Micro-Unit Decided Sustainability

Corporate Social & Environmental Responsibility of S & P 500

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1 INTRODUCTION

Why do firms make sustainable efforts? What does it mean by a corporate to have "social responsibility" in its capacity? Following Friedman (2007)'s discussion, it means that the corporate would not be acting in representation of its own (employees') benefits. While it is tempting to conclude that strong prosocial preferences drive this decision, other motives are also possible. In a financial perspective, the investors may have optimistic risk-return expectation towards *social responsible investment* or a desire to diversify their portfolio risks, and this motivation is observed by the corporate executive.

Would there be a way that combines interests of both financial and prosocial sides? If a continual sustainable effort would produce promising long-run returns of the corporate, then this brings the endeavours devoted in firms' own interests again. This paper illustrates financial performance outcomes of corporate that is of different sustainable rankings, as it is crucial for the decision-making process of micro-units.

KEYWORDS

Corporate Social Responsibility, Financial Performance, Environmentally Sustainable, GMM, Quasi-Maximum Likelihood, Nonparametric kernel regression

2 LITERATURE REVIEW

2.1 Beginning of the Story

Earliest, classic analysis focuses on the need to establish the conceptual importance of corporate social responsibility (CSR) for firms, various perspectives can be found in Bowen (2013), and counter point of view comes from Friedman (2007) arguing that the discussion of CSR of business are notable for analytical looseness and rigor, as in Friedman (2007), a firm in legal stance are essentially an artificial person corresponding to only artificial responsibilities, but business as a whole cannot be said to have responsibilities even in vague sense since only "living people" have responsibilities, and proposing that CSR should be narrowed to the duty of its executives. These early literature's view on the need of CSR is then divided.

The literature that is in favor of CSR can be firstly found at Russo and Fouts (1997), who posited that environmental performance and financial performance are positively linked; a more recent literature by Baron (2008) which took a theoretical decomposition on firms' profits and argued that CSR is a "productive investment" for the future, specifically, high CSR rankings would be particularly useful for the firms that has the target-investors that has a social preference for social responsible firms Riedl and Smeets (2017). These can be a representative of a group of findings suggesting that CSR is a competitive advantage. As in Besley and Ghatak (2007), the motive of pursuing self-interest is the main source of views that against the efforts devoted to CSR, pointing out that a break on the promise of being sustainable will bring the decrease of profits.

2.2 Mixed Views, Mixed Results

In Benabou and Tirole (2010), the view of points on CSR can be decomposed into 3 visions:

Vision 1 (Win-win). *'doing well by doing good', advocates the fact that the pays devoting into doing good is also in favor of the business for doing well themselves.*

The first vision argues that the maximization of profits considering CSR by taking a long-term perspective. Correspondingly, "Short-termism" often implies both an intertemporal loss of profit and an externality on stakeholders.

Vision 2 (Delegated philanthropy). *The firm work as a channel for the expression of citizen values.*

A willingly forgo on the profits initiated by stakeholders that have the motivation in philanthropy, in essence, this vision is saying that firms do good on consumers' behalf.

Vision 3 (Insider-initiated corporate philanthropy)**.** *Reflects management's or the board members' own desires to engage in philanthropy.*

Coincides with Friedman (2007)'s view, philanthropy is not initiated from investors but their executives.

Vision 1 is in a perspective of long-termism that hopes the effort would pay in the future as a reward of being good, and vision 2 and 3 dissect the sources of social responsible behaviour and align the reasons to different parties. Overall, the mixed nature of CSR comes from the the multiple facets on the definition and party in interest.

The empirical tries in CSR and its relationship between FINANCIAL PERFORMANCE are also divided. Those that are finding positive relationship between the two using mata-analysis: Orlitzky, Schmidt, and Rynes (2003) which designed for the purpose of integrating the fracturing views of CSR and FP and deliver a generalisable conclusions; Margolis, Elfenbein, and Walsh (2007) found that though the effect is significant but small; The study of Barnett and Salomon (2012) suggested that firms with a higher CSR index score have better performance compared to those with a lower CSR score. For reports that specifically targeting at S & P 500 firms, Alareeni and Hamdan (2020) found that Environmental, Social and Governance disclosure (ESG) positively affects a firms' performance measures.

Compare to this group of findings, as in the findings of Fisher-Vanden and Thorburn (2011), the corporate promise to reduce environmentally harmful emission appear to negatively affect firm value maximization, further, they found that the group of firms facing climate-related shareholder resolutions and those with weak corporate governance standards are more likely to be more sustainable, this is in line with vision 2 and 3 in Benabou and Tirole (2010). Further about Alareeni and Hamdan (2020), while they measure (ESG) sub-components separately showed that environmental and corporate social responsibility disclosure is negatively associated with *returns on assets* and *returns on equity*.

This divide in the empirical findings provided rationale for us to find out the sign and evolution of CSR-FP, in Mittal, Sinha, and Singh (2008), they have proposed a U-shape relationship. In this group of literature, Han, Kim, and Yu (2016) and Nollet, Filis, and Mitrokostas (2016) both applied panel methods and quasi-maximum likelihood methods and were the first to use environmental and social disclosure data instead of composition data, specifically, Han, Kim, and Yu (2016) found U-shape relation for environment index and inverse-U-shape relation for social index in Korean stock market context, and their finding is not consistent with Nollet, Filis, and Mitrokostas (2016).

2.3 Testing of Hypothesis

Hypothesis 1 (Sign)**.** *There is linear and negative effect of environmental sustainability score to firms' financial performance.*

Hypothesis 2 (Non-Linearity)**.** *The effect of environmental sustainability score on financial performance is non-linear (quadratic).*

The initiative to construct these hypothesis is to check whether our results are consistent with the findings of literature, and also because in general the CSR-FP analysis in the literature we have reviewed usually delivered mixed results, and the goal of our following analysis is to some extent to find out the evolution of the relationship.

3 Data

As in the previous discussion, we collect two sides that constitutes the argument:

Composition of the Dataset

- ✓ Financial and operational disclosure data
- ✓ Sustainability scores in *percentile*
  - * environmentally sustainable score;
  - * socially sustainable score.

For the first counterpart, we selected conventional choices of variables that are widely adopted in the literature, namely, what one can obtained from corporate annual fiscal reports. Among which, *net income to stockholders*, *returns on equity*, *returns on asset*, *returns on capital* are what an investor would generally use for the assessment of company's financial performance. These indicators by accounting theory is strongly correlated with variables *total asset* or *total debt*, and consequently we saved these for controls.

The other counterpart conveys necessary information about the rankings of the sustainability score, as well as executives' rewards.

One limitation that our data exhibits is the lacking of financial information relevant. For this reason, we have tried to combine the financial information for the firms that we can find, and firms whose fiscal report is available may not be an exact fit of the definition of micro-units, since some of the firms even constitutes as a pillar of the local economy. However, one silver lining is that these firms, despite of their large scale, are also the main generator of environmental cost, as well as larger social impacts comparing to small and medium enterprises, and it is still valuable investigating the outcomes of their sustainable tries.

Omitted variable issue also exists in our data. For most of the cases, *returns on equity* and *total debt* are missing for some of the firms with relatively smaller scale among these S & P firms. Financial and operational related variables are all documented in per fiscal year, for no year-end data case, we fill in the entries with data points that are the closest to the chosen date. This nature of the data will create a unbalanced panel structure and post threats to unit root analysis.

The data set without fill-ins is a not strongly balanced short panel, with $T = 4$ (from 2014 to 2017), companies $N = 485$, and the data set with fill-ins is a balanced one, with $T = 4$ and companies $N = 424$. We provided the summary statistics for the with fill-ins at Table 4 and a figure of variable description along with their sources at Figure 2.

4 Econometric Specification

To estimate the determinants of important indicators, with considering that these indicators could be correlated with those of the previous year, we analyze panel data by building dynamic models, where there are 4 periods from 2014 to 2017. The basic model of company sustainable development indicators is for the following form:

$$y_{i,t} = \gamma y_{i,t-1} + \mathbf{x}'_{i,t}\boldsymbol{\beta} + \alpha_i + \varepsilon_{i,t} \quad i = 1, \ldots, N, t = 2, \ldots, T \tag{1}$$

Let $y'_{i,t}$ be the company sustainable development indicator system of ticker i in year t. The dependent variable lagged once $y_{i,t-1}$ is included in the regressors implying the causal impact of $y_{i,t-1}$ on $y_{i,t}$. The dependent variables $x'_{i,t}$ denote the determinants of assessment indice including $environmental$ and $social$ and other control variables. $\varepsilon_{i,t}$ is $iid[0, \sigma_\varepsilon]$ and α_i presents the impact of time-invariant unobserved heterogeneity of ticker i assuming to be $iid[0, \sigma_\alpha]$.

The time-series correlation in a company sustainable development indicator comes from two sources, one is the indirect effect (when γ is small) through α_i, which is individual-specific unobserved heterogeneity, and as well as a direct effect (when γ is large) through $y_{i,t-1}$. The dynamic model allows disentangling the direct and indirect sources of serial correlation. Considering that there is a correlation between α_i and $y_{i,t-1}$, the pooled-OLS estimator is inconsistent for our model.

However, when we apply fixed-effect model to get rid of α_i, the endogeneity still exists. The within-estimator will not be consistent because it relies on strict exogeneity assumptions, which is unsatisfactory in our dynamic model:

$$E\left[\varepsilon_{i,t} \mid y_{i,t}\right] = E\left[\varepsilon_{i,t} \mid \gamma y_{i,t-1} + x'_{i,t}\beta + \alpha_i + \varepsilon_{i,t} \neq 0\right]$$

Therefore, the estimation of the dynamic model with the fixed effect (within) estimator would be biased. To estimate the dynamic model consistently, we are going to use First-Difference IV Estimator by Anderson and Hsiao (1981), and IV-GMM estimator by Arellano and Bond (1991).

If $\varepsilon_{i,t}$ is serially uncorrelated for all i, then we are under the weak exogeneity assumption where $E[\varepsilon_{i,t}|y_{i,1}, ..., y_{i,t-1}] = 0$, we construct the consistent estimators through the First-Difference model for the following form:

$$\Delta y_{i,t} = \gamma \Delta y_{i,t-1} + \Delta x'_{i,t}\beta + \Delta\varepsilon_{i,t}$$

The OLS estimator of the First-Difference model is inconsistent since $\Delta y_{i,t-1}$ is correlated with $\Delta\varepsilon_{i,t}$. Suggested by Anderson and Hsiao (1981), we are going to use $\Delta y_{i,t-2}$ or $y_{i,t-2}$ as an instrument of $\Delta y_{i,t-1}$ as a solution, which is related to $\Delta y_{i,t-1}$ and irrelevant with $\Delta\varepsilon_{i,t}$, and the first 2 or 3 periods cannot be used to estimate.

Since longer lags can also be considered as instruments, we can gain in efficiency by the IV-GMM estimator. Considering that the sample variance is very likely to be different, samples with small variance should be given a larger weight, and samples with large variance are on the contrary, and the choice of empirical weighting matrix depends on the assumption of error terms. Therefore, if the error terms are *i.i.d.*, i.e. homogeneous and have no serial correlation, we perform One-Step GMM (OS-GMM), if not *i.i.d.* we need to consider Two-Step GMM (TS-GMM). In addition, We also consider a situation where the variable *total asset* is a weakly exogenous covariate said to be predetermined, since the present shocks on the financial performance indicator may impact on the future firm size.

We first apply First-Difference IV model and IV-GMM model in the linear dynamic model. As mentioned above, in order to better solve the bias problem caused by unbalanced panel with small T and ommited variable issue, then in the following sections, we will use Quasi-Maximum Likelihood methods as a further improvement. Our research process is presented at Table 1:

In the third stage, we are going to estimate the determinants according to ticker types, Green or Non-Green. We suspected that different percentile of environmental scores may lead to different strategies. For example, firm with higher ranking on *environment* may had already paid the cost of being sustainable. These companies have advanced production technology, which reduces the consumption of raw materials. The discharge of various pollutants meets the prescribed emission standards. Or through continuous improvement of production processes, energy consumption and pollution control costs are reduced, which may ultimately lead to higher returns from Green performance. In addition, we apply a weighted-sector analysis.

Table 1: STAGE TABLE

	FIRST STAGE	SECOND STAGE	THIRD STAGE		
Model	Linear Dynamic Model	Quadratic Dynamic Model	Quadratic Dynamic Model		
Specifications	Anderson-Hsiao IV Arellano-Bond GMM	Dynamic MLE	Anderson-Hsiao IV, twice differenced		
Sample	All Tickers	All Tickers	Green Tickers	Non-Green Tickers	All tickers with weight
Explanatory Variables	Lags of dependent variables, Env, Csr, Net sales, Leverage, TA, NI, Net Cash, TD	Lags of dependent variables, Env, Env^2, Csr, Csr^2, $Netsales$, Leverage, TA, NI, Net Cash, TD	Lags of dependent variables, Env, Env^2, Csr, Csr^2, $Netsales$, Leverage, TA, NI, Net Cash, TD		

Variable *net income* only for the indicator *net income to stockholders* but not for other indicators

5 EMPIRICAL RESULT

5.1 Linear Dynamic model

In the First-Difference Estimation, our over-identification test is always valid. In fact, our unbalanced short-panel data leads us to end up with only 1 observation per group, so that no matter how many variables we remove, there are always too many instrumental variables.

The results in Table 5 show that the lagged value of the indicator ROE has a significant negative impact on itself. But the other indicators did not reflect the impact of their own performances in the previous period. Our variable of interest, *environment*, has a significant negative effect on ROC and *net income to stockholders*, meaning that for every 1 increase in *environment*, ROC decreases by 0.002, while *net income to stockholders* decreases by 9.366. In addition, *net income to stockholders* is also significantly negatively affected by *social*, and positively affected by *free cash flow* and *net income*. Only the *net income to stockholders* model shows a higher goodness-of-fit result, where $R^2 = 0.6852$.

Next, to estimate the IV-GMM models, we implement a Sargan-type test of over-identifying restrictions to test the exogeneity of instruments, and a Hausman-type test of auto-correlation in first-differenced errors is applied to check the consistency of the GMM estimator, which depends on the fact of $E[\Delta\varepsilon_{i,t}, \Delta\varepsilon_{i,t-2}] = 0$. Therefore, the ideal result is that the p-value of Sargan test and $AR(2)$ test is large, while the p-value of $AR(1)$ test is < 0.05.

Table 2 the explanatory variables chosen for each model, along with the corresponding results of tests of over-identifying Restrictions & of auto-correlation.

Let's take ROE as an example. In the One-Step GMM model, when only $y_{i,t-1}$ is used as an explanatory variable, the Sargan test shows that the instrument is invalid, which means endogeneity problem. The same result is also displayed when other explanatory variables are added. $AR(1)$ in One-Step shows no autocorrelation of order 1, also implying that residuals are significantly serially correlated, contrary to what we would expect. And since we only have 4 periods, we cannot get the result of $AR(2)$. No matter how we adjust the composition of variables in the OS-GMM of ROE, we have no way of addressing its endogeneity. However, in the TS-GMM model of ROE, the instruments are valid, although there is still no autocorrelation of order 1.

We also have cases where the endogeneity problem is resolved by removing variables. In the GMM model of ROA, whether it is One-Step or Two-Step, when only $ROA_{i,t-1}$ is used as a variable, all the control variables are valid. However, after adding all the remaining variables, we reject the validity of the instruments. So the vacant cell is the variable we removed, and by

Table 2: Instruments & Model Validity

Tests of Overidentifying Restrictions & Tests of Autocorrelation																
Indicator	ROE				ROA				ROC				NIStockholders			
Control Variables	One-Step GMM		Two-Step GMM		One-Step GMM		Two-Step GMM		One-Step GMM		Two-Step GMM		One-Step GMM		Two-Step GMM	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Env	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
Csr	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
Sales	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
Risk	-	O	-	O	-		-		-	O	-	O	-	O	-	O
TA	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
NI	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	O
FCF	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
TD	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
Year4	-	O	-	O	-	O	-	O	-	O	-	O	-	O	-	O
Sargan Test	Invalid		Valid		Valid		Valid		Invalid		Valid		Invalid		Valid	
AR(1)	No	No	No	No	No	No	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
AR(2)	No results of AR(2) as there are only 4 periods															

Selected variables are denoted by "O" in each model, and unused variables are denoted by "-". All (1) columns have a whole list of "-", indicating that only the $y_{i,t-1}$ is used as an explanatory variable in a model.

removing $risk$, the test finally shows exogeneity. However, we have no solution to solve the endogeneity problem for the other invalid models.

All of the Ts-Gmm's instruments are valid, which is the advantage it shows compared to our Os-Gmm. Unfortunately, however, almost all models in the Ts-Gmm show no first-order serial correlation in first differences, except for *net income to stockholders*, whose Ts-Gmm is the best performing model in both tests, the instruments are valid and there is autocorrelation of order 1. We expect there is no autocorrelation of order 2, however our data cannot support us for applying $AR(2)$ test. Although our results suffered from a short study period, we are able to draw tentative conclusions according to our results. We will show the results of all column(2) models in Table 6. For the above reasoning, in the following analysis, we will focus on Ts-Gmm.

In our GMM estimation, there are maximum 2 observations per group. The IV-GMM estimation in Table 6 shows that both ROE and ROC were significantly negatively affected by their lagged forms. Compared with First-Difference IV estimation, *environment* has a negative impact on ROA besides ROC. And ROA was also significantly negatively affected by *social* in Ts-Gmm, although this significance was not shown in Os-Gmm. In the Ts-Gmm estimation, we also noticed that the ROC will decrease by 0.548 for every 1 increase in risk. The results of *net income to stockholders* is quite different from those in First-Difference IV estimation. The effects of *environment* and *social* lose their significance, and the sales is significantly negative, but the same is that the positive effect of *net income* is still significant, and the magnitude is quite similarly small.

When we apply GMM with *total asset* as a weakly exogeneous covariate, in Table 7, *environment* is hardly significant in all models except One-Step model of ROA and ROC. Similar to the previous results, ROE and ROC are negatively affected by its lag term, and *net income* still has a positive effect on *net income to stockholders*. And *sales revenue return* is significant positive in Ts-Gmm of ROA.

Based on our original linear First-Difference model, we simply add Env^2 and Csr^2 to build the quadratic model. The regression results using quadratic specification is displayed in Table 8. Compared with the linear form, the Quadratic dynamic First-Difference IV Estimation does not actually improve R^2 as much as we expected. And neither Env nor Env^2 is significant. Similar to the previous results, the lagged term of ROE has a significant negative effect on itself at time t. There are many significant results in the *net income to stockholders* model. For every 1 increase in CSR, *net income to stockholders* will decrease by 27.408. The *free cash flow* variable in this model shows similar behavior to its linear model, and so does *net income*.

5.2 Quasi-Maximum Likelihood Methods

Reasons for the use of QML is twofold. Ordinary least-squares(OLS) or generalized least-squares (GLS) estimators for random-effects or fixed-effects models that condition on the initial observations yield biased estimates because of the correlation of the lagged dependent variable with the combined error term. The motive of circumventing this bias provides the incentive to apply quasi-maximum likelihood(QML) and by modeling the unconditional likelihood function instead of conditioning on the initial observations. Another nice feature that comes with the method is that, by Bhargava and Sargan (1983), estimators provided by QML can accommodate when data has a unbalanced structure.

5.2.1 Alternative Specification

Slightly different from the model specification we had in Equation 1, the following model specification comes with a combined error term:

$$y_{it} = \lambda y_{i,t-1} + \mathbf{x}'_{it}\boldsymbol{\beta} + \epsilon_{it} \tag{2}$$
$$\epsilon_{it} = u_i + e_{it} \tag{3}$$

The combined error term consists of time-invarying, unit-specific error u_i and an idiosyncratic component e_{it}. For a dynamic fixed-effect model, where we allow for every independent variable to be correlated with u_i, we do a first differencing transformation to remove the unit-specific error component on Equation 2:

$$\Delta y_{it} = \lambda \Delta y_{i,t-1} + \Delta \mathbf{x}'_{it}\boldsymbol{\beta} + \Delta e_{it} \tag{4}$$

5.3 Estimation of Maximum Likelihood

For an unbalanced structure, workhorse tests for panel unit root such as Harris-Tzavalis cannot be performed, instead, we use FISHER test for panel, which uses an augmented dicker fuller test, with lag 1. With the null:

$$H_0: \quad \text{All panels contain unit roots.}$$

The p-value for models suggesting that for all financial performance indicators being considered, we cannot reject the null. The problem of unit root long existing in the panels.

For the goal of preventing the explosive cases or spurious regressions, we cannot work with the original series of *returns on equity* etc. without differencing them. Due to the number of periods available, we consider taking the first-order difference and use it in Equation 4, and the resulting specification is therefore involves with the analysis of second-differences variables:

$$\Delta\Delta y_{it} = \lambda \Delta\Delta y_{i,t-1} + \Delta\Delta \mathbf{x}'_{it}\boldsymbol{\beta} + \Delta\Delta e_{it} \tag{5}$$

The estimation result is given in Table 9. From the table, the effect of environmental rankings improvement and its squared term on *return on equity* is proved to be significant, moreover, the sign of the coefficients on *environment* and $environment^2$ suggests an inverse-U shape. In later stage when we implement nonparametric kernel regression, this finding is again validated, as depicted in Figure 1(a). For *returns on asset* and *returns on capital*, the adding of square terms though have improved the fit, the parameters are not significant.

However, this differencing strategy comes with a cost, for one, the sample size further shrinks, only $N = 844$ were used as comparing to the original sample size approximately 1800 entries, which posts threats to the consistency of our estimator, and on the other side, specification in Equation 4 can at most afford two-times differencing.

5.3.1 Goodness of Fittings

To test for the Hypothesis of a quadratic specification, we performed likelihood ratio tests for the three models, all three models suggest that under the null that:

H_0 The without-squared-term specification is nested within the with-squared-term specification.

Testing results are displayed in Table 3, as indicated, in comparison to without-squared-term added specification, we are in favor of a with-squared-term specification.

Financial Performance Indicators	$\chi^2(6)$	p-value
Net Income to Stockholders	3.34	0.7657
Returns on Capital	6.44	0.3753
Returns on Asset	8.04	0.2349
Returns on Equity	8.16	0.2268

Table 3: LIKELIHOOD RATIO TEST

6 SUB-SAMPLE ANALYSIS

6.1 Green-Sub-Sample Analysis

The estimation for green and non-green tickers is based on the quadratic model.

Overall, *environment*, *corporate* and their squared forms for Green and Non-Green tickers are almost insignificant, while *net income* still shows a positive effect on *net income for stockholders* as before. The $ROE_{i,t-1}$ of Green tickers has a significant negative impact on $ROE_{i,t}$, and none of the indicators in non-green is related to itself at $t-1$. An interesting point is that the *risk* has a significant negative impact on indicators, -0.337 and -0.298 on ROA and ROC, respectively, while green tickers has no such concern. This shows that green companies are more financially stable. *free cash flow* is significantly positive for ROA and ROC of Non-Green tickers, and no impact on those of Green tickers.

6.2 Weighted by Natural Resource Usage

As we suspect that S & P 500 companies distributed in different sectors, and environmental cost in different sectors may be associated with lower or higher level of environmental cost, we would like to weight our sample by a weight that indicates this difference.

A good choice for this construction of weights can be found at S&P North American Natural Resources Sector Index, and since this is not available to us, we instead choose a natural resource usage average weights provided by Baron (2008). This Baron Energy and Resource Fund statistics [2] provided the performance attrition of natural resources in 5 different sectors, [3] energy, utilities, information technology, industrial and materials, these 5 sectors' weights in total takes up to 93.22 % of the total natural resource usage. In total, we have 16 sectors in the data set, we created an indicator, *baron*; after assigning weights for the 5 sectors, we equally

[2] we used year 2015 as our study span 2014 to 2017.

[3] the classification method of the sector is aligned with our data set's classification, both by GICS Sectors.

divide the rest of the weights among other 11 sectors, each to 0.616.

The stata command `aweight` are available for dynamic fixed effect model. The sign and the magnitude of parameters do not show inconsistency with the estimation results of our main specification, though mostly not significant; this may suggest there is no sector-heterogeneity in the *environment* score. One limitation to be noted here is, Baron Energy and Resource Fund statistics only include U.S. firms, and our sample include multiple international firms.

7 NONPARAMETRIC FITTING

Though in Section 4 and 5 we have concluded that the results are in favor of a model specification with squared terms of *environment* and *social*, we cannot yet completely posit that there is indeed a linear or quadratic relationship between CSR-FP, or to exactly depict the shape of the evolution between financial performance indicator and CORPORATE SOCIAL RESPONSIBILITY. The previous findings had motivated us to try a nonparametric kernel regression on the data.

Without the constraint of a fixed functional form, we proposed that financial performance indicator y_{it} satisfies:

$$y_{it} = g(\mathbf{x}_{it}) + \varepsilon_{it} \tag{6}$$

where $\mathbf{x}_{it}$ are a list of controls, including the main variable of interest, *environment* and *social*. The other controls we adopted are consistent with previous model setup, i.e., *total asset*, *risk*, *free cash flow*, *sales revenue returns* and *total debt*.

For nonparametric regression settings, we used the conventional choice of epanechnikov kernel and collected the bootstrap standard errors, and replicate the fitting for 5 times. [4]

7.1 Empirical Results of Nonparametric Regression

The fitting results can be summarised in Table 10.

From Table 10, the first panel of *Mean* introduces the average predictive value for the dependent variable, and we can only conclude that the *social* percentile of the firm has a significant negative impact on firm's *returns on capital*, approximately -0.0002. The goodness of fit for model net income for stockholders (Column (4)) is relatively higher, but for the rest of the model, the goodness of fit cannot exceed 0.2.

To be more lucid on the point, we also provided the illustration of marginal effects of *environment* percentile on four main financial performance indicator, as shown in Figure 1. How much would financial performance been improved if the firm's rankings or percentile improved by 10 percent? Except for the case of *returns on equity*, which has an inverse-U-shape on the changes of marginal effect, the other cases all had shown to have a U-shape evolution on effects. Moving towards a higher ranking in terms of being more sustainable, the marginal effects on financial performance will decrease before the firm reaches 50^{th} percentile, and will pick up once the firm is a green firm. Moreover, fluctuations are observed at 20^{th} to 30^{th} percentile.

A common trend that we can observe for Figure 1(b), 1(c) and 1(d) is that, the evolution of marginal effects can be described as the combination of an inverse-U-shape and a standard-U-shape.

[4] In general a number of replication that is approximately 50 is ideal, though it is computationally costly in this case, and we have tried increased the number of replicates, the results do not show significant differences after 5.

8 Conclusion

We have applied multiple methods on the analysis of four models, namely, model *returns on equity*, model *returns on asset*, model *returns on capital* and model *net income to stockholders*, we summarised our key findings in the following conclusion box:

Conclusion Box: Key Findings

- The effects of sustainable scores (*environment*, *social*) on S & P 500 firms' Fp are margin, magnitudes are small, this finding is consistent with the literature.
- In terms of sign, the result on financial indicator *returns on equity*, comparing to *returns on assets* and *returns on capital*, throughout different methods of Fdiv, Os-gmm, Ts-Gmm, Qmle, Nonparametrics, are usually different.
- In terms of validity of instruments, Ts-Gmm out-performs Os-gmm.
- In linear dynamic models, *environment*, *social* in Fdiv are all negative, especially for indicator *net income stockholders*. For GMM Estimation part, focus on Ts-Gmm as the instruments are almost not valid in Os-Gmm, the signs of *environment*, *social* are negative for *returns on assets* and *returns on capital*. While considering *total asset* as a weakly exogenous covirate, their signs remain negative.
- We cannot accept the null that the relationship of Csr-Fp is linear, and ergo not able to posit on the sign in this setup. Though under linear specification, we can tentatively summarise that the sign is mostly negative on sustainable scores.
- Likelihood ratio tests suggest that we are more in favor of a non-linear specification.
- Combining the results of Qmle and nonparametric kernel regressions, we can posit that there an inverse-U shape between *returns on equity* and *environment*.

References

Alareeni, Bahaaeddin Ahmed and Allam Hamdan (2020). "ESG impact on performance of US S&P 500-listed firms". In: *Corporate Governance: The International Journal of Business in Society*.

Anderson, T. W. and Cheng Hsiao (1981). "Estimation of Dynamic Models with Error Components." In: *Journal of the American Statistical Association* 76(375), pp. 598–606.

Arellano, Manuel and Stephen Bond (1991). "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations". In: *Review of Economic Studies* 58, pp. 277–297.

Barnett, Michael L and Robert M Salomon (2012). "Does it pay to be really good? Addressing the shape of the relationship between social and financial performance". In: *Strategic Management Journal* 33(11), pp. 1304–1320.

Baron, David P (2008). "Managerial contracting and corporate social responsibility". In: *Journal of Public Economics* 92(1-2), pp. 268–288.

Benabou, Roland and Jean Tirole (2010). "Individual and corporate social responsibility". In: *Economica* 77(305), pp. 1–19.

Besley, Timothy and Maitreesh Ghatak (2007). "Retailing public goods: The economics of corporate social responsibility". In: *Journal of public Economics* 91(9), pp. 1645–1663.

Bhargava, Alok and J Dennis Sargan (1983). "Estimating dynamic random effects models from panel data covering short time periods". In: *Econometrica: Journal of the Econometric Society*, pp. 1635–1659.

Bowen, Howard R (2013). *Social responsibilities of the businessman*. University of Iowa Press.

Fisher-Vanden, Karen and Karin S Thorburn (2011). "Voluntary corporate environmental initiatives and shareholder wealth". In: *Journal of Environmental Economics and management* 62(3), pp. 430–445.

Friedman, Milton (2007). "The social responsibility of business is to increase its profits". In: *Corporate ethics and corporate governance*. Springer, pp. 173–178.

Han, Jae-Joon, Hyun Jeong Kim, and Jeongmin Yu (2016). "Empirical study on relationship between corporate social responsibility and financial performance in Korea". In: *Asian Journal of Sustainability and Social Responsibility* 1(1), pp. 61–76.

Margolis, Joshua D, Hillary Anger Elfenbein, and James P Walsh (2007). "Does it pay to be good? A meta-analysis and redirection of research on the relationship between corporate social and financial performance". In: *Ann Arbor* 1001(48109-1234), pp. 1–68.

Mittal, RK, Neena Sinha, and Archana Singh (2008). "An analysis of linkage between economic value added and corporate social responsibility". In: *Management Decision*.

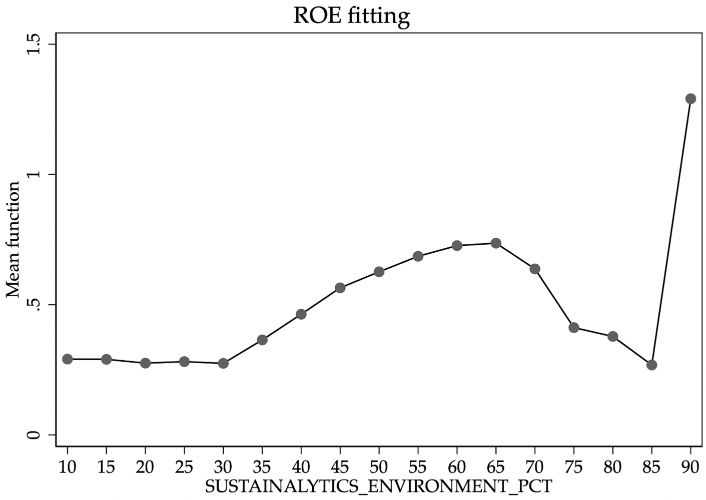
Nollet, Joscha, George Filis, and Evangelos Mitrokostas (2016). "Corporate social responsibility and financial performance: A non-linear and disaggregated approach". In: *Economic Modelling* 52, pp. 400–407.

Orlitzky, Marc, Frank L Schmidt, and Sara L Rynes (2003). "Corporate social and financial performance: A meta-analysis". In: *Organization studies* 24(3), pp. 403–441.

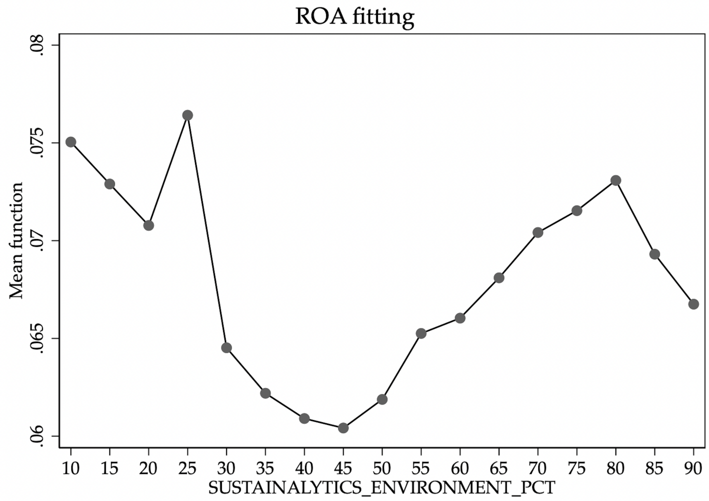
Riedl, Arno and Paul Smeets (2017). "Why do investors hold socially responsible mutual funds?" In: *The Journal of Finance* 72(6), pp. 2505–2550.

Russo, Michael V and Paul A Fouts (1997). "A resource-based perspective on corporate environmental performance and profitability". In: *Academy of management Journal* 40(3), pp. 534–559.

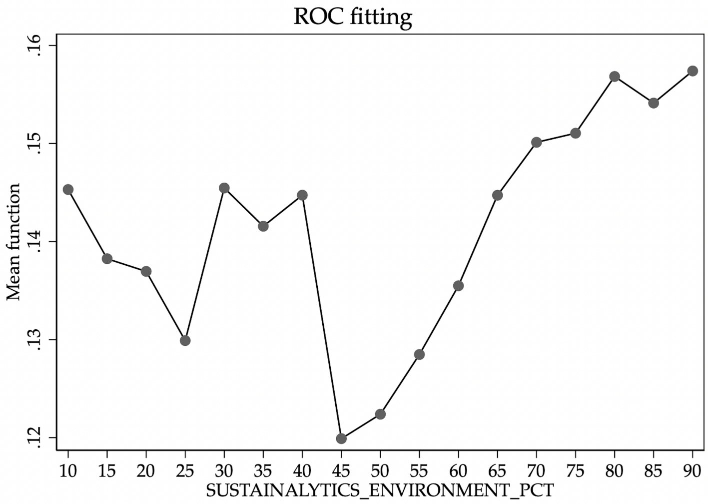
9 ANNEX



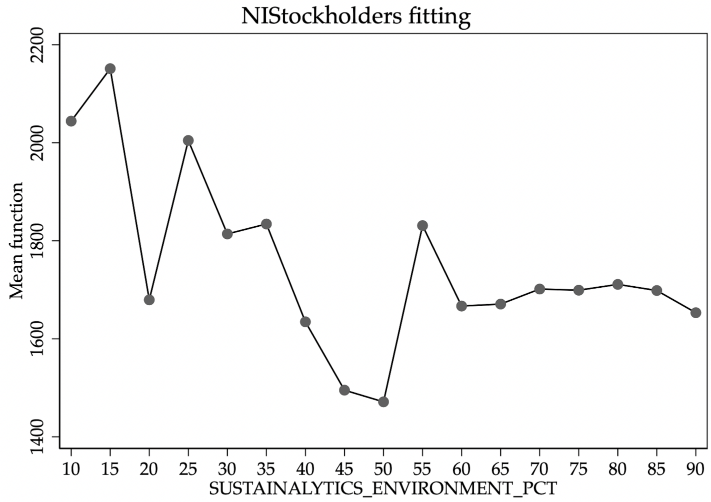
(a) returns on equity



(b) returns on asset



(c) returns on capital



(d) Net income to shareholders

Figure 1: MARGINAL EFFECTS of *environment* on Financial Performance Indicator

Table 4: SUMMARY STATISTICS OF MAIN VARIABLES

	N	Mean	S.D.	Min	Max
returns on asset	1696	.0528127	.167855	-3.725	1.043
returns on equity	1695	.4733664	7.597829	-13.01	304.235
returns on capital	1688	.1377319	.3146837	-7.822	2.533
net income to holders	1696	2045.848	4728.896	-12896	53394
free cash flow	1696	558.9569	1385.142	-3927.4	20442.4
total asset	1696	69374.28	223990.7	-513	2572274
asset turnover	1680	.7343226	.6821003	0	5.91
total debt	1696	16955.89	54715.59	0	692582
risk	1694	1.084302	17.28761	-12.7193	634.5
sales revenue return	1696	5727.148	10261.13	132.7802	123753
environment	1696	49.53435	27.70006	0	99.62508
social	1696	49.40245	26.78734	0	100

Figure 2: SUMMARY OF VARIABLES USED IN THE DATASET

	Variable (Name)	Label	Source
Sustainability Score (Percentile)	***social*** (SOCIAL)	Ranking, disclosure on energy use, waste, pollution, natural resource conservation and animal treatment.	GH
	environmental (ENVIORNMENT)	Ranking, disclosure of business relationships, donation, volunteer work, employees' health and safety.	GH
Main Control Variables	***firm size*** (TA)	Measured by the total assets of the firm (i), in the period (t).	FB
	total debt (TD)	as named.	FB
	total liability (TL)	as named	GH
	total equity (TE)	Total assets (***firm size***) deducted by total liability.	Calculated
	net income (NI)	as named.	GH
	risk (risk)	Financial leverage, measured by total debt to total assets (***firm size***) of the firm (i), in the period (t).	Calculated
	asset turnover (AT)	Measured by net sales as a percentage of total assets.	FB
	sales revenue returns (SALESRM)	as named.	GH
	free cash flow (FCF)	as named.	GH
	CEO compensation (TOT_STK_AWARDS_GIVEN_TO_EXECS)	Total amount of stocks in terms of real value that is rewarded to the corperate's executive.	GH
Financial Performance Indicator	***net income to stockholders*** (NIStockholders)	as named.	FB
	return on equity (ROE)	equals net income divided by firm size (TE) of the firm (i), in the period (t).	FB
	return on asset (ROA)	equals net income divided by firm size (TA) of the firm (i), in the period (t).	FB
	return on capital (ROC)	equals net income divided by firm size (TC) of the firm (i), in the period (t).	FB
	GICSSector (sector1-15)	Global Industry Classification Standard Sector, 15 sectors included.	GH
	Baron Energy and Resources Fund (baron)	Average weighted performance attribution by ***GICSSectior,*** weighted natural resource usage.	Constructed

Table 5: LINEAR FIRST-DIFFERENCE IV ESTIMATION

	(1) d.ROE	(2) d.ROA	(3) d.ROC	(4) d.NIStockholders
LD.ROE	-0.953***			
	(0.0111)			
D.ENVIRONMENT	-0.0117	-0.00164	-0.00243*	-9.366**
	(0.00897)	(0.00442)	(0.00130)	(4.137)
D.SOCIAL	0.0115	-0.000803	-0.00138	-5.095*
	(0.0153)	(0.000556)	(0.00101)	(2.884)
D.SALESRM	-0.00000562	0.00000844*	0.00000118	-0.139
	(0.0000429)	(0.00000485)	(0.00000799)	(0.157)
D.risk	0.717	0.155	1.631	281.8
	(0.687)	(0.570)	(1.675)	(824.0)
D.TA	0.000000130	-4.63e-08	0.00000100	-0.00646
	(0.00000319)	(0.000000276)	(0.00000128)	(0.00772)
D.FCF	-0.00000330	-0.00000166	0.0000324	0.365**
	(0.0000416)	(0.00000499)	(0.0000232)	(0.186)
D.TD	-0.00000577	-0.000000867	-0.0000121	0.0578
	(0.00000448)	(0.00000285)	(0.0000102)	(0.0352)
D.yr4	0.150	-0.00264	-0.00136	-9.548
	(0.125)	(0.0102)	(0.0141)	(88.90)
LD.ROA		0.385		
		(2.272)		
LD.ROC			-0.473	
			(0.330)	
LD.NIStockholders				0.126
				(0.218)
D.NI				3.973***
				(0.343)
N	390	403	384	409
R^2	0.1753	0.0679	0.0140	0.6852

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: GMM ESTIMATION

	One-Step GMM				Two-Step GMM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROE	ROA	ROC	NIStockholders	ROE	ROA	ROC	NIStockholders
L.ROE	-0.869***				-0.838***			
	(0.0632)				(0.0867)			
ENVIRONMENT	0.100	-0.000605*	-0.00118**	-2.413	-0.0180	-0.000495**	-0.00134***	0.197
	(0.110)	(0.000315)	(0.000560)	(3.491)	(0.0172)	(0.000247)	(0.000469)	(2.796)
SOCIAL	0.00531	-0.000512*	0.000139	0.663	0.00546	-0.000432*	-0.000337	0.410
	(0.00860)	(0.000263)	(0.000391)	(1.990)	(0.00833)	(0.000224)	(0.000279)	(1.997)
SALESRM	-0.000113	0.00000435	0.00000279	-0.122	0.00000588	0.00000414	0.00000626*	-0.140*
	(0.000123)	(0.00000353)	(0.00000360)	(0.0930)	(0.0000451)	(0.00000269)	(0.00000323)	(0.0844)
risk	-0.242		0.0820	-148.3	1.097		-0.548**	-143.1
	(1.408)		(0.448)	(144.2)	(0.901)		(0.261)	(144.6)
TA	0.00000874	4.18e-08	-0.00000125	-0.00510	0.000000361	4.27e-08	-0.00000157	-0.00382
	(0.00000840)	(0.000000107)	(0.00000131)	(0.00643)	(0.00000313)	(1.00e-07)	(0.00000126)	(0.00618)
FCF	0.0000624	0.00000244	0.0000224	0.115	0.0000193	0.00000209	0.00000613	0.0922
	(0.0000586)	(0.00000177)	(0.0000141)	(0.124)	(0.0000407)	(0.00000174)	(0.0000111)	(0.0998)
TD	-0.0000162	-0.000000572*	-0.00000238	0.00751	-0.00000343	-0.000000651**	0.00000260	-0.00181
	(0.0000151)	(0.000000316)	(0.00000396)	(0.0256)	(0.00000793)	(0.000000289)	(0.00000279)	(0.0211)
yr4	0.507	-0.00102	-0.00592	21.29	0.149	0.000676	-0.0146	15.44
	(0.410)	(0.00482)	(0.0189)	(59.82)	(0.107)	(0.00617)	(0.00930)	(53.69)
L.ROA		-0.109				-0.0357		
		(1.876)				(1.296)		
L.ROC			-0.567*				-0.944*	
			(0.334)				(0.530)	
L.NIStockholders				-0.0167				-0.0397
				(0.120)				(0.106)
NI				3.900***				3.957***
				(0.179)				(0.176)
N	813	839	796	849	813	839	796	849
$Sargan, Prob > chi2$	0.0004	0.3297	0.0012	0.0001	0.3715	0.8405	0.1440	0.3688
$AR(1), Prob > z$	0.2879	0.4806	0.0007	0.0000	0.2501	0.5524	0.9488	0.0043

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: GMM Estimation with TA as a weakly exogenous variable

	One-Step GMM				Two-Step GMM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROE	ROA	ROC	NIStockholders	ROE	ROA	ROC	NIStockholders
L.ROE	-0.869***				-0.843***			
	(0.0636)				(0.0834)			
TA	0.00000362	-0.000000176	-0.000000829	-0.00935	-0.00000230	-0.000000109	-0.00000115	-0.00222
	(0.00000664)	(0.000000911)	(0.00000229)	(0.0115)	(0.00000503)	(0.000000498)	(0.00000348)	(0.0115)
ENVIRONMENT	0.100	-0.000611*	-0.00115**	-2.831	-0.0140	-0.000452	-0.000586	-0.195
	(0.110)	(0.000348)	(0.000532)	(3.325)	(0.0181)	(0.000286)	(0.000453)	(2.609)
SOCIAL	0.00521	-0.000515*	0.000147	0.181	0.00225	-0.000330	-0.000448*	0.504
	(0.00860)	(0.000284)	(0.000401)	(1.869)	(0.00912)	(0.000374)	(0.000236)	(1.906)
SALESRM	-0.000105	0.00000461	0.00000224	-0.0866	0.0000150	0.00000452***	0.00000526	-0.0669
	(0.000120)	(0.00000496)	(0.00000402)	(0.0876)	(0.0000489)	(0.00000157)	(0.00000741)	(0.0640)
risk	-0.294		0.0964	-230.9	0.965		-0.305	-141.0
	(1.447)		(0.452)	(159.3)	(0.903)		(0.311)	(163.3)
FCF	0.0000613	0.000000275	0.0000226	0.120	0.00000592		0.0000211*	0.0723
	(0.0000710)	(0.00000486)	(0.0000153)	(0.140)	(0.0000412)		(0.0000120)	(0.109)
TD	-0.0000117	-0.000000446	-0.00000319	0.0157	0.000000904	-0.000000527	0.000000375	-0.00565
	(0.0000125)	(0.00000115)	(0.00000519)	(0.0281)	(0.00000855)	(0.00000134)	(0.00000646)	(0.0262)
yr4	0.494	-0.000545	-0.00521	13.63	0.101	0.000349	0.000817	14.98
	(0.394)	(0.00591)	(0.0175)	(57.40)	(0.116)	(0.00336)	(0.00767)	(51.90)
L.ROA		-0.112				-0.0234		
		(1.699)				(0.586)		
L.ROC			-0.553*				-0.589*	
			(0.318)				(0.328)	
L.NIStockholders				-0.0775				-0.0760
				(0.115)				(0.109)
NI				3.839***				3.810***
				(0.180)				(0.174)
N	813	839	796	849	813	839	796	849
$Sargan, Prob > chi2$	0.0130	0.6677	0.0313	0.0000	0.7459	0.1215	0.1048	0.3733
$AR(1), Prob > z$	0.2859	0.4632	0.0004	0.0000	0.2741	0.4019	0.4124	0.0046

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: QUADRATIC FIRST-DIFFERENCE IV ESTIMATION

	(1) d.ROE	(2) d.ROA	(3) d.ROC	(4) d.NIStockholders
LD.ROE	-0.954***			
	(0.0117)			
D.ENVIRONMENT	-0.0395	0.00201	0.00310	1.190
	(0.0357)	(0.00591)	(0.00327)	(11.89)
D.ENVIRONMENT2	0.000312	-0.0000354	-0.0000544	-0.127
	(0.000311)	(0.0000974)	(0.0000404)	(0.118)
D.SOCIAL	0.0366	0.00105	0.00226	-27.41***
	(0.0439)	(0.00350)	(0.00138)	(9.633)
D.SOCIAL2	-0.000301	-0.0000194	-0.0000395*	0.262**
	(0.000345)	(0.0000399)	(0.0000210)	(0.124)
D.SALESRM	-0.0000145	0.00000843*	0.00000100	-0.130
	(0.0000512)	(0.00000482)	(0.00000762)	(0.152)
D.risk	0.469	0.144	1.580	487.1
	(0.519)	(0.547)	(1.641)	(837.5)
D.TA	0.00000157	-4.90e-09	0.00000111	-0.00762
	(0.00000334)	(0.000000236)	(0.00000138)	(0.00743)
D.FCF	0.00000483	-0.000000808	0.0000343	0.359**
	(0.0000422)	(0.00000497)	(0.0000242)	(0.181)
D.TD	-0.00000982	-0.000000750	-0.0000118	0.0602*
	(0.00000876)	(0.00000298)	(0.0000101)	(0.0350)
D.yr4	0.167	-0.00424	-0.00453	-14.48
	(0.137)	(0.0134)	(0.0140)	(88.97)
LD.ROA		0.331		
		(1.947)		
LD.ROC			-0.482	
			(0.327)	
LD.NIStockholders				0.130
				(0.216)
D.NI				3.964***
				(0.335)
N	390	403	384	409
R^2	0.1748	0.0466	0.0181	0.6929

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: QUASI-MAXIMUM LIKELIHOOD ESTIMATION, DIFFERENCED

	(1) $\Delta\Delta$ROA	(2) $\Delta\Delta$ROE	(3) $\Delta\Delta$ROC
$\Delta\Delta\text{ROA}_{t-1}$	0.325***		
	(0.0718)		
$\Delta\Delta\text{ROE}_{t-1}$		0.0535*	
		(0.0214)	
$\Delta\Delta\text{ROC}_{t-1}$			0.225***
			(0.0438)
$\Delta\Delta$environment	0.00230	0.653**	0.00340
	(0.00206)	(0.249)	(0.00759)
$\Delta\Delta$sqenvironment	-0.0000338*	-0.00649**	-0.0000307
	(0.0000201)	(0.00242)	(0.0000739)
$\Delta\Delta$social	-0.0000476	0.211	0.00893
	(0.00192)	(0.232)	(0.00707)
$\Delta\Delta$sqsocial	-0.00000208	-0.00136	-0.000107
	(0.0000198)	(0.00239)	(0.0000731)
$\Delta\Delta$RISK	0.0000870	-0.00296	-0.00239
	(0.000572)	(0.0691)	(0.00210)
$\Delta\Delta$TA	6.88e-08	-0.00000113	-0.00000153
	(0.000000833)	(0.000101)	(0.00000326)
$\Delta\Delta$fcf	0.00000407	0.000292	-0.0000259
	(0.0000101)	(0.00123)	(0.0000380)
$\Delta\Delta$TD	3.79e-08	0.0000287	-0.000000386
	(0.00000207)	(0.000250)	(0.00000783)
Δyr3	0.0108	1.484	-0.0408
	(0.0120)	(1.448)	(0.0441)
σ			
_cons	0.0297***	432.7***	0.401***
	(0.00297)	(31.19)	(0.0327)
ω			
_cons	0.634***	0.521***	0.573***
	(0.0235)	(0.00228)	(0.00955)
N	846	844	842

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: NONPARAMETRIC KERNEL REGRESSION

	(1) ROE	(2) ROA	(3) ROC	(4) NIStockholders
Mean				
ROE	0.443***			
	(0.124)			
ROA		0.0581***		
		(0.00422)		
ROC			0.132***	
			(0.00570)	
NIStockholders				1703.7***
				(88.81)
Effect				
environment	0.00909	0.000197	0.000579	0.144
	(0.0102)	(0.000158)	(0.000426)	(3.174)
social	-0.00736	-0.000147	-0.000249*	1.086
	(0.00923)	(0.000146)	(0.0000997)	(3.566)
RISK	0.221	-0.0132	0.00252	-1525.5
	(0.649)	(0.0193)	(0.00580)	(1106.8)
TA	-0.0000102	-0.000000541***	-0.000000114	0.00608
	(0.00000672)	(3.82e-08)	(8.86e-08)	(0.00530)
FCF	0.00115	0.0000668***	0.0000225*	2.081***
	(0.000697)	(0.00000588)	(0.00000932)	(0.182)
TD	0.00000278	-0.000000534	0.000000237	0.0365**
	(0.0000185)	(0.000000694)	(0.000000217)	(0.0139)
N	1620	1621	1613	1621
R^2	0.0348	0.1758	0.1004	0.8388

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$