HEC LIÈGE
Management School - Liège Université

Master Thesis Defense

Reliability of ESG ratings – A qualitative and quantitative assessment

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Outline

1. Context and research questions
2. Qualitative and quantitative results
3. Conclusions and implications
4. Appendix

1 Context and research questions

1 Context and research questions (1/3)

Context : Socially Responsible Investing (SRI)

Growing importance of SRI

Growing SRI assets

- + 34% from 2016 to 2018 globally
- + 38% from 2016 to 2018 in the U.S.
- + 11% from 2016 to 2018 in Europe

Increase of investors' interests

- 85% of U.S. investors have concerns in SRI
- 61% of investors agree that funds should use sustainable criteria

High flows and adapted offers

- Positive and growing inflows
- Repurposed funds
- New sustainable funds

Firms' interests

- SDG Goals
- Emission goals

Green New Deal in Europe

- SRI regulatory framework
- Emission goals

United Nations

- UN's Principles for Responsible Investment

Source: GSIA (2018), Morgan Stanley (2019), Schroders (2019), Hale (2018 & 2019), Microsoft (2020), Nestle (2020), European Commission (2020), UN PRI (2020)

1 Context and research questions (2/3)

Context : Utility of ESG ratings

1 Context and research questions (3/3)

Three research questions (RQ) on the reliability of ESG ratings

	Research question	Purpose	Methodology
RQ1	*On which basis are ESG ratings derived?*	• Clarity on the rating processes • Heterogeneity between agencies	➢ Qualitative analysis ➢ Case studies

RQ2	*Are ESG ratings subject to significant biases?*	• Identification of an effect of:
		  • Size
		  • Location
		  • Learning
			➢ Panel regressions

RQ3	*Do ESG ratings provide material information leading to overperformance?*	• Testing components of ESG delivering overperformance • Testing overall sustainability	➢ Multi-factors models

2 Qualitative and quantitative results

2 Qualitative and quantitative results (1/3)

RQ1: On which basis are ESG ratings derived?

Data	Methodologies	Results

Data

- Comparison of the processes and ratings of the following agencies:

Agency	Loc.	Coverage
MSCI		+8,300
SUSTAINALYTICS		+11,000
ROBECOSAM We are Sustainability Investing.		+7,300
REFINITIV		+8,000
CDP DRIVING SUSTAINABLE ECONOMIES		+8,400

Methodologies

- Qualitative review and comparison of the processes
- Case studies analysis based on availability

Results

- ➢ Different processes
- ➢ Different purposes
  - ➢ Forward-Looking
  - ➢ Current situation
- ➢ Alignment but with different strengths

- ➢ Ratings should not be limited to their final scores
- ➢ Ratings can be complementarity

2 Qualitative and quantitative results (2/3)

RQ2: Are ESG ratings subject to significant biases?

Data	Methodologies	Results

○ Refinitiv's ratings on European and U.S. based firms
○ Testing the influence of:
  ○ Location (Baldini et al., 2018)
  ○ Size (Drempetic et al., 2019)
  ○ Learning (Descriptive statistics)
	• Panel regressions
	  • Fixed-effects models
	  • Random-effects models
	  • Dynamics models
	• Investigation of global and pillars scores
	• Different specifications applied
		➢ Statically significant fixed-effect models
		➢ Economically meaningful but insignificant random-effects models
		➢ Insignificant dynamics models

- ➢ Confirmation of a size effect
- ➢ Indication of a location and learning effect

2 Qualitative and quantitative results (3/3)

RQ3: Do ESG ratings provide material information leading to overperformance?

Data	Methodologies	Results

○ Refinitiv's ratings on European and U.S. based firms
○ Monthly returns of rated firms
 	
Portfolios of high and low rated stocks
	• Multi-Factors models
	  • Fama-French 3 factors
	  • Fama-French Carhart 4 factors
	  • Fama-French 5 factors
	• Enhanced strategy reflecting biases identified in RQ2
	• Robustness specifications
		➢ No overperformance associated even for the enhanced strategy
		➢ Over exposition to the size risk factors

- ➢ Failure to replicate findings on ESG components
- ➢ Best-In-Class strategy: risks of over exposition to one area or to large firms

3 Conclusions and implications

3 Conclusions and implications (1/2)

ESG ratings are but not as simple as they look like

Are ESG ratings reliable?

+	-
• Alignment between agencies from case studies • Complementarity of ratings • Complementarity with financial information	• Specificities of methodologies • Lack of significant evolution and occurrence of issues • Source of information: non-audited, private sources • Presence of biases and over-exposition to risk factors

➢ Ratings should be used cautiously and not be limited to their final scores

3 Conclusions and implications (2/2)

Implications and future outlooks

Agencies	Investors	Firms

○ Towards more consensus?
  ○ Impact of forthcoming regulations
  ○ Consolidation
○ Generalization of biases?
	○ Usage of ratings
	  ○ Complementary agencies?
	  ○ Integration of biases?
	○ Evolution of sustainable preferences
		○ Self-initiative
		  ○ Ideology: CSR
		  ○ Benefits: Reduced cost of capital
		○ Compliance
		  ○ Stricter rules

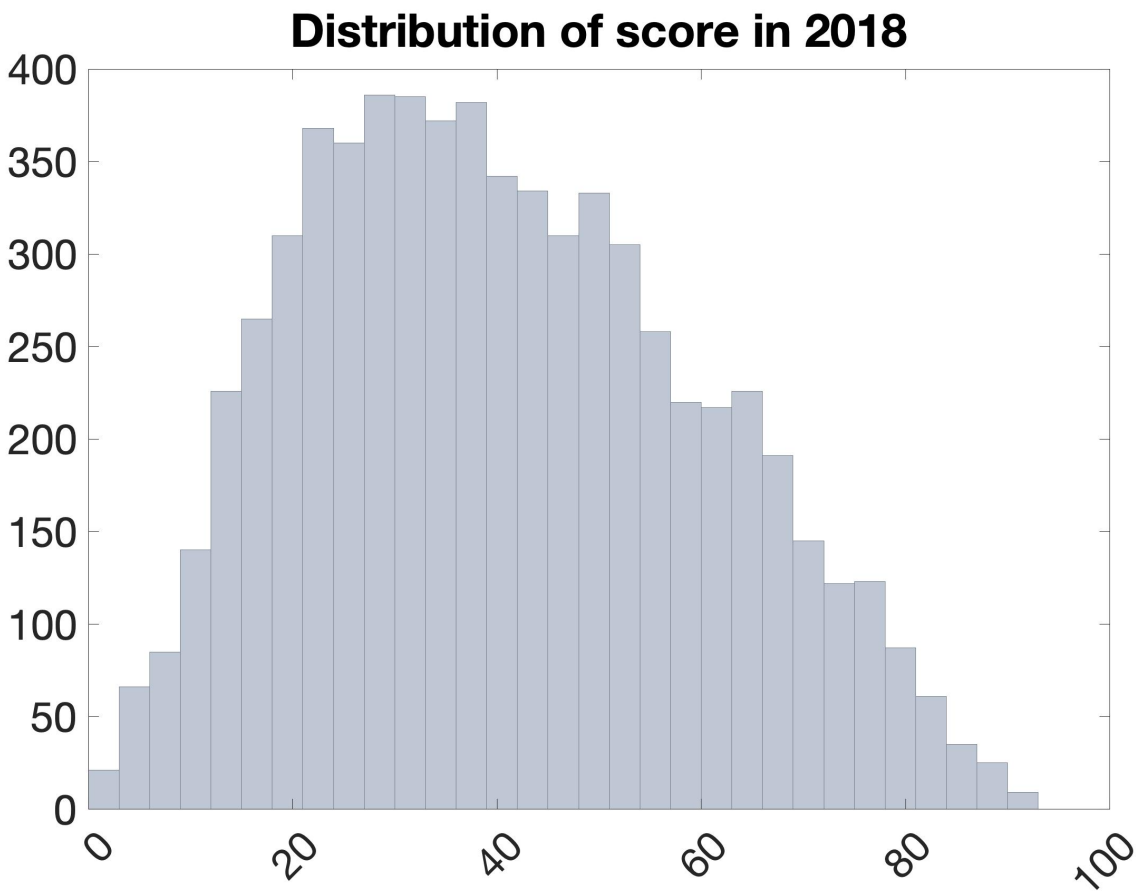
➢ Ratings will continue to gain strength in the financial area and theses key actors will have to adapt.

Thank you for your attention

4 Appendix

4 Appendix

Descriptive statistics: Distribution in 2018



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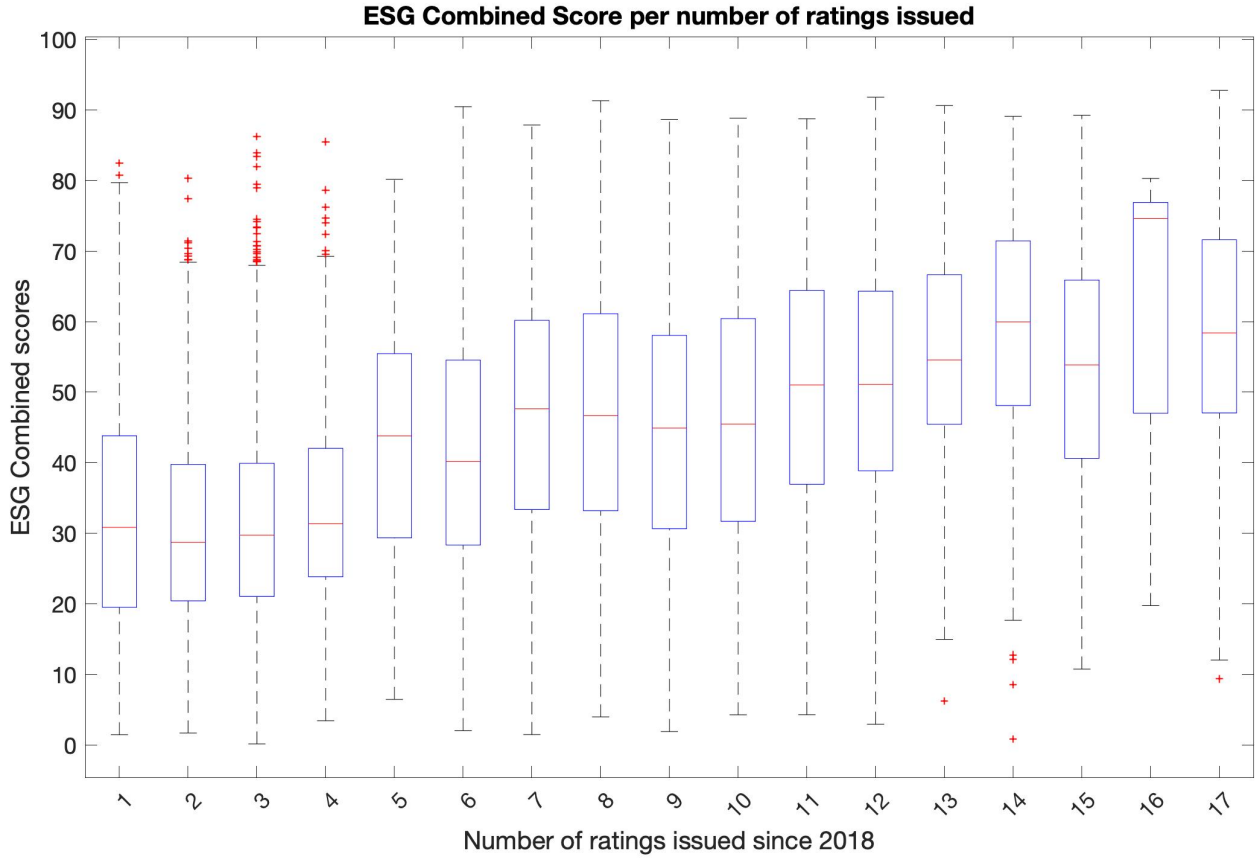
Descriptive statistics: number of ratings issued



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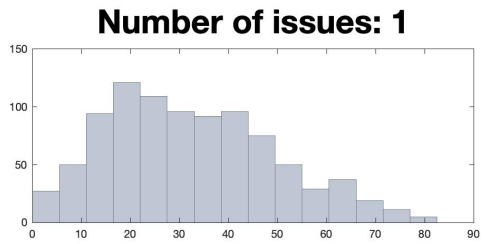
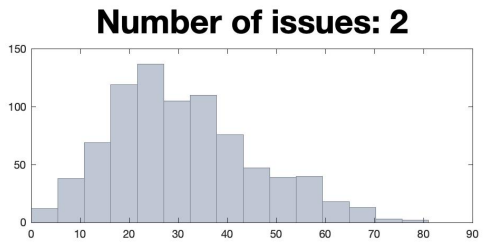
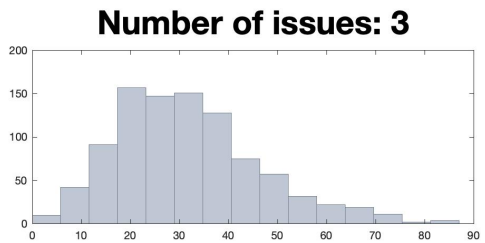
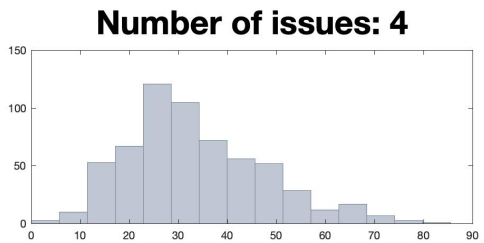
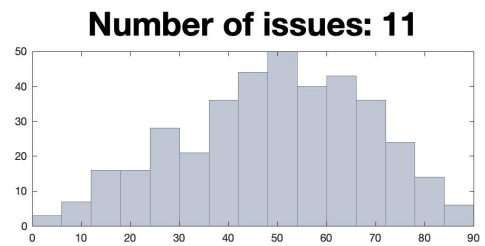
Descriptive statistics: Distribution by ratings issued

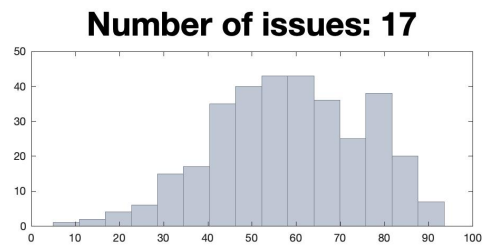












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RQ1: Summary table

Agency	Methodology	Comments
RobecoSAM (S&P)	ESG Profile & Preparedness	Forward looking and information from meetings Scores affected by the industry (not normalized) • E: Greenhouse gas [GHG] emissions, waste, water use, land use • S: workforce and diversity, safety management, customer engagement, and communities • G: structure and oversight, code and values, transparency & reporting, cyber-risk & technological systems
MSCI	Industry Adjusted weighted average	Issues specific by industries and final score normalized by industries • E: Climate Change, Natural Resources, Pollution and Waste, Environmental Opportunities • S: Human Capital, Product Liability, Stakeholder Opposition, Social Opportunities • G: Corporate Governance, Corporate Behavior
Sustainalytics (Morningstar)	Risk Rating based on key issues	Focus on the risk and its management Only consider material issues
Refinitiv	ESG Score & Controversy factor	Industry normalized and controversy scores • E: Resource Use, Emissions, Innovation • S: Workforce, Human Rights, Community, Product Responsibility • G: Management, Shareholders, CSR Strategy

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RQ2: Models

$y_{i,t} = x'_{i,t}\beta_{i,t} + \varepsilon_{i,t}$, where:

- i=1,…,N represents the cross sectional aspects (the companies)
- t=1,…,T represents the time-series aspect (the years)
- $y_{i,t}$ is the dependent variable (the ESG rating of the company i at time t)
- $x_{i,t}$ is the Kth independent variable (the firm size, the industry,…)
- $\beta_{i,t}$ are the coefficients of the Kth explanatory variable.
- $\varepsilon_{i,t}$ are the error terms (Verbeek, 2004)

Fixed-effects models

$y_{i,t} = a_i + x'_{i,t}\beta + \varepsilon_{i,t}$, where a_i is the slope fixed for each individual

Random-effects models

$y_{i,t} = \beta_0 + x'_{i,t}\beta + a_i + \varepsilon_{i,t}$, where:

- β_0 is the intercept term fixed for all firms
- a_i is the time-invariant part of the error term
- $\varepsilon_{i,t}$ is the second part of the error term and is uncorrelated over time.

Dynamics models

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

- γ is the coefficient of the lag variable

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RQ2: Results

	Model 1 : log market cap.		Model II : log total assets		Model III : log # employees	
Number of obs	18167		18198		17778	
Number of Groups	3350		3353		3268	
R2	0,2678		0,2668		0,2705	
Adj R2	0,1020		0,1009		0,1059	
R2 within	0,2678		0,2668		0,2705	
R2 between	0,2808		0,3004		0,3069	
R2 overall	0,2748		0,2933		0,2958	
Corr(ui , Xb)	0,1781		0,1550		0,1111	
F test (all ß=0)	902,9652		900,0174		17778	
P value (F test)	0,0000		0,0000		0,000	
	coefficient	p	coefficient	p	coefficient	p
size	1,8509	0,0000	2,3181	0,0000	2,3326	0,0000
Numbissue	1,6448	0,0000	1,6497	0,0000	1,7064	0,0000
wret	-0,0073	0,0000	-0,0004	0,8042	-0,0002	0,9107
roa	-0,0200	0,0157	0,0030	0,7031	0,0095	0,2391
td_e	0,0000	0,3252	0,0000	0,1693	0,0000	0,2197
revgrowth	-0,0032	0,0752	-0,0026	0,1548	-0,0012	0,5737
_cons	-6,0514	0,0775	-16,8277	0,0006	14,3009	0,0000

Table 3 : Fixed-effects regression on ESG Combined score

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RQ2: Results

	Model 1 : log market cap.		Model II : log total assets		Model III : log employee	
Number of obs	18167		18198		17778	
Number of Groups	3350		3353		3268	
R2	0,2846		0,2816		0,2855	
Adj R2	0,1210		0,1174		0,1227	
R2 within	0,2846		0,2816		0,2855	
R2 between	0,0421		0,0114		0,0000	
R2 overall	0,0204		0,0324		0,0490	
Corr(ui , Xb)	-0,1909		-0,1557		-0,1511	
F test (all ß=0)	183,8340		181,4184		180,8001	
P value (F test)	0,0000		0,0000		0,0000	
	coefficient	p	coefficient	p	coefficient	p
Size	2,1718	0,0000	2,2430	0,0000	2,3560	0,0000
numbissue	-0,2176	0,1631	-0,2153	0,1684	-0,2285	0,1477
7b.year	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
8.year	4,0065	0,0000	2,7909	0,0000	2,8556	0,0000
9.year	6,9325	0,0000	5,9546	0,0000	6,1294	0,0000
10.year	8,1625	0,0000	7,5214	0,0000	7,7752	0,0000
11.year	9,6582	0,0000	8,7657	0,0000	9,0833	0,0000
12.year	11,2209	0,0000	10,3596	0,0000	10,7850	0,0000
13.year	11,2128	0,0000	10,7110	0,0000	11,1945	0,0000
14.year	12,1445	0,0000	11,7215	0,0000	12,1951	0,0000
15.year	16,1512	0,0000	15,6840	0,0000	16,1220	0,0000
16.year	17,9014	0,0000	17,4109	0,0000	17,9032	0,0000
17.year	19,4707	0,0000	19,0624	0,0000	19,7143	0,0000
18.year	21,1069	0,0000	20,3562	0,0000	21,1092	0,0000
wret	-0,0096	0,0000	-0,0026	0,1057	-0,0024	0,1385
roapct	-0,0196	0,0176	0,0070	0,3790	0,0132	0,1027
td_epct	0,0000	0,4877	0,0000	0,2462	0,0000	0,3016
revgrowth	-0,0025	0,1739	-0,0018	0,3181	-0,0003	0,8694
_cons	-18,1652	0,0000	-19,5340	0,0001	9,6964	0,0000

Table 44 : Fixed-effects regression on ESG Combined score with time fixed-effects

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RQ2: Results

	Model 1 : log market cap.		Model II : log total assets		Model III : log employee	
Number of obs	18167		18198		17778	
Number of Groups	3350		3353		3268	
R2 within	0,2656		0,2658		0,2700	
R2 between	0,3841		0,3946		0,4002	
R2 overall	0,3604		0,3654		0,3630	
Wald: chi (all ß=0)	7509,0249		7628,0012		7609,2978	
Wald: p	0,0000		0,0000		0,0000	
	coefficient	p	coefficient	p	coefficient	p
size	2,8856	0,0000	3,3280	0,0000	2,9950	0,0000
numbissue	1,6080	0,0000	1,6089	0,0000	1,6874	0,0000
hq	10,0185	0,0000	9,2264	0,0000	9,0673	0,0000
1b.industry	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
2.industry	-0,8058	0,4142	-0,0542	0,9559	-2,0121	0,0388
3.industry	-0,9452	0,4369	-0,0356	0,9765	-1,4582	0,2242
4.industry	-4,5337	0,0002	-5,1951	0,0000	-1,4347	0,2303
5.industry	-3,9470	0,0001	-4,8809	0,0000	4,5985	0,0000
6.industry	-2,4613	0,0195	0,9984	0,3458	1,3177	0,2104
7.industry	-1,7119	0,0788	-1,2233	0,2068	-3,3134	0,0006
8.industry	-0,4436	0,6753	1,9940	0,0590	0,6601	0,5271
9.industry	-7,5448	0,0000	-7,8748	0,0000	-5,6664	0,0010
10.industry	3,6438	0,0127	1,5326	0,2937	6,4419	0,0000
wret	-0,0109	0,0000	0,0001	0,9469	0,0003	0,8407
roapct	-0,0161	0,0119	0,0055	0,3781	0,0106	0,1418
td_epct	0,0000	0,3665	0,0000	0,1076	0,0000	0,1757
revgrowth	-0,0063	0,0003	-0,0047	0,0074	-0,0028	0,1666
_cons	-31,6879	0,0000	-41,9447	0,0000	4,9626	0,0001

Table 52 : Random-effects regression on ESG Combined score

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RQ2: Results

			With Time effect	
	chi(5)	p value	chi(15)	p value
ESGC	139.42	0.0000	210.76	0.0000
ESG	454.33	0.0000	507.20	0.0000
Env	484.26	0.0000	673.13	0.0000
Soc	300.51	0.0000	307.29	0.0000
Gov	52.91	0.0000	59.66	0.0000

Table 59 : Hausman test (Random-effects models)

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RQ2: Results

One-step results			Two-step results		
Number of obs	10,018		Number of obs	10,018	
Number of instruments	61		Number of instruments	61	
	Coef	p>z		Coef	p>z
Lag esgc	0,2771	0,0000	Lag esgc	0,3393	0,0000
logmc	0,5606	0,0580	logmc	0,3859	0,1800
numbissue	0,8673	0,0000	numbissue	0,9099	0,0000
wret	-0,0028	0,1490	wret	-0,0019	0,2310
roapct	0,0068	0,5310	roapct	0,0062	0,6330
td_epct	0,0000	0,3370	td_epct	-0,0000	0,5290
revgrowth	0,0014	0,5040	revgrowth	0,0009	0,5930
			Warning: gmm two-step standard errors are biased		
Sargan test of overidentifying restrictions			**Sargan test of overidentifying restrictions**		
H0: overidentifying restrictions are valid			H0: overidentifying restrictions are valid		
Chi2(54)	249,8385		Chi2(54)	186,4912	
Prob > chi2	0		Prob > chi2	0	
Arellano-Bond test for zero			**Arellano-Bond test for zero**		
H0: no autocorrelation			H0: no autocorrelation		
Order	z	Prob > z	Order	z	Prob > z
1	-29,5790	0,0000	1	-15,9220	0,0000
2	7,3395	0,0000	2	5,4474	0,0000

Table 62 : Arellano and Bond results

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RQ3: Models

$$r_{i,t} - r_{f,t} = a_i + \beta_i * (r_{M,t} - r_{f,t}) + s_i SMB_t + h_i HML_t + \varepsilon_{i,t}$$, where:

- $r_{i,t}$ is the return of stock/portfolio i at month t
- $r_{f,t}$ is the risk-free rate of return at month t
- $r_{M,t}$ is the market rate of return at month t
- SMB_t, the size premium computed as the difference between a portfolio of small firms and a portfolio of big firms at month t
- HML_t, the value premium computed as the difference between a portfolio of firms with high book-to-market (BM) ratio and a portfolio of firms with low BM ratio at month t
- $\beta_i, s_i \; and \; h_i$ are the coefficients of the market effect, size effect and value effect

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RQ3: Results ESGC (US – Fama French 3 Factors - 15Y)

2004 ESGC	a	RM-RF	SMB	HML			R2	AdjR2	ESG
High Portfolio									
ESG > 100%	-0,05%	1,05	(0,15)	0,07			0,96	0,96	44,91
p value	0,96	0,00	0,00	0,01					
ESG > 90%	-2,60%	1,08	(0,24)	0,08			0,88	0,88	65,67
p value	0,08	0,00	0,00	0,12					
ESG > 85%	-0,80%	1,04	(0,18)	0,09			0,91	0,91	63,30
p value	0,52	0,00	0,00	0,04					
ESG > 80%	-0,54%	1,06	(0,16)	0,11			0,91	0,91	61,47
p value	0,66	0,00	0,00	0,01					
ESG > 75%	-0,53%	1,06	(0,17)	0,12			0,93	0,93	59,14
p value	0,63	0,00	0,00	0,00					
Low Portfolio									
ESG < 100%	-0,05%	1,05	(0,15)	0,07			0,96	0,96	44,91
p value	0,96	0,00	0,00	0,01					
ESG < 10%	0,58%	1,16	0,11	0,03			0,81	0,81	15,22
p value	0,79	0,00	0,19	0,64					
ESG < 15%	0,41%	1,17	0,13	0,02			0,84	0,84	17,22
p value	0,84	0,00	0,09	0,72					
ESG < 20%	0,18%	1,18	0,06	(0,04)			0,86	0,85	18,94
p value	0,92	0,00	0,40	0,48					
ESG < 25%	0,99%	1,12	0,03	(0,07)			0,88	0,88	20,44
p value	0,52	0,00	0,61	0,19					
Long Short portfolio									
ESG - 100%	0,00%	-	-	-			-	-	-
p value	-	-	-	-					
ESG - 10%	-3,18%	(0,08)	(0,35)	0,04			0,12	0,11	-
p value	0,19	0,12	0,00	0,60					
ESG - 15%	-1,21%	(0,12)	(0,31)	0,06			0,16	0,15	-
p value	0,57	0,01	0,00	0,38					
ESG - 20%	-0,72%	(0,11)	(0,21)	0,15			0,12	0,10	-
p value	0,73	0,01	0,01	0,03					
ESG - 25%	-1,53%	(0,06)	(0,20)	0,19			0,12	0,11	-
p value	0,37	0,11	0,00	0,00					

4 Appendix

RQ3: Results ESGC (US – 4 Factors - 15Y)

2004 ESGC	a	RM-RF	SMB	HML	UMD		R2	AdjR2	ESG
High Portfolio									
ESG > 100%	0,26%	1,03	(0,14)	0,01	(0,10)		0,97	0,97	44,91
p value	0,72	0,00	0,00	0,77	0,00				
ESG > 90%	-2,20%	1,04	(0,23)	(0,00)	(0,13)		0,89	0,89	65,67
p value	0,11	0,00	0,00	0,96	0,00				
ESG > 85%	-0,50%	1,02	(0,17)	0,03	(0,10)		0,91	0,91	63,30
p value	0,68	0,00	0,00	0,55	0,00				
ESG > 80%	-0,22%	1,03	(0,15)	0,05	(0,10)		0,92	0,92	61,47
p value	0,85	0,00	0,00	0,27	0,00				
ESG > 75%	-0,25%	1,03	(0,16)	0,06	(0,09)		0,94	0,93	59,14
p value	0,81	0,00	0,00	0,10	0,00				
Low Portfolio									
ESG < 100%	0,26%	1,03	(0,14)	0,01	(0,10)		0,97	0,97	44,91
p value	0,72	0,00	0,00	0,77	0,00				
ESG < 10%	1,38%	1,08	0,13	(0,13)	(0,26)		0,84	0,84	15,22
p value	0,49	0,00	0,08	0,08	0,00				
ESG < 15%	1,15%	1,10	0,15	(0,12)	(0,24)		0,87	0,87	17,22
p value	0,52	0,00	0,03	0,06	0,00				
ESG < 20%	0,76%	1,12	0,08	(0,16)	(0,19)		0,88	0,87	18,94
p value	0,92	0,00	0,25	0,01	0,00				
ESG < 25%	1,36%	1,09	0,04	(0,14)	(0,12)		0,89	0,89	20,44
p value	0,52	0,00	0,47	0,01	0,00				
Long Short portfolio									
ESG - 100%	0,00%	-	-	-	-		-	-	-
p value	-	-	-	-	-				
ESG - 10%	-3,59%	(0,04)	(0,36)	0,12	0,13		0,15	0,13	-
p value	0,13	0,42	0,00	0,15	0,01				
ESG - 15%	-1,65%	(0,08)	(0,32)	0,15	0,14		0,21	0,19	-
p value	0,42	0,08	0,00	0,04	0,00				
ESG - 20%	-0,99%	(0,09)	(0,22)	0,21	0,08		0,14	0,12	-
p value	0,63	0,06	0,01	0,01	0,05				
ESG - 25%	-1,61%	(0,05)	(0,20)	0,21	0,03		0,13	0,11	-
p value	0,34	0,19	0,00	0,00	0,45				

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RQ3: Results ESGC (US – Fama French 5 Factors - 15Y)

2004 ESGC	a	RM-RF	SMB	HML	RMW	CMA	R2	AdjR2	ESG
High Portfolio									
ESG > 0%	-0,21%	1,05	(0,13)	0,11	0,05	(0,07)	0,96	0,96	44,91
p value	0,81	0,00	0,00	0,00	0,27	0,18			
ESG > 90%	-2,54%	1,08	(0,23)	0,11	(0,00)	(0,01)	0,88	0,88	65,67
p value	0,10	0,00	0,00	0,06	1,00	0,96			
ESG > 85%	-1,02%	1,05	(0,16)	0,11	0,06	(0,01)	0,91	0,90	63,30
p value	0,43	0,00	0,00	0,02	0,42	0,87			
ESG > 80%	-0,66%	1,07	(0,14)	0,13	0,04	0,00	0,91	0,91	61,47
p value	0,61	0,00	0,01	0,01	0,64	0,97			
ESG > 75%	-0,86%	1,07	(0,14)	0,14	0,09	(0,00)	0,93	0,93	59,14
p value	0,45	0,00	0,00	0,00	0,21	1,00			
Low Portfolio									
ESG < 10%	0,25%	1,15	0,16	0,08	0,11	(0,24)	0,81	0,81	15,22
p value	0,91	0,00	0,07	0,32	0,42	0,11			
ESG < 15%	0,19%	1,15	0,17	0,08	0,09	(0,28)	0,85	0,84	17,22
p value	0,93	0,00	0,03	0,28	0,48	0,04			
ESG < 20%	0,16%	1,15	0,09	0,05	0,05	(0,35)	0,86	0,86	18,94
p value	0,93	0,00	0,22	0,52	0,67	0,01			
ESG < 25%	0,87%	1,10	0,06	0,02	0,07	(0,32)	0,89	0,89	20,44
p value	0,58	0,00	0,31	0,77	0,46	0,00			
Long-short portfolio									
ESG - 10%	-2,79%	(0,07)	(0,39)	0,02	(0,11)	0,23	0,14	0,11	-
p value	0,26	0,22	0,00	0,79	0,47	0,16			
ESG - 15%	-1,20%	(0,10)	(0,33)	0,03	(0,02)	0,27	0,18	0,16	-
p value	0,58	0,04	0,00	0,72	0,85	0,06			
ESG - 20%	-0,83%	(0,09)	(0,22)	0,08	(0,01)	0,35	0,15	0,13	-
p value	0,69	0,08	0,01	0,29	0,92	0,01			
ESG - 25%	-1,74%	(0,03)	(0,20)	0,13	0,02	0,32	0,16	0,14	-
p value	0,31	0,44	0,00	0,06	0,87	0,01			

Table 6 : 15Y Fama-French 5 factors results on ESG Combined score

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RQ3: Factors conversions

$$r_{i,t}^{USD} = \frac{\frac{P_{i,t}^{EUR}}{USD/EUR_t} - \frac{P_{i,t-1}^{EUR}}{USD/EUR_{t-1}}}{\frac{P_{i,t-1}^{EUR}}{USD/EUR_{t-1}}} = \frac{P_{i,t}^{EUR}}{P_{i,t-1}^{EUR}} * \frac{USD/EUR_{t-1}}{USD/EUR_t} - 1 = \frac{\left(1 + r_{i,t}^{EUR}\right)}{\left(1 + r_{i,t}^{USDE/UR}\right)} - 1$$

where $r_{i,t}^{XXX}$ is the return in currency XXX of asset i at time t, $P_{i,t}^{EUR}$ is the price in euro of asset i at time t, USD/EUR_t is the exchange rate at time t (1 USD =USD/EUR_t EUR at time t).

$$AMB_t^{EUR} = r_{A,t}^{EUR} - r_{B,t}^{EUR} = \left(\frac{A_t^{EUR}}{A_{t-1}^{EUR}} - 1\right) - \left(\frac{B_t^{EUR}}{B_{t-1}^{EUR}} - 1\right)$$

$$= \left(\frac{A_t^{USD} * USDEUR_t}{A_{t-1}^{USD} * USDEUR_{t-1}} - 1\right) - \left(\frac{B_t^{USD} * USDEUR_t}{B_{t-1}^{USD} * USDEUR_{t-1}} - 1\right) =$$

$$= \left(1 + r_{A,t}^{USD}\right)\left(1 + r_t^{USDEUR}\right) - \left(1 + r_{B,t}^{USD}\right)\left(1 + r_t^{USDEUR}\right)$$

$$= \left(1 + r_{i,t}^{USDEUR}\right) * \left(r_{A,t}^{USD} - r_{B,t}^{USD}\right)$$

where AMB is the short long factor A minus B, X_t^{YYY} is the factor X in currency YYY at time t associated to the $r_{X,t}^{YYY}$ return.

$$ERM_t^{EUR} = (1 + RM_t^{USD}) * (1 + r_t^{USDEUR}) - 1 - rf_t^{EUR}$$

where RM_t^{USD} is the market return in USD.

Glück et al., 2020

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RQ3: Results ESGC (EU – Fama French 3 Factors - 15Y)

2004 ESGC	a	RM-RF	SMB	HML			R2	AdjR2	ESG
High Portfolio									
ESG > 100%	0,26%	1,06	(0,18)	0,11			0,97	0,97	56,95
p value	0,78	0,00	0,00	0,01					
ESG > 90%	0,61%	1,10	(0,39)	0,23			0,90	0,89	75,60
p value	0,75	0,00	0,00	0,01					
ESG > 85%	0,91%	1,07	(0,40)	0,24			0,92	0,92	74,54
p value	0,56	0,00	0,00	0,00					
ESG > 80%	1,13%	1,04	(0,37)	0,24			0,93	0,93	73,03
p value	0,42	0,00	0,00	0,00					
ESG > 75%	1,41%	1,03	(0,35)	0,27			0,94	0,94	71,72
p value	0,30	0,00	0,00	0,00					
Low Portfolio									
ESG < 100%	0,26%	1,06	(0,18)	0,11			0,97	0,97	56,95
p value	0,78	0,00	0,00	0,01					
ESG < 10%	-0,28%	1,12	0,32	0,11			0,89	0,88	21,27
p value	0,88	0,00	0,00	0,21					
ESG < 15%	-2,23%	1,10	0,39	0,14			0,90	0,90	26,15
p value	0,21	0,00	0,00	0,08					
ESG < 20%	-0,93%	1,05	0,25	0,21			0,90	0,90	30,48
p value	0,60	0,00	0,00	0,01					
ESG < 25%	0,20%	1,07	0,18	0,15			0,91	0,91	33,40
p value	0,90	0,00	0,02	0,03					
Long Short portfolio									
ESG - 100%	0,00%	-	-	-			-	-	-
p value	-	-	-	-					
ESG - 10%	0,89%	(0,02)	(0,72)	0,12			0,25	0,23	-
p value	0,67	0,64	0,00	0,19					
ESG - 15%	3,14%	(0,04)	(0,78)	0,10			0,33	0,32	-
p value	0,09	0,29	0,00	0,21					
ESG - 20%	2,06%	(0,01)	(0,62)	0,02			0,28	0,26	-
p value	0,21	0,72	0,00	0,73					
ESG - 25%	1,20%	(0,03)	(0,53)	0,12			0,25	0,24	-
p value	0,43	0,21	0,00	0,08					

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RQ3: Results ESGC (EU – 4 Factors - 15Y)

2004 ESGC	a	RM-RF	SMB	HML	UMD		R2	AdjR2	ESG
High Portfolio									
ESG > 100%	2,43%	1,03	(0,18)	(0,01)	(0,20)		0,98	0,98	56,95
p value	0,00	0,00	0,00	0,68	0,00				
ESG > 90%	3,50%	1,05	(0,40)	0,06	(0,27)		0,91	0,91	75,60
p value	0,05	0,00	0,00	0,42	0,00				
ESG > 85%	3,00%	1,04	(0,40)	0,12	(0,20)		0,93	0,93	74,54
p value	0,05	0,00	0,00	0,08	0,00				
ESG > 80%	3,18%	1,01	(0,37)	0,12	(0,19)		0,94	0,94	73,03
p value	0,02	0,00	0,00	0,05	0,00				
ESG > 75%	3,85%	1,00	(0,35)	0,13	(0,23)		0,95	0,95	71,72
p value	0,00	0,00	0,00	0,02	0,00				
Low Portfolio									
ESG < 100%	2,43%	1,03	(0,18)	(0,01)	(0,20)		0,98	0,98	56,95
p value	0,00	0,00	0,00	0,68	0,00				
ESG < 10%	1,70%	1,09	0,32	(0,01)	(0,19)		0,89	0,89	21,27
p value	0,39	0,00	0,00	0,95	0,00				
ESG < 15%	0,13%	1,07	0,38	0,00	(0,22)		0,91	0,91	26,15
p value	0,94	0,00	0,00	0,96	0,00				
ESG < 20%	1,49%	1,02	0,25	0,07	(0,23)		0,91	0,91	30,48
p value	0,60	0,00	0,00	0,34	0,00				
ESG < 25%	2,89%	1,03	0,18	(0,00)	(0,25)		0,93	0,93	33,40
p value	0,90	0,00	0,01	0,99	0,00				
Long Short portfolio									
ESG - 100%	0,00%	-	-	-	-		-	-	-
p value	-	-	-	-	-				
ESG - 10%	1,79%	(0,03)	(0,72)	0,07	(0,08)		0,26	0,24	-
p value	0,41	0,42	0,00	0,47	0,14				
ESG - 15%	2,87%	(0,03)	(0,78)	0,12	0,03		0,33	0,32	-
p value	0,14	0,36	0,00	0,18	0,62				
ESG - 20%	1,69%	(0,00)	(0,62)	0,05	0,03		0,28	0,26	-
p value	0,32	0,87	0,00	0,55	0,44				
ESG - 25%	0,96%	(0,03)	(0,53)	0,13	0,02		0,25	0,24	-
p value	0,55	0,28	0,00	0,07	0,57				

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RQ3: Results ESGC (EU – Fama French 5 Factors - 15Y)

2004 ESGC	a	RM-RF	SMB	HML	RMW	CMA	R2	AdjR2	ESG
High Portfolio									
ESG > 100%	0,66%	1,03	(0,22)	0,21	0,03	(0,23)	0,97	0,97	56,95
p value	0,52	0,00	0,00	0,00	0,71	0,00			
ESG > 90%	0,48%	1,08	(0,40)	0,34	0,12	(0,08)	0,90	0,89	75,60
p value	0,82	0,00	0,00	0,01	0,51	0,60			
ESG > 85%	0,97%	1,07	(0,40)	0,28	0,04	0,01	0,92	0,92	74,54
p value	0,57	0,00	0,00	0,01	0,79	0,95			
ESG > 80%	1,14%	1,04	(0,37)	0,29	0,06	(0,01)	0,93	0,93	73,03
p value	0,46	0,00	0,00	0,00	0,68	0,91			
ESG > 75%	1,46%	1,02	(0,35)	0,34	0,06	(0,06)	0,94	0,93	71,72
p value	0,33	0,00	0,00	0,00	0,63	0,56			
Low Portfolio									
ESG < 100%	0,66%	1,03	(0,22)	0,21	0,03	(0,23)	0,97	0,97	56,95
p value	0,52	0,00	0,00	0,00	0,71	0,00			
ESG < 10%	0,68%	1,06	0,25	0,21	(0,07)	(0,47)	0,89	0,89	21,27
p value	0,75	0,00	0,01	0,12	0,68	0,00			
ESG < 15%	-0,23%	1,04	0,29	0,13	(0,31)	(0,52)	0,91	0,91	26,15
p value	0,90	0,00	0,00	0,30	0,06	0,00			
ESG < 20%	1,43%	0,99	0,14	0,16	(0,37)	(0,51)	0,91	0,91	30,48
p value	0,44	0,00	0,09	0,17	0,02	0,00			
ESG < 25%	1,01%	1,02	0,11	0,25	(0,05)	(0,39)	0,92	0,91	33,40
p value	0,57	0,00	0,16	0,03	0,76	0,00			
Long Short portfolio									
ESG - 100%	0,00%	-	-	-	-	-	-	-	-
p value	-	-	-	-	-	-			
ESG - 10%	-0,20%	0,03	(0,65)	0,13	0,19	0,39	0,27	0,25	-
p value	0,93	0,53	0,00	0,36	0,33	0,02			
ESG - 15%	1,20%	0,03	(0,68)	0,15	0,34	0,53	0,38	0,37	-
p value	0,54	0,46	0,00	0,22	0,04	0,00			
ESG - 20%	-0,29%	0,05	(0,51)	0,12	0,43	0,50	0,35	0,33	-
p value	0,87	0,13	0,00	0,26	0,00	0,00			
ESG - 25%	0,45%	0,00	(0,46)	0,10	0,11	0,33	0,27	0,25	-
p value	0,78	0,89	0,00	0,37	0,44	0,01			