Accounting for the non-linearity in the relationship between environmental corporate social responsibility and financial performance using PSTR model

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Abstract:

By employing a Panel Smooth Transition Regression model, this paper explores the idea of a regime switching as a novel framework in the analysis of the non-linear relationship between environmental performance and financial performance. The main purpose of the study is to ask to the long-standing question 'when it pays to be green?' by identifying the threshold values of environmental performance that determine the smooth movement from one regime to another. The methodology is applied, individually then globally, to a panel of listed French, German, Italian, and Spanish firms over the period 2005 to 2017. The results obtained from the estimation of the five models are various and different ranging from positive to negative. This is consistent with the theoretical model that predicts different possible relationships.

Key words: environmental performance, financial performance, panel smooth transition regression, inverted-U shaped, non-linear.

1. Introduction

Over the past several decades, firms and their stakeholders (i.e., governments, non-governmental organizations, consumers, activists, business groups and trade unions, employees, local communities, financial agencies), has recognized the trade-off between economic efficiency, social justice and environmental protection in a globalized economy. Consumers are increasingly incorporating environmental responsibility into their consumption habits, national and international environmental regulations are more stringent and stricter, and environmental management is becoming a significant and visible part of business priorities and management decisions (Callan and Thomas, 2013). Today, firms have accepted the challenge of preserving and protecting the natural environment whilst continuing to create wealth for their shareholders. Therefore, firms are more responsive to environmental issues not only to abide by regulations and address stakeholders' interests, but also to develop a competitive advantage in the marketplace over non-complying firms (Iwata and Okada, 2011; Vafeas and Nikolau, 2001).

Therefore, is it safe to say that corporate social responsibility (CSR) in general, and environmental CSR (ECSR) in particular, leads to superior financial performance (FP)? This question has been investigated by both economists and management researchers for nearly 50 years (Busch and Friede, 2018). Hence, the business case for ECSR has been widely explored to make the case or refute the insightful economic rationale for corporate environmental management practices. However, scholars have yet to reach a definitive conclusion as the effect of ECSR on financial performance as empirical studies, so far, have yielded to mixed and inconclusive results (Ben Lahouel et al., 2019; Rost and Ehrmann, 2017).

Although, the results of several meta-analysis tend to confirm slightly the existence of a positive relationship (Albertini, 2013; Busch and Friede, 2018; Dixon-Fowler et al., 2013; Endrikat et al., 2014; Horváthová, 2010 ; Margolis et al., 2009; Margolis and Walsh, 2001, 2003; Orlitzky et al., 2003;), a substantial group of studies empirically support that socially/environmentally responsible firms may incur additional costs that adversely affect their bottom line (Cordeiro and Sarkis, 1997; Gonec and Scholtens, 2017; Horváthová, 2012; Lioui and Sharma, 2012; Makni et al., 2009; Moore, 2001). By contrast, other group of researchers have identified neutral effect of ECSR performance on FP because the costs and benefits of being socially responsible tend to cancel each other out (Alexander and Buchholtz, 1978; Aupperle et al., 1985; Ben Lahouel et al., 2019; Fauzi, 2009; Iwata and Okada, 2011; McWilliams and Siegel, 2000; Nelling and Webb, 2009).

These conflicting and opposable results, which are often of low statistical significance, once again amplify the vagueness and the paradox surrounding the ECSR-FP relationship. Yet, another set of scholars have tried to look at more complex possibilities for this relationship. In that respect, unlike the large body of research that mainly assumes a causal relationship between ECSR performance and FP, recent theoretical and empirical studies have suggested that there is no natural or mechanical economic effect that links automatically ECSR and FP (Schaltegger and Synnestvedt, 2002; Wagner and Schaltegger, 2004). Hence, some researchers suggest that the noticeable discrepancies among studies are mainly due to more complex non-linear relationships between ECSR and FP (Brammer and Millington, 2008; Elsayed and Paton, 2009; Moore, 2001; Wang et al., 2016). Recent advancement in micro-economic theory suggest that non-linear relationships is in line with neoclassic economic intuition (Lankoskli, 2008; Nollet et al., 2016). For instance, if the marginal costs of additional environmental protection expenditure are increasing and their respective marginal benefits are decreasing, an inversely U-shaped curve should describe the relationship between ECSR and FP (Schaltegger and Figge, 2000; Schaltegger and Synnestvedt, 2002; Wagner and Schaltegger, 2001; Wagner and Schaltegger, 2004). The major conclusion drawn from recent studies is that firm's performance improves at an optimal level of ECSR and worsens at higher level of environmental protection expenditure (see, for example Barnea and Rubin, 2010; Bénabou and Tirole, 2010; Lankoski, 2008).

To empirically model and estimate the aforementioned non-linearity, researchers have used reduces form regression models of FP with polynomial specifications of quadratic function of social/environmental performance. Yet again, results from empirical studies, exploring the non-linear relationship between ECSR and FP, have been mixed. For example, Wagner (2005) find that end-of-pipe strategies result in negative effects of environmental performance improvements on financial performance. He also finds that this relationship is non-significant when environmental performance is measured by an index reflecting integrated pollution prevention. Wang et al. (2008) develop some arguments that the relationship between corporate philanthropy and FP is best captured by and inverse U-shape. They show that this shape varies with the level of dynamism in firm's operational environment. By contrast, Chen et al. (2017) find that the influence of CSR on firm value in captured by a U-shaped curve. In the same vein, the empirical results from the study of Chen et al. (2018) support the U-shaped hypothesis. By disentangling the Bloomberg's ESG disclosure score, as a measure of corporate social performance, into its environmental, social and governance sub-components, Nollet et al. (2016) show that the environmental component has no significant effect on FP. The result of their study show that a U-shaped relationship exists between the governance sub-component and FP. Additionally, Ramanathan (2018)'s results are in line with those of Barnett and Salomon (2006) who discern a positive curvilinear EP-FP relationship.

In summary, the evidence on the non-linear social/environmental-financial performance record has been inconclusive. The reduced-form models applied to the exploration of the relationship between social/environmental and financial performance merely reflect the statistical inverted U-shaped (U shaped) curve rather than decrypt the mechanisms that lead to the rise (fall) of the FP at an optimal level. Hence, none of the studies aforementioned above has calculated the optimal level of ECSR beyond which the relationship between ECSR and FP is represented by a downturn sloping curve. Moreover, the weakness of the comparability of the results could be explained by the differences in the econometric techniques to determine the values and the significance of the coefficients. For example, some studies have simply pooled the data, while others have controlled for firm-specific differences using fixed or random effects. Additionally, no study has addressed the problem of endogeneity that may rise from such a relationship.

What seems to be missing in the previous studies, is a critical and rigorous econometric modeling of the non-linear relationship undertaken since then. To improve the insight in the explanations of the observed U (inverted U) relationship and to reconcile some of the conflicting results provided by polynomial models broadly used so far, we employ the more robust and flexible panel smooth transition regression (PSTR) model of González *et al* (2005).

As an innovation, this paper aims to answer to the 'it depends' hypothesis raised by Reinhard (1999) which recognizes that the question whether it pays to be green is overwhelmed and that the best question to be asked is 'when it pays to be green?'. Stated differently, this paper suggests that what is more crucial than the fact of being green, is the identification of the optimal level of ECSR that determines whether the correlation between ECSR and FP is positive or negative. In line with McWilliams and Siegel (2001), we argue that the optimal level of ECSR can be identified, by recognizing the marginal costs and benefits, in the same way of any other investment. Hence, we make the assumption that there is no given universally automatic either positive or negative relationship between ECSR and FP.

This study uses 4 samples from French (60), German (56), Italian (31), and Spanish (34) listed firms from 2005 to 2017. Then, we employ the PSTR model to obtain the value transition threshold for ECSR (transition variable) for each country before employing the same model to search for the value transition threshold for ECSR fir the sample composed by the four countries.

2. Literature Background

Does it pay to be green? Or do expenditures on improved ECSR entail financial detriment? These questions are still unresolved, and a general consensus has not yet been reached so far, despite decades of research on the impacts of environmental management activities on corporate financial success (Adegbite, 2018).

The “traditionalist” view of neoclassical environmental economics on ECSR and FP argues for a negative relationship stemming from explicit and implicit costs of environmental protection activities (Chen et al., 2018). It has been forcefully argued that higher environmental standards and stringent national environmental regulations adversely affect companies’ competitiveness by imposing additional unrecoverable costs. Hence, companies complying with environmental regulations incur opportunity costs which negatively affect profitability, prices, innovation, productivity and profitable investment opportunities (Palmer et al., 1995; Walley & whitehead, 1994). Indeed, the conventional wisdom is that strict environmental policies deviate managers from their main responsibility (Friedman, 1970) and generate financial diversions from paramount fruitful investments (Testa et al., 2011).

In contrast, Porter (1991) and Porter and van der Linde (1995) challenge the conventional wisdom and suggest that improved EP is beneficial for companies as well as for the wider society. Based on the theory of dynamic competitiveness, this “revisionist” view, known as Porter Hypothesis, argues that improving EP, as a consequence of more stringent but well-designed environmental regulations, may lead to a “win-win” situations by enhancing companies’ competitiveness through stimulating innovations, developing more efficient processes, improving productivity, offsetting compliance costs, and opening new markets opportunities by achieving a ‘first-mover’ advantage (Elsayed and Paton, 2005; Xie et al., 2017).

Based on these two polar perspectives, the unidirectionality of the relationship between ECSR and FP has been brought into question as it is dynamic and would change from positive to negative, or vice versa (Wagner et al., 2001). Accordingly, the relationship between ECSR and FP should fundamentally follow an inverted-U shaped curve (fig.1) which simultaneously supports the standard microeconomic theory as well as the outcomes of environmental regulations within the Porter Hypothesis theoretical reasoning (Lankoski, 2008; Schaltegger and Figge, 2000, Schaltegger and Synnestvedt, 2002, Wagner, 2005; Wagner and Schaltegger, 2004; Wagner et al., 2001). Considering the number of internal and external factors that affect the relationship between ECSR and FP (see Lankoski, 2000), it is impossible to determine the exact shape and position of the inverted-U for a specific company because the curve’s shape is dynamic and depends on company’s own cost-benefit combination (Lankoski, 2008; Salzmann et al., 2005).

According to Schaltegger and Synnestvedt (2002), the ‘win-win’ hypothesis (i.e. the ‘revisionist’ view in fig. 1) , developed by Porter and van der Linde (1995), is illustrated by the inverted U-shaped curve which would reflect the 'best' possible situation describing the relationship between ECSR and FP. This configuration suggests the existence of an optimal level of ECSR (i.e. the level of ECSR that corresponds to the maximum FP) beyond which a downward-sloping curve represent the 'traditionalist' view (see fig. 1) characterized by decreasing marginal revenues with increasing marginal costs from environmental protection activities.

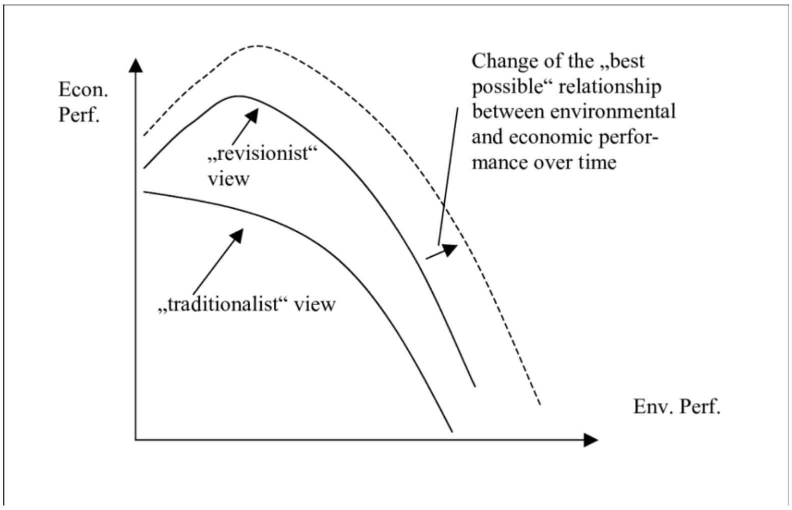

Figure 1. The relationship between EP and FP and environmental regulations (from Wagner 2005)

To summarize, existing theory regarding the relationship between ECSR and FP is inconclusive. Given the aforementioned literature and considering the synthesis from the 'traditionalist' and the 'revisionist' views, we believe that the influence of ECSR on FP follows a non-linear path and an inverted-U shaped curve should describe this relationship.

Hypothesis: The relationship between environmental performance (ECSR) and financial performance (FP) is inverse-U shaped.

3. Data and methodology

3.1. Data and variables

We propose to investigate the ECSR-financial performance link in listed firms belonging to four European countries namely France, Germany, Italy and Spain for the period between 2005 and 2017. First, the investigation is conducted in each single country. Then, we investigate the linkage using an aggregated panel of all firms from the 4 countries. Our panels data are balanced with 780, 728, 403, and 432 firm-year observations for France, Germany, Italy, and Spain, respectively. Our aggregated panel data is balanced with 2343 firm-year observations.

We use Thomson Reuters Datastream ASSET4 ESG database to measure all the variables in the study. To test our hypothesis, we use ASSET4 ESG environmental score to measure the firm's environmental performance (ECSR). Following prior studies (e.g. Wiengarten, Lo & Lam, 2017; Bhandari & Javakhadze, 2017), financial performance was measured by a market-based measure namely the Tobin's Q. Following Adegbite et al. (2018) and Yang and

Baasandorj (2017), we include three control variables: company size (SIZE) measured as market capitalization, leverage (LEVER) measured as the ratio of the total liabilities over total assets, and current growth rate (GROWTH) measured as the percentage change on the previous year's sales.

3.2. The PSTR model

As mentioned in the introduction, previous studies on the ECSR-FP relationship commonly used polynomial traditional econometric models based on Ordinary Least Squares (OLS) and fixed-effects estimators. In this paper, we adopt a PSTR model, an extension of panel threshold regressions (Hansen, 1999). We apply the PSTR model to ask the question "when it pays to be green"? by capturing the optimal level of investment in environmental management project (in terms of environmental performance). We also aim to determine whether the non-linearity hypothesis holds in the relationship between ECSR and FP. The PSTR model has a number of advantages over the previous econometric tools used so far. First, it offers the possibility to consider the heterogeneity across the panel members and over time. Second, it allows for a smooth rather than an abrupt transition between the extreme regimes, which makes it a more flexible and reliable framework. Finally, the PSTR model allows to account for more than two regimes, which provide a better presentation of the FP states induced by different levels of corporate environmental performance.

Formally, the simplest PSTR model with two extremes regimes and a single transition function is defined as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it}; \gamma, c) + \varepsilon_{it}, \qquad (1)$$

where $i = 1, \dots\dots, N$, $t = 1, \dots\dots, T$ and N and T stands for individual and panel time dimensions of the panel, respectively. The dependent variable y_{it} represents denotes the endogenous variables and x_{it} refers to a vector of time-varying exogenous variables. μ_i represents the fixed individual effect and ε_{it} denotes the error term. The transition function $g(q_{it}; \gamma, c)$ is a continuous function of the transition variable q_{it} and bounded between 0 and 1. The extreme values are associated with regression coefficients β_0' and $\beta_0' + \beta_1'$. The value of q_{it} determines the value of $g(q_{it}; \gamma, c)$ and thus the effective regression coefficients $\beta_0' + \beta_1' \, g(q_{it}; \gamma, c)$ for individual *i* at time *t*.

Following González *et al* (2005), the transition function in this study is to be of a logistic type:

$$g(q_{it}; \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right)^{-1} \qquad (2)$$

where $\gamma > 0, c_1 \leq c_2 \leq \cdots \leq c_m$ and c is a m-dimensional vector of threshold parameters and the slope parameter γ determines the smoothness of the transitions. When γ tends to infinity, the transition between the extreme regimes is sharp. Then, the PSTR model becomes the two-regime panel threshold model of (Hansen,1999). However, when the γ tends to zero, the transition function $g(q_{it}; \gamma, c)$ becomes constant and the model collapses into a linear panel regression model with fixed effects (the "*within*" model).

González *et al* (2005) report that a first (m =1) or a second (m = 2) order of transition function is sufficient to meet the required variation of slope coefficients suitable for the most non-linear cases. Therefore, González *et al* (2005) developed a multi-level PSTR model as a generalization of the PSTR model which allows for several transition functions:

$$y_{it} = \mu_i + \beta_0' x_{it} + \sum_{j=1}^{r} \beta_j' x_{it} g_j(q_{it}^{j}\,;\, \gamma_{j,} c_j) \; + \varepsilon_{it}, \qquad (3)$$

We apply the PSTR model (González et al., 2005) to investigate the non-linear relationship between ECSR and FP. Following Ramanathan (2018) which finds a strong positive moderating impact of ECSR on the ECSR-FP link as well as Chen et al. (2017) which used the PSTR model to study the influence of CSR on firm value, we contend that the level of ECSR could operate as a transition variable that may captures the non-linearities and the smoothness of the transition from one regime to another in exploring the relationship between ECSR and FP. Several recent studies have commonly used the dependent variables as a transition variable in economics, finance, and environmental economics papers, when applying PSTR model (see, for example, Aslanidis and Iranzo, 2009; Chang and Chiang, 2011; Chen et al., 2017; Chiu, 2012; Chui 2017; Duarte et al., 2013; Namouri et al., 2017;).

The standard linear panel regression previously used to test the impact of firm ECSR on financial performance has generally defined as follow:

$$y_{it} = \alpha_i + \beta ECSR_{it} + \lambda' Z_{it} + \varepsilon_{it}, \qquad (4)$$

where y_{it} denotes Tobin's Q, ECSR represents the environmental score and Z is a set of control variables including the market capitalization (MK), sales growth (SGW) and Leverage (LEV). We propose to extend this linear form to a nonlinear one where the threshold variable is the environmental performance score ECSR.

As we expect the presence of a non-linear dynamics in the relationship between ECSR and FP, we propose to introduce a regime-switching behavior in Eq. (4) to account for the presence of threshold effect by adopting the ECSR variable as a potential threshold variable. Consequently, the impact of ECSR on FP can vary across different identified regimes or states identified by this threshold variable. The modified equation has the form of a non-linear PSTR model as follows:

$$y_{it} = \alpha_i + \beta ECSR_{it} + \sum_{j=1}^{r} \beta_l' ECSR_{it} g_j\left(q_{it}^{(j)}; \gamma_j, c_j\right) + \lambda' Z_{it} + \varepsilon_{it}, \qquad (5)$$

Where g_j represents the logistic transition function. $q_{it}^{(j)}, \gamma_j$ and c_j are respectively the transition variable (the environmental performance score (ECSR)), the speed of transition between the regimes to be identified and the threshold value calculated endogenously in the model.

The empirical strategy prior to the application of the PSTR model should begin by a series of tests to investigate whether the model is relevant to modify Eq. (4) or not. It allows also identification of the number of regimes driven by the transition variable when the linearity is rejected. The test begins by testing the null assumption of a linear model against a non-linear PSTR model namely H_0: r = 0 against H_1: r = 1. If the null hypothesis is not rejected, we conclude that the model is linear. If the null is rejected, our model is a non-linear PSTR model with one transition function (j =1). We then proceed to test H_0: r = 1 against H_1: r = 2 (we basically test the presence of one transition function against two transition functions). The procedure of this sequential test is repeated for H_0: r = j against H_1: r = $j+1$, until the null assumption is accepted then the final number of regimes is the number j tested in hypothesis H_0. Once the number of transition functions (r) is selected, the number of extreme regimes is equal to $r+1$. Using the non-linear least squares method, we estimate the parameters of Eq. (5) after eliminating the fixed effect by removing individual-specific mean[1]. The impact of ECSR on FP varies from β_0 in the first extreme regime to $\beta_0 + \sum_{j=1}^{r} \beta_j$ in the latter extreme regime.

4. The empirical results

4.1. Linearity versus non-linearity test

The linearity versus nonlinearity test is the first step prior to the specification and estimation of the nonlinear model. The Linearity tests are conducted using LM_w, LM_F and LR tests. For each model, we test for H_0: $r = j$ against H_1: $r = j + 1$, until the null assumption is accepted (numbers in bold). Under H_0, the LM_w and LR statistics are distributed as a $\chi^2(k)$, whereas the LM_F statistic has an approximate $F(k, TN - N - k)$ distribution.

The estimation of the PSTR in equation (7) consists of two steps. First, fixed effects are eliminated by removing individual-specific means. Then, in the second step, parameters $(\gamma_j, c_j, \beta_0, \beta_j)$ are estimated by Nonlinear Least Squares (NLS).[2] Before estimating the PSTR model, it is important to test whether the regime-switching effect is statistically significant. We begin to test the null assumption of a linear model against a nonlinear PSTR model namely H_0: $r = 0$ against H_1: $r = 1$. Then, if the linearity is rejected, we determine the optimal number of transition functions, g_i, as well as the appropriate order of m by conducting tests of no remaining nonlinearity. Let us consider a simple PSTR model with two extreme regimes and a single transition function as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it}; \gamma, c) + \varepsilon_{it}, \tag{6}$$

Testing the linearity is equivalent to test H_0: $\gamma = 0$ or H_0: $\beta_1 = 0$. Both tests are nonstandard because the PSTR model contains unidentified nuisance parameters under this null hypothesis. González *et al.* (2005) propose is to replace $g(q_{it}; \gamma, c)$ by a first-order Taylor expansion around $\gamma = 0$. After reparameterization, this leads to the following auxiliary regression:

$$y_{it} = \mu_i + \beta_0'^{*} x_{it} + \beta_1'^{*} x_{it} q_{it} + \cdots + \beta_m'^{*} x_{it} q_{it}^{*} + \varepsilon_{it}^{*}, \tag{7}$$

where the parameters $\beta_0'^{*}, \cdots, \beta_m'^{*}$ are proportional to the slope parameter γ and $\varepsilon_{it}^{*} = \varepsilon_{it} + R_1 \beta_1'^{*} x_{it}$, with R_1 is the remainder of the Taylor expansion. Therefore, testing H_0: $\gamma = 0$ in equation (6) is equivalent to testing H_0^{*}: $\beta_1'^{*} = 0$ in equation (7). We can use the Wald, Fisher and Likelihood Ratio tests and their statistics respectively defined are as follows:

[1] See Gonzalez et al. (2005) for detailed description of the estimation method of PSTR model and the elimination of the fixed effect.
[2] An important issue to take into account is the selection of starting values of γ_j and c_j, since this notably determines the convergence procedure. To select good starting values, a two-dimensional grid search of 50 values of γ_j and 100 values of c_j is carried out. Given these grids, the vector with the minimum residual sum of squares is used to estimate the corresponding $\beta_0$and β_j.

$$LM_w = \frac{TN(SSR_0 - SSR_1)}{SSR_0} \quad (8)$$

$$LM_F = \frac{TN(SSR_0 - SSR_1)/k}{SSR_0/(TN - N - k)} \quad (9)$$

$$LR = -2[\log(SSR_1) - \log(SSR_0)] \quad (10)$$

where k is the number of explanatory variables, SSR_0 is the panel sum of squared residuals under H_0(linear panel model with individual effects) and SSR_1 is the panel sum of squared residuals under H_1 (*i.e.* the PSTR model with two regimes). Under the null hypothesis, the LM_w and LR statistics are distributed as a $\chi^2(k)$ and the LM_F statistic has an approximate $F(k, TN - N - k)$ distribution. If the null hypothesis is not rejected, we conclude that the model is linear. If the null is rejected, then we can determine the number of transition functions, r, and hence the number of extreme regimes which is equal to $r + 1$. Then, we proceed to test the null H_0: $r = 1$ against H_1: $r = 2$, (the presence of one transition function versus at least two transition functions). The procedure is then repeated for H_0: $r = i$ against H_1: $r = i + 1$, until the null assumption is accepted.

The results of these tests are reported in table 2 for the different samples used to estimate the PSTR model. We can clearly see from table 2 that the model can be specified only with one transition function and through two regimes (i.e. a low and a high regime of environmental score ECSR). All the tests rejected the null hypothesis H0 at the first step and accepted it at the second step, when the dependent variable is Tobin's Q.

Table 2. Linearity and non-remaining heterogeneity tests

Dependent variable	Tobin's Q	Tobin's Q	Tobin's Q	Tobin's Q	Tobin's Q
Panel of companies' origin	France	Germany	Italy	Spain	4 countries
Threshold variables (q_{it})	ECSR	ECSR	ECSR	ECSR	ECSR
H_0: $r = 0$ vs H_1: $r = 1$:					
LM_W	6.08	8.35	2.34	4.54	2.89
	(0.01)	(0.03)	(0.05)	(0.06)	(0.03)
LM_F	6.21	5.93	4.56	3.65	7.65
	(0.04)	(0.02)	(0.04)	(0.03)	(0.05)
LR	3.05	3.21	3.54	5.64	4.75
	(0.08)	(0.02)	(0.06)	(0.05)	(0.02)
H_0: $r = 1$ vs H_1: $r = 2$:					
LM_W	5.19	1.08	2.32	3.54	0.74
	(0.28)	(0.29)	(0.34)	(0.43)	(0.32)
LM_F	5.35	0.76	1.54	2.34	2.55
	(0.32)	(0.38)	(0.43)	(0.32)	(0.15)
LR	6.33	0.64	0.76	0.87	0.74
	(0.48)	(0.14)	(0.19)	(0.21)	(0.41)

4.2. Estimation results from the PSTR models

Following the outcome of the linearity versus nonlinearity tests, only one transition function has been suggested for all the 5 models to be estimated. Hence, the impact of the score of ECSR on FP ranges from low regime of ECSR score to high regime of ECSR score. The non-linear effect of the ECSR on FP is obtained by estimating the following non-linear PSTR model:

$$FP_{it} = \alpha_i + \beta_0 ECSR_{it} + \lambda' Z_{it} + \beta_1 ECSR_{it} \times \mathrm{g}\,(q_{it}, \gamma, \mathrm{c}) + \varepsilon_{it} \qquad (11)$$

where $ECSR_{it}$ denotes the environmental performance at *t*; β_0 and β_1 denote the coefficient of the environmental performance in the first regime and the second regime, respectively. The transition function $\mathrm{g}\,(q_{it}, \gamma, \mathrm{c})$ is continuous and dependent on the threshold variable q_{it}. c is the value of the threshold variable and γ is a measure of the slope of the transition function.

The non-linear impact of ECSR on FP is captured as a weighted average of β_0 and β_1:

$$\frac{\delta FP_{it}}{\delta ECSR_{it}} = \beta_0 + \beta_1 \times g(q_{it}; \gamma, \mathrm{c}) \qquad (12)$$

In high regime of environmental performance, the nonlinear impact of ECSR on FP can be captured by the linear impact (β_0+β_1) when the transition function takes the value of 1 (equation (12). However, in low regime of environmental performance, the transition function is equal zero and the impact of ECSR on the FP is equal to the linear coefficient (β_0). We estimate the two-regime PSTR model using the non-linear least square method and report the results in table 3.

The estimation procedure begins by estimating the linear panel data model as specified in Eq. (4) without the non-linear part, using the firm fixed effects estimator. The results obtained indicate that, for the 5 estimated models, the higher the environmental performance, the lower the financial performance is. This relationship is very significant (p<1%) for the case of France and Germany. Moreover, the two control variables, market capitalization and firm leverage, show signs consistent with managerial literature and have a significant effect on FP. While sales growth has a negative and significant effect on FP for the case of Germany, it presents a positive and significant effect for model 3 (Italy) and model 5 (all countries) and a non-significant impact in model 1 (France) and model 4 (Spain).

For the case of France (model 1), the estimation results from the PSTR model show an inverted U-shape relationship between ECSR and FP. We find a positive link when the level of environmental performance is below the threshold value c = 27,33 during the low regime. Once this threshold is reached, under the environmental performance high regime, additional investments in environmental protection may jeopardize fir profitability. Regarding Germany (model 2), our estimations show a non-linear relationship between ECSR and FP within German firms. But this relationship is not significant. However, this relationship turns to be positive and significant for Italian and Spanish firms during the two regimes. The threshold values are 19,89 and 40,56 respectively for Italy and Spain. Unlike the previous results, the estimation results from model 5 (the 4 countries) show a sustained negative and significant relationship during the two regimes. Hence, below and above the threshold value of 41,6 the relationship between ECSR and FP remains significantly negative with less intensity in the high regime. Graphs 1-5 plot the shape of the estimated transition functions vs the transition variable ECSR.

Table 3. Estimated results from the PSTR

	Model 1 - France		Model 2 - Germany		Model 3 - Italy		Model - 4 Spain		Model 5 - All countries	
	Linear	PSTR	Linear	PSTR	Linear	PSTR	Linear	PSTR	Linear	PSTR
Dependent variable	Tobin's Q		Tobin's Q		Tobin's Q		Tobin's Q		Tobin's Q	
Threshold variable (q_{it})	-	ECSR	-	ECSR		ECSR		ECSR		ECSR
Threshold value (c_1)	-	27.33* (0.79)	-	76.65* (0.002)	-	19.89* (1.58)	-	40.56* (0.03)	-	41.6* (0.12)
Speed of transition (γ_1)	-	9.7* (0.001)	-	593.7* (0.009)	-	5.68 (5.92)	-	88.7* (0.25)	-	44.28** (24.8)
$g(q_{it};\gamma,c) = 0$:										
ECSR	-0.006* (0.001)	0.022* (0.004)	-0.37* (0.08)	-0.34 (0.3)	-0.001 (0.007)	0.01* (0.003)	-0.03 (0.02)	0.39* (0.13)	-0.001 (0.007)	-0.01* (0.004)
MK	0.45* (0.04)	0.43* (0.02)	0.33* (0.03)	0.32* (0.02)	0.12* (0.03)	0.10* (0.01)	2.27* (0.76)	1.2** (0.75)	0.12* (0.03)	0.36* (0.03)
LEV	-0.009* (0.001)	-0.005* (0.001)	-0.008* (0.002)	-0.002* (0.001)	- 0.009* (0.001)	0.004* (0.001)	-0.07 (0.08)	-0.11* (0.04)	-0.009* (0.001)	-0.005 (0.007)
SGW	-0.002 (0.002)	-0.003 (0.004)	-0.01* (0.003)	-0.05* (0.003)	0.005* (0.001)	-0.01 (0.1)	0.01 (0.01)	0.07* (0.02)	0.005* (0.001)	0.03* (0.001)
$g(q_{it};\gamma,c) = 1$:										
ECSR	-	-0.003* (0.001)	-	-0.30 (0.28)	-	0.002* (0.001)		0.06** (0.04)	-	-0.003* (0.001)
Observations	780	780	728	728	403	403	442	442	2392	2392
Adjusted R^2	0.9	0.91	0.78	0.78	0.72	0.73	0.58	0.41	0.56	0.36
firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SSR_{ratio}		7.71		7.86		9.65		6.29		7.54
Parameter constancy Test		7.40 (0.39)		6.48 (0.23)		9.41 (0.29)		4.78 (0.21)		6.68 (0.46)
Note: Standard errors error are presented into parenthesis *and** indicate significance at 1 and 5%.										

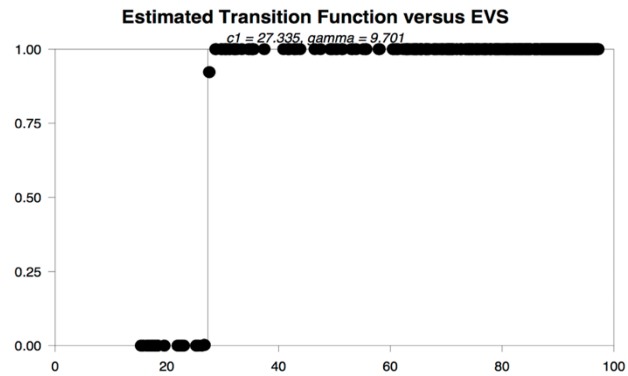

Figure 1: Estimated transition function for French firms

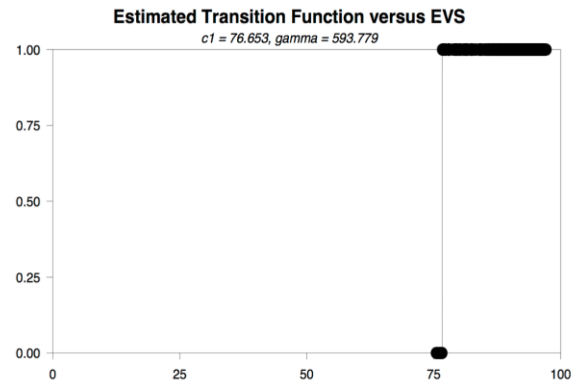

Figure 2 : Estimated transition function for German firms

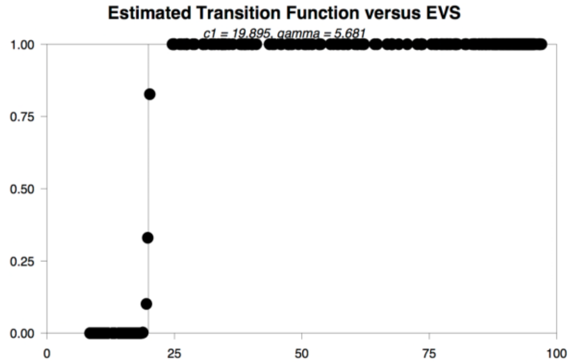

Figure 3: Estimated transition function for Italian firms

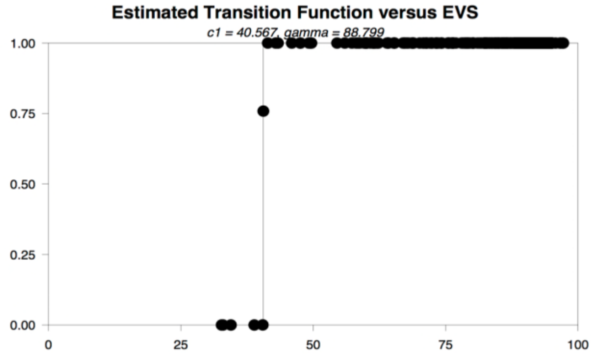

Figure 4: Estimated transition function for Spanish firms

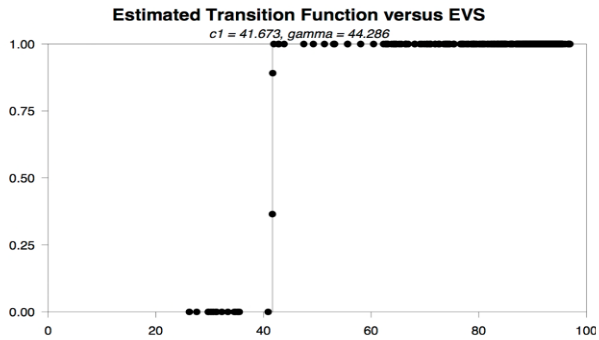

Figure 5: Estimated transition function for the panel of the firms from 4 countries

Conclusion

The relationship between environmental performance and financial performance has been one of the most widely examined in organizational studies during the past four decades. This study contributes to the existing literature by re-addressing this relationship from a novel perspective based on the exploration of the non-linearities between ECSR and FP using the Panel Smooth Transition Regression model. This study makes the case that the PSTR framework is more insightful and robust than previously used quadratic and cubic polynomial models for the estimation of the non-linearities between ECSR and FP. The threshold values of ECSR identified in our study are reasonable and occur within the range of the observed variables in the study. However, the relationship between environmental performance and financial performance is too dynamic and cannot be determined universally. Indeed, our study demonstrate that the inconclusiveness of previous study can be understandable since the link between ECSR and FP depends on a myriad of factors in the operational environment of the firms that are beyond the capacities of the management. Additionally, our results are consistent with the theoretical model of Schaltegger and Synnestvedt (2002) which predicts the possibility of various relatioships.

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