This is the title of my thesis

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Abstract

This is an abstract

Aknowledgments

I would like to thank some of you . . .

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Introduction

Over the past decades, humanity is progressively becoming aware of the finiteness of earth's resources and its impact on the current global warming. On the one hand, Houghton and Change (1996) anticipated in their first report an average global warming between +1° and +3.5° C until 2100 relative to the temperature of 1990. They also warned that an increase of temperatures superior to +2° C could have some harsh climatic repercussions. On the other hand the Kyoto Protocol had been written in 1997, enforced in 2005 and led to the first Global Agreement on global warming during the Paris Conference in 2015. Those different solutions implemented over the past decades did not have any significant impacts on the fight against global warming. Greenhouse Gas Emissions (GGE) have still increased considerably across years. Although the environmental consciousness-raising had already gained ground, according to Jean Jouzel (2017) human being have to act now if he we want to have a chance to reduce effects of climate change.

For the last several decades, companies have been more and more considered as entities responsible for stewardship of the natural environment (Majumdar and Marcus 2001; Przychodzen and Przychodzen 2015). Ecosystem degradation and resources depletion engender a threat to firm's longevity (Dowell, Hart, and Yeung 2000), and as a reaction, firms have to pro-actively adopt an environmental strategy (Hart 1995). In his speech at Lloyds of London 2015, Mark Carney, Governor of the Bank of England and Chair of the Financial Stability Board (FSB), identified climate change as one of the most material threats to financial stability (Elliott 2015). To this end, companies facing higher risks associated to climate change are ones subject to greater incentives to develop green strategies (Hoffman 2005). However, both economic benefits and strategic opportunities deriving from sustainable development are usually underestimated by managers and still too many companies do not feel concerned about global warming (Berchicci and King 2007; Hart 1995). Moreover, according to Scarpellini, Valero-Gil, and Portillo-Tarragona (2016), green projects are not common in companies of many countries because of significant barriers and a negligible culture of excluding sustainable development from an organization's strategy. If we consider that people's actions reflect a variable mix of altruistic motivation, material self-interest, and social or self-image concerns (Bénabou and Tirole 2006), demonstrating that green development is a significant interest for firms could be a serious step forward in the fight against global warming.

To be continued...

1 Literature Review

According to...

- The link between CEP and CFP. Literrature have shown that it pays to be green. However answering the question "When an how does it pay to be green?" remains unclear.
- Citation from (Endrikat, Guenther, and Hoppe 2014)

  > Over the last four decades, myriad studies have sought to identify the relationship between these performance constructs. In this context, one of the most fundamental issues shaping research on the focal relationship refers to the direction of causality (i.e., whether CEP influences CFP, whether CFP influences CEP, or whether there is a bidirectional relationship) ## Subsection 1

-

1.1 Subsection 2

2 Hypotheses

Here are my three hypotheses based on Li, Ngniatedema, and Chen (2017) and Chen, Ngniatedema, and Li (2018) :

- **H1:** The higher the level of green initiatives (Pay Link, Sustainability Themed Committee and Audit), the higher the level of green performance (Energy Productivity, Carbon Productivity, Water Productivity, Waste Production and Green Revenue).
- **H2:** The higher the level of green performance (Energy Productivity, Carbon Productivity, Water Productivity, Waste Production and Green Revenue), the higher the level of financial performance (ROA and Tobin's Q).
- **H3:** The higher the level of green initiatives (Pay Link, Sustainability Themed Committee and Audit), the higher the level of financial performance (ROA and Tobin's Q).

3 Data

3.1 Overview

The starting point of my data collection was the Newsweek Green Ranking which had assessed the world's largest publicly-traded companies in the US and in the world since 2009. This ranking had been developed through a collaboration between Newsweek, Corporate Knights Capital, HIP Investor Inc and leading sustainability minds from nongovernmental organizations and the academic and accounting communities. The ranking attribute an overall green score to companies. The score is based on a weighted average of key performance indicators (KPI's). This study uses these KPIs to measure both green initiatives and green performance of the 500 largest publicly-traded companies in the United States. Due to a methodology change in the 2014 Newsweek Green Rankings, only the 2014, 2015 and 2016 ranking were considered. Among those three ranking and of the 500 US companies, 405 companies were listed for each years.

Even though green rankings were published in 2014, 2015 and 2016, each company is evaluated based on the 2012, 2013 and 2014 data. Therefore, measures for financial performance of companies will be based on the 2012, 2013 and 2014 fundamental data. Financial data have been mainly collected on stockpup and in case of missing values I have completed with data coming from morningstar and ycharts. Of the 405 initial companies, a total of 6 companies were dropped because of missing data. The sample final includes 399 publicly-traded companies in the US covering the period from 2012 till 2014 inclusively.

The Table 3.1 contains a sample of my database. The Table 3.2 describes my variables.You can notice that there are some missing values in the TobinsQ column. Indeed,compared to ROA, calculating Tobin's q requires a relatively high number of financial variables and is more susceptible to missing values. This creates a disparity among the number of observations for each dependent variables. Delmas, Nairn-Birch, and Lim (2015) encountered the same issue and conducted an identical analysis to check whether this introduces sample bias. Therefore I will do the same and depending on the robustness of results I will use one or two sample spaces in my study. I still need to figure out how to perform this test in R.

In the meantime, the function *pdim()* extracts the dimensions of both panel data, namely *DB_Roa* and *DB_TobinsQ*, and we can observe that both are characterized as *unbalanced*. Indeed I had to remove some year observations due to missing values.

```
library(plm)
# Apply pdim on the full panel data
pdim(DB_Roa)
```

```
## Unbalanced Panel: n = 399, T = 1-3, N = 1192
```

```
# Apply pdim on the panel data without missing values of TobinsQ
pdim(DB_Tobin)
```

```
## Unbalanced Panel: n = 360, T = 1-3, N = 1060
```

Table 3.1: Sample selection of the data base

	Companies	YearFinancialIndicator	ROA	TobinsQ
1-2013	1	2013	0.07	1.07
1-2014	1	2014	0.05	1.03
1-2015	1	2015	0.05	1.54
2-2013	2	2013	0.08	0.36
2-2014	2	2014	0.06	
2-2015	2	2015	0.06	
3-2013	3	2013	0.18	1.42
3-2014	3	2014	0.19	1.53
3-2015	3	2015	0.19	1.63
4-2013	4	2013	0.06	2.18

3.2 Dependent Variables

3.3 Independent Variables

3.4 Control Variables

Table 3.2: Variable Definition

	Variables	Description
1	Tobin's Q	The ratio of a firm's market value to the replacement cost of its assets
2	Return on Asset	Earnings before interest over total firm assets
3	Energy Productivity	Revenue ($US) / Total Energy Consumption
4	Carbon Productivity	Revenue ($US) / Total Greenhouse gas Emissions (CO2)
5	Water Productivity	Revenue ($US) / Total water (m3)
6	Waste Productivity	Revenue ($US) / [Total waste generated (metric tonnes)–waste recycled/reused (tones)]
7	Sustainability Pay Link	A mechanism to link the remuneration of any member of a company's senior executive team with the achievement of environmental performance targets. The existence of such a link is awarded a score of 100%. A score of 0% is attributed if there is no such mechanism in place
8	Sustainable Themed Commitment	Refers to the existence of a committee at the Board of Directors level whose mandate is related to the sustainability of the company, including but not limited to environmental matters. A score of 100% accrues to the company when such link exists and a score of 0% is attributed if there is no such link in place
9	Audit Score	Refers to the case where a company provides evidence that the latest reported environmental metrics were audited by a third party. Newsweek and their research partners award a score of 100% if such audit has been performed, and a score of 0% is given when such audit was not performed.
10	Leverage	The ratio of long-term debt to common shareholders' equity (shareholders equity minus preferred equity) in abolute values
11	Net Margin	The ratio of earnings to revenue
12	Firm Size	Log of total assets
13	Industry	Global Industry Classification Standard (GICS) of the firm. The variable take a value from 1 to 10 where 1 = Consumer Discretionary, 2 = Consumer Staples, 3 = Energy, 4 = Financials, 5 = Health Care, 6 = Industrials, 7 = Information Technology, 8 = Materials, 9 = Pharmaceuticals / Biotechnology, 10 = Telecommunication Services and 11 = Utilities

4 Methodology

Here is my methodology...

4.1 Panel Data

4.1.1 Definition of panel data

Panel data, also called longitudinal data or cross-sectional time-series data include observations on N cross section units (i.e., firms) over T time-periods.

4.1.2 Advantages of panel data :

As panel data analysis uses variation in both these dimensions, it is considered to be one of the most efficient analytical methods for data (Dimitrios Asteriou 2006). It usually contains more degrees of freedom, less collinearity among the variables, more efficiency and more sample variability than one-dimensional method (i.e.cross-sectional data and time series data) giving a more accurate inference of the parameters estimated in the model (Hsiao 2007, Hsiao (2014)).

4.1.3 Fixed or random effect model

Panel data may have individual (group) effect, time effect, or both, which are analyzed by fixed effect and/or random effect models. *A fixed effect model* examines if intercepts vary across group or time period, whereas a *random effect model* explores differences in error variance components across individual or time period. (Park 2011).

!! I need to test the fixed-random effect model of my database before moving forward !!

- Ng and Rezaee (2015) used the two-stage-least-square regressions to estimate its models.

** In case of presence of endogeneyity in an econometric model, OLS is not capable of delivering consistent parameter estimates (Wooldridge 2008).**

Citation from (Wooldridge 2008) :

> The general concept is that of the instrumental variables estimator; a popular form of that estimator, often employed in the context of endogeneity, is known as two-stage least squares (2SLS)

4.1.4 Endogeneity test

Even if panel data have a lot of advantages...

Two issues involved in utilizing panel data, namely heterogeneity bias and selectivity bias (Hsiao 2014).

Citation from Hsiao (2014):

> It is only by taking proper account of selectivity and heterogeneity biases in the panel data that one can have confidence in the results obtained.

Dang, Kim, and Shin (2015) examine which methods are appropriate for estimating dynamic panel data models in empirical corporate finance,especially in short panels of company data, in the likely presence of (1) unobserved heterogeneity and endogeneity, (2) residual serial correlation, or (3) fractional dependent variables. The bias-corrected fixed-effects estimators, based on an analytical, bootstrap, or indirect inference approach, are found to be the most appropriate and robust methods.

But Miroshnychenko, Barontini, and Testa (2017) used the OLS regressions in micro panel using the Huber-White sand which estimator, to account for the heteroscedasticity problem... **Which method should I use?**

Hausmann test to test the random effects model for both dependent variables?

4.2 Econometric Model

The first hypothesis will be tested with T-tests on the impact of each green initiative on green performance.

Hypotheses two and three will be tested by regression analysis using the *plm* package. Econometric models are based on Delmas, Nairn-Birch, and Lim (2015) and Miroshnychenko, Barontini, and Testa (2017) and started from the general form:

$$Y_{t+1} = \beta_0 + \beta_1(X_{it}) + +\beta_2(C_{it}) + \varepsilon_{it} \tag{1}$$

where Y_{t+1} is the financial performance of firm i in year $t+1$, β is the vector of estimated regression coefficients for each of the explanatory variables X_{it}, C_{it} is a vector of control variables , ε_{it} is the error term.

More precisely I will regress six models :

Model 1 : Green Initiatives on Tobin's Q

$$TobinsQ_{it+1} = \beta_0 + \beta_1(SP_{it}) + \beta_2(ST_{it}) + \beta_3(AS_{it}) + \beta_4(C_{it}) + \varepsilon_{it} \tag{2}$$

Model 2 : Green Initiatives on ROA

$$ROA_{it+1} = \beta_0 + \beta_1(SP_{it}) + \beta_2(ST_{it}) + \beta_3(AS_{it}) + \beta_4(C_{it}) + \varepsilon_{it} \tag{3}$$

Model 3 : Green Performance on Tobin's Q

$$TobinsQ_{it+1} = \beta_0 + \beta_1(EP_{it}) + \beta_2(CP_{it}) + \beta_3(WatP_{it}) + \beta_4(WasP_{it}) + \beta_5(C_{it}) + \varepsilon_{it} \tag{4}$$

Model 4 : Green Performance on ROA

$$ROA_{it+1} = \beta_0 + \beta_1(EP_{it}) + \beta_2(CP_{it}) + \beta_3(WatP_{it}) + \beta_4(WasP_{it}) + \beta_5(C_{it}) + \varepsilon_{it} \tag{5}$$

Model 5 : Both Green Performance and Green Initiative on Tobin's Q

$$TobinsQ_{it+1} = \beta_0+\beta_1(EP_{it})+\beta_2(CP_{it})+\beta_3(WatP_{it})+\beta_4(WasP_{it})+\beta_5(SP_{it})+\beta_6(ST_{it})+\beta_7(AS_{it})+(C_{it})+ \tag{6}$$

Model 6 : Both Green Performance and Green Initiative on ROA

$$ROA_{it+1} = \beta_0+\beta_1(EP_{it})+\beta_2(CP_{it})+\beta_3(WatP_{it})+\beta_4(WasP_{it})+\beta_5(SP_{it})+\beta_6(ST_{it})+\beta_7(AS_{it})+(C_{it})+\varepsilon_{it} \tag{7}$$

where :

- $TobinsQ_{it+1}$ = a proxy for a firm's financial performance
- ROA_{it+1} = a proxy for a firm's financial performance
- EP_{it} = a proxy for a firm's energy productivity
- CP_{it} = a proxy for a firm's carbon productivity
- $WatP_{it}$ = a proxy for a firm's water productivity
- $WasP_{it}$ = a proxy for a firm's waste productivity
- SP_{it} = a proxy for a firm's sustainability pay link
- ST_{it} = a proxy for a firm's sustainability themed commitment
- EP_{it} = a proxy for a firm's audit score
- C_{it} = a vector of control variables that include financial leverage, firm size, net margin and industry sector
- ε_{it} = the error term

4.3 Panel Data Tests

This section will not be in the final document but in appendix. It is only to report the result of the bunch of tests I carried out in order to define which panel data methotolodies I will use for each one of my 6 models.

Croissant and Millo (2008a) and Torres-Reyna (2010) really helped me.

Here are the tests :

1. Test of poolability
2. Hausmann Test to determine the fixed or random effect
3. Test for time fixed effect
4. Test for cross-sectional dependence
5. Test for serial correlation
6. Test for stationarity
7. Test for heteroskedasticity

The table 4.1 summaries the result of each test for each model. You can find details below.

Regarding the poolability test I have an issue with my code that I still need to solve. This is why it is written *NA* in the table 4.1.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Poolability	NA	NA	NA	NA	NA	NA
Hausmann	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Time Fixed Effect	No	Yes	No	Yes	No	Yes
Cross Sectional Dependence	Yes	Yes	Yes	No	No	No
Serial Correlation	Yes	Yes	Yes	Yes	Yes	Yes
Stationarity	None	None	None	None	None	None
Heteroskedasticity	Yes	Yes	Yes	Yes	Yes	Yes

Table 4.1: Test Summary

4.3.1 Test of poolability

Citation from (Croissant and Millo 2008b) :

> *Pooltest tests the hypothesis that the same coefficients apply to each individual. It is a standard F test, based on the comparison of a model obtained for the full sample and a model based on the estimation of an equation for each individual. The first argument of pooltest is a plm object. The second argument is a pvcm object obtained with model=within. If the first argument is a pooling model, the test applies to all the coefficients (including the intercepts), if it is a within model, different intercepts are assumed.*

To carry out the of poolabiloty I have used the *pooltest* function. The null hypothesis of poolability assumes homogeneous slope coefficients.

When running my code I got this error : Error in FUN(X[[i]], . . .) : insufficient number of observations

I still need to understand the origin of this error.

4.3.2 Hausmann Test to determine the fixed or random effect

Citation from Torres-Reyna (2010) :

> *To decide between fixed or random effects you can run a Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects (see Green, 2008, chapter 9). It basically tests whether the unique errors (ui) are correlated with the regressors, the null hypothesis is they are not.*

The Table 4.2 summarizes results of the Hausman Test of each model. I hae used the *phtest* function to carry out this test. We can observe that all p-values are < 0.05 meaning that HO is not verified and my models are caraterized by a fixed effect.

Table 4.2: Hausman Test PValue

Model	P-Value
Model 1	3.91743371664877e-11
Model 2	0.00295804024618629
Model 3	2.03716389543958e-08
Model 4	6.48087009803431e-06
Model 5	4.61015773467216e-08
Model 6	7.7661907780088e-07

4.3.3 Test for time fixed effect

The Table 4.3 summarizes results of the test for each model. I have used the *pFtest* function to carry out this test.

P-Value is > 0.05 for model 1, model 3 and model 5 meaning that null hypothesis is verified and that there is not a significant time-fixed effect. However for model 2,model 4 and model 6 P-Value is < 0.05 meaning that null hypothesis is rejected and that there is a significant time-fixed effect.

Does this mean that for model 2,4 and 6 I have to add the time fixed effect in my model?

Table 4.3: Fixed Time Effect Test PValue

	Model	P-Value
F	Model 1	0.294413678243895
F	Model 2	0.000368808643889729
F	Model 3	0.430605654981738
F	Model 4	0.0012952612768481
F	Model 5	0.563399152332159
F	Model 6	0.000818153246924005

4.3.4 Test for cross-sectional dependence

Citation from Torres-Reyna (2010) :

> *According to Baltagi, cross-sectional dependence is a problem in macro panels with long time series. This is not much of a problem in micro panels (few years and large number of cases). The null hypothesis in the B -P/LM and Pasaran CD tests of independence is that residuals across entities are not correlated. B- P/LM and Pasaran CD (cross-sectional dependence) tests are used to test whether the residuals are correlated across entities. Cross-sectional dependence can lead to bias in tests results (also called contemporaneous correlation).*

I have used the *pcdtest* function to carry out this test. The Table 4.4 show results of the test for cross-sectional dependence. We can observe that I have cross-sectional dependence in my model 1,2 and 3. However for model 4, 5 and 6, the P-Value is superior to 0.05 meaning that HO is verified and these models do not have cross-sectional dependence.

Table 4.4: Cross-sectional dependence's test - PValue

Model	Method	P-Value
Model 1	cd	5.1349772167113e-06
Model 2	cd	6.47407516580982e-08
Model 3	cd	0.00395522799662467
Model 4	cd	0.139271504054302
Model 5	cd	0.312716750944021
Model 6	cd	0.0603296334211678

Note :'cd' stands for Pesaran's CD Statistic

4.3.5 Test for serial correlation

I used the Wooldridge's test for serial correlation in FE panels with the *pwartest* function to test the serial correlation of my models. According to Croissant and Millo (2008b) this test is applicable to any fixed effect panel model, and in particular to short panels with small T and large n, which is my case. The null hypothese is that there is no serial correlation in the model. According to the P_Value of my models, I can conclude that I have serial correlation in all models.

Table 4.5: Wooldridge's test - PValue

	Model	P-Value
F	Model 1	4.21011764648126e-06
F	Model 2	0.00124485310798165
F	Model 3	5.30532007820228e-06
F	Model 4	0.00285315999299492
F	Model 5	5.40416344992354e-06
F	Model 6	0.00454094152388585

4.3.6 Test for stationarity

The Dickey-Fuller test to check for stochastic trends with the *adf.test* function. The null hypothesis is that the series has a unit root (i.e. non-stationary). In my case HO is rejected for both databases meaning that they do not have stationarity.

Table 4.6: Dickey-Fuller test - PValue

Database	P_Value
Roa	0.01
TobinsQ	0.01

4.3.7 Test for heteroskedasticity

I have used the *Bptest* function to test the presence of heteroskedasticity of my model. The Table 4.7 summarizes the p-value of each model. I find strange that all p-value equals zero. By meaning a p-value cannot be null, right? **What do you think?**

Table 4.7: Heteroskedasticity Test - PValue

	Model	P_Value
BP	Model 1	0
BP	Model 2	0
BP	Model 3	0
BP	Model 4	0
BP	Model 5	0
BP	Model 6	0

Starting from the premise that I have heteroskedasiticy I will compute the **sandwich estimators** of my models. The Table 4.8 summarizes the sandwich estimators for each model. **What should I do with that?**

See Miroshnychenko, Barontini, and Testa (2017) and Stock and Watson (2008)

If hetersokedaticity is detected you can use the sandwich estimaror (Torres-Reyna 2010)

vcovHC is a function for estimating a robust covariance matrix of parameters for a fixed effects or random effects panel model according to the White method (White 1980, 1984; Arellano 1987). The –vcovHC– function estimates three heteroskedasticity-consistent covariance estimators:

- “white1” - for general heteroskedasticity but no serial correlation. Recommended for random effects.
- “white2” - is “white1” restricted to a common variance within groups. Recommended for random effects.
- “arellano” - both heteroskedasticity and serial correlation. Recommended for fixed effects.

The following options apply*:

- HC0 - heteroskedasticity consistent. The default.

- HC1,HC2, HC3 – Recommended for small samples. HC3 gives less weight to influential observations.
- HC4 - small samples with influential observations
- HAC - heteroskedasticity and autocorrelation consistent (type ?vcovHAC for more details)

4.4 Sensitivity Analysis

Table 4.8: Sandwich Estimators

	Dependent variable:					
	(1)	(2)	(3)	(4)	(5)	(6)
SustainabilityPayLink	0.782*	−0.065			0.541	−0.065
	(0.463)	(0.048)			(0.581)	(0.054)
SustainableThemedCommitment	3.475	0.351**			2.886	0.389***
	(2.515)	(0.141)			(2.611)	(0.139)
AuditScore	0.454	0.016			0.085	0.020
	(0.931)	(0.067)			(0.911)	(0.071)
EnergyProductivity			0.072	0.012	0.090	0.009
			(0.152)	(0.014)	(0.152)	(0.013)
CarbonProductivity			−0.070	−0.027	−0.043	−0.029*
			(0.173)	(0.017)	(0.180)	(0.017)
WaterProductivity			−0.095	0.025**	−0.096	0.026**
			(0.130)	(0.012)	(0.131)	(0.012)
WasteProductivity			−0.208*	0.002	−0.183*	0.005
			(0.108)	(0.008)	(0.111)	(0.009)
Leverage	−0.00004	−0.00003	−0.00004	−0.00003	−0.00004	−0.0000
	(0.0002)	(0.00005)	(0.0002)	(0.00005)	(0.0002)	(0.00005
NetMargin	0.018	0.202***	0.020	0.199***	0.023	0.199***
	(0.185)	(0.040)	(0.187)	(0.041)	(0.188)	(0.041)
FirmSize	−0.326	−0.024*	−0.322	−0.023*	−0.329	−0.023*
	(0.441)	(0.013)	(0.439)	(0.013)	(0.443)	(0.013)

Note: *p<0.1; **p<0.05; ***p<0.0

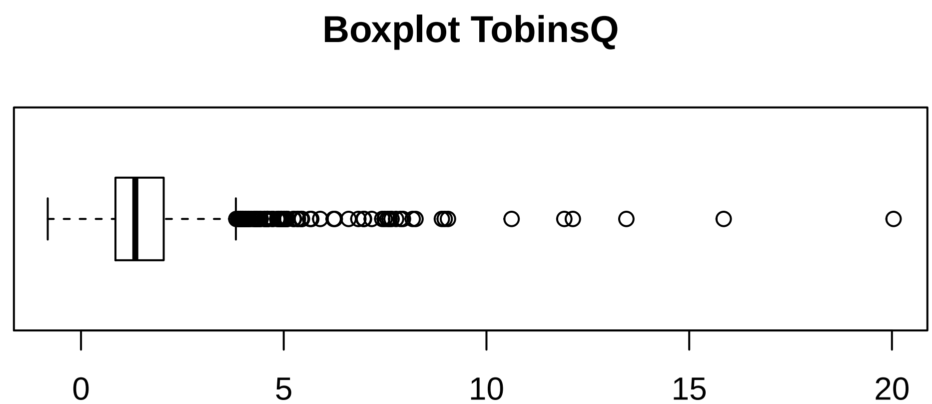
5 Results

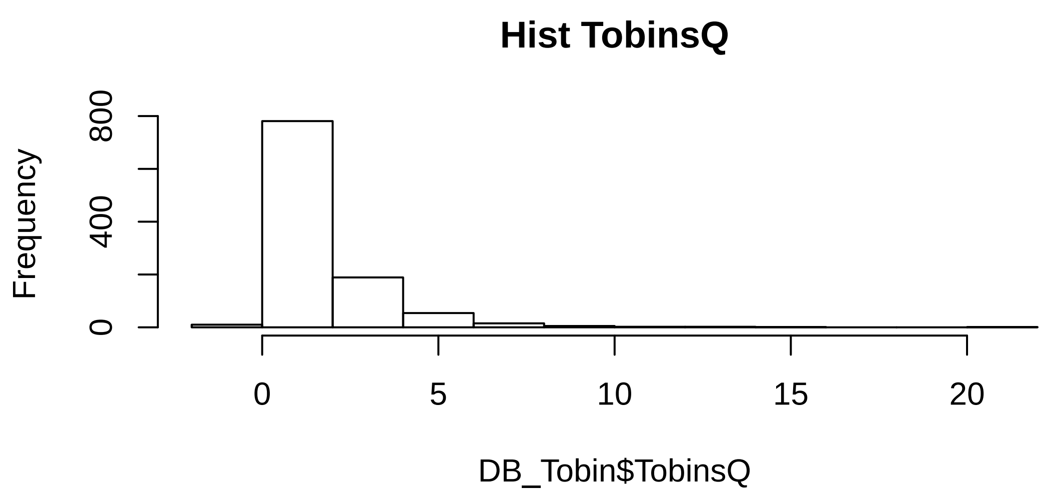
5.1 Descriptive Statistics

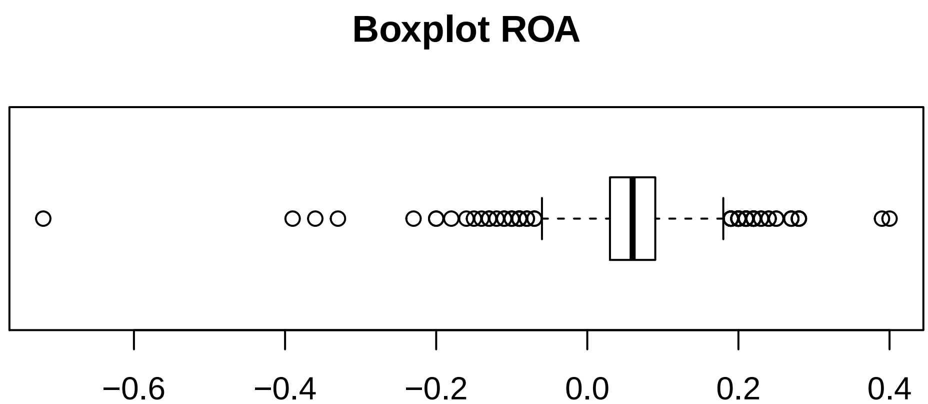
Table 5.1: Statistic Descriptive

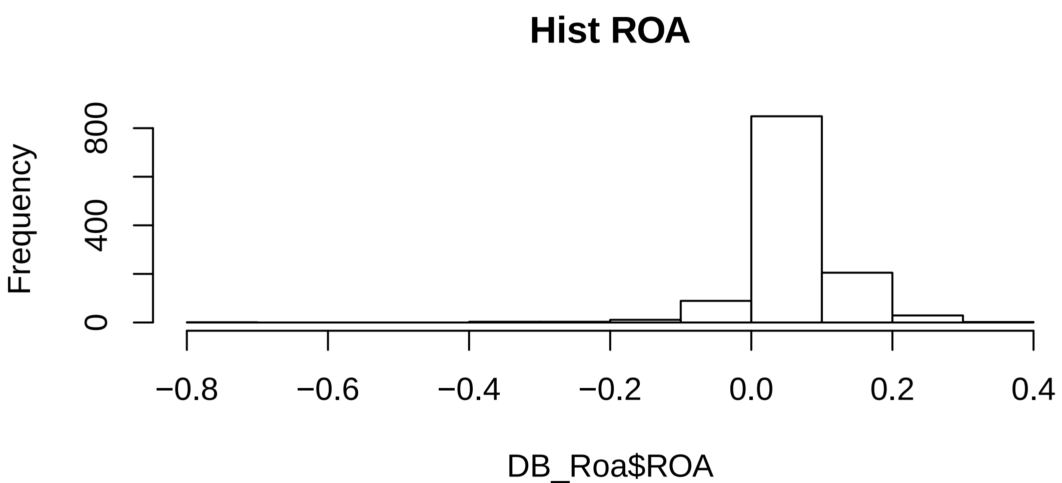
Statistic	N	Mean	St. Dev.	Min	Max
ROA	1,192	0.062	0.070	−0.720	0.400
TobinsQ	1,060	1.738	1.679	−0.820	20.040
EnergyProductivity	1,192	0.110	0.200	0.000	0.970
CarbonProductivity	1,192	0.119	0.182	0.000	0.970
WaterProductivity	1,192	0.085	0.184	0.000	0.990
WasteProductivity	1,192	0.072	0.169	0.000	0.970
SustainabilityPayLink	1,192	0.049	0.050	0.000	0.100
SustainableThemedCommitment	1,192	0.024	0.025	0.000	0.050
AuditScore	1,192	0.023	0.025	0.000	0.050
Industry	1,192	4.589	2.666	1	11
FirmSize	1,192	10.374	0.598	8.740	13.910
Leverage	1,192	3.798	42.377	0.000	875.590
NetMargin	1,192	0.105	0.220	−3.600	1.630

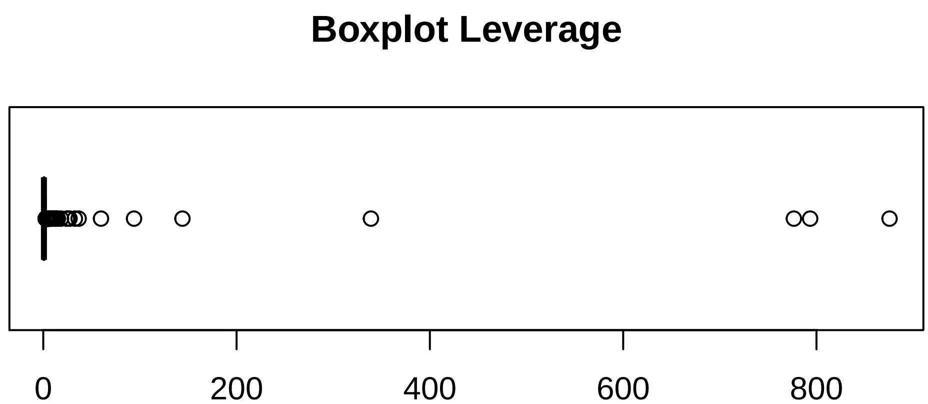
5.2 Some boxplots and histogram

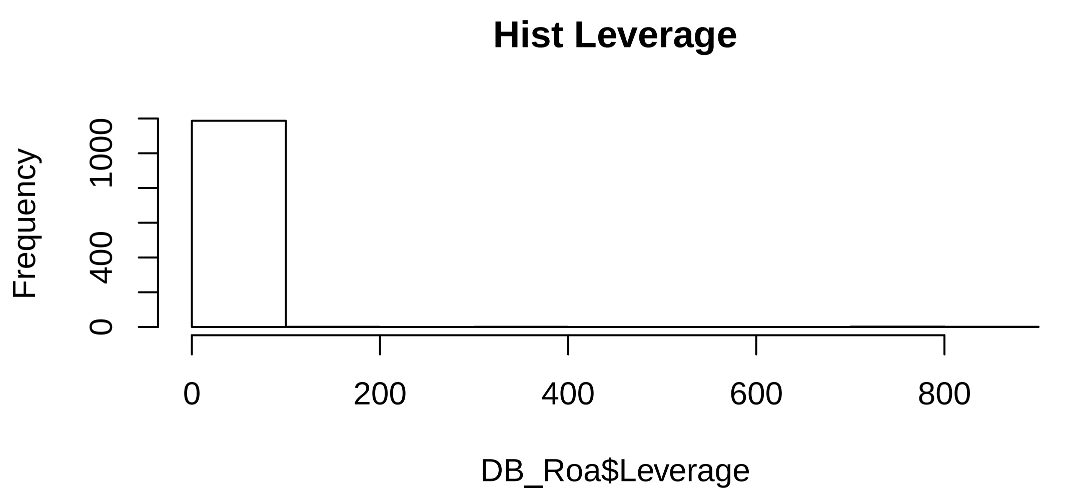


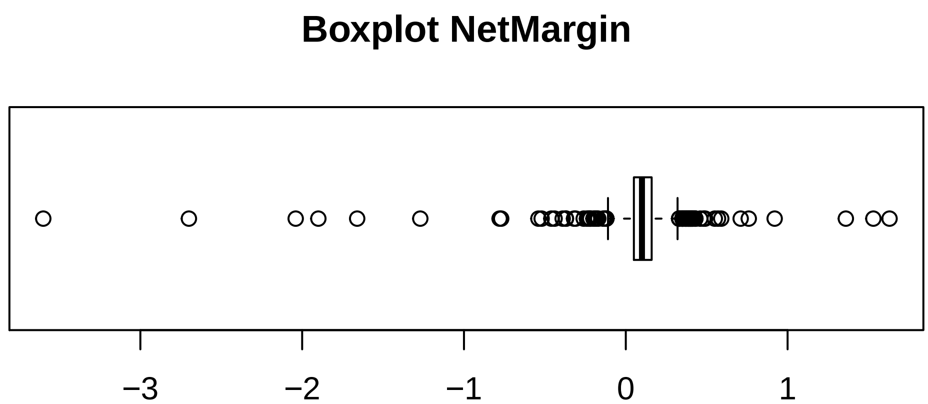


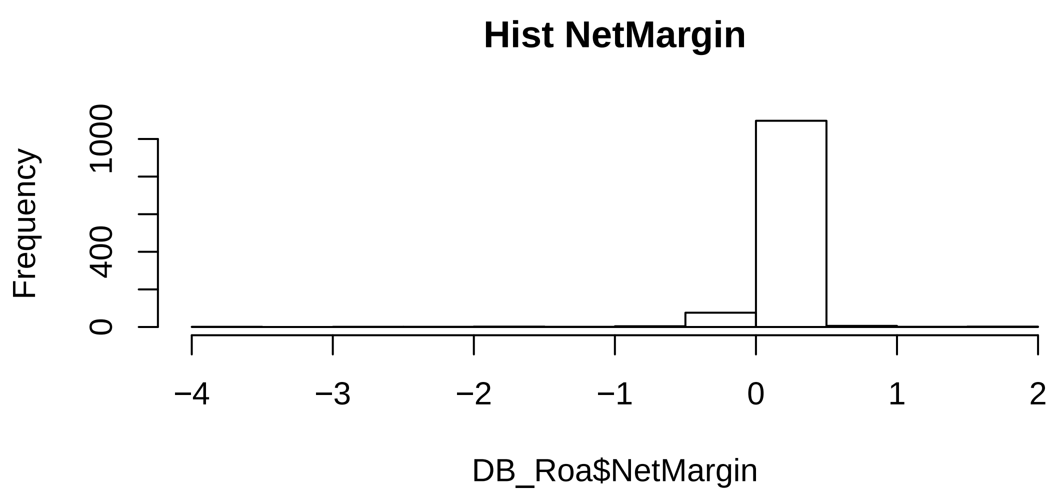

Boxplot ROA
−0.6
−0.4
−0.2
0.0
0.2
0.4

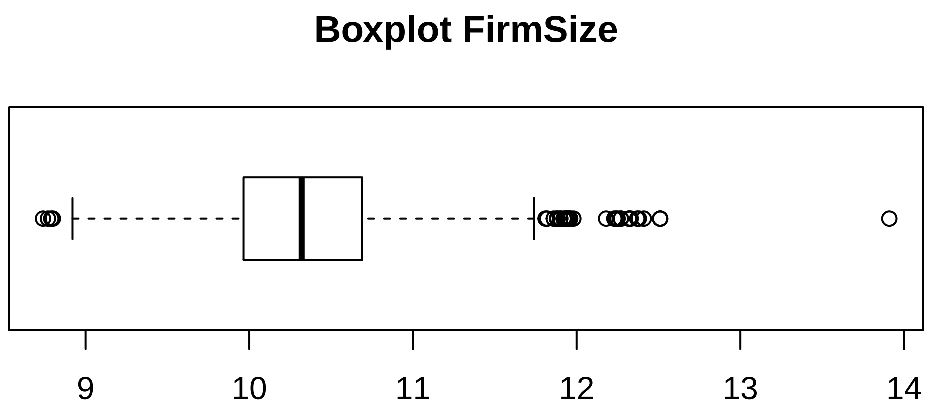

Hist ROA
Frequency
0
400
800
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
DB_Roa$ROA

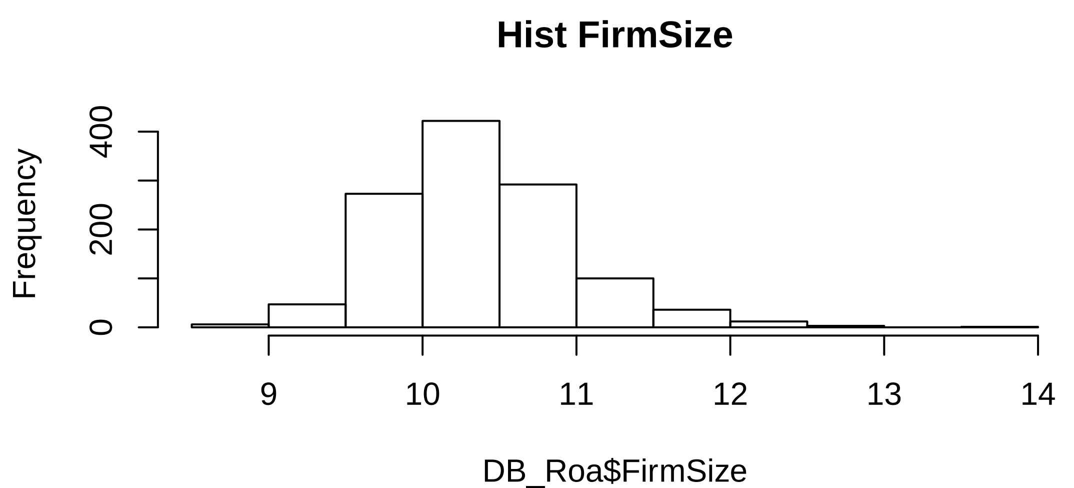

Boxplot Leverage
0
200
400
600
800


Hist Leverage
Frequency
0
400
1000
0
200
400
600
800
DB_Roa$Leverage


Boxplot NetMargin
−3
−2
−1
0
1


Hist NetMargin
Frequency
0
400
1000
−4
−3
−2
−1
0
1
2
DB_Roa$NetMargin

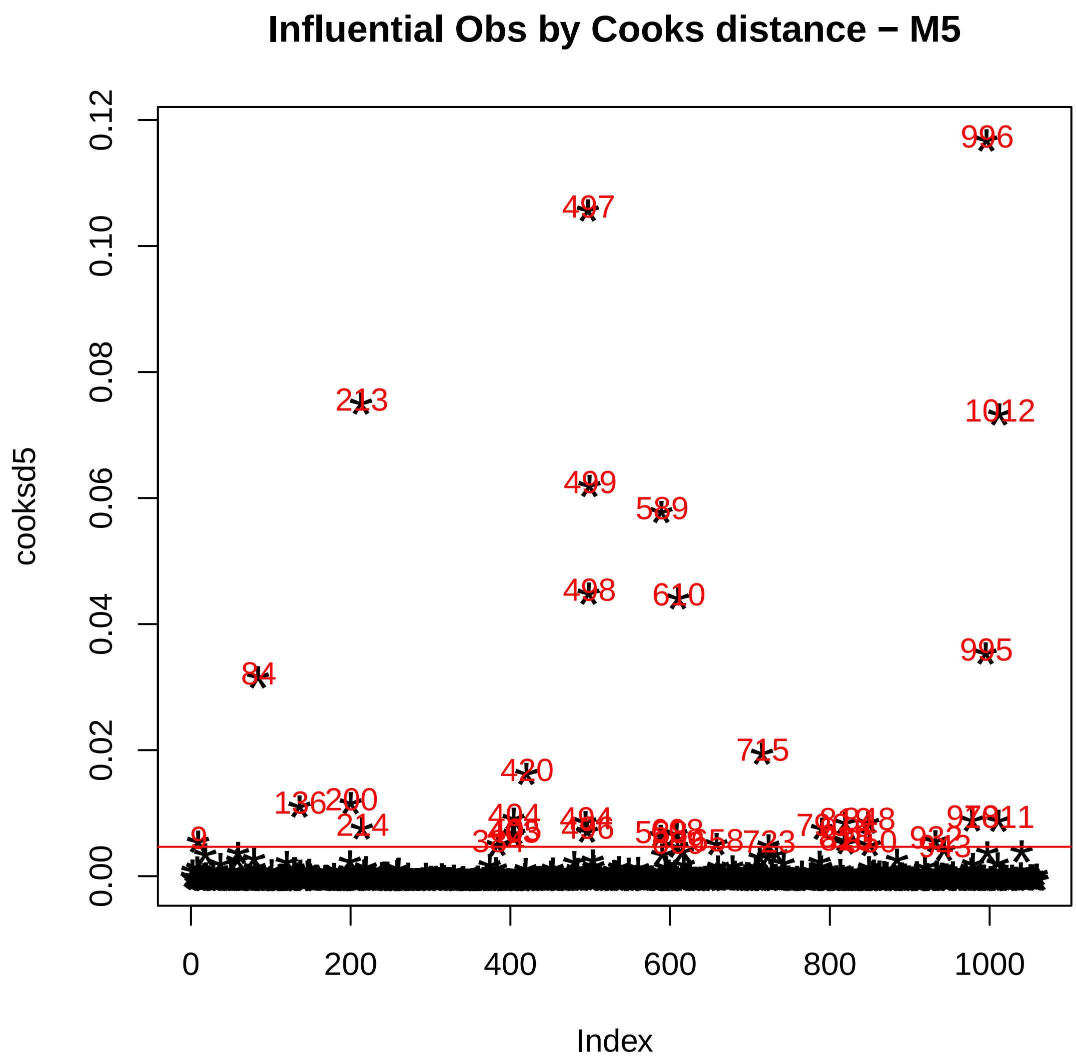

Boxplot FirmSize
9
10
11
12
13
14

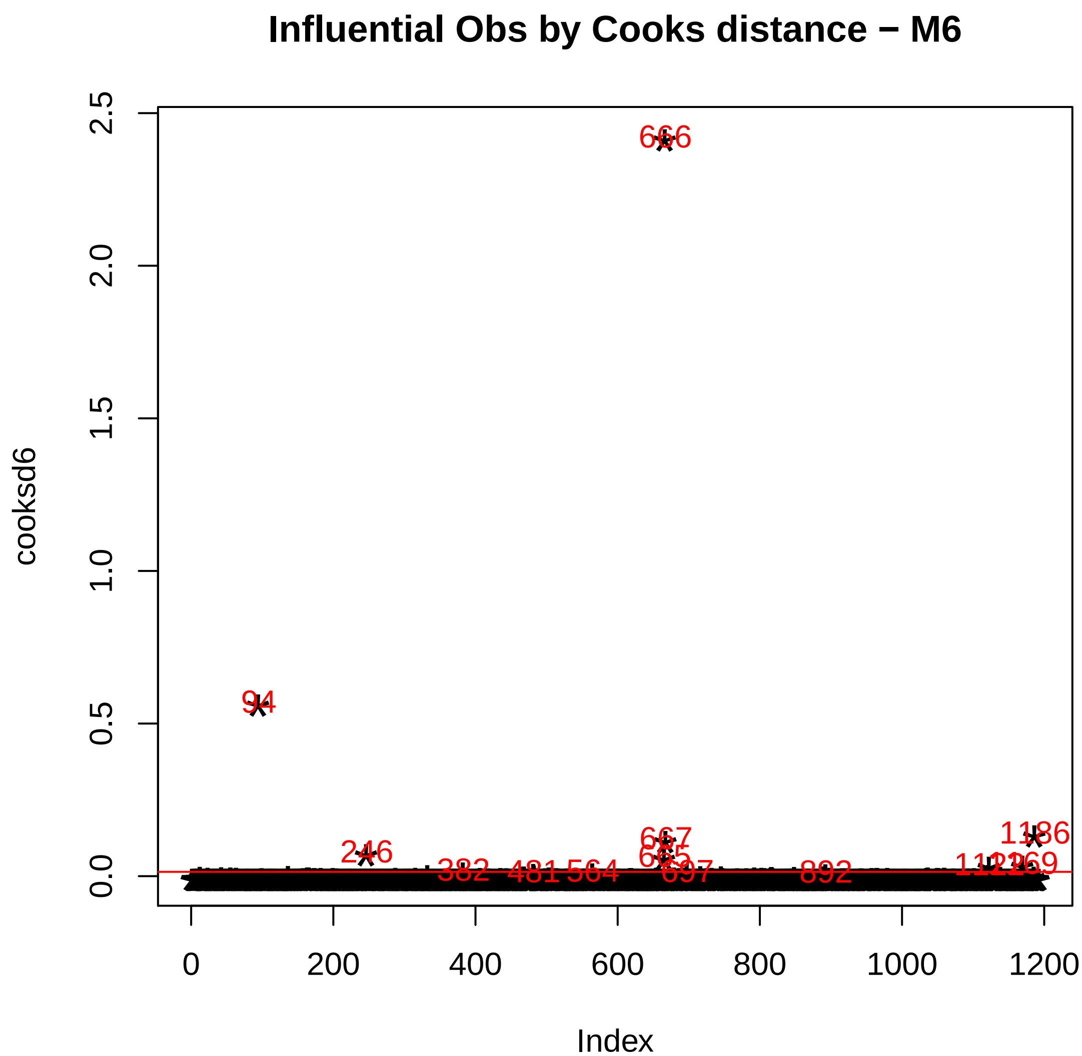

Hist FirmSize
Frequency
0
200
400
9
10
11
12
13
14
DB_Roa$FirmSize

5.3 Cooks Distance

This section will not be in the final document. Here I measure the cook's distance of my model 5 and 6. Cook's distance is a measure computed with respect to a given regression model and therefore is impacted only by the X variables included in the model. Cook's distance computes the influence exerted by each data point (row) on the predicted outcome. I summarise on a graph (i.e. one for each model), those observations that have a cook's distance greater than 4 times the mean and which may be classified as influential. I want to detect which observations is an outlier. See below both graphics.

Should I redo this process for each Model?


Influential Obs by Cooks distance − M5
cooksd5
Index
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0
200
400
600
800
1000
996
497
213
1012
499
589
498
610
995
84
715
420



Here the function outlierTest from *car* package gives the most extreme observation based on the given model. **Should I remove those observations from my database?**

```
##       rstudent unadjusted p-value Bonferonni p
## 666   9.905081         2.8491e-22   3.3961e-19
## 382  -8.232273         4.8257e-16   5.7522e-13
## 1186 -6.474909         1.3892e-10   1.6559e-07
## 94   -6.465151         1.4786e-10   1.7625e-07
## 481   5.119119         3.5819e-07   4.2696e-04
## 482   5.020838         5.9372e-07   7.0771e-04
```

```
## 564  -4.383331          1.2730e-05   1.5174e-02
## 848  -4.379382          1.2959e-05   1.5447e-02
```

```
##        rstudent unadjusted p-value Bonferonni p
## 497  12.101376          1.2047e-31   1.2769e-28
## 499   8.633204          2.1908e-17   2.3222e-14
## 498   6.669377          4.1518e-11   4.4009e-08
## 995   6.227579          6.8476e-10   7.2585e-07
## 1012  6.138307          1.1819e-09   1.2528e-06
## 996   5.989238          2.8948e-09   3.0685e-06
## 819   5.441583          6.5755e-08   6.9700e-05
## 610   4.996946          6.8225e-07   7.2319e-04
## 820   4.387600          1.2620e-05   1.3377e-02
## 818   4.097120          4.5062e-05   4.7765e-02
```

6 Discussion

Let's speak…

Conclusion

This is my conclusion…

Appendix

Appendix A : This is an appendix a

Appendix B : This is an appendix b

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