Operational Performance and Sustainability Capability of Healthcare Firms During the COVID-19 Pandemic

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This study investigates the effects of sustainability capability on the operational performance of the healthcare sector in the United States during the unprecedented COVID-19 crisis in 2020. Taking industry groups into account, seven metrics are calculated from healthcare firms' financial statements to measure the operational performance in profitability, liquidity, and efficiency. Our model demonstrates that industry group, sustainability capability, and their interactions have significant effects on operating margin, ROA, cash conversion cycle, and payables turnover. The insights gained from this study help to understand the effects of sustainability capability in an uncertain environment.

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I. INTRODUCTION

In 1987, the Brundtland Commission defined sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their needs" (Brundtland Report, 1987). Carter and Rogers took this widely-cited definition and applied it to sustainable supply chain management in their 2008 report, further defining sustainability as the "strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains" (Carter & Rogers, 2008). This definition ties in core principles of risk management, transparency, strategy, and culture to evaluate individual organizations and to examine the strategic value of sustainability. Companies in many industries, including the healthcare sector, have invested resources to strengthen their sustainability capabilities over the years. Many organizations have made public commitments to sustainable practices, but the impact of these commitments has not been well characterized (Johnson, 2010; Milanesi et al., 2020).

With the growing investment in sustainability, we are interested to know whether firms with higher sustainability capabilities can lower downside risk and are more resilient, especially during turbulent times. The COVID-19 pandemic has caused unprecedented and widespread turmoil in the world. It is not just a global health crisis, but

also a labor market and economic crisis. Global supply chains and manufacturing have been disrupted with severe consequences for consumers, businesses, and societies. The healthcare sector is selected for the study since its importance during the COVID-19 pandemic is evident and the pandemic has placed enormous stress on the sector and the communities they serve.

In 2020, healthcare spending in the United States grew to a total of $4.1 trillion, accounting for 19.7% of the nation's GDP (Hartman et al., 2021). This figure has grown continuously in absolute terms and as a percentage of the overall GDP. Compared to other top spenders, the United States far outpaces the next highest countries, with Switzerland spending 12.2% of the GDP and France, Germany, and Sweden about 11% (OECD, 2019).

One of the central tenets of healthcare since the age of Hippocrates has been *primum non nocere* – "first, do no harm." While this principle from the Hippocratic Oath often applies to individual clinicians in their decision-making capacities, recent attention has shifted toward assessing the impact of the overall healthcare sector with metrics beyond traditional clinical outcomes (Hussain et al., 2018; Sherman et al., 2020). The importance of sustainability can be linked to nearly every stage of the healthcare supply chains. Environmental and economic impact, equity, and governance are a few metrics via which industry-wide impacts have been at the center of much discussion and reform. For example, Consolandi, et. Al., (2020) mapped the 17 UN Sustainable Development Goals to Sustainability Accounting Standard Board's 30 generic environmental, social, and governance (ESG) issues to identify contributions from the healthcare sector. From the environmental perspective, the use of toxic organic solvents in the synthesis of pharmaceutical compounds to the release of anesthetic agents in surgery that have greenhouse gas effects is the subject of active mitigation efforts in healthcare (Andersen et al., 2012; Constable et al., 2007).

As defined by the World Health Organization, the healthcare sector includes all organizations, institutions, and resources that are devoted to producing health actions, whose primary purpose is to improve health (World Health Organization, 2007). This definition, applied to the healthcare landscape in the United States, generally consists of businesses or organizations that directly provide medical services, manufacture pharmaceuticals, produce medical equipment and devices, or otherwise support healthcare delivery. For this research, we gathered data from three industry groups in the healthcare sector—medical equipment and devices, pharmaceuticals, and service providers. We investigated whether the sustainability capability have any effects on operational performance during the unprecedented COVID-19 crisis.

II. LITERATURE REVIEW

There are various metrics to measure collective conscientiousness for sustainability commitment, among which the Environmental, Social, and Governance (ESG) criteria are the most widely utilized. The ESG criteria have their roots in the disciplines of ethical finance and investing and were originally termed in the 2004 United Nations report "Who Cares Wins." This initial conference sought to connect financial markets to ESG value drivers (Knoepfel, 2004).

In practice, ESG scores provide a numerical measure of how an organization is performing on an array of environmental, social, and governance matters. Often, this takes the form of industry-specific ESG risks counterbalanced with the organization's effectiveness at managing those risks (Filbeck et al., 2019). This method of defining ESG indicators focuses on an organization's preparedness, disclosure, and performance with respect to each ESG incident (Huber et al.,

2017). Other scoring systems feature rules-based methodologies, or composite scores based on industry-specific models with varying weights for each sector (Escrig-Olmedo et al., 2019).

With ESG scores being utilized in the company reporting more frequently, some studies explore the relationship between ESG scores and the impacts on financial and market performance. Albuquerque et al. (2021) studied the stock market crash during the COVID-19 pandemic and showed that stocks with higher rating in environmental and social policies has sufficiently higher returns, lower return volatility, and higher operating profit margins during the first quarter of 2020.

Similarly, Yoo et al. (2021) examined the effect of sustainability on stock returns and volatility using cross-sector data from October 2019 to June 2020. Their results showed an increasing environment score is related to higher stock returns and lower volatility. However, an increasing governance score is correlated with lower stock returns and higher volatility.

Other studies had linked ESG scores to corporate financial performance (Ortas et al., 2015; Beretta et al., 2019; Brammer & Millington, 2008; Ferrero-Ferrero et al., 2016; Yoon et al., 2018). Most of the studies focus mainly on the stock performance or a single measure of the financial returns and are not specific to the healthcare industry.

Few studies focused on the healthcare sector. One study mapped ESG standards within healthcare companies to UN Sustainable Development Goals (Consolandi et al., 2020). Using data from January 2007 to February 2018, they found that all industries in the healthcare sector displayed positive ESG performance on average, however, the score distributions within industries varied significantly. Another study that examined a matched sample of US companies found that high sustainability companies significantly outperformed their counterparts in the long

term, with respect to the stock market and return on equity performance from 1993 to 2010 (Eccles et al., 2014). Their findings detailed that companies with a focus on sustainability had greater stakeholder engagement and were better able to measure and disclose their non-financial information. This analysis was performed on 180 firms, of which only 12.2% were related to the healthcare industry. A case report examining Johnson & Johnson determined that the company's focus on corporate social responsibility (CSR) and sustainability contributed to improve the organization's economic performance (Turcsanyi & Sisaye, 2013). They suggested that in the long run, organizations committed to sustainability in their strategic planning processes demonstrate greater ability to manage risks and take advantage of economic opportunities.

Given that that current literature is limited in scope, not specific to the healthcare industry, and does not consider effects of the pandemic, further study is warranted. We are interested in wider measurements of operational performance of the different industries within the healthcare sector during the turbulent pandemic year 2020 by taking their sustainability capability into account as well. This study focused on the following research questions.

- Did the different industry groups affect the healthcare firm's operational performance during the pandemic?
- Did sustainability capability affect the healthcare firms' operational performance during the pandemic?
- Did the interaction of the industry group and sustainability capability affect the firm's operational performance?

2.1. Financial Metrics for Operational Performance

Financial ratios are commonly used to assess a firm's operational performance and to make comparisons. Unlike many prior studies

that used a single measurement for a firm's stock market or financial performance, we used a wider range of metrics to assess a firm's operational performance. Seven financial ratios are examined to evaluate healthcare companies in profitability, liquidity, and efficiency.

Profitability ratios evaluate the ability of a healthcare company to generate a surplus. Operating margin and return on asset (ROA) are metrics used in the profitability category. The operating margin ratio measures how profitable the healthcare company is when looking at the performance of its primary activities. Return on asset ratio assesses how much profit a company makes compared to its assets.

The liquidity ratio evaluates the ability of the healthcare company to generate cash for normal business operations. The cash conversion cycle (CCC) metric is used in the liquidity category. CCC roughly measures the average amount of time a company takes to convert its cost to inventory and other resources into returns as collected revenue. Generally, the lower the number for the CCC, the better it is for the company. The lower the CCC means the better relationship with suppliers and customers and lower inventory level.

Efficiency ratios indicate a firm's ability to use its assets and liabilities to generate revenues. Inventory turnover, asset turnover, receivables turnover, and payables turnover are metrics used in this category. The asset turnover ratio indicates the efficiency with which a company is using its assets to generate revenue. The inventory turnover ratio can indicate how efficient the company is at managing its inventory. A high ratio implies either strong sales or insufficient inventory. Receivables turnover indicates how quickly net sales are turned into cash. The accounts payables turnover ratio measures the speed with which a company pays its suppliers. A lower accounts payables ratio indicates that the company is paying its suppliers slowly.

The efficiency metrics are related to the CCC metric. A high payables turnover ratio implies a shorter accounts payables turnover in days, which will lengthen the cash conversion cycle time. A high ratio of inventory turnover and receivables turnover means a shorter turnover in days, which will shorten the cash conversion cycle time.

III. METHODOLOGY AND DATA

Sustainalytics, a Morning Star company, rates the sustainability of global companies based on their environmental, social, and corporate governance (ESG) performance. Sustainalytics is one of the top ESG data and rating providers (Hirai & Brady, 2021). It starts with rating the exposure of manageable and unmanageable risk to each material ESG issue. The exposure ratings are in three levels—low, medium, and high. Then it rates how well the company manages its relevant ESG issues by assessing the robustness of a company's ESG programs, practices, and policies. The management ratings are categorized in three levels—weak, average, and strong. Sustainalytics also provides an overall ESG risk score as well as a risk rating in five levels—negligible, low, medium, high, and severe.

This study used the risk rating levels, exposure rating levels, and management rating levels to find the distinct clusters of sustainability capability in healthcare companies. The dendrogram from the Hierarchical cluster analysis is used to determine the best number of clusters, and the K-Means cluster analysis is used to conduct the classification.

We extracted seven financial ratios in 2020 from the Compustat database through Wharton Research Data Services (WRDS). We conducted MANOVA to test for between-subject effects of the two factors of our research interest, industry group and sustainability capability. Box's test is used to test the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups. For insignificant Box's test,

Wilk's Lambda is used for multivariate tests. Otherwise, Pillai's Trace is used.

Whenever Levene's test for homogeneity of variance is significant, nonparametric statistics (Kruskal-Wallis or Mann-Whitney U) are used to confirm the MANOVA results. We only report the results for which the Kruskal-Wallis tests confirm the MANOVA findings. The Bonferroni adjusted p values are reported to reduce the chances of obtaining type I errors when multiple pair wise tests are performed on a single set of data.

IV. RESULTS

4.1. Sustainability Capability Clustering

Data from the healthcare sector includes data from device and equipment manufacturers, drug manufacturers, and service providers. Overall, 359 global companies assessed by Sustainalytics are in the healthcare sector, and 114 are U.S. companies. Among the U.S. firms, 45 companies are device and equipment manufacturers, 45 are drug manufacturers, and 24 are service providers. 38.60% of the companies have low ESG exposure, 61.40% have medium exposure, and none have high exposure. For ESG management, 13.16% of the companies have weak management, 72.81% have average management, and 14.04% have strong management.

In the Hierarchical cluster analysis, the Ward method is chosen for combining clusters with an agglomerative approach. Unlike the other methods of measuring the distance directly, the Ward method analyzes the variance of clusters and minimizes the total within-cluster variance. Ward linkage is used to group relationships between similar data sets in the dendrogram. The Ward method tends to generate results in more balanced sample sizes. We reviewed the agglomeration schedule coefficients to identify the most distinct groups and found two groups. We also repeated the test using Centroid linkage method and received the same clustering results. Then K-Means clustering was used to partition the observations into two clusters. Table 1 shows the clustering results and the ANOVA of the K-Means cluster analysis. The first cluster has a lower risk level, lower exposure level, and better management level. Hence, it is named a Leader group of sustainability capability. The second cluster has a higher risk level, higher exposure level, and below-average management level. Hence, it is named a Lagger group of sustainability capability. The ANOVA table for the K-means cluster analysis shows that all three ESG levels are significant (p=0.000) for the clusters. 86 companies are clustered as Leaders, and 28 are clustered as Laggers.

TABLE 1. FINAL CLUSTER CENTERS AND ANOVA.

	Cluster Centers		Cluster		Error			
	1 (Leader)	2 (Lagger)	Mean Square	df	Mean Square	df	F	Sig.
ESG Risk Level	1.71	3.00	35.188	1	0.194	112	181.35	0.000
Exposure Level	1.49	2.00	5.529	1	0.192	112	28.82	0.000
Management Level	2.15	1.57	7.099	1	0.213	112	33.28	0.000

4.2. MANOVA

Among 114 U.S. healthcare companies from Sustainalytics, financial ratios are available for 99 companies from the Compustat database through WRDS. We conducted a two-way MANOVA to compare three healthcare industry groups and two sustainability

capability clusters on seven operational performance measurements. MANOVA is more appropriate than multiple ANOVAs when the dependent variables used in the analysis are highly negatively correlated or if the dependent variables are found to be correlated around .60, either positive or negative. Table 2 shows the dependent variables' Pearson correlations to justify the use of MANOVA in this study.

TABLE 2. PEARSON CORRELATIONS.

	Operating Margin_2020	ROA_2 020	Cash Conversion Cycle_2020	Inventory Turnover_ 2020	Asset Turnover_ 2020	Receivables Turnover_ 2020	Payables Turnover_ 2020
Operating Margin_2020	1						
ROA_2020	.502**	1					
Cash Conversion Cycle_2020	0.110	0.103	1				
Inventory Turnover_2020	0.020	-.209*	-0.104	1			
Asset Turnover_2020	0.132	.199*	-.346**	0.101	1		
Receivables Turnover_2020	0.190	0.122	-.334**	-0.029	.525**	1	
Payables Turnover_2020	-0.189	-.485**	-.216*	.568**	-0.021	0.023	1

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

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

Table 3 shows the descriptive statistics of the operational performances in 2022. The device and equipment manufacturers had the best operating margin and ROA but had the longest cash conversion cycle. The drug manufacturers had the lowest operating margin and ROA and the CCC is over three months. Both the device and equipment manufacturers and the drug manufactures scored lower in efficiency measurements. The service industry in the healthcare sector showed a different picture. Healthcare service providers did have inventory burden, generated a good asset turnover, collected payments from the customers faster, and paid their suppliers faster.

The Box's test is significant (p<0.001) so Pillai's Trace test is used for multivariate test. Significant multivariate effects were found for the independent variables—industry group (Pillai's Trace=0.617, F(14,176)=2.354, p=0.030, η^2 =0.159) and sustainability capability (Pillai's Trace=0.159,

F(7,87)=5.603, p=0.000, η^2 =0.308). Significant multivariate effect was also found for the interaction of the two independent variables (Pillai's Trace=0.502, F(14,176)=4.213, p=0.000, η^2 =0.251).

Table 4 shows the tests of between-subjects effects. Significant effects were found for the sustainability capability on the profitability metrics—operating margin and ROA. The industry group had significant effects on operating margin, ROA, cash conversion cycle, asset turnover, and payables turnover. However, Bonferroni adjusted Kruskal-Wallis Test did not confirm the MANOVA results for the operating margin, ROA, and asset turnover. We took a conservative approach to consider the factors with test for homogeneity confirming the MANOVA results. Hence, the further analysis below will focus on the cash conversion cycle and payables turnover. The interaction of industry group and sustainability capability had significant effects on the profit

margin, ROA, cash conversion cycle, and payables turnover.

4.3. Multiple Comparisons

We conducted multiple comparisons on the significant effects identified in MANOVA.

Table 5 shows the average operating margin and average ROA between the leader and lagger in sustainability capability. Sustainability leaders had positive profitability while the laggers had negative profitability.

TABLE 3. DESCRIPTIVE STATISTICS.

	Industry classification	Mean	Std. Dev.	N
Operating margin	Device and equipment manufacturer	0.22	0.10	41
	Drug manufacturer	-3.13	14.59	35
	Service provider	0.12	0.11	23
ROA	Device and equipment manufacturer	0.13	0.07	41
	Drug manufacturer	0.02	0.25	35
	Service provider	0.11	0.11	23
Cash conversion cycle (in days)	Device and equipment manufacturer	160.39	108.24	41
	Drug manufacturer	157.17	138.23	35
	Service provider	32.19	31.92	23
Inventory turnover	Device and equipment manufacturer	3.60	3.09	41
	Drug manufacturer	7.90	16.72	35
	Service provider	100.64	287.01	23
Asset turnover	Device and equipment manufacturer	0.86	0.94	41
	Drug manufacturer	0.42	0.25	35
	Service provider	1.07	0.60	23
Receivables turnover	Device and equipment manufacturer	6.65	2.75	41
	Drug manufacturer	6.33	4.04	35
	Service provider	9.75	6.84	23
Payables turnover	Device and equipment manufacturer	7.43	2.85	41
	Drug manufacturer	10.43	10.88	35
	Service provider	16.86	14.53	23

TABLE 4. TESTS OF BETWEEN-SUBJECTS EFFECTS.

Source		Type III Sum of Squares	df	Mean Square	F	Sig. (2 tailed)	η^2
Corrected Model	Operating Margin_2020	1577.74[a]	5	315.548	4.970	0.000	0.211
	ROA_2020	1.14[b]	5	0.228	12.980	0.000	0.411
	Cash Conversion Cycle_2020	414392.70[c]	5	82878.541	7.631	0.000	0.291
	Inventory Turnover_2020	172872.993[d]	5	34574.599	1.777	0.125	0.087
	Asset Turnover_2020	8.581[e]	5	1.716	3.631	0.005	0.163
	Receivables Turnover_2020	218.419[f]	5	43.684	2.189	0.062	0.105
	Payables Turnover_2020	3321.154[g]	5	664.231	8.839	0.000	0.322
Intercept	Operating Margin_2020	299.416	1	299.416	4.716	0.032	0.048
	ROA_2020	0.095	1	0.095	5.416	0.022	0.055
	Cash Conversion Cycle_2020	417128.401	1	417128.401	38.409	0.000	0.292
	Inventory Turnover_2020	33666.459	1	33666.459	1.731	0.192	0.018
	Asset Turnover_2020	27.789	1	27.789	58.803	0.000	0.387
	Receivables Turnover_2020	2496.666	1	2496.666	125.097	0.000	0.574
	Payables Turnover_2020	6172.766	1	6172.766	82.138	0.000	0.469
Sustainability capability	Operating Margin_2020	300.956	1	300.956	4.741	*0.032*	0.049
	ROA_2020	0.171	1	0.171	9.721	*0.002*	0.095
	Cash Conversion Cycle_2020	16904.789	1	16904.789	1.557	0.215	0.016
	Inventory Turnover_2020	3792.742	1	3792.742	0.195	0.660	0.002
	Asset Turnover_2020	0.030	1	0.030	0.064	0.800	0.001
	Receivables Turnover_2020	7.609	1	7.609	0.381	0.538	0.004
	Payables Turnover_2020	103.725	1	103.725	1.380	0.243	0.015
Industry Group	Operating Margin_2020	962.962	2	481.481	7.584	*0.001*	0.140
	ROA_2020	0.771	2	0.385	21.943	*0.000*	0.321
	Cash Conversion Cycle_2020	151338.937	2	75669.469	6.968	*0.002*	0.130
	Inventory Turnover_2020	25028.505	2	12514.252	0.643	0.528	0.014
	Asset Turnover_2020	6.000	2	3.000	6.348	*0.003*	0.120
	Receivables Turnover_2020	56.121	2	28.061	1.406	0.250	0.029
	Payables Turnover_2020	1037.520	2	518.760	6.903	*0.002*	0.129
Cluster * Industry	Operating Margin_2020	850.116	2	425.058	6.695	*0.002*	0.126
	ROA_2020	0.565	2	0.283	16.092	*0.000*	0.257
	Cash Conversion Cycle_2020	117528.444	2	58764.222	5.411	*0.006*	0.104
	Inventory Turnover_2020	12816.224	2	6408.112	0.329	0.720	0.007
	Asset Turnover_2020	1.537	2	0.768	1.626	0.202	0.034
	Receivables Turnover_2020	17.874	2	8.937	0.448	0.640	0.010
	Payables Turnover_2020	1573.051	2	786.525	10.466	*0.000*	0.184
Error	Operating Margin_2020	5904.089	93	63.485			
	ROA_2020	1.633	93	0.018			
	Cash Conversion Cycle_2020	1009992.508	93	10860.134			
	Inventory Turnover_2020	1809138.786	93	19453.105			
	Asset Turnover_2020	43.950	93	0.473			
	Receivables Turnover_2020	1856.083	93	19.958			
	Payables Turnover_2020	6989.070	93	75.151			
Total	Operating Margin_2020	7578.110	99				
	ROA_2020	3.570	99				
	Cash Conversion Cycle_2020(Days)	3083798.319	99				
	Inventory Turnover_2020	2057788.012	99				
	Asset Turnover_2020	109.183	99				
	Receivables Turnover_2020	7287.183	99				
	Payables Turnover_2020	21606.887	99				
Corrected Total	Operating Margin_2020	7481.831	98	a. R Squared = .211 (Adjusted R Squared = .168)			
	ROA_2020	2.773	98	b. R Squared = .411 (Adjusted R Squared = .379)			
	Cash Conversion Cycle_2020	1424385.212	98	c. R Squared = .291 (Adjusted R Squared = .253)			
	Inventory Turnover_2020	1982011.779	98	d. R Squared = .087 (Adjusted R Squared = .038)			
	Asset Turnover_2020	52.531	98	e. R Squared = .163 (Adjusted R Squared = .118)			
	Receivables Turnover_2020	2074.501	98	f. R Squared = .105 (Adjusted R Squared = .057)			
	Payables Turnover_2020	10310.224	98	g. R Squared = .322 (Adjusted R Squared = .286)			

TABLE 5. SIGNIFICANT UNIVARIATE EFFECTS FOR SUSTAINABILITY CAPABILITY.

Dependent Variable	df	Error	F	Sig.		Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Operating Margin_2020	1	5904.089	4.741	0.032	Leader	0.01	0.89	(1.77)	1.78
					Lagger	(5.45)	2.34	(10.10)	(0.80)
ROA_2020	1	1.633	9.721	0.002	Leader	0.11	0.01	0.08	0.14
					Lagger	(0.02)	0.04	(0.09)	0.06

Table 6 shows the average cash conversion cycle time and average payables turnover among the three industry groups. The device and equipment manufacturers had the most extended cash to cash conversion cycle of 175 days, while the service providers had only 22 days. Drug manufacturers paid their suppliers the fastest while the device and equipment manufacturers paid their suppliers the slowest.

Significant interaction effects were found on operating margin, ROA, cash converging cycle, and payables turnover. Table 7 shows the detailed comparisons of the two-level sustainability capability and the three industry groups. The Laggers in drug manufacturing had a larger negative operating margin and a negative ROA. The Leaders in drug manufacturing and service providers had a longer cash converging cycle. For payables turnover, the Leaders in drug manufacturing had a lower turnover than the Laggers.

V. DISCUSSION

We focused on the operational performance in the healthcare sector in 2020, a challenging year amid the COVID-19 pandemic. The results showed that the sustainability capability was a significant main factor in profitability measures—operating margin and ROA. Using the η2 measurements, the sustainability capability factor accounts for 4.9% of the variance in the operating margin and 9.5% in ROA. Leaders with better sustainability capability across all three industries were more profitable in operations and received better returns from their assets.

The industry group factor also had significant main effects on the cash conversion cycle and payable turnover. Using the η2 measurements, the industry group accounts for 13% of the variance in the cash conversion cycle and 12.9% of the variance in the payables turnover. η2 is a measure of effect size and reflects the percentage of the variance in the dependent variable explained by the independent variables in a sample. The device and equipment manufacturers had the longest cash conversion cycle and the lowest payable turnover. The drug manufactures also had longer CCC in comparison with the healthcare service providers. The result might be due to the difference in the manufacturing industry and the service industry, where the manufacturing firms typically have more inventory pressure.

More interestingly, the interactions of industry group and sustainability capability had significant effects on the operating margin, ROA, cash conversion cycle, and payables turnover. Using the η2 measurements, the interactions account for 12.6% of the variance in operating margin, 25.7% in ROA, 10.4% in cash conversion cycle, and 18.4% in payables turnover.

The interaction analysis, shown in Figure 1 and Figure 2, clearly showed the difference between sustainability Leader and Lagger in the drug manufacturing industry, where the Leaders were significantly better in profitability measurements. The gaps in profitability measurements between the sustainability Leaders and the Laggers are substantial in the drug manufacturing group. Sustainability capability also generated an advantage for the device and equipment manufacturers and the service providers, but the gaps were not statistically significant.

However, the liquidity measurement and one of the efficiency measurements showed a different picture for the drug manufacturers. In general, a shorter cash conversion cycle is preferred because a company can convert its investment into cash flows from sales faster. However, Figure 3 shows the differential effects of sustainability on this metric. In 2020, the Leaders' cash conversion cycle was 5.5 times longer than the Laggers' in the drug manufacturing industry. This difference is statistically significant. Similar findings applied to the service provider industry. Although it is not statistically significant, the Leaders' cash conversion cycle time was 3.6 times longer than the Laggers'.

TABLE 6. SIGNIFICANT UNIVARIATE EFFECTS FOR INDUSTRY GROUP.

Dependent Variable	df	Error	F	Sig.		Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Cash Conversion Cycle_2020	2	1009992.508	6.968	0.002	Device and equipment manufacturer	174.836	19.660	135.795	213.877
					Drug manufacturer	108.091	23.369	61.684	154.498
					Service provider	21.915	38.559	-54.655	98.486
Payables Turnover_2020	2	6989.070	6.903	0.002	Device and equipment manufacturer	7.396	1.635	4.148	10.644
					Drug manufacturer	16.756	1.944	12.895	20.616
					Service provider	12.932	3.208	6.562	19.301

TABLE 7. SIGNIFICANT INTERACTION EFFECTS.

|			Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Operating Margin_2020	Leader	Device and equipment manufacturer	0.223	1.409	-2.574	3.020
		Drug manufacturer	-0.323	1.480	-3.261	2.615
		Service provider	0.121	1.739	-3.332	3.574
	Lagger	Device and equipment manufacturer	0.211	2.656	-5.063	5.485
		Drug manufacturer	-16.677	3.253	-23.136	-10.217
		Service provider	0.110	5.634	-11.078	11.298
ROA_2020	Leader	Device and equipment manufacturer	0.138	0.023	0.091	0.184
		Drug manufacturer	0.095	0.025	0.046	0.144
		Service provider	0.108	0.029	0.050	0.165
	Lagger	Device and equipment manufacturer	0.122	0.044	0.034	0.210
		Drug manufacturer	-0.327	0.054	-0.434	-0.219
		Service provider	0.155	0.094	-0.031	0.341
Cash Conversion Cycle_2020	Leader	Device and equipment manufacturer	149.087	18.422	112.504	185.669
		Drug manufacturer	182.774	19.352	144.345	221.202
		Service provider	34.350	22.741	-10.808	79.509
	Lagger	Device and equipment manufacturer	200.586	34.737	131.604	269.567
		Drug manufacturer	33.408	42.544	-51.076	117.893
		Service provider	9.480	73.689	-136.852	155.812
Payables Turnover_2020	Leader	Device and equipment manufacturer	7.457	1.532	4.413	10.500
		Drug manufacturer	7.132	1.610	3.935	10.328
		Service provider	17.688	1.892	13.931	21.445
	Lagger	Device and equipment manufacturer	7.336	2.890	1.597	13.074
		Drug manufacturer	26.380	3.539	19.352	33.408
		Service provider	8.175	6.130	-3.998	20.348
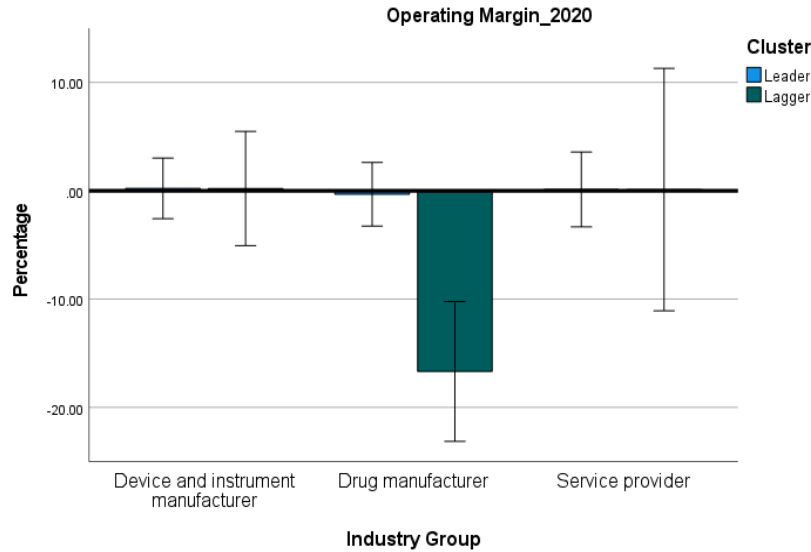
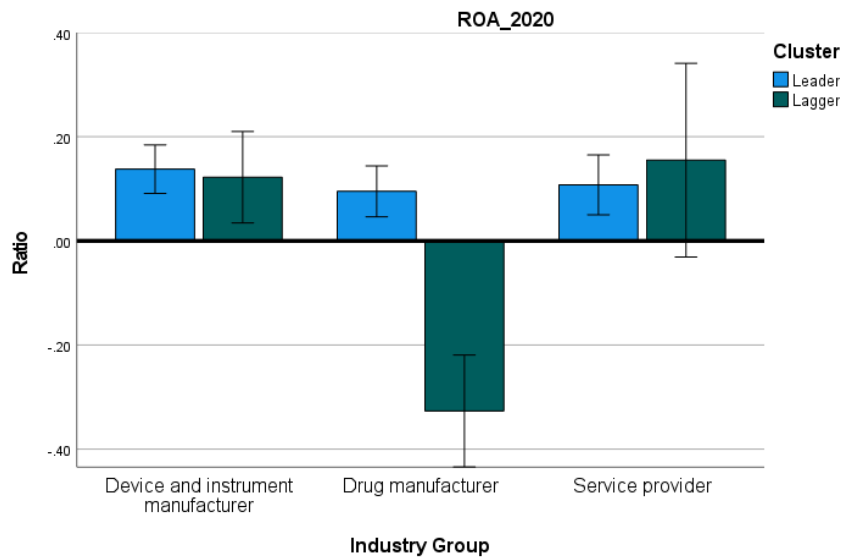**FIGURE 1. SIGNIFICANT INTERACTION EFFECTS ON OPERATING MARGIN.**

FIGURE 2. SIGNIFICANT INTERACTION EFFECTS ON ROA.

The cash conversion cycle measurement has three components: Days Inventory Outstanding, Days Sales Outstanding, and Days Payable Outstanding. MANOVA showed significant interaction effects only on payable turnover in our model, which is the inverse of Days Payable. Figure 4 depicted the comparison results. There was not much difference between the Leaders and the Laggers in the device and equipment industry. The Leaders' payables turnover ratio was 2.16 times larger than the Laggers' in the service providing industry, but the gap is not significant. On the contrary, the Laggers' payables turnover ratio was 3.7 times larger than the Leaders' in the drug manufacturing industry.

Sustainability Leaders in drug manufacturing paid debt to their suppliers

slowly during the pandemic year. This might be due to better bargaining power with their suppliers or better supplier relationships of more favorable payment terms. This could also imply the suppliers of sustainability Leaders in drug manufactures had financial strength to sustain the uncertainty during the pandemic. However, the gained efficiency benefit in accounts payable was limited, as revealed in the longer CCC shown in Figure 3. This might imply that sustainability capability of the drug manufacturers did not have competitive advantages in managing cash flow for the operations. They had slow inventory-to-sales processes.
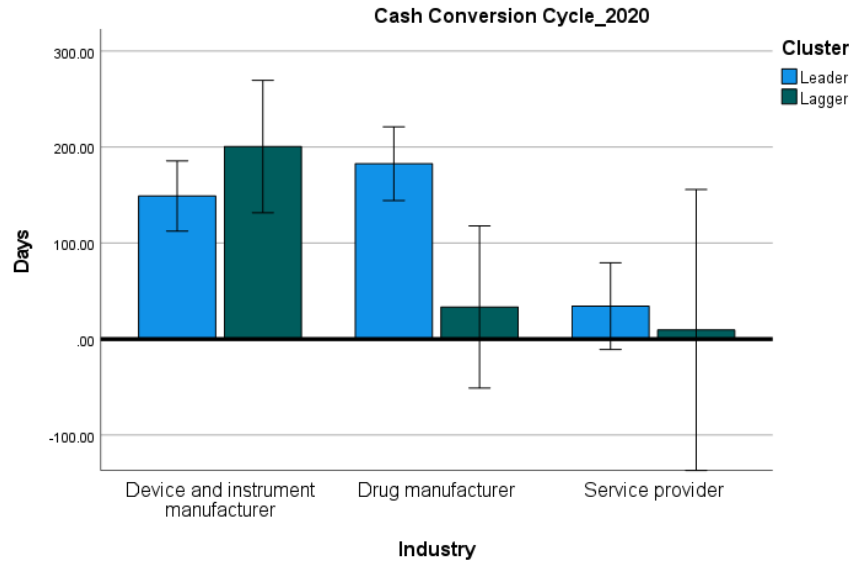
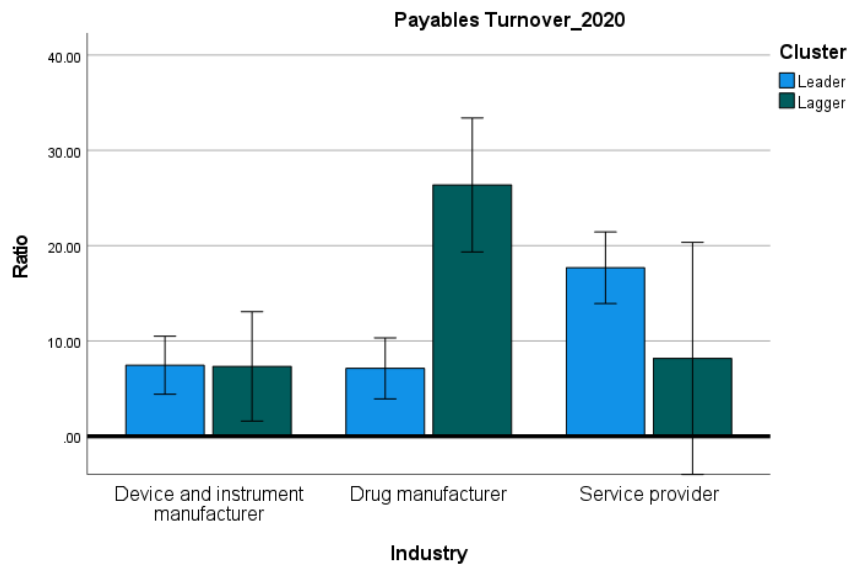**FIGURE 3. SIGNIFICANT INTERACTION EFFECTS ON CASH CONVERSION CYCLE.**

FIGURE 4. SIGNIFICANT INTERACTION EFFECTS ON PAYABLES TURNOVER.

VI. CONCLUSION AND FUTURE STUDIES

The healthcare sector is a complex ecosystem. The three industry groups—device and equipment manufacturing, drug manufacturing, and services—have different characteristics and business models. These industries represent the upstream and downstream players of healthcare supply chains. This study investigated the effects of sustainability capability on the operational performance of this important sector in the United States by taking the industry groups into account during the year of the global pandemic in 2020. While most extant literature focused on the relationship between stock market performance and sustainability, this study contributed to the literature by focusing on the operational performance. We used seven metrics calculated from healthcare firms' financial statements to measure operational performance in profitability, liquidity, and efficiency. The insights gained from this study can help understand the effects of sustainability capability during uncertain environment.

We found that industry group, sustainability capability, and their interactions had significant effects on the operational performance in operating margin, ROA, cash conversion cycle, and payables turnover. Firms with stronger sustainability capability are more profitable with higher operating margin and ROA, regardless of the industry groups. The device and equipment manufacturing industry had the longest cash conversion cycle and the lowest payable turnover, regardless of the sustainability capability. Significant interaction effects were found between the sustainability Leaders and Laggers in cash conversion cycle and payable turnover, only in the drug manufacturing industry. Sustainability capability did not show advantages in drug manufacturer's ability to quickly generate cash needed to fund ongoing operations.

There are several limitations and future extensions of our study. First, the analysis is based on data from the start of the COVID-19 pandemic year. As the pandemic continues, the sustainability effect may or may not last. It would be interesting to gather data through the life of the pandemic for further analysis. Second, it would also be interesting to compare data before and after the pandemic to see if healthcare firms with higher sustainability capability are more resilient. Third, the interaction analysis showed that the drug manufacturing industry has different characteristics than the other two industry groups. Further studies could be conducted with more firm-level detailed demographic data and supply chain structures to investigate the drivers. Fourth, this study used categorical ESG data for analysis. Future studies could be conducted using different scoring systems, such as Bloomberg's ESG scores, to confirm if these results are generalizable across different metrics.

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