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MEASURING FIRM PERFORMANCE: TESTING A PROPOSED MODEL

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Abstract:

Firm performance is a very complex and exhaustive concept. It can be related to many factors: starting with variables from balance sheet, income statement or cash-flow statement, continuing with research and development expenses or IT competences, and last but not least with intangible assets like human capital, goodwill, or brand value. The purpose of the present paper is to develop and test a model in order to measure firm performance by considering US companies that are ranked into the Global Fortune 500. In this study we used control variables (assets growth rate, net income growth rate and revenue growth rate) and depended variables – return on assets (ROA), debt to equity, research and development expenses to total operating expenses, environment, social and governance rating, Tobin's q – to measure firm performance. The article's findings suggest that when analyzing the firm performance much more factors must be considered.

Key words: *Firm performance, Model, US-based companies*

1. Introduction

At a Google Scholar search we find out that there are approximately 785000 results with content about firm performance. According to Clarivate Analytics Web of Science, there are 2697 titles with the collocation firm performance.

Considering that, it will be very difficult to define firm performance. But, we will try to identify some determinants/factors/characteristics that are commonly used to measure or to describe firm performance. Many researchers have considered financial ratios, others IT capabilities, others resource-based theory, and so one. According to Richard, Devinney, Yip and Johnson (2009), “**organizational performance** encompasses three specific areas of firm outcomes: (a) financial performance (profits,

return on assets, return on investment, etc.); (b) product market performance (sales, market share, etc.); and (c) shareholder return (total shareholder return, economic value added, etc.)". On the other hand, Bharadwaj (2000) emphasized that "the resource-based view of the firm attributes superior financial performance to organizational resources and capabilities". More, Klassen and McLaughlin (1996) argued that "the environmental management has the potential to play a pivotal role in the financial performance of the firm".

Table 1 provides an overview on the most important factors that can influence firm performance according to an extensive literature research.

Table 1: Firm performance determinants

Guo, Wang & Wei (2018)	R&D spending, strategic position
Artz, Norman, Hatfield & Cardinal (2010)	R&D, patents, product innovation
Bharadwaj (2000)	ROA, Sales, Tobin's q
Tippins & Sohi (2003)	IT competency
Klassen & McLaughlin (1996)	Environmental management
Lang & Stulz (1994)	Tobin's q and firm diversification
Wernerfelt & Montgomery (1988)	Tobin's q
Crook, Todd, Combs, Woehr & Ketchen (2011)	ROA
Anderson & Reeb (2003)	ROA, Tobin's q
Wu, Wu, Zhou & Wu (2012)	ROA, Tobin's q
Richard, Devinney, Yip & Johnson (2009)	ROA, ROI, TSR
Dess & Robinson Jr (1984)	ROA, Sales
Bhagat & Bolton (2008)	Corporate governance
Gu & Lev (2011)	Intangible assets
St-Pierre & Audet (2011)	Intangible assets
Delen, Kuzey & Uyar (2013)	Financial ratios

A model for the organization performance was developed by Hansen and Wernerfelt (1989). The authors have considered three categories of factor with a direct impact on organization performance: organizational factors, environmental factors and people factors.

2. Methodology

2.1. Data and sample

The purpose of the present study is to develop and measure firm performance. The sample consist in 109 US companies that are ranked into Global Fortune 500 in 2017 (The World Largest Companies).

Table1: Sample distribution

Sector	No. of Firms	R&D	NI	ESG
Aerospace & Defense	6	2/6	6/6	6/6
Apparel	1	1/1	1/1	1/1
Chemicals	1	1/1	1/1	1/1
Energy	14	2/14	10/14	12/14
Food, Beverages & Tobacco	9	1/9	9/9	8/9
Foods & Drug Stores	5	0/5	5/5	4/5
Health Care	16	8/16	15/16	15/16
Hotels, Restaurants & Leisure	2	0/2	2/2	2/2
Household Products	1	0/1	1/1	1/1
Industrials	6	4/6	5/6	6/6
Materials	2	1/2	2/2	2/2
Media	2	0/2	2/2	2/2
Motor, Vehicles & Parts	3	0/3	2/3	3/3
Retailing	10	0/10	9/10	9/10
Technology	12	12/12	11/12	12/12
Telecommunications	3	0/3	3/3	3/3
Transportation	7	0/7	6/7	6/7
Wholesalers	9	1/9	8/9	6/9
Total	109	33/109	98/109	99/109
		30.27%	89.90%	90.82%

Note: R&D – no. of firm with research and development expenses; NI – no. of firm with net income; ESG – no. of firm with calculated ESG rating.

As it can be observed, only 30% of analyzed companies have invested in research and development and most of them are from sectors like health care or technology. The rest of the companies have no interest for this kind of investment. However, over 90% from the sample has registered net income and have calculated ESG rating.

Based on literature review, the considered variables are:

Table 2: Variables

a₁	ROA – Return on assets = Net income / Total Assets
a₂	Debt/Equity = Long term debt / Shareholders` equity
a₃	R&D expenses / Total operating expenses
a₄	ESG Score – Environment, Social and Governance Rating
a₅	Tobin`s q = Equity market value / Equity book value
AGR	Total assets growth rate
NIGR	Net income growth rate
RGR	Revenue growth rate

Total score for firm performance will be calculated based on the following formula:

$$Score = \frac{ROA + \frac{Debt}{Equity} + R\&D + \frac{R\&D\ expenses}{Total\ operating\ expenses} + ESG\ Score + Tobins\ q}{5} \quad (1)$$

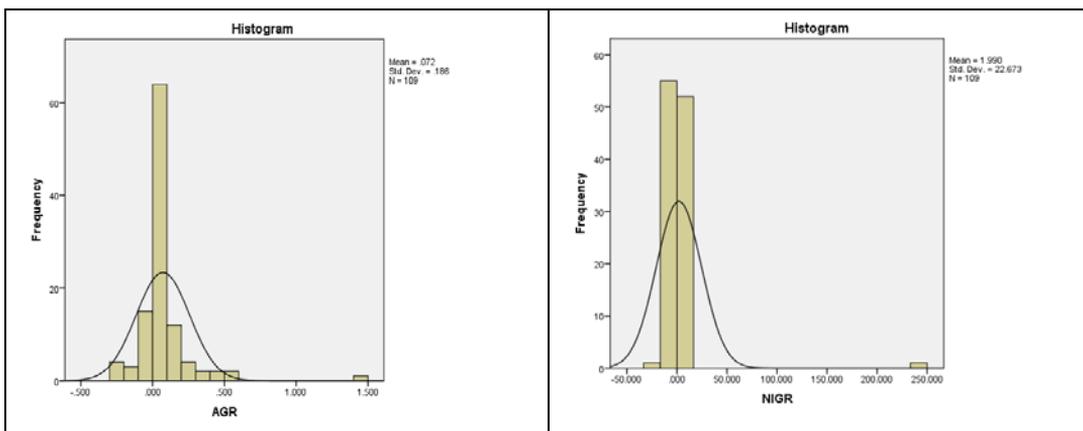
Table 3: Descriptive statistics

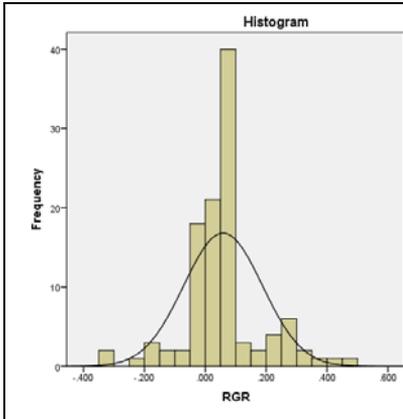
	a1	a2	a3	a4	a5	AGR	NIGR	RGR
Mean	0.07	0.70	0.05	56.02	10.16	0.07	1.99	0.06
Standard Error	0.01	0.49	0.01	1.85	5.67	0.02	2.17	0.01
Median	0.06	0.62	0.00	61.00	3.30	0.04	0.00	0.05
Standard Deviation	0.11	5.16	0.10	19.28	59.17	0.19	22.67	0.13
Sample Variance	0.01	26.68	0.01	371.76	3500.70	0.03	514.07	0.02
Minimum	-0.14	-26.58	0.00	0.00	-135.61	-0.22	-19.50	-0.34
Maximum	1.11	22.98	0.45	86.00	572.51	1.42	234.75	0.47
Sum	7.25	75.86	5.08	6106.00	1107.93	7.81	216.93	6.36
Count	109	109	109	109	109	109	109	109

Source: authors calculation

The analysis of descriptive statistics shows that some data has to be adjusted. The difference between minimum and maximum levels are too high; the same it is for sample variation. As a consequence, we have to take a look on normal distribution and identify the standard deviation interval.

Table 4: Histograms for normal distribution





If we analyze the control variable like assets growth rate (AGR), net income growth rate (NIGR) and revenue growth rate (RGR), it can be observed that some of the companies must be eliminated from the sample because they registered values that will be very difficult to normalize (standardize), and the results will be sensitive different.

Source: authors computation in SPSS

The same procedure is available for the other five variables: a1, a2, a3, a4, and a5.

Table 5: Variables representation

	<p>As we already described in Table 1, a3 variable is the most critical one. It is not about missing date, it is about the fact that companies does not invest in research and development. But, even so, we cannot eliminate for our analysis these companies, we have to adjust the sample by considering all variables.</p>

Further, based on the descriptive statistic, we must calculate the standard deviation interval for each variable in order to identify those companies that integrate the best for the purpose of the paper.

Table 6: Standard deviation interval

	a1	a2	a3	a4	a5	AGR	NIGR	RGR
Standard deviation INTERVAL	[-0.04; 0.18]	[-4.46; 5.86]	[-0.05; 0.15]	[36.74; 75.3]	[-49.01; 69.33]	[-0.11; 0.26]	[-20.68; 24.66]	[-0.07; 0.19]

After SPSS data computation, 70 companies were selected to be included into the firm performance model.

3. Results

Considering the described methodology, the analysis will be focus on 70 companies, 1050 observations and 560 results for used variables.

The calculated variables have been normalized by using formula (2) below.

$$a_{ij}norm = 90 X \frac{a_{ij} - a_{imin}}{a_{imax} - a_{imin}} + 10 \quad (2)$$

Where,

a_{ij} : represents the result of variable i for company j

a_{imin} : represents the minimum level of variable i

a_{imax} : represents the maxim level of variable i

The normalization interval is [10;100]

In order to calculate the firm performance score we used the formula 3 (based on formula 1).

$$Score = (a_{1normj} + a_{2normj} + a_{3normj} + a_{4normj} + a_{5normj})/5 \quad (3)$$

Then, we compute a Pearson correlation diagram in SPSS in order to find out the level of confidence and the link between variables.

Table 7: Variables Pearson Correlation

		Correlations								
		a1norm	a2norm	a3norm	a4norm	a5norm	Score	AGRnorm	RGRnorm	
a1norm	Pearson Correlation	1	-.102	-.108	-.040	-.023	.474**	-.089	-.253*	
	Sig. (2-tailed)		.402	.374	.744	.848	.000	.462	.035	
	N	70	70	70	70	70	70	70	70	
a2norm	Pearson Correlation	-.102	1	-.036	-.045	.406**	.300*	-.065	-.113	
	Sig. (2-tailed)	.402		.769	.709	.000	.012	.593	.353	
	N	70	70	70	70	70	70	70	70	
a3norm	Pearson Correlation	-.108	-.036	1	.067	.478**	.554**	.406**	.290 [†]	
	Sig. (2-tailed)	.374	.769		.583	.000	.000	.000	.015	
	N	70	70	70	70	70	70	70	70	
a4norm	Pearson Correlation	-.040	-.045	.067	1	-.174	.465**	-.131	-.021	
	Sig. (2-tailed)	.744	.709	.583		.149	.000	.280	.860	
	N	70	70	70	70	70	70	70	70	
a5norm	Pearson Correlation	-.023	.406**	.478**	-.174	1	.514**	.175	.174	
	Sig. (2-tailed)	.848	.000	.000	.149		.000	.146	.149	
	N	70	70	70	70	70	70	70	70	
Score	Pearson Correlation	.474**	.300*	.554**	.465**	.514**	1	.097	-.007	
	Sig. (2-tailed)	.000	.012	.000	.000	.000		.425	.951	
	N	70	70	70	70	70	70	70	70	
AGRnorm	Pearson Correlation	-.089	-.065	.406**	-.131	.175	.097	1	.532**	
	Sig. (2-tailed)	.462	.593	.000	.280	.146	.425		.000	
	N	70	70	70	70	70	70	70	70	
RGRnorm	Pearson Correlation	-.253*	-.113	.290 [†]	-.021	.174	-.007	.532**	1	
	Sig. (2-tailed)	.035	.353	.015	.860	.149	.951	.000		
	N	70	70	70	70	70	70	70	70	

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Source: authors computation in SPSS

As regarding the score of firm performance, the level of research and development expenses from total operating expenses has the highest value of Person correlation (0.554) at a level 0.01 of confidence. We did not weighted the variables into the models. We have considered that all variables have the same influence. That could be a limitation of our study. Excepting the debt/equity ratio, also the other 3 variables (ROA, ESG score and Tobin`s q) are very well correlated at the level of confidence of 0.01.

After calculating the score for firm performance, we have conducted a cluster analysis by using RapidMiner. Two clusters have been identified. The results are presented in Figure 1.

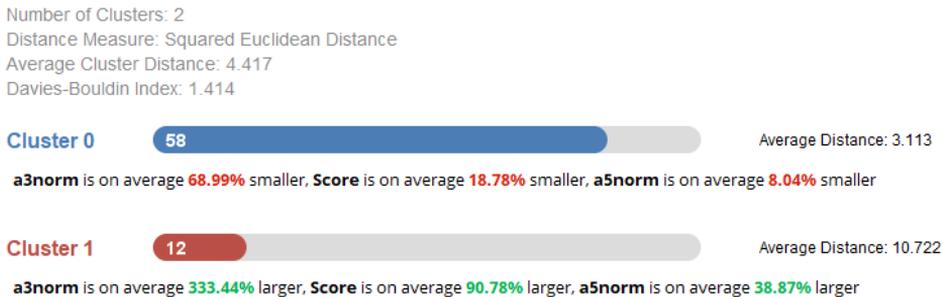


Figure 1: Cluster Analysis (RapidMiner authors computation)

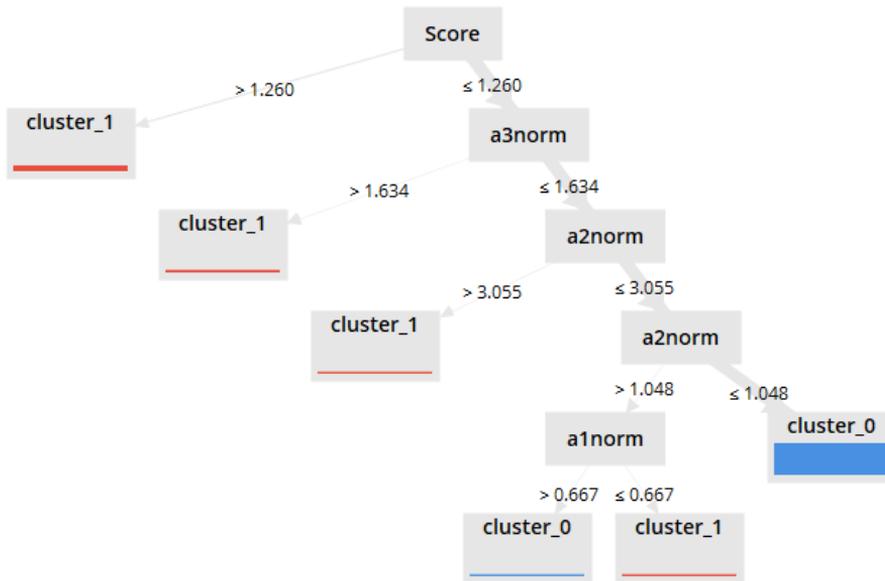


Figure 2: K-Means Cluster Tree
(RapidMiner authors computation)

4. Discussions and Conclusions

Measuring firm performance is very challenging. In this study we used control variables (assets growth rate, net income growth rate and revenue growth rate) and depended variables – return on assets (ROA), debt to equity, research and development expenses to total operating expenses, environment, social and governance rating, Tobin’s q – to measure firm performance.

We first identify the most suitable sample in order to test the proposed model. 70 US companies were eligible from 109, after descriptive statistics interpretation. Even if the analyzed companies are ranked in the same top, there are many disparities between them. Our findings show that the calculated variables have to be normalized in order to be integrated into the model. Then, the score for firm performance has been computed.

The article’s findings suggest that when analyzing the firm performance much more factors must be considered. Only the revenues, assets, or net income are not enough. More, relative factors have to be used in order to be able to compare companies. For instance, in 2017 Walmart registered 450 \$B in revenue, two times bigger than Apple, but she has zero investment in research and development and a much lower score for performance, according to our results. More, if you take a closer look at the a3norm (R&D) and score results (appendix 1) you will find out that the best

performers are the companies that have invested in research and development. In our opinion, this kind of investment, alongside with intangible assets, can drive to sustainable performance.

We also conducted a cluster analysis. In the first cluster (Cluster 0) are placed 58 companies with a lower score for performance, a low level of research and development investment and a low Tobin's q. in the second cluster (Cluster 1) are placed the rest of the companies, more exactly 12. Here are the best performers in terms of ROA, research and development, Tobin's Q or environment, social and governmental rating.

Overall, the findings reported here support and extend previous research showing that the firm performance is very difficult to measure, is a very subjective concept, and it can be influenced by hundreds factors.

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Appendix 1

Company name	a1norm	a2norm	a3norm	a4norm	a5norm	Score
3M	93.19	49.33	62.43	77.50	53.42	67.17
Apple	93.71	45.86	57.76	87.14	47.93	66.48
Amazon.com	34.24	47.68	100.00	16.43	100.00	59.70
Verizon	87.10	66.49	10.00	87.14	42.82	58.71
PepsiCo	55.48	71.12	19.64	80.71	61.88	57.77
Johnson Controls	40.97	47.36	50.47	100.00	35.58	54.88
Lowe's	76.19	65.13	10.00	58.21	60.44	54.00
Sysco	57.43	72.52	10.00	64.64	65.37	53.99
Procter & Gamble	92.85	41.61	10.00	74.29	39.96	51.74
Abbott Laboratories	24.77	47.54	71.10	71.07	39.56	50.81
Northrop Grumman	53.71	60.12	10.00	80.71	47.13	50.33
Nike	69.50	41.84	10.00	67.86	59.77	49.79
Deere	39.71	44.23	45.78	74.29	42.03	49.21
Best Buy	71.10	40.68	10.00	80.71	41.93	48.88
Disney	73.98	43.02	10.00	71.07	40.32	47.68
Macy's	66.15	49.14	10.00	74.29	36.27	47.17
AT&T	58.55	47.66	10.00	83.93	35.55	47.14
FedEx	70.39	46.51	10.00	67.86	39.04	46.76
American Airlines Group	42.25	100.00	10.00	38.93	41.72	46.59
International Paper	56.82	56.01	10.00	71.07	38.75	46.53
Target	62.38	48.91	10.00	67.86	40.33	45.90
Kroger	50.09	55.62	10.00	74.29	39.41	45.88
CVS Health	60.41	44.38	10.00	77.50	36.10	45.68
United Technologies	47.67	47.15	41.82	51.79	39.56	45.60
Comcast	89.59	47.34	10.00	42.14	36.92	45.20
Exelon	39.42	49.80	10.00	90.36	34.95	44.91
Raytheon	58.14	43.17	10.00	67.86	43.80	44.59
Humana	71.92	43.26	10.00	55.00	41.38	44.31
Marathon Petroleum	60.61	47.52	10.00	64.64	37.23	44.00
Caterpillar	26.76	43.93	43.07	58.21	44.48	43.29
Walgreens Boots Alliance	56.20	43.01	10.00	67.86	37.23	42.86
Exxon Mobil	53.05	39.37	13.29	71.07	35.54	42.46
Costco	62.71	44.61	10.00	42.14	51.09	42.11
Andeavor	51.33	46.33	10.00	64.64	36.69	41.80
Kraft Heinz	72.71	42.66	10.00	48.57	34.29	41.65
Rite Aid	80.26	60.58	10.00	22.86	33.97	41.53
Coca-Cola	29.24	57.80	10.00	55.00	55.63	41.53

Mondelez International	47.29	43.39	10.00	67.86	36.93	41.09
Dollar General	90.41	42.60	10.00	19.64	41.66	40.86
Delta Air Lines	59.01	42.91	10.00	51.79	37.87	40.31
Philip Morris International	100.00	10.00	10.00	71.07	10.00	40.26
Cigna	41.63	42.11	10.00	67.86	38.78	40.08
Anthem	51.89	45.11	10.00	55.00	37.30	39.86
Express Scripts Holding	68.24	46.96	10.00	35.71	37.61	39.71
Phillips 66	74.07	42.28	10.00	35.71	36.44	39.70
Alcoa	28.25	41.34	12.18	80.71	35.66	39.63
Schlumberger	10.00	42.38	29.80	77.50	37.01	39.24
Valero Energy	66.84	39.31	10.00	42.14	36.39	38.94
General Dynamics	67.99	41.78	10.00	32.50	42.38	38.93
Walmart	48.37	42.04	10.00	55.00	39.22	38.93
Duke Energy	33.73	50.73	10.00	64.64	34.87	38.79
Aetna	40.67	43.68	10.00	58.21	40.56	38.63
Avnet	51.70	41.63	10.00	55.00	34.27	38.52
General Electric	12.64	56.29	10.00	77.50	35.53	38.39
DowDuPont	25.52	41.26	36.49	51.79	35.27	38.06
ConocoPhillips	14.69	43.82	10.00	83.93	37.54	38.00
Ford Motor	37.84	41.92	10.00	61.43	34.33	37.10
Chevron	41.63	40.46	10.00	58.21	35.15	37.09
AmerisourceBergen	27.05	57.83	10.00	38.93	50.94	36.95
Cardinal Health	39.40	52.44	10.00	45.36	36.86	36.81
Arrow Electronics	34.99	44.43	10.00	58.21	34.89	36.50
United Continental Holdings	49.57	52.39	10.00	32.50	37.46	36.38
Twenty-First Century Fox	53.99	51.40	10.00	22.86	42.93	36.24
Archer Daniels Midland	43.70	41.93	10.00	48.57	35.20	35.88
Tyson Foods	56.80	47.56	10.00	26.07	36.50	35.39
Halliburton	10.87	51.57	10.00	58.21	40.89	34.31
Honeywell International	36.93	45.89	10.00	32.50	45.86	34.23
Bunge	26.02	45.04	10.00	51.79	34.88	33.55
General Motors	11.02	41.28	10.00	67.86	35.07	33.05
Centene	42.56	45.54	10.00	10.00	40.86	29.79

Source: authors computation