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# Voluntary Environmental Information Disclosure and Firms' Profitability: Evidence from the Italian Manufacturing Sector

**Manuela Coromaldi**

*University Niccolò Cusano, Italy*

Email: manuela.coromaldi@unicusano.it

**Valentino Parisi***

*University of Cassino and Southern Lazio, Italy*

**Abstract:** This paper investigates the impact of voluntary environmental information disclosure on firm profitability. Based on data for the period 2015–2018, we implement a two-stage panel endogenous switching regression model to deal with endogeneity issues. Our findings document that voluntary environmental information disclosure enhances firms' performance.

**Keywords**: Environment, Information Disclosure, Firm's Profitability, Panel Models, Endogenous Switching

**JEL Classification Number**: Q56, D21, C23, C24

## 1. Introduction

With effect from 2015, Italian firms have been able to publicly disclose their environmental actions on a voluntary basis in sustainability reports. Firms will disclose their private environmental information if the benefits from disclosing information outweigh its costs. Motivations to engage in environmental information disclosure (EID) rely on signaling theory (Spence, 1973) and on legitimation theory (Pfeffer and Salancik, 1978). When the distribution of information between managers and stakeholders is asymmetric, signaling theory states that one part tries to credibly convey information about itself - its environmental activities- to a second part (Spence, 1973). Indeed, because of the limited information, investors will undervalue good performing companies and overvalue bad performing companies. Hence, the capital market will fail to optimally allocate resources. One solution is to send reliable signals to the market to diminish the information asymmetry between managers and stakeholders.

Legitimacy theory posits that firms will enact practices in accordance with society's expectations. As the absence of environmental information can indicate a risk of increased regulatory costs, firms disclose environmental information to legitimize corporate

* Corresponding author. Email: valentino.parisi@unicas.it

activities with shareholders, investors, consumers, and the enlarged community. Legitimation strategies aim at securing legitimacy as a valuable resource itself and provide incentives to engage in corporate reporting. EID may be also be driven by intrinsic motivations. Firms do not only seek for external legitimation and disclosing environmental information is a means through which firms supervise their environmental behaviour (Cohen and Santhakumar, 2007). Moreover, EID can provide opportunities for firms to incorporate more innovative/efficient production process, thereby increasing their profits (Porter and Van der Linde, 1995).

However, disclosing information is not costless. Firms incur the costs of publishing data andthe costs associated with the desired environmental actions. Furthermore, the proprietary cost theory suggests that information disclosure may provide strategic information to potential competitors thus reducing their competitive advantage (Verrecchia, 1983). This research sheds light on the effects of EID on firms' profitability. To our knowledge, there is a lack of empirical studies in the literature analyzing the association between corporate profitability and EID, especially for Italy, and the results are far from conclusive (Clarkson et al., 2011; Plumlee et al., 2015; Chen et al., 2015). Therefore, more evidence is needed to verify the above relationship. Moreover, the extant research does not address the endogeneity arising between the disclosure decision and a firm's profitability (Najid et al., 2019). Basing on Murtazashvili and Wooldridge (2016), we address this issue by developing a two-stage panel endogenous switching regression (PESR) model.

## 2. Empirical strategy

Firms that voluntarily disclose environmental information may systematically differ from their counterparts. Indeed, a firm's choice may be driven by unobserved factors that could lead to biased estimations. The disclosure decision is modeled on the basis of firm characteristics, and therefore the relationship between profitability and explanatory variables may vary across environmentally and non-environmentally oriented firms. Specifically, the procedure to estimate a control function (CF) approach consists of two stages. First, a self-selection equation is estimated by applying a correlated random effects (CRE) probit model. In the second stage, the outcome equation is modeled using a standard estimator and by adding generalized residuals to correct for the selection bias.

Following Murtazashvili and Wooldridge (2016), the EID decision allows us to observe for the *i-th* firm in year *t*two outcomes, $roa_{it}^{(0)}$ and $roa_{it}^{(1)}$, with different coefficients across the two regimes[1]:

[1]This methodology combines the Mundlak (1978) approach to heterogeneity with CF methods for continuous and discrete endogenous variables.

$$roa_{it} = (1 - eid_{it})roa_{it}^{(0)} + eid_{it}roa_{it}^{(1)}$$
$$roa_{it}^{(0)} = x_{it}\beta_0 + c_{i0} + u_{it0}$$
$$roa_{it}^{(1)} = x_{it}\beta_1 + c_{i1} + u_{it1} \qquad \forall\, i = 1, \dots, N \text{ and } t = 1, \dots, T \qquad (1)$$

Where $eid_{it}$ is the endogenous switching indicator. The vector of explanatory variables $x_{it}$ includes an intercept, a time trend, and exogenous explanatory variables ($z_{it}$). Based on previous literature (Coles et al., 2012), we take the potential endogeneity between profitability and a firm's total assets into account. Thus, $x_{it}$ may include continuous endogenous explanatory variables. A PESR model with constant coefficients linearly combines the two regimes (0 and 1):

$$roa_{it} = x_{it}\beta_0 + evd_{it}x_{it}\gamma \quad + \bar{z}_i\rho_0 + eid_{it}\bar{z}_i\rho_1 + \xi_0\hat{h}_{it3} + \xi_1 y_{it3}\hat{h}_{it3} + a_{it}$$
$$\text{with } E(a_{it}|y_{it3}, z_{it}) = 0 \quad \forall\, i = 1, \dots, N \text{ and } t = 1, \dots, T \qquad (2)$$

where $eid_{it}$ interacts with both time-constant and time-varying unobservables, $\gamma$ is the difference of the coefficients of $x_{it}$ in the two regimes and is calculated as $(\beta_1 - \beta_0)$, $\bar{z}_i$ (Mundlak devices) are the means of exogenous variables, $\hat{h}_{it3}$ are the generalized residuals that account for the endogeneity of the selection variable, and $x_{it}$ incorporates the endogenous explanatory variable. The generalized residuals in eq. (2) are estimated by the following selection equation:

$$eid_{it} = 1[k_t + z_{it}\pi_3 + \bar{z}_i\delta_3 + v_{it} > 0], \qquad v_{it} \sim N[0,1] \qquad \forall\, i = 1, \dots, N \text{ and } t = 1, \dots, T \qquad (3)$$

where 1 is the unit function, $z_{it}$ contains all exogenous variables and instrumental variables, $k_t$ represents the time-specific intercepts, and $v_{it}$ is the error term. Equation (2) is estimated using an instrumental variables method for panel data when endogenous regressors are considered, otherwise by CRE model. In this stage, since the estimated generalized residuals are included, the standard errors are adjusted through the bootstrapping procedure.

## 3. Data

We collected non-financial reports for all corporations in the manufacturing sector that voluntarily disclosed their environmental information in the period 2015–2018. Then, we matched these data with AMADEUS accounts data for a sample of companies representative of the manufacturing sector (Altomonte and Aquilante, 2012) for the same period[2]. Our analysis is based on unbalanced panel data of a total of 2,344 firm-year observations, 258 of which disclose environmental information.

[2]We further restrict the analysis to the NACE sectors to which companies disclosing environmental information belong.

We use the variable *EID* that equals 1 if the firm has disclosed environmental information, and 0 otherwise. Profitability is measured by *ROA* (operating surplus/total assets) and we control for the logarithm of *Total Assets* (firm size), *Fixed assets intensity* (fixed assets/total assets), *Intangible assets intensity* (intangible assets/total assets), the logarithm of *Labor productivity* (value added/employees), and *Demand variability* (standard deviation of turn-over by NACE sector) to capture firm-specific demand shocks.

To deal with the potential endogeneity between *Total assets* and *ROA*, an instrument that influences a firm's assets and is not strictly related to *ROA* is *Shareholder's funds*. In a principal-agent setting, separation of ownership and management may lead to decisions taken by managers (agents) that differ from those that shareholders (principals) consider as optimal, as variables maximizing firm profits may not necessarily maximize shareholders' utility (Jensen and Meckling, 1979)[3].

To correct the endogeneity of the selection variable, we consider an air quality indicator measured by the concentration of particulate matter (PM 10) at the provincial level, available from Italy's Institute of Statistics. We assume firms in more polluted provinces are keener to enact environmental actions and to disclose them. Table 1 presents the descriptive statistics of the variables.

**Table 1: Summary statistics of variables**

| | **Mean** | **SD** | **Min** | **Max** |
|---|---|---|---|---|
| ROA | 0.039 | 0.055 | -0.568 | 0.601 |
| Total Assets | 12.994 | 0.572 | 12.773 | 17.579 |
| Fixed assets intensity | 0.237 | 0.171 | 0.000 | 0.932 |
| Intangible assets intensity | 0.031 | 0.062 | 0.000 | 0.492 |
| Labour productivity | 5.039 | 0.322 | 2.155 | 8.983 |
| Demand variability | 13.274 | 0.541 | 12.835 | 16.437 |
| Air quality | 55.424 | 29.978 | 0.000 | 118.000 |
| Shareholder Funds | 11.792 | 0.565 | 11.459 | 16.700 |

## 4. Results

Table 2 presents the CRE Probit first-stage results, when *Total assets* are assumed exogenous (column 1) or endogenous (column 2). To test endogeneity of switching we performed a Durbin-Wu-Hausman test which rejected the null hypothesis that the specified regressor should be treated as exogenous with ($\chi^2(1)=7.69$, $p$-value=0.005).

The estimated coefficients are all statistically significant, except for *Shareholders' Funds* (model1). Both a firm's total assets and the asset composition are relevant in explaining

[3] A similar approach is employed in Auci et al. (2021).

the probability of engaging in EID. While a higher share in fixed capital reduces the estimated probability of EID, a higher intensity of intangibles increases it, as companies with higher intensity in intangible assets are more innovative, dynamic, and environmentally sensitive. The negative association between *Labor productivity* and the probability of performing EID can be interpreted considering that less productive firms may have greater incentive to disclose their environmental information to change market perceptions about their activities. Greater *Demand variability* results in greater uncertainty in the economic cycle that the company faces, thus reducing the likelihood of voluntarily enacting environmental measures.

**Table 2: First stage coefficient estimates**

| | (1) | (2) |
|---|---|---|
| | **CRE Probit (Total Assets exogenous)** | **CRE Probit (Total Assets endogenous)** |
| Fixed assets intensity | -0.725** | -0.719*** |
| | (0.294) | (0.279) |
| Intangible assets intensity | 0.430** | 0.431** |
| | (0.180) | (0.183) |
| Labour productivity | -0.472* | -0.479* |
| | (0.244) | (0.272) |
| Shareholder Funds | -0.940 | |
| | (0.595) | |
| Total Assets | 2.584*** | 1.684*** |
| | (0.640) | (0.211) |
| Demand variability | -0.834** | -0.798*** |
| | (0.338) | (0.303) |
| Air quality | 0.005** | 0.004** |
| | (0.002) | (0.002) |
| Constant | -15.017*** | -15.005*** |
| | (3.450) | (3.333) |
| N | 2344 | 2344 |

Note: Trend variables, sector effects and Mundlak corrections are included. Fully robust standard errors are shown in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$

*Air quality* has a positive and statistically significant coefficient in both regressions: firms operating in more polluted areas are more likely to disclose their environmental information. This result supports the use of *Air quality* as an instrument to correct for the endogeneity of the switching variable[4].

[4]To test the validity of this instrument, a falsification test was implemented. This is confirmed and the results are available upon request.

Table 3 presents the estimates of the *ROA* equation, depending on whether *Total Assets* is considered as an exogenous (Column 1) or endogenous (Column 2) regressor[5]. Regressions include trend variables, sub-sector fixed effects, Mundlak corrections and their interactions with the *EID*[6], generalized residuals, time averaging covariates, and their interactions with *EID*.

Firms that voluntarily enact EID outperform their counterparts, as demonstrated by the positive and significant coefficient of the selection variable (1.154). A higher level of assets and increased labor productivity exert a positive impact on a firm's profitability. The coefficients for firms that do not engage in EID are respectively 0.084 and 0.091, reduced to 0.001 and 0.011 for firms performing EID, as demonstrated by the coefficients of the interaction terms. These results can be interpreted by considering that firms that perform EID are more capitalized and more productive than their counterparts, as shown by the data[7]. Thus, the marginal effect of an increase in assets or labor productivity is smaller for such firms.

The coefficient of fixed assets intensity is -0.071 and statistically significant at the 1% level. Although the literature presents mixed results on the association between *ROA* and capital intensity, Brealey and Myers (1984) and Shapiro and Titman (1986) point out that higher capital intensity tends to increase a firm's risk specifically during economic cycle fluctuations, which might explain our result for those firms that do not perform EID. As the coefficient of the interaction term between EID and fixed capital intensity is not statistically significant, the negative effect also affects companies engaging in EID. Greater demand variability (firm-level uncertainty) reduces profitability whether firms perform EID or not.

Finally, generalized residuals and their interaction with the EID dummy are statistically significant at the 5% and 10% levels, respectively. These results further confirm that we can reject the exogeneity of EID. Lastly, to test the validity of *Shareholders' Funds* as an instrument, an under-identification test was run and it is reported in the bottom section of Table 3[8].

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[5]Fixed assets intensity and intangible assets intensity might be, in principle, considered endogenous. The Durbin-Wu-Hausman tests of endogeneity shows that we cannot reject the null hypothesis of exogeneity ($\chi^2(1)= 0.464$, $p$-value= 0.495) and ($\chi^2(1)= 0.546$, $p$-value= 0.4601, respectively) providing evidence that both variables are exogenous.

[6] For brevity, we do not tabulate this set of variables.

[7]For companies performing/not performing EID the means are 18,846 and 16,528 Euros (labour productivity), 1,687,637 and 1,004,158 Euros (total assets).

[8] A rejection of the null hypothesis indicates that the matrix is full column rank, and thus the model is identified.

**Table 3: Second stage coefficient estimates**

| | (1) | (2) |
|---|---|---|
| | **CF (Total Assets exogenous)** | **CF (Total Assets endogenous)** |
| Total Assets | -0.007 | 0.084* |
| | (0.034) | (0.044) |
| Fixed assets intensity | -0.061*** | -0.071*** |
| | (0.023) | (0.023) |
| Intangible assets intensity | -0.010 | 0.009 |
| | (0.011) | (0.013) |
| Labour productivity | 0.097*** | 0.091*** |
| | (0.021) | (0.020) |
| Demand variability | -0.016*** | -0.026*** |
| | (0.006) | (0.008) |
| EID (Yes=1) | 0.186 | 1.154** |
| | (0.478) | (0.569) |
| Generalized Residuals | 0.016 | 0.120** |
| | (0.046) | (0.058) |
| EID * Total Assets | 0.019 | -0.074* |
| | (0.033) | (0.039) |
| EID * Fixed assets intensity | 0.077 | 0.087 |
| | (0.067) | (0.068) |
| EID * Intangible assets intensity | 0.004 | -0.007 |
| | (0.013) | (0.014) |
| EID * Labour productivity | -0.085*** | -0.080*** |
| | (0.027) | (0.025) |
| EID * Demand variability | -0.004 | 0.009 |
| | (0.015) | (0.014) |
| EID * Generalized Residuals | -0.006 | -0.115* |
| | (0.051) | (0.059) |
| Constant | -0.278 | -1.230*** |
| | (0.337) | (0.423) |
| N | 2344 | 2344 |
| Log-likelihood | 2935.811 | 2905.250 |
| Kleibergen-Paap LM statistic $\chi^2(1)$ | | 73.663 |
| P-value | | 0.000 |

Note. Bootstrapped standard errors are reported in parentheses. Trend variables, sub-sector fixed effects and Mundlak corrections are included. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

## 5. Concluding remarks

In this paper, we analyzed the effects of voluntary EID on a firm's performance. Although EID involves obvious costs to firms, it can help reduce information costs and allow firms to gain a competitive advantage. In a rational market, conveying environmental information can result in better corporate performance and can be regarded as an instrument to shape the perceived legitimacy of a firm. Additionally, EID can provide incentives for companies to adopt more efficient production processes with positive effects on profits. In conclusion, EID can be considered as another type of environmental regulation that can be effective and less costly, alongside traditional command-and-control and market-based measures, in addressing environmental concerns (Tietenberg, 1998). Results for our dataset document that EID can stimulate enterprise profitability.

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