online**, via **e-mail** or by **fax**.
- For **online** submission please insert your corrections in the online correction form. Always indicate the line number to which the correction refers.
- You can also insert your corrections in the proof PDF and **email** the annotated PDF.
- For fax submission, please ensure that your corrections are clearly legible. Use a fine black pen and write the correction in the margin, not too close to the edge of the page.
- Remember to note the **journal title**, **article number**, and **your name** when sending your response via e-mail or fax.
- **Check** the metadata sheet to make sure that the header information, especially author names and the corresponding affiliations are correctly shown.
- **Check** the questions that may have arisen during copy editing and insert your answers/ corrections.
- **Check** that the text is complete and that all figures, tables and their legends are included. Also check the accuracy of special characters, equations, and electronic supplementary material if applicable. If necessary refer to the *Edited manuscript*.
- The publication of inaccurate data such as dosages and units can have serious consequences. Please take particular care that all such details are correct.
- Please **do not** make changes that involve only matters of style. We have generally introduced forms that follow the journal's style.
  Substantial changes in content, e.g., new results, corrected values, title and authorship are not allowed without the approval of the responsible editor. In such a case, please contact the Editorial Office and return his/her consent together with the proof.
- If we do not receive your corrections **within 48 hours**, we will send you a reminder.
- Your article will be published **Online First** approximately one week after receipt of your corrected proofs. This is the **official first publication** citable with the DOI. **Further changes are, therefore, not possible.**
- The **printed version** will follow in a forthcoming issue.

Please note

After online publication, subscribers (personal/institutional) to this journal will have access to the complete article via the DOI using the URL: http://dx.doi.org/[DOI].
If you would like to know when your article has been published online, take advantage of our free alert service. For registration and further information go to: http://www.springerlink.com.

Due to the electronic nature of the procedure, the manuscript and the original figures will only be returned to you on special request. When you return your corrections, please inform us if you would like to have these documents returned.

Metadata of the article that will be visualized in OnlineFirst

ArticleTitle	Impact of CO_2 Emissions Reductions on Firms' Finance in an Emerging Economy: The Case of the Czech Republic	
Article Sub-Title		
Article CopyRight	Springer-Verlag (This will be the copyright line in the final PDF)	
Journal Name	Transition Studies Review	
Corresponding Author	Family Name	**Brzobohatý**
	Particle	
	Given Name	**Tomáš**
	Suffix	
	Division	Faculty of Economics and Business Administration
	Organization	Goethe University Frankfurt
	Address	Frankfurt, Germany
	Email	tomas.brzobohaty@gmail.com
Author	Family Name	**Janský**
	Particle	
	Given Name	**Petr**
	Suffix	
	Division	Institute of Economic Studies, Faculty of Social Sciences
	Organization	Charles University in Prague
	Address	Prague, Czech Republic
	Email	jansky.peta@gmail.com
Schedule	Received	14 December 2009
	Revised	
	Accepted	5 April 2010
Abstract	This paper investigates the relationship between economic and environmental performance with focus on firms in an emerging economy, the Czech Republic, and their CO_2 emission reductions. We discuss whether the hypotheses tested for local pollutants that firms emit and firms' finances are relevant for CO_2 emissions. We test the hypotheses on a sample of Czech firms included in the first phase of European Union Emissions Trading Scheme (EU ETS). We observe that introduction of EU ETS did not encourage significant investments in CO_2 emissions reduction. Importantly, the results show that the firms that did invest in CO_2 reductions experienced a negative impact on their finance. We argue that this is explained by the drop in the price of allowances on the carbon market in 2006 which resulted in firms receiving less revenue from saved allowances than they had expected.	
Keywords (separated by '-')	CO_2 emissions reductions - Firms - Finance - European Union Emissions Trading Scheme - Czech Republic	
JEL Classification (separated by '-')	Q5 - G3 - P3	
Footnote Information		

Journal: 11300
Article: 168

Author Query Form

Please ensure you fill out your response to the queries raised below and return this form along with your corrections

Dear Author

During the process of typesetting your article, the following queries have arisen. Please check your typeset proof carefully against the queries listed below and mark the necessary changes either directly on the proof/online grid or in the 'Author's response' area provided below

Query	Details required	Author's response
1.	Dean and Hoeller (2000) has been changed to Dean and Hoeller (1992) so that this citation matches the list.	
2.	Bovenberg et al. 2005 has been changed to Bovenberg et al. 2003 so that this citation matches the list.	
3.	Kettner et al. 2006 has been changed to Kettner et al. 2007 so that this citation matches the list.	
4.	References Kolshus and Torvanger **2005**, Kratena and Schleicher **1999**, Shrivastava and Hart **1992** are given in list but not cited in text. Please cite in text or delete from list.	

Transit Stud Rev
DOI 10.1007/s11300-010-0168-9

WORLD TRANSITION ECONOMY RESEARCH

Impact of CO_2 Emissions Reductions on Firms' Finance in an Emerging Economy: The Case of the Czech Republic

Tomáš Brzobohatý · Petr Janský

Received: 14 December 2009 / Accepted: 5 April 2010

Abstract This paper investigates the relationship between economic and environmental performance with focus on firms in an emerging economy, the Czech Republic, and their CO_2 emission reductions. We discuss whether the hypotheses tested for local pollutants that firms emit and firms' finances are relevant for CO_2 emissions. We test the hypotheses on a sample of Czech firms included in the first phase of European Union Emissions Trading Scheme (EU ETS). We observe that introduction of EU ETS did not encourage significant investments in CO_2 emissions reduction. Importantly, the results show that the firms that did invest in CO_2 reductions experienced a negative impact on their finance. We argue that this is explained by the drop in the price of allowances on the carbon market in 2006 which resulted in firms receiving less revenue from saved allowances than they had expected.

Keywords CO_2 emissions reductions · Firms · Finance · European Union Emissions Trading Scheme · Czech Republic

JEL Classification Q5 · G3 · P3

T. Brzobohatý (✉)
Faculty of Economics and Business Administration,
Goethe University Frankfurt, Frankfurt, Germany
e-mail: tomas.brzobohaty@gmail.com

P. Janský
Institute of Economic Studies, Faculty of Social Sciences,
Charles University in Prague, Prague, Czech Republic
e-mail: jansky.peta@gmail.com

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

Introduction

In the last few years climate change has become one of the most discussed topics in our society. Politicians of many developed countries are committing to binding limits on emitted CO_2 to slow down the whole process. As a consequence, companies have to adjust to new rules of game in order to reach the emissions target. This adjustment is of interest to economists as many questions arise. How costly is the reductions of emissions? Does it not harm country's economy and competitiveness? Which industries and companies are affected most by the regulations? Why do companies not reduce their emissions voluntarily? Or do they? What is the impact of CO_2 reduction on their financial performance?

To answer the last question, we continue as follows. First, we briefly review recent literature on relation between companies' economic and environmental performance in "Climate Change in Companies: Relationship between Financial and Environmental Performance". We compare impacts of CO_2 and local pollutants and investigate how much they are related in "Extension from Local Pollutants to CO_2 Emissions". We also analyze decomposition of CO_2 reduction. "Introduction of the Emission Allowances Market" deals with the influence of the introduction of the EU Emissions Trading Scheme and ask to which extent the system with traded allowances generates additional revenues for companies that reduce their CO_2 emission. "Dataset: Czech Firms after Transition" describes the dataset of Czech firms. In "Empirical Models: From Environmental to Financial Performance and Back" we describe four models that empirically test the hypotheses derived in the theoretical section, and we discuss the results. The last section concludes.

Climate Change in Companies: Relationship between Financial and Environmental Performance

Since the 1990s economists have often questioned the popular perception that both economic growth and a cleaner environment cannot be reached at the same time. And indeed, there are good economic arguments why the investment in cleaner technology should be profitable. Higher level of waste is strongly correlated with high amount of raw materials, which is of course costly. So installing better technology leads not only to lower levels of pollution, but it also improves the utilization of materials and resources and thus increases the overall productivity and efficiency in the production process, as discussed by Schmidheiny (1992). Rooney (1993) showed that in early stages of pollution abatement, there is a great deal of 'low hanging fruit' abatement which is caused by cheap material and structural changes that lead to high emissions reduction for low costs. If the company is in later stages of pollution abatement efforts, further reduction is increasingly difficult and thus costs of abatement per one unit of pollution are becoming more expensive because reduction requires substantial changes in production technologies, as shown by Frosch and Gallopoulos (1989).

Generally we distinguish between two approaches to investigate the relation between economic and environmental performance. The first asserts that

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

environmental performance influences economic performance and investigates the influence of the environmental measures that company has taken on its financial performance. There might be a lag of a few years as it takes time to renegotiate supply and waste disposal contracts as discussed, for example, by White et al. (1993).

The environmental incentive approach was tested by Hart and Ahuja (1996) who found that emissions reduction improves a company's return on sales and return on assets one and 2 years after the reduction took place. This research also confirmed the hypothesis of Rooney (1993) that reduction brings higher profits to high polluters in comparison with low polluters. Similarly, Feldman et al. (1996) found that improvement in both environmental performance and environmental management system decreases the environmental risks of the company, decreases costs of capital, and therefore increases stock price.

Rennings et al. (2003) evaluate the impact on the share value of the company. Contrary to Feldman et al. (1996), the authors focused not only on impacts of environmental performance but also on impacts of social performance. While better environmental performance leads to higher price of the shares, social performance does not. They include more variables as indicators of environmental performance contrary to some other authors who use only information about hazardous accidents from the US Toxic Release Inventory (TRI). Earnhart and Lizal (2007) are probably the first to analyze these issues in a transition economy, specifically in the Czech Republic between 1996 and 1998. The authors revealed that pollution reduction leads to both lower revenues and lower costs, resulting in improved profitability.

The second, financial incentive approach investigates which companies are likely to invest in cleaner technologies and as a consequence reduce their emissions. Contrary to the previous approach, these analyses are quite rare in the literature. For example, Earnhart and Lizal (2002) analyzed the relation between environmental performance and ownership structure as well as financial performance in the Czech economy. They found a positive effect of state ownership on environmental performance, and that causality runs from financial performance to emissions.

Extension from Local Pollutants to CO_2 Emissions

In the past the economic literature focused on local pollutants like SO_2, CO, NO_X or waste. These pollutants have largely been regulated. Efforts to decrease these emissions have been highly successful, as the abatement costs have been relatively low and factories at least in developed countries have been forced to tackle these emissions. However, this paper focuses on CO_2 emissions data which have not often been the focus of analysis, for which we can see several reasons. First, regulators and public did not pay much attention to this issue until the problems of global warming became a broadly discussed topic. In addition, it has been observed, that the abatement costs of CO_2 are much higher. OECD (2007) confirms these expectations. Companies were asked whether they had decreased their environmental impact. More than 50% of companies experienced decrease in solid waste, but less than 20% of companies mentioned reducing global pollutants.

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

More research on companies' CO_2 performance was initiated with the introduction of the European Union European Trading Scheme (EU ETS) in 2005. However, despite growing interest in CO_2 emissions reduction and the impact of the introduction of the EU ETS on it, there is still little literature evaluating relations between CO_2 reduction and economic performance at the firm level. We hypothesize whether the results for CO_2 vary significantly from the impact of local pollutants reduction or not. Companies can hardly expect that a decrease in CO_2 emissions will lead to an increase in their revenues. So the only way they can benefit from CO_2 abatement may be a decrease in costs. In this section we decompose the CO_2 reduction into several effects and analyze whether any of them may result in a decrease in expenditures.

Liaskas et al. (2000) decomposed the changes of CO_2 emissions between four factors: output level, energy intensity, fuel mix, structural change. In the empirical section, they analyzed the effects of these factors on the change of CO_2 emissions in 13 EU countries in the years 1973–1993. In most of the countries, the increase of industrial output had a negative effect on CO_2 emissions reduction, but it was outweighed by the change in the energy intensity and fuel mix. Ang and Pandiyan (1997) investigated factors that influenced changes of CO_2 intensity in manufacturing industry in China, Taiwan and South Korea between 1980 and 1993. The results showed the major influence of energy intensity reduction, while other factors were far less significant. Other authors estimated the cheapest ways that would lead to future CO_2 reduction, such as Dean and Hoeller (1992).

The results of all the studies suggest that decrease in emissions intensity is mostly linked with a decrease in energy intensity. This outcome indicates that a decrease in emissions is caused by lower energy consumption and thus leads to decreases in costs. This outcome suggests that the main driver motivating companies to invest in CO_2 reduction are savings on energy bills. Another motivation that leads companies to invest in cleaner technologies is the goal to become the industry leader who sets the standards that the competitors must later adjust to. The last reason why companies should decrease the emissions is the avoidance of control inspections.

As for the financial incentive approach, the reasoning is the same for CO_2 as for local pollutants. Companies with sufficient amounts of cash generated in the form of accumulated profits can invest it in measures that lead to reductions in energy consumption. Such investment is very desirable for companies because it can save considerable amounts of money in future.

Introduction of the Emission Allowances Market

There is one new aspect that has influenced the relation between revenues, costs and environmental performance. The EU ETS was introduced in 2005 in order to decrease CO_2 emissions and to reach the target ratified in the Kyoto Protocol.

Out of the potential regulatory mechanisms, the European Union decided for a cap-and-trade grandfathering system, which does not generate any profits for governments but which is politically feasible: companies get their caps for free

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

according to their historical emissions.[1] Big polluters are concerned about their increasing costs and therefore oppose any kind of measures that would generate additional revenues for state budget and imply additional costs for them (Goulder and Parry 2008). However, not only is a division of allowances important, but the overall cap is crucial as well. Even grandfathering may harm companies significantly if the overall cap is too small as they have to invest a lot in abatement measures (Bovenberg et al. 2003).

This system may compensate incentives to abate CO_2 emissions that are quite rare in the business-as-usual scenario compared to local pollutants, as we described in the previous section. It rewards those who have decreased emissions in the given period and punishes those who have increased them. Each company receives a cap, i.e. certain amount of emissions that the company is allowed to emit. The advantage of the cap-and-trade system is its flexibility and efficiency. The reduction takes place in the companies, where it is the cheapest. The desired level of emissions will be reached in any case; it is determined just by the overall cap that the government sets. The necessary condition is that the penalty that the regulation authority sets for exceeding the cap is sufficiently above the marginal costs of abatement.

In reality, there are several problems that undermine the advantages of the cap-and-trade system. The main problem is the amount of allowances that are allocated. The government is on the one hand biased by lobbying companies that require the highest possible cap. On the other hand, certain emissions reduction should be reached and therefore the caps for companies must be stricter than in the business-as-usual case. Allowances were allocated according to the historical emissions, also benchmarking was taken in consideration, but as the production patterns of single companies vary significantly there was no possibility to reach the common standard for more firms (Ellerman and Buchner, 2007). The data on past emissions cannot be considered as entirely reliable and this lack of reliability could be one of the reasons for the overallocation. Sometimes the overallocation was done even intentionally by governments in order not to harm their industries. This bias was confirmed on the data from the year 2005 which show that all new member countries were in the net long position, i.e. they disposed overall abundance of allowances. Some countries did not ask for more allowances than they used, but the allocation within the states was biased towards non-electricity industrial sectors, which were mostly in the net long position (Kettner et al. 2007).

The overallocation reflected in the carbon market in April 2006 when the price of CO_2 allowance sharply dropped. At the beginning of the first phase of the EU ETS, until the end of April 2006, the system worked quite well, and traders with allowances generally expected that there would be a lack of allowances in the majority of member states. However when it was revealed in April 2006 that France

[1] There are two market-based instruments that are applied to reduce the emissions to lead to emissions reduction: taxation and the cap-and-trade system. The cap-and-trade system is further divided into three versions: auctioning, benchmarking and grandfathering. Auctioning has some similar features with taxation, companies have to pay for allowances and the system generates revenues for government which can be used, for example, to cut other taxes; in benchmarking the caps are derived from the emission-rate standard in certain industry; and grandfathering is based on companies' previous performance.

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

and Belgium were unexpectedly long on the allowances, the price of the allowance fell by more than 50%.

The volatility of the system had several negative impacts. Firstly, it undermined the credibility of the EU ETS. The second impact of overallocation was the unfair distribution of the costs and benefits.

If the marginal benefits of abatement remained stable, companies could well calculate whether investments into CO_2 reduction would be profitable or not. Revenues from sold redundant allowances would substitute additional revenues stemming from better image in the case of local pollutants. However, this holds only in the well functional carbon market. The situation in the first phase of the EU ETS with high volatility implies high uncertainty and therefore companies are rather reluctant to invest because the reward for emissions reduction is insecure. Especially companies that invested into new technologies before the fall in price were harmed. They expected much higher revenues for their emissions allowances sold in the market. On the other hand, those that did not invest at all were the winners, especially if they expected the overallocation. They could have used their allocations when the price was low and buy the missing ones much more cheaply after the price fall. These imperfections of the first phase of the EU ETS significantly determined the payoffs of investment on CO_2 abatement that we test empirically.

Dataset: Czech Firms after Transition

We focus on Czech companies included in the first phase of the ETS and analyze the development of their emissions, financial indicators and relations between them. We gather data on CO_2 emissions of each installation from the Czech Ministry of Environment. Unfortunately, only data for 2004, 2005 and 2006 are reliable because of technical problems at the Ministry. Data on financial performance come from the Aspekt database. Unfortunately, the database is not complete and so we have data for only 125 companies included in National Allocation Plan 1 (NAP 1). If more data become available in the future, the research might be expanded to analyze whether there is a selection bias in this present paper stemming from the size and selectivity of the dataset. However, the database covers the majority of big polluters and our dataset includes 48% of all companies that emit 71% of total emissions.

We analyze how the emissions intensity (emissions/revenues) changed between years 2004/2005 and 2005/2006. Average emissions intensity reduction was 11% between 2004 and 2005 and 12% between 2005 and 2006. However, it is important to point out that total emissions increased by 3% between 2005 and 2006, so the emissions reduction was not high enough to offset the economic growth. Also, Czech owners (57%) slightly prevail over foreign. ISO 14001 is a certification for companies with environmental management systems (20%). Companies participating in NAP1 were divided between 12 industries and so we followed this division. Most companies are from the public power sector (27%) or business power sector (33%). The only common feature of the companies in the second group is that they

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

own their own power or heat station. Other sectors are significantly less numerous, maybe with the exceptions of chemicals (9%) and ceramics (8%).

We analyzed revenues (r), profits (p) and costs (c) of the companies. For the purpose of the analysis we often use not the total values but ratios. In this way we want to smooth away the size effect and focus rather on efficiency or productivity. So we use the ratio revenues/assets (ra in the table) which indicate how efficiently companies use their assets. We use ratios also for costs (costs/assets) (ca) and for profits. Ratio profits/assets (pa) is well known in finance as the *return on assets* ratio. It indicates the ability of the company to turn its assets into profits and is very important in a company's valuation. We observe that, in the case of ratios, differences between extreme values are much lower. In the case of the indicator of environmental performance, i.e. emissions (e), we also avoid using total values. We rather consider the ratio emissions/revenues (er) which describes emissions intensity. Because of computational problems, we are restricted to a sample of profitable companies. These companies are on average larger. From an environmental point of view, these companies have not only higher total emissions but also emissions intensity.

Empirical Models: From Environmental to Financial Performance and Back

We empirically investigate the relationship between environmental and financial performance and start with the environmental to financial performance model in the first three models. The fourth model investigates the other direction. We analyze the impact of reduction/increase in emissions intensity on most relevant aspects of financial performance of the company: its total revenues, total costs and profits.

We analyze data for 2004, 2005 and 2006, in the later 2 years the EU ETS was running. Companies that reduced CO_2 emission could be rewarded by additional revenues from the emissions allowances that they sold on the market. Therefore, the effect of emissions/revenues ratio on revenues/assets could be negative. As for costs we expect that companies with lower emissions invested in modern technologies. These investments are particularly aimed at the reduction of energy consumption. Lower energy consumption leads to lower operating costs. Lower emissions can have both positive and negative impact on costs. We observe how decrease/increase in emissions results in profitability in last models with dependent variable profits/assets. However, this research will be done only on a limited dataset of 90 companies out of the original 125. It is due to the fact that as we use logarithm of profits/assets, we can include only companies that have this ratio positive within all 3 years. We must be aware that the results are derived from the dataset of profitable companies only and therefore cannot be applied to all companies.

We believe that also other factors may have a significant influence on the revenues and costs of the companies than their CO_2 emissions and we include them in the model as well. The owner of the company may originate from Czech Republic or from abroad. We hypothesize that companies with foreign owners may tend to have higher revenues/assets as the foreign investors pick out the companies that derive benefit from their assets effectively. Another variable is the kind of

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

ownership. We consider three types: joint stock companies (a.s.), limited company (s.r.o.) and other kinds of ownership (mostly cooperations). We add other variable ISO, which equals 1 for the companies that are certified by the standard ISO 14001. Each industry has a specific utilization level of resources. Another important aspect is the industry where companies operate and we include the dummies for twelve industries. We also include the level of assets, which enables us to observe the effect of economies of scale. We add a dummy variable for years 2005 and 2006.

We use a logarithmic model that measures the elasticities of variables, i.e. what impact a change of emissions/revenues has on revenues/assets. We chose this dynamic version because it allows us to observe real reactions and make predictions about the future. As we have a panel dataset, we apply general least square model (GLS) and, on the basis of the results of Hausman's specification tests, we prefer the application of fixed effects models. Table 1 in the Appendix contains coefficients and p values for all four models and there is also a detailed discussion of the results below.

In the first model, the revenues/assets is a dependent variable.

$$\ln(R/A)_t = \beta_0 + \beta_1 \times \ln(E/R)_t + \beta_2 \times \mathrm{nat}_t + \beta_3 \times \mathrm{own}_t + \beta_4 \times \mathrm{iso}_t + \beta_5 \times \mathrm{ind} + \beta_6 \times \ln A_t + \beta_7 \times \mathrm{YEAR}_t + \ln \varepsilon_t$$

The assets are significant and the negative sign indicates that companies with higher values of assets have certain problems with turning them into revenues. The logarithm of emissions/revenues is significant and negative. A possible interpretation is that companies that decrease their emissions intensity may sell their abundant allowances on the carbon market and thus increase their revenues. The results for dummies are relatively unexpected with Czech-owned companies using their assets more effectively than foreign-owned companies. Companies with environmental management systems also turn their assets into revenues less effectively. As for industries, the outcome corresponds to our expectations. Heavy industries, such as public power, refineries and coke, have quite lower revenues/assets ratio, while business power, chemicals and paper have a relatively high one.

The second model with costs/assets as dependent variable shows a similar outcome to the first one due to the very high correlation between revenues and costs.

$$\ln(C/A)_t = \beta_0 + \beta_1 \times \ln(E/R)_t + \beta_2 \times \mathrm{nat}_t + \beta_3 \times \mathrm{own}_t + \beta_4 \times \mathrm{iso}_t + \beta_5 \times \mathrm{ind} + \beta_6 \times \ln A_t + \beta_7 \times \mathrm{YEAR}_t + \ln \varepsilon_t$$

The outcome for assets has similar explanations, as in the case of revenues. The higher the values of assets, the more problems the companies have with their utilization. As for the costs/assets ratio, this key variable of our interest emissions/revenues is significant with a negative sign. It indicates that companies with lower emissions have higher costs. So the depreciation of investments probably overweighs the decrease in operating costs. Also results for dummies are very similar to Model 1. Companies with high ratio revenues/assets have also higher ratio costs/assets, so it indicates only that they have a quicker turnover of their assets. Model 1 was empirically tested as follows:

Model 3 observes that with lower emissions, both revenues and costs rise. It further asks what increases more: revenues or costs?

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

Table 1 Results of empirical models

Model	1		2		3		4	
Dependent	*Lnra*		*lnca*		*lnpa*		*lner*	
	coef.	*p* value	coef.	*p* value	coef.	*p* value	coef.	*p* value
ISO	0.122	0.488	0.179	0.327				
Lner	−0.336	0.000	−0.330	0.000	0.007	0.758		
Lna	−0.334	0.000	−0.345	0.000	−0.006	0.815	−0.512	0.000
Year 2006	0.022	0.429	0.022	0.443	−0.073	0.058	−0.287	0.000
Year 2005	−0.033	0.209	−0.039	0.155	−0.105	0.007	−0.182	0.000
Lnpa							−0.144	0.000
As	−0.405	0.000	−0.413	0.000	−0.161	0.028	1.080	0.000
Oth	−0.585	0.020	−0.598	0.018	0.799	0.000	1.765	0.000
Cz	0.371	0.000	0.386	0.000	−0.544	0.000	−0.866	0.000
ISO	−0.317	0.001	−0.277	0.003	0.578	0.000	0.457	0.068
ind2	0.833	0.000	0.815	0.000	0.213	0.106	−3.140	0.000
ind3	−0.760	0.030	−0.787	0.025	−1.485	0.000	0.614	0.198
ind4	0.448	0.000	0.423	0.000	0.418	0.000	−1.822	0.000
ind5	−0.250	0.461	−0.280	0.411			−1.349	0.005
ind6	0.368	0.027	0.345	0.039	0.428	0.016	0.004	0.990
ind7	0.140	0.422	0.149	0.392	0.505	0.000	0.611	0.199
ind8	−0.618	0.014	−0.607	0.016	−0.380	0.289	−1.585	0.000
ind9	0.326	0.034	0.316	0.041	0.440	0.000	−1.699	0.000
ind10	0.473	0.000	0.465	0.000	1.212	0.000	−1.260	0.000
ind11	0.201	0.176	0.181	0.224	0.180	0.118	−2.332	0.001
ind12	0.570	0.028	0.561	0.031	0.028	0.880		
Cons	−0.172	0.048	−0.240	0.006				

ISO is a dummy for companies with ISO 14001 certification, as is a dummy for joint stock companies and *oth* is for other than that and limited liability companies, *cz* is a dummy for Czech-owned companies, year 2006 and year 2005 are year dummies. The benchmark for industries is a public power sector and the other industries follow: business power (ind2), refineries (ind3), chemicals (ind4), coal (ind5), metal and steel (ind6), cement (ind7), lime (ind8), glass (ind9), ceramics (ind10), paper (ind11), pulp (ind12)

lnra logarithm of revenues over assets, *lnca* costs over assets, *lnpa* profits over assets, *lner* emissions over revenues

$$\ln(P/A)_t = \beta_0 + \beta_1 \times \ln(E/R)_t + \beta_2 \times \mathrm{nat}_t + \beta_3 \times \mathrm{own}_t + \beta_4 \times \mathrm{iso}_t + \beta_5 \times \mathrm{ind} + \beta_6 \times \ln A_t + \beta_7 \times \mathrm{YEAR}_t + \ln \varepsilon_t$$

The emissions/revenues coefficient is insignificant and therefore the impact of change in emissions on profits is not clear and we cannot assert whether increase in revenues or increase in costs prevails. Many dummy variables are significant and so we can interpret their sign. Both years 2005 and 2006 show lower profitability than year 2004, which is rather surprising with respect to the growing economy. Joint stock companies are less profitable than limited companies, which may be also quite a surprising finding. But companies with Czech owners tend to be significantly less

Journal : Small-ext 11300 Article No. : 168 MS Code : Brzobohat_Jansky
Dispatch : 22-6-2010 LE CP
Pages : 12 TYPESET DISK

profitable than those owned by foreigners. Companies certified by ISO are more profitable. However, we must be aware of possible inverse causality: companies that are already profitable can afford environmental management.[2]

The fourth model investigates the inverse relation, how financial performance influences environmental performance.

$$\ln(E/R)_t = \beta_0 + \beta_1 \times \ln(P/A)_t + \beta_2 \times \mathrm{nat}_t + \beta_3 \times \mathrm{own}_t + \beta_4 \times \mathrm{iso}_t + \beta_5 \times \mathrm{ind}_t + \beta_6 \times \ln A_t + \beta_7 \times \mathrm{YEAR}_t + \ln \varepsilon_t$$

We hypothesize that companies that generate high profits have lots of cash which they can invest and thus increase the value of their assets. Part of the investments is invested into projects that decrease consumption of energy and thus decrease emissions. It means that higher profits should theoretically lead to lower emissions. And indeed, the ratio of profits/assets is significant with a negative sign. The more profitable a company is, the lower emissions intensity it has. It may confirm the original idea that profitable companies invest in emissions reduction, but we must be aware of pitfalls of causality. If the company is profitable in a given year, it has lower costs which may be a consequence of energy savings which came first. So the causality between profits and emissions remains unclear. Joint stock companies and companies with foreign owners tend to have a higher emissions/revenues ratio. As for assets, expected economies of scale took place, which is shown by a negative coefficient for logarithm of assets.

Conclusion

We analyzed relations between firms' environmental and financial performance in both directions: how environmental performance influences financial results of the companies, and how financial results affect companies' emissions. This paper is innovative as the existing literature mostly focuses on local pollutants and there is little research on the impact of CO_2 emissions reductions on companies' finance in emerging economies.

The European Union Emissions Trading Scheme (EU ETS) was introduced to increase the incentive for firms to reduce CO_2 by rewarding those that invested in CO_2 abatement. The more a company reduces its emission, the more allowances it can sell on the market and the more revenues it gains. So after the introduction of the EU ETS, revenues should in theory rise as a consequence of CO_2 emissions reduction. However, as the EU ETS did not work perfectly in the first phase and suffered from high volatility, we challenge the idea of increased incentives for companies and assert that it may hold only in a perfect functional market.

[2] The immediate impact might be different from the longer-term effects. Therefore we also used models with explanatory variables lagged 1 year. We do not present the detailed results here because of space constraints. The results were mixed with all three variations indicating positive, i.e. non-negative, significant impact of emissions on financial performance. We hypothesize that these counterintuitive results might be caused by the short panel dataset, which is further shortened by the lagged variable, and that is also why we decided to focus on the models without the lagged variable. These results might also indicate that there are some other problems with the dataset and possibly with the four models discussed here in detail. Alternatively, these interesting results also signal the potential of future research on long-term impacts of emissions reduction on firms' finance.

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

In the empirical part of our paper, we tested the above-mentioned hypotheses on the dataset of Czech companies included in the National Allocation Plan of CO_2 emissions allowances. We investigated how firms' emissions affect revenues, costs, and profits in a given year. We also controlled for other explanatory variables such as industry, ownership, environmental management system and size of their assets representing the economies of scale.

We found that the more CO_2 a company emitted, the lower revenues and costs it had. It suggests that company that decreased emissions could earn additional revenues on the carbon market. But at the same time, the company experiences an increase in costs because emissions reduction requires investments in change of the production process, mostly aimed at energy savings that are reflected in higher depreciation and thus higher costs. Investments in new technologies tend to decrease consumption of energy and thus decrease overall operating costs. But according to the results, the impact of higher depreciation prevails and companies with lower emissions tend to have higher costs. The impact of emissions reduction on firms' profits remains unclear; we cannot say whether revenues or costs increase more in consequence of lower emissions. We also investigated the inverse relation, how profitability influences companies' emissions. We found that more profitable companies tend to have lower emissions. When interpreting the results, we should be aware of the limited dataset and relatively short panel data.

We conclude that introduction of the first phase of the EU ETS did not encourage significant investments in CO_2 emissions reduction. The 3-year time horizon was too short for calculations of investment profitability, and uncertainty of development of the carbon market after 2007 did not enable a prediction of potential future revenues. Although the reduction of CO_2 emissions between 2004 and 2006 had a positive impact on companies' revenues, we cannot claim that the investments paid off. Firstly, companies with lower revenues experienced increases in costs resulting from high depreciations of costly investments. The higher costs offset the impact of higher revenues and profitability of such investments is thus unclear. In addition, our sample does not cover year 2007 when the additional revenues dropped due to the fall in carbon price to virtually zero. To conclude, the EU ETS did not introduce sufficient incentives that would reward companies abating CO_2. However, although these companies lost on their investments, they may be rewarded in later years as the European carbon regulation is expected to be stricter.

Acknowledgments The authors are grateful to Milan Ščasný and Jan Brůha for helpful comments on an earlier draft of this paper. We are also grateful to the Centre for the Environment of the Charles University in Prague for the access to the dataset. The authors acknowledge the support by the Institutional Research Framework 2005–2010, MSM0021620841 of Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague. The usual disclaimer applies.

References

Ang BW, Pandiyan G (1997) Decomposition of energy-induced CO_2 emissions in manufacturing. Energy Econ 19:363–374

Bovenberg AL, Goulder LH, Gourney DJ (2003) Efficiency Costs of Meeting Industry-Distributional Constraints under Environmental Permits and Taxes. NBER Working Paper W10059

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK

Dean A, Hoeller P (1992) Costs of reducing CO_2 emissions: evidence from six global models. OECD Economic Department Working Papers No. 122

Earnhart D, Lizal L (2002) Effects of ownership and financial status on corporate environmental performance. William Davidson Institute Working Paper No. 492

Earnhart D, Lizal L (2007) Does better environmental performance affect revenues, cost, or both? Evidence from a transition economy. William Davidson Institute Working Paper No. 856

Ellerman D, Buchner B (2007) The European Union Emissions Trading Scheme: origins, allocation, and early results. Rev Environ Econ Policy 1:66–87

Feldman SJ, Soyka PA, Ameer P (1996) Does improving a firm's environmental management system and environmental performance reset in a higher stock price? ICF Kaiser International 1996, Inc

Frosch RA, Gallopoulos NE (1989) Strategies for manufacturing. Sci Am 261(3):144–152

Goulder LH, Parry IWH (2008) Instrument choice in environmental policy. Rev Environ Econ Policy 2:152–174

Hart SL, Ahuja G (1996) Does it pay to be green? An empirical examination of the relationship between pollution prevention and firm performance. Bus Strategy Environ 5:30–37

Kettner C, Köppl A, Schleicher SP, Thenius G (2007) Stringency and Distribution in the EU Emissions Trading Scheme—the 2005 Evidence. FEEM Working Paper No. 22 2007

Kolshus HH, Torvanger A (2005) Analysis of EU member states' national allocation plans. CICERO

Kratena K, Schleicher SP (1999) Emissions reduction policies and induced technological change: microeconomic evidence and macroeconomic impacts of the Austrian Kyoto Policy package. Austrian Institute of Economic Research, University of Graz, Vienna

Liaskas K, Mavrotas G, Mandaraka M, Diakoulaki D (2000) Decomposition of industrial CO2 emissions: the case of European Union. Energy Econ 22:384–394

OECD (2007) Business and the Environment. Policy Incentives and Corporate Responses. OECD Publishing

Rennings K, Schröder M, Ziegler A (2003) The Economic Performance of European Stock Corporations. Does sustainability matter? Greener Management International

Rooney C (1993) Economics of pollution prevention: How waste reduction pays? Pollut Prev Rev: 261–276

Schmidheiny S (1992) Changing Course. A Global Business Perspective on Development and Environment. MIT Press

Shrivastava P, Hart S (1992) Greening organizations. Acad Manage Best Paper Proc 52:185–189

White A et al (1993) Environmentally smart accounting: using total costs assessment to advance pollution prevention. Pollut Prev Rev: 247–259

Journal : Small-ext 11300 | Dispatch : 22-6-2010 | Pages : 12
Article No. : 168 | LE | TYPESET
MS Code : Brzobohat_Jansky | CP | DISK