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"It pays to be green" - a premature conclusion?

Abstract:

It has been claimed that good environmental performance can improve firms' economic performance. However, because of e.g. data limitations, the methods applied in most previous quantitative empirical studies of the relationship between environmental and economic performance of firms suffer from several shortcomings. We discuss these shortcomings and conclude that previously applied methods are unsatisfactory as support for a conclusion that it pays for firms to be green. Then we illustrate the effects of these shortcomings by performing several regression analyses of the relationship between environmental and economic performance using a panel data set of Norwegian plants. A simple correlation analysis confirms the positive association between our measures of environmental and economic performance. The result prevails when we control for firm characteristics like e.g. size or sub-industry in a pooled regression. However, the result could still be biased by omitted unobserved variables like management or technology. When we control for unobserved plant specific characteristics in a panel regression, the effect is no longer statistically significant. Hence, greener plants perform economically better, but the analysis provides no support for the claim that it is because they are greener. These empirical findings further indicate that a conclusion that it pays to be green is premature.

Keywords: Economic performance; environmental performance; environmental regulations, pays to be green

JEL classification: Q25, Q28, K23

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1. Introduction

Traditionally, economists claim that production is optimally determined by profit maximization and hence that new environmental regulations inevitably yield (weakly) lower profits. This view has been challenged by several authors, most notably Porter and van der Linde (1995). This relatively new strand of economics suggests several mechanisms linking better environmental performance to higher profits. For example, a better environmental profile can improve the energy efficiency of the firm, raise the motivation and productivity of the employees, or improve market shares (see e.g. Reinhardt 1999, or Brekke and Nyborg 2004).

In addition to theoretical arguments, the claim that better environmental performance can be profitable is often based on quantitative empirical studies revealing a positive association between economic and environmental performance.[1] When interpreting such results, it is important to be aware of the shortcomings of the methods applied in these studies. As this paper will show, there are a number of unresolved problems when one wants to illuminate the relationship between environmental and economic performance of firms empirically. Hence, we argue that using empirical correlations evolving from the applied methods to conclude that the "results indicate that it 'pays to be green' as a rule" (Russo and Fouts 1997, p. 549) or, moreover, that the "results of this study suggest that it does indeed pay to be green" (Hart and Ahuja 1996, p. 34) is unwarranted.

There are several reasons why it is important to improve our knowledge of the relationship between environmental and economic performance. First, documentation of a positive relationship between environmental and economic performance can be used to invoke environmental awareness among firm management or owners, claiming that actively pursuing an environmental profile can increase economic performance (Gallarotti 1995, Hart 1997, Orlitzky et al. 2003). Second, however, a positive association can also be used to argue that certain environmental regulations could be relaxed: If firm owners perceive that it pays to be green, they have economic incentives to implement environmentally sensitive production methods, and there is less need for further government interventions to secure good environmental performance (Orlitzky et al. 2003). Improving the flow of information about the relationship between economic and environmental performance can then be seen as a policy means to provide incentives for environmental improvements without expanding traditional regulations. Third,

[1] Overviews of the empirical literature on the relationship between environmental and economic performance at the firm level, sometimes labeled the "pays to be green"-literature, are included in e.g. Griffin and Mahon (1997), Wagner et al. (2001), King and Lenox (2001) and Filbeck and Gorman (2004).

it seems reasonable that the relationship between environmental and economic performance can be positive for plants with certain characteristics, but not for all plants, and for some, but not all, elements of environmental performance. Identifying the characteristics of firms for which good environmental performance is positively associated with profitability can provide important information, especially for the enforcement of environmental regulations. An environmental agency may direct more inspections towards plants with a weak association between environmental and economic performance, presupposing that such plants need stronger incentives to comply with environmental regulations. Hence, knowledge of the relationship between environmental and economic performance, including knowledge of possible causal effects, is crucial for the construction of effective environmental regulations.

There is a growing empirical literature on the relationship between environmental and economic or financial performance (see e.g. Filbeck and Gorman 2004 or Wagner 2001 for overviews). Examples of such studies are comparisons of the payoff of green funds compared to conventional ones, or the effect on stock values of environmentally related events. The relationship between economic and environmental performance is also studied by comparing various indices of the environmental (and social) profile with measures based on the market value of firms listed on the stock market (e.g. Konar and Cohen 2001, Ziegler et al. 2002, Filbeck and Gorman 2004). One problem using firms registered on the stock market is that such firms are normally big and diversely composed corporations, making it difficult to disentangle or comprehend the impact of environmental performance of particular manufacturing units on total corporate profits. Moreover, non-temporary increases in market value from improved environmental performance can only be expected if the profitability of firms with good environmental performance is actually higher than the profitability of other firms. Hence, several studies include measures of economic performance that are not connected with stock market expectations, like return on sales, capital, equity or assets (e.g. Jaggi and Freedman 1992, Hart and Ahuja 1996). The present paper focuses on studies applying such measures of firms' actual economic performance when investigating the relationship between environmental and economic performance at the firm level.

The aim of the present paper is twofold. First, we discuss shortcomings in the methods applied in most of these previous quantitative firm level studies. For example, many studies in this literature do not control for variables likely to be important for the economic performance of firms, like type of sub-industry or degree of environmental regulation. Such simple procedures are likely to yield an association between environmental and economic performance that is biased: The effect of omitted variables that are correlated with both environmental and economic performance is loaded onto the estimated association between environmental and economic performance. The net effect of environmental performance on economic performance remains undisclosed. We argue that this and other shortcomings render the results of most of these previous studies difficult to interpret, and clearly inappropriate as support for a claim that it pays to be green. To our knowledge, no previous paper includes such a systematic discussion of the methods applied in this literature. Second, we apply similar (unsatisfactory) methods and thereby find a positive association between environmental and economic performance using a panel data set of Norwegian manufacturing plants covering more than 10 years. However, by amending one important shortcoming of most previous studies[2], namely the problem of omitted unobserved variables, the positive association between environmental and economic performance is no longer statistically significant. This further indicates that a conclusion that it pays to be green is premature.

Some examples of previous empirical studies of the relationship between environmental and economic performance of firms are briefly surveyed in Section 2. More important, this section includes a discussion of the shortcomings of the applied methods, suggests ways of amending these shortcomings, and points at remaining econometric problems that are left for future research. Section 3 presents the data applied in the present study, including a discussion of the applied measures of environmental and economic performance. We present the empirical results in Section 4 and conclude in Section 5.

2. Previous empirical studies and their shortcomings

2.1. Briefly on the theoretical background

If improved environmental performance pays off, why do so many firms reveal a poor environmental performance? Rational agents responding to economic incentives would be environmentally friendly if it paid off, i.e. environmental management would be a widespread and integrated part of the overall corporate management. The fact that environmental performance is poor in many industries can be regarded as indication of a negative, rather than a positive, relationship between the two dimensions.

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[2] King and Lenox (2001) seems to be the only previous study in this field that addresses the problem of unobserved firm specific effects.

However, as pointed out by Palmer et al. (1995), there may be some overlooked benefits from environmental innovation, but the authors maintain that these are small compared to abatement and control costs. Improving environmental performance generally involves several types of cost: Search costs of identifying and analysing abatement options, costs regarding capital investments and crowding out of other investments, costs for operating and maintenaning equipment, and costs of shifting focus from production resources and R&D to production of nonmarketable output, etc. (see Jaffe et al. 1995 for a more detailed discussion).

Those arguing for a positive causal relationship between environmental performance and profitability highlight the possibility of costs reductions and/or increased revenues. (see e.g. WBCSD 1997, Scmidtheiny and Zorraquin 1996, Bonifant et al. 1995, Porter and van der Linde 1995, Dechant and Altman 1994, Elkington 1994, Porter 1991).

Regarding cost reductions, it has been argued that firms directing focus to pollution prevention discover opportunities for energy savings, waste reduction, recycling and lower packaging and transportation costs etc. It has also been argued that improved environmental performance increases labour loyalty, reduces the turnover, and improves the ability to hire and retain high quality staff, especially young and motivated workers who tend to be environmentally conscious.

Another argument regards the cost of capital and the cost of insurance. Improving environmental performance might reduce the risk for accidents and the risk for legal sanctions. If successfully communicated to stakeholders, meaning that the perception of firm specific risk is reduced, this will lower the required return on capital and thus increase the share value. Reducing risk will also give lower insurance costs and lower interest rates on debt.

Improved environmental performance could also lead to increased revenues if customers are concerned about environmental effects of the production process or the products, and thus have a higher willingness to pay for “green” than “brown” products.

To sum up, there is a myriad of theoretical arguments supporting or opposing a positive relationship between environmental and economic performance. Still, to test the hypotesis that it pays to be green empirically remains difficult because formal theories are scarce or contain non-observable variables like e.g. employee motivation. These difficulties have not hindered attempts to test the hypotesis empirically. As we shall now argue, however, most of these attempts suffer from serious shortcomings.

2.2. Shortcomings of correlations studies

Several previous studies have investigated the relationship between environmental and economic performance by calculating simple correlations coefficients. One early example is Bragdon and Marlin (1972) who estimate the correlation coefficient between economic and environmental performance for 17 US companies in the Pulp and Paper industry. An index of the pollution control is used to measure environmental performance, while economic performance was measured by e.g. return on equity and capital. They find a positive correlation between environmental and economic performance, and conclude that "some degree of pollution control is likely to increase profits" (Bragdon and Marlin 1972, p. 17).

Jaggi and Freedman (1992) is another example. They estimate the correlation coefficient between several measures of economic performance (e.g. return on assets and return on equity) and an environmental index based on emissions to water for 13 Pulp and Paper firms in the USA in 1978. The estimated correlations show a negative association between environmental and economic performance, but the association is often statistically insignificant.

Results emerging from application of such simple methods provide very limited, if any, guiding for the construction of regulatory policies. The reason is that the simple correlation cannot illuminate *why* greener plants are more profitable; it does not even provide information on *what* characterizes plants that are both greener and more profitable. The point is that this method only reveals the *gross* association between environmental and economic performance. Hence, the result could be due to omitted variables, like plant size or sub-industry. If e.g. plant size is omitted and correlated with both environmental and economic performance, then the effect of plant size on environmental performance is loaded onto the estimated association between environmental and economic performance. Hence, it is possible that the positive correlation would disappear once variables like firm size is controlled for (see discussion in e.g. Orlitzky 2001). In the next section we comment on some studies where control variables are included in an attempt to get closer to the net effect of environmental performance on economic performance.

2.3. Shortcomings of simple regression studies

An increasing number of researchers have recognized the shortcomings of restricting the analysis to correlation coefficients, and therefore perform regression analyses where observed firm heterogeneity is accounted for, like in the following model:

$$(1) \qquad ECP_i = a + b\,ENP_i + X_i d + u_i \,,$$

where ECP_i is economic performance for plant i, ENP_i is the environmental performance, X_i is a vector of control variables, and u_i is an error term. Common control variables in previous studies are measures of firm size, capital, or sub-industry.

Hart and Ahuja (1996) is a much-cited study, where environmental performance is measured as a sum of reduction in toxic release emissions. The economic performance of the included 127 US firms is measured by return on assets or return on sales for the years 1989-1992. The authors run regressions including some control variables and find a positive association between economic and environmental performance. This leads the authors to suggest that "it does indeed pay to be green".

Russo and Fouts (1997) measure environmental performance by an environmental rating of firms based on compliance records, expenditures on waste reduction, etc. Economic performance is measured by return on assets. Data were available for 243 US firms for 1991 and 1992. A regression on (1) yields a positive and significant assosiation between economic and environmental performance. This leads the authors to conclude that the results indicate that "it pays to be green".

Although (1) controls for several apparently relevant factors, unobserved variables could still be the main reason for the observed correlation. Imagine that e.g. good management or investment in efficient technology causes both environmental and economic performance to increase but are still omitted from the regression. Then we could observe a positive association between environmental and economic performance even if no relationship existed between them. Moreover, if omitted variables that influence economic performance, like the age of capital or quality of management, are correlated with environmental performance, an OLS regression on (1) would produce biased and inconsistent estimates. Such omitted variable bias is not unlikely to plague all the firm level studies of the relationship between economic and environmental performance. The next subsection addresses ways of reducing the problem of omitted variable bias.

2.4. Addressing possible omitted variable bias

There are several ways of addressing the problem of omitted variable bias. The first and most appearent procedure is to try to measure the (omitted) variable and then include it in the model. However, good quantitative data on e.g. the quality of the management is notoriously unavailable. Moreover, good management may not even be measurable. Second, instrumental variable estimation may be applied: A variable is a valid instrument for environmental performance if it is correlated with the environmental performance variable and uncorrelated with the error term; or put another way, uncorrelated with the omitted variables. However, it is often difficult to come up with good instruments. One direction to look for instruments would be plant external events that are correlated with environmental performance and uncorrelated with management or technology. The frequency of regulatory inspections may appear an interesting candidate. Unfortunately, it does not seem unlikely that badly managed firms receive more inspections than plants with good management. Hence, the frequency of regulatory inspections is not likely to be uncorrelated with the omitted management variable.

Another direction to look for instruments may be measures of greenness that are aggregated to industrial, regional or national levels. Such aggregates are unlikely to be correlated with the management of a specific plant (provided there are many plants). However, the problem with such aggregates is that their correlation with a specific plant's measure of environmental performance would not be very high, rendering estimation results in finite samples imprecise and unreliable.

Finally, there is a way to address the problem of omitted variables that is easy to apply if panel data are available. Consider the following model:

$$(2) \qquad ECP_{it} = a + b\,ENP_{it} + Y_{it}d + v_i + e_{it}\ ,$$

where Y_{it} includes the same variables as X_i in (1), and e_{it} is an error term. The inclusion of v_i controls for unobserved plant characteristics, like plant location, or time invariant elements of plant technology, management, or employee motivation and education. Hence, to the extent that the omitted variable (e.g. quality of management) is constant over time, this procedure amends the problem of omitted variable bias.

To our knowledge, only one previous study controls for unobserved firm specific effects in estimating the effect of environmental performance on economic performance. King and Lenox (2001) use a panel data set consisting of 652 US firms for the period from 1987 to 1996. They use book values to construct a simplified version of Tobin's q and use this as measure of economic performance. Total emissions of toxic pollutants (relative to the mean emissions of the firm's sub-industry) are applied as measure for environmental performance. Several control variables are also included. They run regressions like the one represented by (2), and tend to find a positive relationship between environmental and economic performance. However, for some specifications the association is not statistically different from zero. The authors conclude that they are "unable to rule out possible confounding effects" (p. 113). Hence, it does not seem unlikely that the association between environmental and economic performance found in many previous studies could be attributable to unobserved variables like e.g. management or technology. In our empirical analysis, reported in Section 4, we elaborate on this.

2.5. Simultaneity bias

Simultaneity bias is another potentially serious problem that is not unlikely to plague all the firm level studies of the relationship between environmental and economic performance. It may be argued that the causality does not go from good environmental performance to profitability (only), as presupposed above, but (also) from economic to environmental performance (see. e.g. Wagner et al. 2002). Numerous reasons have been suggested to support this view. First, profitable firms may invest in new capital, which inevitably (and maybe even unintentionally) leads to lower emissions. Second, it may be easier to pay attention to stakeholders and to obey moral standards towards environmental responsibility when business is sound. Third, regulatory environmental agencies may be more lenient towards economically bad performers than profitable ones. Such two-way-causality may be represented by the following deterministic model:

(3a) $$ECP = f\left(ENP, Y\right)$$

(3b) $$ENP = g\left(ECP, ECP\_1, Y\right)$$

where we maintain notation from the previous sub-section, and let *ECP_1* denote lagged values of economic performance.

If the environmental performance of the firm depends on the firm's economic performance, then environmental performance cannot be considered an exogenous variable in (1) or (2) above. This is serious and renders the estimated coefficients inconsistent and biased.

Such considerations have led some authors to suggest estimating equations like (3a) and (3b) in a simultaneous econometric model, where several structural relations can be estimated at the same time (Wagner et al. 2002, Al-Tuwaijri et al. 2004). Such approaches are extensively used in economics to estimate e.g. demand and supply relations. However, for the estimated coefficients to be interpretable, the procedure requires that each equation is structural. This may be taken to mean that every structural equation is derived from theory and describes a separate aspect of the economy (Greene 2000, p. 653).[3] In our case however, it is difficult to argue, with the relatively vague theories available, that (3b) is derived from theory *and* describes a separate aspect of the economy. It is hard to see how a plant has any reason to *separately* set (3a) and (3b). Rather, why would not a plant incorporate (3b) when adjusting production to achieve the highest available profits? Applying the simultaneous econometric model in this case is therefore inappropriate as the model fails the requirement that the equations are structural since both the endogenous variables are "choice variables of the *same* economic unit" (Wooldridge 2002, p. 210).

The problem of simultaniety bias may alternatively be addressed by applying the instrumental variable method. Again, a valid instrument for environmental performance in this case of endogeniety would be a variable that is correlated with environmental performance and uncorrelated with the error term. Instrumenting environmental performance in (1) by lagged values of the same variable, may reduce (but hardly eliminate) the problem of simultaniety bias. The reason is that lagged values of environonmental performance is likely to be highly correlated with present environmental performance, while the association between lagged values of environmental performance and the error term may be weaker.

In the empirical part of this paper we restrict focus to consequences of omitted variable bias; leaving the problem of simultaneity bias for future research. Hence, our estimates should only be interpreted as associations. They may still serve as *indications* of *possible* causal channels between environomental and economic performance to be further illuminated in future work.

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[3] See e.g. Hendry (1996), Aldrich (1989), or Cooley and LeRoy (1985) for further discussions on what characterizes structural equations.

3. Data and applied variables

3.1. Data

The Norwegian Pollution Control Authority (NPCA) monitors the environmental performance of polluting operations. When a plant is granted an emission permit, the NPCA puts the plant in one of four so-called risk classes. Plants whose operation is considered potentially highly environmentally dangerous are put in risk class one, while the potentially least environmentally dangerous plants are placed in risk class four, etc. In addition, all plants in risk class one and two, and most plants in risk class three, are obliged to submit annual self-reports containing detailed information on violations, emissions, energy use, etc.[4]

We use a plant level panel data set covering 1990-2001. The data set includes plants holding emission permits (emission data are generally unavailable for non-permit-holding plants). Plants from four industries are included, chemicals, basic metals, pulp and paper, and other non-metallic minerals.[5] Hence, the sample is not representative for Norwegian manufacturing plants: The (potentially) most polluting plants and industries are over-represented. These emission data are used to calculate aggregate Norwegian emissions, see e.g. Flugsrud et al. (2000). From this inventory, we have received plant specific emissions of greenhouse gases, acids, particles and NMVOC-equivalents (ozone precursors). These emission data initially originates from plants' self reports. However, the quality of the reported data is carefully investigated, e.g. by comparing the figures with data on energy or input consumption. When inconsistencies are observed, officers in NPCA or the plant are normally consulted, and the figure most consistent with the energy or input data may be chosen. This procedure secures that the firms' incentive to under-report emissions is unlikely to bias the data.

Survey data on manufacturing plants are available from Statistics Norway. This extensive database includes a variety of plant specific data, like production, production costs, employment, and gross investments. We have these variables back to 1983.

Table 1 provides summary statistics for all variables used in this paper, except for the year dummies. Throughout the paper the logarithm of explanatory variables is applied.[6] The production variable used

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[4] Golombek and Raknerud (1997) argue that firms in risk classes one and two are considered highly regulated, while other firms are not.

[5] NACE-code 24, 27, 21, and 26 respectively.

[6] We use the variables as given in Table 1; specifically, we always refer to the logarithm of all variables, except return on sales and dummies.

to normalize emissions is current value of production deflated to 1992. A proxy for capital stock is created as follows. First current values of gross investment are deflated to 1983 (using a price index for investments in manufacturing industries). Then the capital stock for 1983 is set to the mean of gross investments in 1983-1985 divided by the depreciation rate (set to[7] 0.08, cf. Todsen 1997). Finally, deflating the capital stock of the previous year and adding gross investment yields present year's capital stocks.

Table 1: Variables and summary statistics

Variable	Obs.	Mean	Std.Dev.	Min.	Max.
ROS	1012	0.11	0.16	-1.99	0.83
Measures of environmental performace:					
JFIs (log)	1012	-0.81	1.55	-5.38	2.01
JFI (log)	1012	-6.26	2.10	-11.32	0.00
Mean of JFI in sub-industry (log)	1012	-5.45	1.68	-8.83	-1.01
Capital stock (log)	981	11.97	1.40	6.07	14.93
Employees (log)	1006	5.24	0.99	0.69	7.04
Emissions relative to production:					
Greenhouse gases (log)	813	-2.82	2.97	-13.67	0.98
Acids (log)	723	-11.12	1.92	-16.12	-7.79
NMVOC-equivalents (log)	821	-8.26	2.15	-14.77	-4.58
Particles (log)	917	-9.28	2.08	-15.84	-4.52
Dummy variables:					
Risk class 1	1012	0.59	0.49	0.00	1.00
Risk class 2	1012	0.23	0.42	0.00	1.00
Risk class 3/4	1012	0.18	0.39	0.00	1.00
Pulp and paper sub-industry	1012	0.12	0.32	0.00	1.00
Chemicals sub-industry	1012	0.32	0.47	0.00	1.00
Non-metallic minerals sub-industry	1012	0.17	0.38	0.00	1.00
Basic metals sub-industry	1012	0.39	0.49	0.00	1.00

3.2. Measure of economic performance (ECP)

Several measures have been proposed and applied in previous empirical work. As most previous work is based on data on corporations, a range of financial data has been available. We, however, possess

[7] We also ran the regressions reported in Section 4 with the depreciation rate alternatively set to 0.06 and 0.1. This yielded very similar results.

very disaggregate data, where virtually none of the plants alone constitute a corporation registered on the stock market. Measures based on stock rates are therefore unavailable. Moreover, our data is normally even more disaggregate than the legal units required to report to the tax authorities. This excludes measures based on book values, like equity, assets, or capital.[8] However, return on sales (ROS) which is one of the commonly most included measures of economic performance,[9] is available on plant level. ROS is calculated as sales minus variable production costs, divided by sales. Financial costs are not included in these production costs. This has the advantage that high environmental investments that may be unprofitable in the short run but profitable in the long run, would not disguise a possibly positive relationship between long-term economic and environmental performance when the data set covers a relatively short time period. Moreover, if we fail to detect such a positive relationship using ROS, it is unlikely that a positive relationship would be detected using a measure of profitability that includes costs of capital. Nevertheless, it is a general perception that ROS is highly correlated with other common measures of economic performance.

3.3. Measure of environmental performance (ENP)

In principle, a measure of the firm's environmental performance should capture the external (environmental) effects of the firm's activities. In practice, it is very difficult to create measures that capture even the most important external effects of the firm's activity. There is a growing literature on how to measure greenness in applied work (Tyteca 1995, Olsthoorn et al. 2001, Ebert and Welsch 2004, Callens and Tyteca 1999). A variety of measures have been employed in previous studies of the relationship between environmental and economic performance. Among the more objective measures, percentage change in emissions of an aggregate of pollutants (Hart and Ahuja 1996, King and Lenox 2001) or an index of emissions of various pollutants (Jaggi and Freedman 1992, Wagner et al. 2002) are some of the most frequently applied ones. Of course, none of these measures are fully satisfactory, and they may capture different aspects of environmental performance.

We follow the approach of Jaggi and Freedman (1992) who construct an index consisting of several pollutants. First, emissions of each pollutant are normalized by production.

$$e_{pit} = \text{Emissions}_{pit} / \text{Production}_{it}$$

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[8] Accounts data are often dismissed as a source for capital measurements since book values are registered at historic costs and the firm has incentives to choose depreciation profiles to minimize tax liabilities, see e.g. Raknerud et al. (2003) for elaborations.

[9] See overview provided in Griffin and Mahon (1997), Table 2.

Here p records emissions of pollutant $(p = 1,...,P)$, i denotes the firm $(i = 1,...,N)$, and t the calendar year $(t = 1,...,T)$. The basic idea behind this index is to say that a firm whose normalized emissions (e_{pit}) are low *relative* to other firms is green. The firm with the least emissions is the baseline:

$$e_{\min,p} = \min_{i=1,...,N}\left(e_{pit}\right)$$

Note that to capture improvements over time, $e_{min,p}$ is identical for all years. Hence, firm i's environmental performance with regard to pollutant p, denoted by E_{pit}, can be measured as follows:

$$E_{pit} = e_{\min,p} / e_{pit}$$

This ranges from zero to one, and the firm performs better the higher the value. We define the Jaggi Freedman index (*JFI*) as follows:[10]

$$JFI_{it} = \frac{1}{P}\sum_{p=1}^{P} E_{pit}$$

JFI ranges from zero to one, and the closer *JFI* is to one, the greener the firm. The correlations between *JFI* and emissions of the four pollutants are reported in Table 2. As a minimum requirement for an index of greenness, these correlations are highly negative (and significant).

Table 2: Pearson correlation coefficients between the measure of environmental performance (*JFI*) and the emissions relative to production of the four pollutants (p-values in parenthesis)

	Emissions (relative to production) of			
	Greenhouse gases	Acids	VOC-eqv.	Particles
JFI	-0.77 (0.00)	-0.95 (0.00)	-0.92 (0.00)	-0.93 (0.00)

We also construct average sub-industry scores of the *JFI* (at the 5 digit NACE-code-level in most cases). To control for differences in technologies etc, our measure of greenness in the regression analysis will be normalized by the sub-industry average of *JFI*. This *JFI* relative to sub-industri, denoted by *JFIs,* is defined as follows:

[10] Wagner et al. (2002) normalize this index with medians of emissions for each pollutant. The correlation between the logarithm of the this normalized index and the logarithm of the original one is very high.

$$JFIs_{it} = \frac{JFI_{it}}{\frac{1}{J}\sum_{j=1}^{J} JFI_{jt}}, \text{ where } j = 1,...,J \text{ comprises the plants in } i\text{'s sub-industry.}$$

In the regression analysis, we will also include the denominator (mean of *JFI* in sub-industry) as a control variable.

4. Empirical results

We start by applying methods very similar to the ones applied in most previous studies, and show that such methods yield a positive association between our measures of environmental and economic performance. Then we address the problem of omitted unobserved variables, and find that by accounting for such variables the correlation between environmental and economic performance is no longer statistically different from zero.

4.1. Simple approaches

Like in many previous studies, a positive association exists in the data of the present study too: The Pearson correlations coefficient between our measures of environmental and economic performance is 0.17; statistically significant at any conventional level.

The OLS regression on equation (1) includes the following variables. ECP_i is return on sales for plant i, ENP_i is the Jaggi-Freedman index normalized by sub-industry average[11] and X_i is a vector of control variables.[12] We include the mean of *ENP* in the plant's sub-industry, capital stock, number of employees, a dummy indicating that the plant is not heavily regulated, and year dummies as controls. From Table 3 we see that the estimate of *b* is positive (0.009) and clearly statistically significant, again indicating a positive relationship between environmental and economic performance. But the correlation has dropped compared to the simple correlation coefficient estimated above,[13] which may indicate that greenness is positively correlated with other factors that normally characterize profitable

[11] The *ENP*-variables and the employment variable are lagged one period in an attempt to reduce the problem of simultaneity bias, see Section 2.5. This is done in the panel regression in the next subsection too. Neither here nor in the next subsection did the alternative approach of instrumenting present values with lagged ones for these variables change the main qualitative results.

[12] Some previous studies have included lagged values of the environmental performance variable, e.g. to take account of the conjecture that green investments might be costly in the short run but beneficial in the longer run. However, as our measure of economic performance is a short-term measure that does not include financial costs, such lagging should be unnecessary in our case. Nevertheless, we ran all regressions including more lags of *ENP*. This did not appear to reveal any systematic patterns.

[13] From the regression reported in Table 3, the corresponding partial correlation coefficient can be computed to be 0.09, see e.g. Greene (2000) p. 233ff.

plants. The coefficient on mean environmental performance in sub-industry is negative. This indicates that, although plants being greener than their sub-industry peers have higher economic performance, the economic performance is negatively associated with the mean of *ENP* in the plant's sub-industry: Economic performance is better in sub-industries with lower environmental performance. Capital stock and low regulatory stringency (Risk Class 3/4) are positively associated with economic performance. The year dummies indicate that environmental performance of firms was above the 1991 level after 1992. However, after the peak in the mid 1990s it declined.

Although (1) controls for several apparently relevant factors, unobserved variables like management or technology could be the main reason for the positive correlation. In the next section we control for time invariant unobserved plant characteristics.

Table 3: Results of the OLS regression on the pooled data with economic performance as dependent variable

ECP	Coef.	Robust Std.Err.	t	P > |t|
ENP	0.009	0.003	2.74	0.006
Mean of ENP in sub-industry	-0.010	0.004	-2.50	0.013
Capital stock	0.046	0.007	6.50	0.000
Employees	-0.027	0.011	-2.41	0.016
Risk class 3/4	0.084	0.017	4.80	0.000
Year dummies (t1991 excluded):				
t1992	-0.008	0.034	-0.24	0.811
t1993	0.048	0.022	2.20	0.028
t1994	0.077	0.022	3.51	0.000
t1995	0.113	0.022	5.18	0.000
t1996	0.080	0.022	3.58	0.000
t1997	0.055	0.021	2.69	0.007
t1998	0.067	0.020	3.40	0.001
t1999	0.064	0.020	3.19	0.001
t2000	0.069	0.021	3.25	0.001
t2001	0.020	0.031	0.64	0.521
Constant	-0.405	0.083	-4.90	0.000
Number of obs.	898			
F (15,882)	11.60			
Prob > F	0.000			
R-squared	0.13			

4.2. Controlling for unobserved plant specific effects

We control for unobserved plant specific effects in accordance with (2) above using panel data. The regression includes the following variables: Y comprises the same variables as X (see previous subsection). We also include v to control for unobserved time invariant plant characteristics, like plant location or sub-industry, or time invariant elements of plant technology, management, or employee motivation and education.

The regression results from a random effect specification (see e.g. Baltagi 2001) are reported in Table 4. Formal tests reveal that unobserved plant specific effects do belong in the model.[14] This indicates that the pooled regression reported in the previous subsection is inappropriate, e.g. because of omitted unobserved variables. The coefficient on environmental performance has declined, but it remains positive (0.002). It is, however, no longer statistically significant. The estimated coefficients of all the other variables remain very similar.

To sum up, it seems like the association between environmental and economic performance tends to dissolve when other plant characteristics are controlled for. This indicates that variables often omitted in previous studies, like e.g. management or technology, are not unlikely to be important when possible causal channels between environmental and economic performance are to be illuminated.

[14] A Breusch/Pagan Lagrangian test for no individual effects can be rejected at any conventional level of significance. A Hausman test of the hypothesis that the individual effects are uncorrelated with the other regressors in the model cannot be rejected at any conventional level of significance. The latter may be taken to indicate that the applied random effect specification is preferred over a fixed effect specification.

Table 4: Results of the random effects panel regression with economic performance as dependent variable

ECP	Coef.	Std.Err.	z	P > |z|
ENV	0.002	0.005	0.45	0.655
Mean of ENV in sub-industry	-0.012	0.005	-2.34	0.019
Capital stock	0.044	0.009	4.82	0.000
Employees	-0.025	0.014	-1.75	0.081
Risk class 3/4	0.084	0.030	2.79	0.005
Year dummies (t1991 excluded):				
t1992	-0.012	0.021	-0.58	0.563
t1993	0.043	0.021	2.00	0.045
t1994	0.072	0.021	3.34	0.001
t1995	0.108	0.021	5.03	0.000
t1996	0.074	0.022	3.45	0.001
t1997	0.050	0.022	2.29	0.022
t1998	0.062	0.022	2.86	0.004
t1999	0.061	0.022	2.78	0.005
t2000	0.065	0.022	2.96	0.003
t2001	0.017	0.022	0.76	0.449
Constant	-0.408	0.108	-3.78	0.000
Number of obs. (i,t)	898 (85,11)			
R-squared	0.12			
Wald chi2 (15)	82.60			
Prob > chi2	0.000			

5. Conclusions

We argue that previous quantitative empirical firm level studies of the relationship between environmental and economic performance have not taken the problem of omitted variable bias or simultaneity bias sufficiently seriously. Both these problems render associations estimated in previous studies unreliable. Moreover, the empirical methods applied are incapable of illuminating the causal links between environmental and economic performance. Hence, results from such studies are inappropriate as support for a claim that it pays for firms to be green.

When not addressing the problem of omitted variables, our data reveal, like several previous studies, a positive association between environmental and economic performance. However, if unobserved variables like good management or more efficient technology cause both better environmental and economic performance, we could *observe* a positive association between environmental and economic performance even if they were unrelated. When we account for unobserved plant specific effects, the positive association between environmental and economic performance dissolves. Hence, this further indicates that the conclusion of previous empirical studies that it pays to be green is premature. We may add, however, that the opposite conclusion, that it does *not* pay to be green, is no less premature.

Our estimations reveal a negative partial association between economic performance and the mean environmental performance of the sub-industry. This may be taken to indicate that present environmental regulations of more polluting sub-industries do not provide sufficient economic incentives to render emphasis on environmental performance clearly profitable. More importantly, however, the present paper reveals the limitations of our knowledge on the mechanisms governing the effects of environmental performance on firms' profits. Generally it should be considered unsettled whether good environmental performance improves economic performance or whether it is the other way around.

In addition to addressing the methodological concern raised in this paper, future research should attempt to identify what characterizes firms with a strong association between environmental and economic performance, and also what elements of environmental performance that is most likely to be improvable without resulting in worse economic performance: Which firms could become green from self-interest and for which would strict regulations be necessary to protect the environment? Such investigations may provide helpful information in designing regulations and improving enforcement. To condition e.g. inspection frequency on plants' characteristics has been found to improve overall compliance (Harrington 1988, Telle 2004).

Case studies seem to indicate that it can be in the firms' self-interest to pursue good environmental performance regarding some aspects of environmental regulations, while strict enforcement may be crucial to ensure compliance with other aspects of the regulations. As several authors have pointed out (King and Lenox 2001, Reinhardt 1999), the most relevant question is presumably *not* "does it pay to be green", but rather *when* and *for whom* may it pay to be green.

References

Aldrich, J. (1989), "Autonomy". *Oxford Economic Papers* **41**, 15-34.

Al-Tuwaijri S.A., T.E. Christensen, and K.E. Hughes (2004), "The relations among environmental disclosure, environmental preformance, and economic performance: a simultaneous equations approach". *Accounting, Organizations and Society* **29**, 447-471.

Baltagi, B. (2001) *Econometric analysis of panel data*. Second edition. New York : John Wiley & Sons.

Bonifant, B.C., M. B. Arnold, and F.J. Long (1995), "Gaining competitive advantage through enviornmental investments". *Business Horizons* July–August, 37-47.

Bragdon, J. and J. Marlin (1972), "Is pollution profitable? Environmental virtue and reward: Must stiffer pollution controls hurt profits?". *Risk Management* (April 1972), 9-18.

Brekke, K.A. and K. Nyborg (2004), "Moral hazard and moral motivation: Corporate social responsibility as labor market screening". Paper presented at the 13th annual EAERE conference in Budapest, June 25-28, 2004.

Callens, I. and D. Tyteca (1999), "Towards indicators of sustainable development for firms. A productive efficiency perspective". *Ecological Economics* **28**, 41-53.

Cooley, T. and S. LeRoy (1985), "Atheoretical macroeconometrics. A critique". *Journal of Monetary Economics* **16**, 283-308.

Dechant, K., and B. Altman (1994), "Environmental leadership: from compliance to competitive advantage". *Academy of Management Executive* **8** (3), 7-20.

Ebert, U. and H. Welsch (2004), "Meaningful environmental indices: a social choice approach". *Journal of Environmental Economics and Management* **47**, 270-283.

Elkington, J. (1994), "Towards the sustainable corporation: win-win-win business strategies for sustainable development". *California Management Review* Winter, 90-100.

Filbeck, G. and R. F. Gorman (2004), "The relationship between the environmental and financial performance of public utilities". *Environmental and Resource Economics* **29** (2), 137-157.

Flugsrud, K., E. Gjerald, G. Haakonsen, S. Holtskog, H. Høie, K. Rypdal, B. Tornsjø, and F. Weidemann (2000), "The Norwegian Emission Inventory. Documentation of methodology and data for estimating emissions of greenhouse gases and long-range transboundary air pollutants". Reports 1/2000, Statistics Norway.

Gallarotti G.M. (1995), "It pays to be green: The managerial incentive structure and environmentally sound strategies". *Columbia Journal of World Business* **30** (4), 38-57.

Golombek, R. and A. Raknerud (1997), "Do environmental standards harm manufacturing employment?". *Scandinavian Journal of Economics* **99** (1), 29-44.

Greene, W. (2000): Econometric analysis, fourth edition, Prentice Hall International.

Griffin, J. and J. Mahon (1997), "The corporate social performance and corporate financial performance debate". *Business and Society* **36** (1), 5-31.

Harrington, W. (1988), "Enforcement Leverage when Penalties are Restricted". *Journal of Public Economics* **37**, 29-53.

Hart, S. (1997), "Beyond greening: Strategies for a sustainable world". *Harvard Business Review* **75** (1), 66-76.

Hart, S. and G. Ahuja (1996), "Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance". *Business Strategy and the Environment* **5**, 30-37.

Hendry, D. (1996), "On the constancy of time-series econometric equations". *The Economic and Social Review* **27** (5), 401-422.

Jaffe, A.B., S.R. Peterson, P.R. Portney, and R.N. Stavins (1995), "Environmental regulations and the competitiveness of U.S. manufacturing: What does the evidence tell us?". *Journal of Economic Literature* **33**, 132-163.

Jaggi, B. and M. Freedman (1992), "An examination of the impact of pollution performance on economic and market performance: Pulp and paper firms". *Journal of Business Finance and Accounting* **19** (5), 697-713.

King, A. and M. Lenox (2001), "Does it really pay to be green? An empirical study of firm environmental and financial performance". *Journal of Industrial Ecology* **5** (1), 105-116.

Konar, S. and M. Cohen (2001), "Does the market value environmental performance?". *The Review of Economics and Statistics* **83** (2), 281-289.

Olsthoorn, X., D. Tyteca, W. Wehrmeyer, and M. Wagner (2001), "Environmental indicators for business: a review of the literature and standardisation methods". *Journal of Cleaner Production* **9**, 453-463.

Orlitzky, M. (2001), "Does firm size confound the relationship between corporate social performance and firm financial performance?". *Journal of Business Ethics* **33**, 167-180.

Orlitzky, M., F. Schmidt, and S. Rynes (2003), "Corporate social and financial performance: A meta-analysis". *Organization Studies* **24** (3), 403-441.

Palmer, K., W.E. Oates, and P.R. Portney (1995), "Tightening environmental standards: the benefit-cost or the no-cost paradigm? *Journal of Economic Perspectives* **9** (4), 119-132.

Porter, M. and C. van der Linde (1995), "Towards a new conception of environment-competitiveness relationship". *Journal of Economic Perspectives*, **4** (4), 97-119.

Porter, M.E. (1991), "America's green strategy". *Scientific American* **264** (4), 96.

Raknerud, A., D. Rønningen, and T. Skjerpen (2003), "A method for improved capital measurement by combining accounts and firm investment data". Discussion Papers 365, Statistics Norway.
Reinhardt, F. (1999), "Market failure and the environmental policies of firms' economic rationales for beyond compliance behavior". *Journal of Industrial Ecology* **1** (3), 9-21.

Russo M. V. and P.A. Fouts (1997), "A resource-based perspective on corporate environmental performance and profitability". *Academy of Management Journal* **40** (3), 534-559.

Schmidtheiny, S and F.J.L. Zorraquin (1996) *Financing Change: The Financial Community, Eco-Efficiency, and Sustainable Development*. Cambridge Massachusetts, MIT

Telle, K. (2004), "Effects of inspections on plants' regulatory and environmental performance - evidence from Norwegian manufacturing industries". Discussion Papers No. 381, Research Department, Statistics Norway.

Todsen, S. (1997), "Nasjonalregnskap: Beregning av realkapitalbeholdninger og kapitalslit (National accounts: Estimation of the stock of physical capital and depreciation)". *Notater* 97/61, Statistics Norway, Oslo.

Tyteca, D. (1995), "On the measurement of the environmental performance of firms - A literature review and a productive efficiency perspective". *Journal of Environmental Management* **46**, 281-308.

Wagner M., P. Nguyen, T. Azomahou, and W. Wehrmeyer (2002), "The Relationship between the Environmental and Economic Performance of Firms. An Empirical Analysis of the European Paper Industry". *Corporate Social Responsibility and Environmental Management* **9**, 133-146.

Wagner, M. (2001), "A review of empirical studies concerning the relationship between environmental and economic performance". Working paper, Center for Sustainability Management, Lüneburg University.

Wagner, M., S. Schaltegger, and W. Wehrmeyer (2001), "The relationship between the environmental and economic performance of firms. What does theory propose and what does empirical evidence tell us?". *Greener Management International* **34**, 95-108.

WBCSD (World Business Council for Sustainable Developement) (1997), "Environmental Performance and Shareholder Value", Geneve.

Wooldridge, J. M. (2002) *Econometric analysis of cross section and panel data*. Cambridge, MIT Press.

Ziegler, A., K. Rennings, and M. Schroder (2002), "The effect of environmental and social performance on the shareholder value of European stock corporations". memo, Centre for European Economic Research (ZEW), Mannheim.

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