Analysis of the Relation between Corporate Sales and Earnings

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This paper examines the relation between corporate sales and earnings in the US on annual basis in the period 1950 to 2016. We document that both total revenues and earnings are non-stationary and therefore we use the Granger representation theorem and the methods of cointegration analysis and make a first attempt at representing the relation between these very important company characteristics with a statistical model. We document that such a relation does not exist between aggregate revenues and earnings. However, industry analysis provides long-run revenue-earnings relations for the different S&P industry sectors. Knowing and understanding better the top-line and bottom-line relation could further help external analysts in their quest for better valuations and forecasts. Many studies have focused on revenues alone and the factors affecting revenues, and earnings alone and the factors affecting earnings. In contrast to these studies this paper examines the relation between corporate sales and earnings, i.e. between the company's top-line and bottom-line. To the best of our knowledge this has not been done in the literature so far.

INTRODUCTION

On August 1, 2017 Apple issued a press release about its quarterly performance:

> "Cupertino, California — Apple today announced financial results for its fiscal 2017 third quarter ended July 1, 2017. The Company posted quarterly revenue of $45.4 billion and quarterly earnings per diluted share of $1.67. These results compare to revenue of $42.4 billion and earnings per diluted share of $1.42 in the year-ago quarter."

Consistently, firms across the US report quarterly and annual revenue and earnings results. Naturally, in the extended earnings reports these companies discuss in detail their income statements line by line. However, the overal focus has always been on top-line and bottom-line separately. The reason for the split focus is the different driving forces behind the revenue and earnings formation, due to GAAP rules, depreciation methods, tax rules and the individual corporate choices made by individual firms in applying the different rules. As a results, many studies have focused on revenues alone and the factors affecting revenues, such as Swaminathan and Weintrop (1991) and Ertimur et al. (2003) to name a couple among many, and earnings alone and the factors affecting earnings alone as in the vast analyst literature, thus effectively de-coupling revenues and earnings.

Other studies, such as Kothari (2001) and Beyer et al. (2010) suggest that revenues and earnings information might come from the same source, thus naturally linking revenues and earnings. Thus the

question of whether revenues and earnings are connected is an empirical question which has not been empirically tested in the prior literature and we make a first attempt at examining this relation.

In contrast to prior studies this paper examines the relation between corporate sales and earnings at the aggregate level, i.e. between the company's top-line and bottom-line. To the best of our knowledge this has not been done in the literature so far. We study this relation on annual basis in the period 1950 to 2016 for all publicly traded firms in the US. We document that both total revenues and earnings are non-stationary and therefore need to be examined with the methods of cointegration analysis and make a first attempt at representing the realtion between these very important company characteristics with a statistical model. We document that such a relation between corporate revenues and earnings at the aggregate level does not exist; however, we document that this relation exists at the industry level, except for the Consumer Staples sector, which is quite surprising.

One of the main roles of external financial analysts is to provide earnings forecasts as an independent check on companies financial guidance. The methodology and findings in this study could help financial analysts develop better earnings forecasts tools. After all, forecasts are only as good as the basic understanding of the fundamental relations among predictive variables. Considering, that potentially revenues are much easier to predict than earnings a macro level analyst or could benefit from the models developed in this study to predict easier future corporate profitability.

LITERATURE REVIEW

Kothari (2001) and Beyer et al. (2010) provide summaries of the vast financial reporting literature. They show the importance of voluntary firm disclosures, mandatory firm disclosures, and disclosures by independent information intermediaries with regards to the value of the firm. They show that earnings announcements play a vital role in firm valuation. Beyer et al. (2010) state:

> p. 335, "We conclude that one of the biggest challenges facing researchers is considering the interactions among the various information sources."

The information sources that they examine are earnings announcements, voluntary management forecasts, analyst forecasts, and regulatory filings. We attempt to address somewhat this issue of studing "the interactions among these various information sources" by examining the relation of company aggregate sales and earnings, between company top-line and bottom-line. Kothari (2001) and Beyer et al. (2010) indicate the predominant assumption and understanding in the profession that revenues and earnings information come from the same source, thus obviously and naturally linking revenues and earnings. On the other hand, companies have a choice in applying GAAP rules and depreciation methods which might potentially de-couple revenues and earnings. Naturally, this is an empirical question which has not been empirically tested so far and we make a first attempt at examining this relation.

Swaminathan and Weintrop (1991) and Ertimur et al. (2003) study investors' reactions to revenue and expense surprises. They show that investors react differently to revenue and expense surprises, with the documented evidence suggesting that investors value revenue surprises more than earnings surprises. Ertimur et al. (2003) suggest that earnings surprises cannot be viewed in isolation and need to be considered in the context of revenues and expenses. Further enforcing the idea that earnings and revenues relation needs to be examined in more detail and motivating the analysis in this study.

Jegadeesh and Livnat (2006) show that revenues contain incremental information in earnings announcements. Also, Chandra and Ro (2008) study corporate revenues and earnings and document that revenues contain valuable information. On the other hand, in the same strand of the literature, Barton et al. (2010) document that sales is one of the least relevant metrics for corporate valuation when compared to earnings, comprehensive income, and operating cash flow, thus suggesting de-coupling of revenues information from earnings information, contrary to the professions' assumption of linkage between revenues and earnings. Thus, the need for this empirical study.

METHODOLOGY

In statistical analysis we first need to ensure that the series are stationary to be able to employ simple ANOVA methods, correlation and regression analysis. Thus, we first use standard Augmented Dickey Fuller and Phillips-Perron Unit Root tests to check for presence of unit-roots in the revenue and earnings series. Both tests have null hypothesis of unit roots. Once we establish that the series are integrated we can rely on the Granger representation theorem (Engle and Granger, 1987) to perform cointegration analysis. The Granger representation theorem postulates that when two series are non-stationary a cointegration of order k can be determined for their relation. We employ the Johansen Cointegration Test to determine the rank of the cointegration relation and later on a vector error correction model VECM(p) to estimate the most fitting model to represent this relation. A VECM(p) with a cointegration rank r<=k can be expressed as follows:

$$\Delta y_t = \delta + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i^* \Delta y_{t-i} + \varepsilon_t \quad (1)$$

where Δ is the difference operator, $\Pi = \alpha\beta'$, with α and β being k*r matrices and α being the adjustment coefficient and β - the long-run parameter.

For the selection of the most parsimonious VECM model to represent the relation between sales and earnings we use the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). AIC is designed to measure the relative quality of a statistical model by controlling for the number of variables used. It determines the quality of a model, relative to other competing models. Similarly, SBC accounts for the number of parameters used. Both AIC and SBC impose a penalty as the number of parameters in each model-candidate increase - the penalty term is larger in SBC than in AIC, thus making SBC a more conservative criterion. The lower AIC and SBC the more parsimonious the model, thus we select the model with lowest AIC and SBC to represent statistically the relation between revenues and earnings.

DATA AND ANALYSIS

The data in this study are from Compustat. We use total company revenues (REVT) and earnings before interest, tax, depreciation and amortization (EBITDA) on annual basis for the period 1950 to 2016. Table 1 Panel A provides summary statistics on the data used in the analysis. There are 67 aggregate annual observations of revenues and earnings, with average revenue of 9,985,661,000 and average earnings of 1,608,955,000 with the medians being 4,841,840,000 and 664,125,500, respectively. The difference in averages and medians is due to the pronounced trend in both series as presented in Figure 1. Both series exhibit a sharp upward trend. Table 1 Panel B provides information on the scaled aggregate revenues and earnings, i.e. scaled by the total number of firms in that year, because of the increase in the number of firms reporting each year, in 1950 there were 607 firms and in 2016 there were 11,732 firms. The trends are still present as evident in Figures 1 and 2, which report the aggregate and scaled revenues in Figure 1 and earnings in Figure 2.

TABLE 1
SUMMARY STATISTICS

Panel A. Aggregate Total Revenue and Earnings

Variable	N	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
REVT	67	9985661	4841840	100677.6	34061248.7	11403889	0.9725	-0.5329
EBITDA	67	1608955	664125.5	19090.3	5764033.68	1917445	1.0582	-0.3659

Note: REVT is total revenues, EBITDA is earnings.

Panel B. Aggregate Revenue and Earnings Scaled by Number of Firms

Variable	N	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
revtscaled	67	891.46	600.02	136.97	2662.13	842.58	1.04	-0.37
ebitdascaled	67	142.43	80.68	21.33	446.03	142.88	1.14	-0.21

Note: REVTSCALED is total revenues scaled by number of firms, EBITDASCALED is earnings scaled by number of forms.

FIGURE 1
AGGREGATE TOTAL REVENUE AND AGGREGATE REVENUE SCALED BY NUMBER OF FIRMS

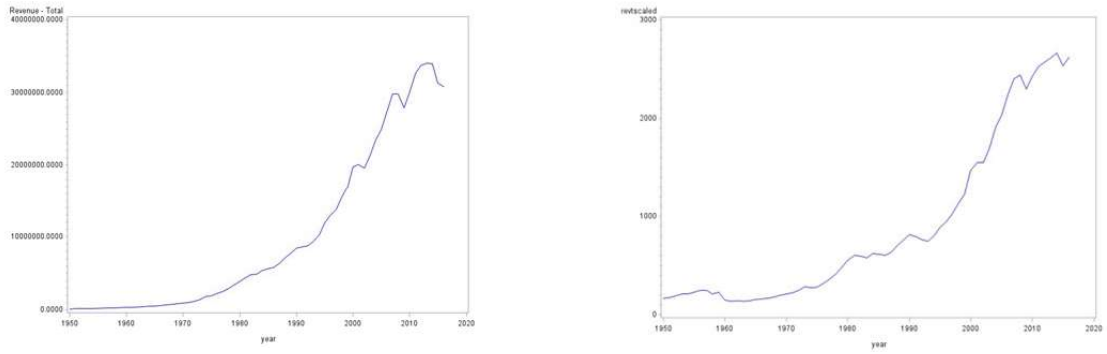
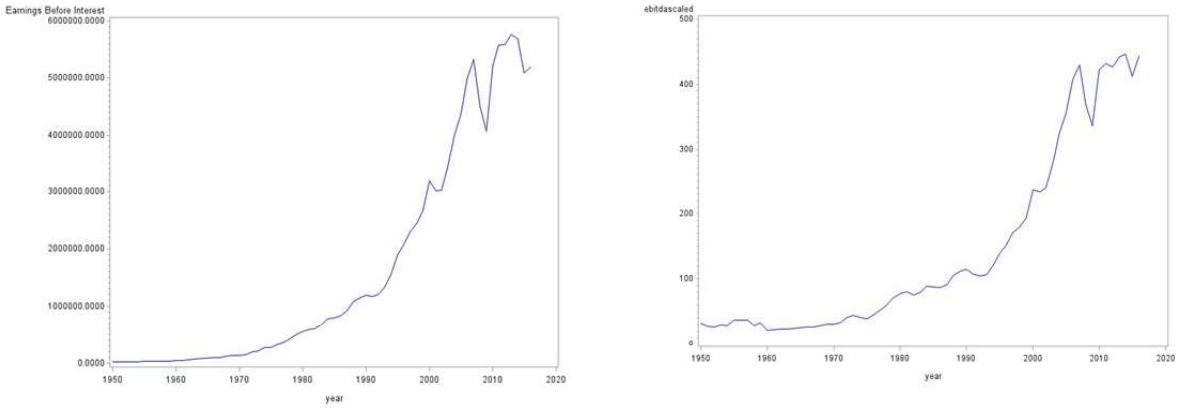


FIGURE 2
AGGREGATE TOTAL EARNINGS AND EARNINGS SCALED BY NUMBER OF FIRMS



Even though visually convincing, as standard in the cointegration analysis methodology, we first formally test for the presence of unit roots in both revenue and earnings series. We employ standard Augmented Dickey-Fuller and Phillips-Perron Unit Root tests. Both tests have null hypothesis of unit roots. Table 2 reports results of the unit root tests. Both tests fail to reject the null hypothesis of unit roots in revenues and earnings for all three model specifications of the test, for the scaled by number of firms aggregate values of revenues and earnings. In the rest of the study we focus on scaled values to remove the effects of the increase of number of firms reporting each year.

Now that we have established that both scaled sales and earnings are non-stationary we cannot use simple ANOVA, correlation and regression analyis to examine relationong the variables, because those type of analyses on non-stationary data are meaningless. However, non-stationarity among two series can be studied with the methods of cointegration. The fact that both sales and earnings are non-stationary suggests that we can use the Granger representation theorem (Engle and Granger, 1987) to formally test for cointegration between the two series. This theorem states that if a set of nonstationary variables are cointegrated then they can be described and modeled with an error correction system.

TABLE 2
UNIT ROOT TESTS, AGGREGATE REVENUE AND EARNINGS SCALED BY NUMBER OF FIRMS

		Dickey-Fuller Unit Root Tests				Phillips-Perron Unit Root Test			
Variable	Type	Rho	Pr < Rho	Tau	Pr < Tau	Rho	Pr < Rho	Tau	Pr < Tau
REVT SCALED	Zero Mean	2.21	0.9914	2.89	0.9989	2.2605	0.9924	4.4297	0.9999
	Single Mean	1.48	0.9939	1.53	0.9993	1.6094	0.995	2.1838	0.9999
	Trend	-2.36	0.9574	-1.24	0.8939	-1.7293	0.9744	-1.0881	0.9233
EBITDA SCALED	Zero Mean	2.14	0.9902	2.23	0.9934	2.179	0.991	2.5894	0.9974
	Single Mean	1.27	0.9916	0.98	0.996	1.3787	0.9928	1.1599	0.9976
	Trend	-3.58	0.9051	-1.37	0.859	-3.2545	0.9217	-1.3479	0.8666

Note: REVTSCALED is total revenues scaled by number of firms, EBITDASCALED is earnings scaled by number of forms.

Therefore, we next formally test for cointegration between the two series. Similar to many studies in the area of cointegration, such as Parker and Rapp (1998), Rajiv Menon, Subha and Sagaran (2009) and Kumar and Kumar (2017) we use Johansen's cointegration technique (Johansen, 1991). Table 3 reports the Johansen Cointegration Test results on corporate top and bottom lines. Panel A displays the unrestricted test and Panel B the restricted test. Both tests' results suggest failure to reject no-cointegration, thus contradicting one of the most widely accepted relations in the accounting and finance literature – the relation between revenues and earnings.

TABLE 3
JOHANSEN TRACE COINTEGRATION TEST RESULTS, AGGREGATE REVENUE AND EARNINGS SCALED BY NUMBER OF FIRMS

Panel A. Cointegration Rank Test Using Trace

Cointegration Rank Test Using Trace						
H0: Rank=r	**H1: Rank>r**	**Eigenvalue**	**Trace**	**Pr > Trace**	**Drift in ECM**	**Drift in Process**
0	**0**	0.1703	12.0428	0.1546	Constant	Linear
1	**1**	0.0015	0.0942	0.7591		

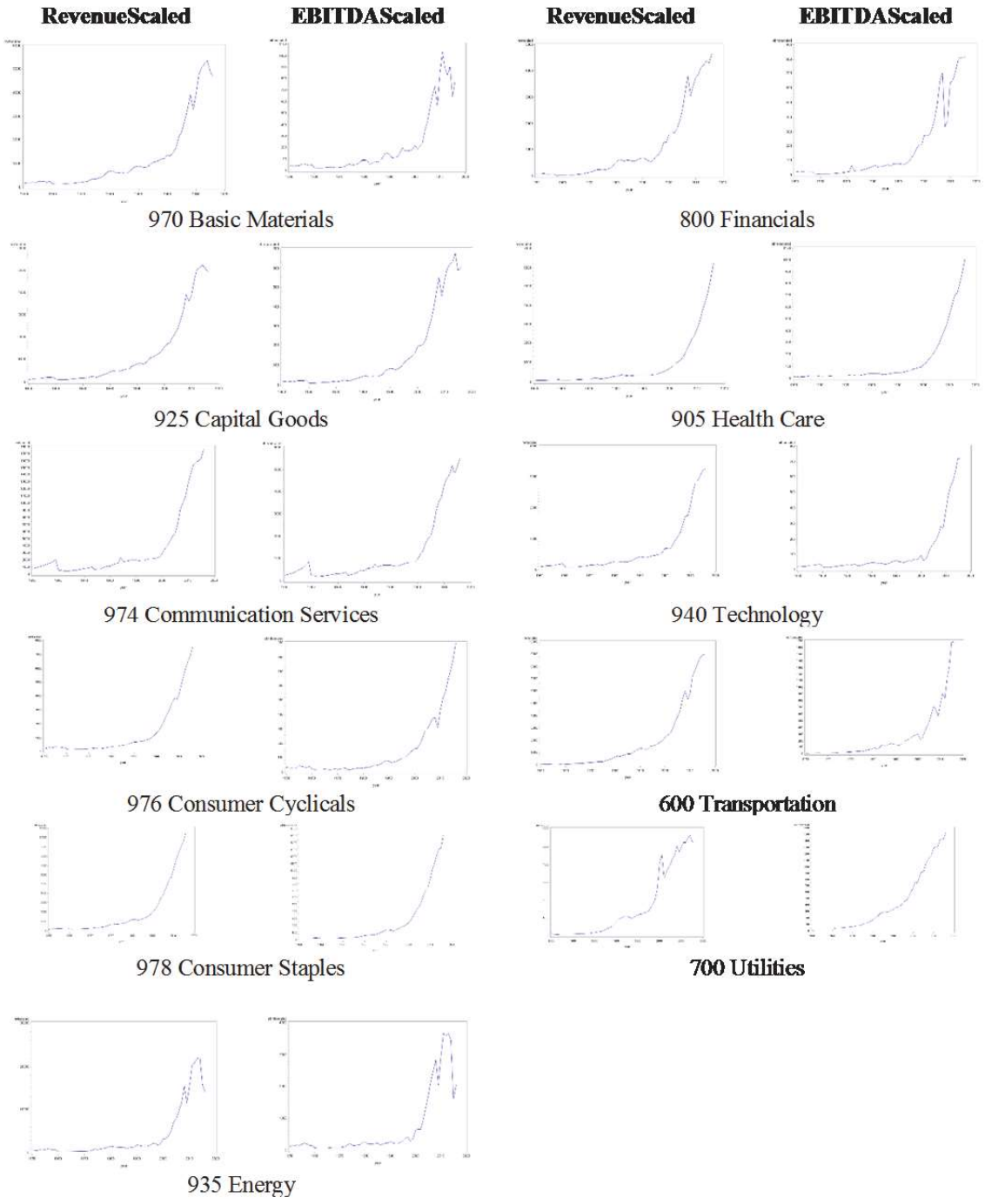
Panel B. Cointegration Rank Test Using Trace Under Restriction

Cointegration Rank Test Using Trace Under Restriction						
H0: Rank=r	**H1: Rank>r**	**Eigenvalue**	**Trace**	**Pr > Trace**	**Drift in ECM**	**Drift in Process**
0	**0**	0.1766	15.0855	0.2209	Constant	Constant
1	**1**	0.0406	2.6528	0.6469		

Note: ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

The fact that there is no cointegration at the aggregate scaled revenues and earnings does not mean that such a relation does not exist. Naturally, one might argue that using such aggregated, macro level analysis is useless for the profession. Therefore, next we proceed the analysis by focusing on the revenue and earnings relation on industry level.

FIGURE 3
S&P INDUSTRY AGGREGATE ANNUAL REVENUES AND EARNINGS, SCALED



INDUSTRY ANALYSIS

In the interest of brevity we do not repeat all the steps of the cointegration analysis. We use the S&P Economic Sectors to identify which industry a firm belongs to. The secotrs are 970 Basic Materials, 925 Capital Goods, 974 Communication Services, 976 Consumer Cyclicals, 978 Consumer Staples, 935 Energy, 800 Financials, 905 Health Care, 940 Technology, 600 Transportation, 700 Utilities. The graphs of S&P industry aggregate annual revenues and earnings presented in Figure 3, clearly show presence of unit roots, therefore we do not report unit-root test results, but these results are available upon request.

TABLE 4
SUMMARY S&P INDUSTRY STATISTICS, AGGREGATE REVENUE AND EARNINGS SCALED BY NUMBER OF FIRMS

	Variable	N	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
970 Basic Materials	**revtscaled**	67	1224	627	137	5368	1494	1.6996	1.6762
	ebitdascaled	67	206	82	24	1033	268	1.7761	1.9023
925 Capital Goods	**revtscaled**	67	1199	498	106	5271	1532	1.6215	1.4089
	ebitdascaled	67	146	48	11	679	198	1.5943	1.1275
974 Communication Services	**revtscaled**	67	3554	1774	459	17674	4651	1.9548	2.5676
	ebitdascaled	67	1201	659	199	5502	1471	1.8629	2.1432
976 Consumer Cyclicals	**revtscaled**	67	1305	367	133	7587	1868	1.9733	3.0170
	ebitdascaled	67	141	45	16	896	203	2.1335	4.0432
978 Consumer Staples	**revtscaled**	67	1902	739	163	10534	2657	1.9132	2.6726
	ebitdascaled	67	242	64	16	1507	375	2.0240	3.1643
935 Energy	**revtscaled**	67	3932	1353	381	22022	5927	1.9980	2.8280
	ebitdascaled	67	689	222	80	3669	1015	1.9469	2.5531
800 Financials	**revtscaled**	67	1079	573	12	4661	1381	1.4542	0.7308
	ebitdascaled	67	178	62	3	826	246	1.6249	1.3198
905 Health Care	**revtscaled**	67	835	328	69	6200	1340	2.4849	5.7706
	ebitdascaled	67	144	41	14	1015	233	2.3037	4.5270
940 Technology	**revtscaled**	67	628	259	80	3274	846	2.0480	3.1596
	ebitdascaled	67	112	43	15	723	173	2.4664	5.1778
600 Transportation	**revtscaled**	67	1837	735	34	9028	2540	1.6998	1.8148
	ebitdascaled	67	251	98	6	1688	381	2.3406	5.4450
700 Utilities	**revtscaled**	67	1648	994	63	5646	1873	1.0223	-0.5393
	ebitdascaled	67	410	245	0	1525	461	1.1247	-0.0355

TABLE 5
INDUSTRY COINTEGRATION TEST RESULTS (WITH DRIFT AND ECM: CONSTANT AND DRIFT IN PROCESS: LINEAR) AND LONG-RUN PARAMETER BETA ESTIMATES

	H0: Rank=r	H1: Rank>r	Eigenvalue	Trace	Pr > Trace	LR Beta Estimates When RANK=1 Variable	
970 Basic Materials	**0**	**0**	0.3397	34.8775***	0.0001	**revtscaled**	1
	1	**1**	0.1371	9.1441***	0.0026	**ebitdascaled**	-8.6964
925 Capital Goods	**0**	**0**	0.2214	25.4626***	0.0008	**revtscaled**	1
	1	**1**	0.1482	9.9439***	0.0015	**ebitdascaled**	-6.7673
974 Communication Services	**0**	**0**	0.3819	31.9685***	0.0002	**revtscaled**	1
	1	**1**	0.0106	0.6953	0.4043	**ebitdascaled**	-3.4187
976 Consumer Cyclicals	**0**	**0**	0.3204	35.6681***	0.0001	**revtscaled**	1
	1	**1**	0.1647	11.3371***	0.0004	**ebitdascaled**	2.84493
978 Consumer Staples	N.A.		N.A.		N.A.		
935 Energy	**0**	**0**	0.4363	38.249***	<.0001	**revtscaled**	1
	1	**1**	0.015	0.9834	0.3215	**ebitdascaled**	-7.0483
800 Financials	**0**	**0**	0.2918	26.5053***	0.0006	**revtscaled**	1
	1	**1**	0.0667	4.4198**	0.0354	**ebitdascaled**	-5.2389
905 Health Care	**0**	**0**	0.4229	35.0064***	0.0001	**revtscaled**	1
	1	**1**	0.0147	0.9197	0.3376	**ebitdascaled**	-10.626
940 Technology	**0**	**0**	0.2496	18.6339**	0.0161	**revtscaled**	1
	1	**1**	0.0133	0.8331	0.3614	**ebitdascaled**	-5.9465
600 Transportation	**0**	**0**	0.4557	37.7333***	<.0001	**revtscaled**	1
	1	**1**	0.0004	0.0224	0.8814	**ebitdascaled**	-6.3361
700 Utilities	**0**	**0**	0.2326	16.432**	0.0356	**revtscaled**	1
	1	**1**	0.0003	0.0178	0.8946	**ebitdascaled**	-3.273

Note: ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

The presence of unit-roots suggests that summary statistics presented in Table 4 of scaled industry revenues and earnings might not be as meaningful, but we report them in the interst of consistency and comparison to the aggregate US summary statistics. Financials have the highest average aggregate revenues and earnings. Again, the averages and medians are so different due to the long time period and the inherent trends.

Table 5 provides Johansen Trace Cointegration Test Results and long-run parameter estimates. We do not report each industry's VECM estimates in the interest of brevity but these results are available upon request. Revenues and earnings for Consumer Staples seem not to be cointegrated in the examined period 1950 to 2016. This lack of cointegration is surprising considering that all the rest of the industries revenues and earnings are cointegrated. This is in direct contrast to the widely accepted and assumed in the profession linkage between revenues and earnings for a sector which does not have a special regulatory or any other kind of restrictive buurden.

Revenue and earnings for the rest of the sectors - Basic Materials, Capital Goods, Communication Services, Consumer Cyclicals, Energy, Financials, Heatlh Care, Technology, Transportation and Utilities seem to be cointegrated at least at rank of one. Therefore, the long-run relations between revenue and earnings based on the Long-Run Parameter Beta estimate are as follows – for Basic Materials REVT=8.6964*EBITDA, for Capital Goods REVT=6.7673*EBITDA, for Communication Services REVT=3.4187*EBITDA, Consumer Cyclicals REVT=-2.84493*EBITDA, Energy REVT=7.0483*EBITDA, Financials REVT=5.2389*EBITDA, Heatlh Care REVT=10.626*EBITDA, Technology REVT=5.9465*EBITDA, Transportation REVT=6.3361*EBITDA and Utilities REVT=3.273*EBITDA. All relations are positive with the exception of the long-run relation between Consumer Cyclicals sector revenue and earnings, which is surprisingly negative.

CONCLUSION

This paper examines the relation between corporate sales and earnings, top line and bottom line, in the US. We study this relation on annual aggregate basis in the period 1950 to 2016. We document that both scaled total revenues and earnings are non-stationary and therefore we use the methods of cointegration analysis and make a first attempt at representing the relation between these company characteristics with a statistical model. We document that in aggregate there is no linkage between revenues and earnings, which is contrary to the suggestion of Kothari (2001) and Beyer et al. (2010) that revenues and earnings information might come from the same source.

We examine the series in addition to the macro aggregate level also at the industry level. The industry level analysis provides more support for the suggestion of a linkage between revenues and earnings suggested by Kothari (2001) and Beyer et al. (2010). The long-run relations between revenue and earnings based on the cointegration tools used in the analysis are as follows – for Basic Materials REVT=8.6964*EBITDA, for Capital Goods REVT=6.7673*EBITDA, for Communication Services REVT=3.4187*EBITDA, Consumer Cyclicals REVT=-2.84493*EBITDA, Energy REVT=7.0483*EBITDA, Financials REVT=5.2389*EBITDA, Heatlh Care REVT=10.626*EBITDA, Technology REVT=5.9465*EBITDA, Transportation REVT=6.3361*EBITDA and Utilities REVT=3.273*EBITDA. Surprisingly, revenues and earnings for Consumer Staples sector seem not to be cointegrated in the examined period 1950 to 2016.

A natural extension of this study is examining relations between other income statement variables besides top-line and bottom-line. Other relations to examine are among the variables discussed in Barton et al. (2010). After all, they document that sales is one of the least relevant metrics for valuation when compared to earnings, comprehensive income, and operating cash flow. Knowing and understanding better these relations could further help external analysts in their quest for better valuations and forecasts.

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