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Original Paper

How Sticky Are the Costs? Evidence from the Shipping Industry

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Abstract

Trying to understand how cost behaves seems to be an essential element of cost and management accounting. In this study, we examine whether costs increase more when operation rises than they decrease when operation falls by an equivalent amount. The shipping industry is taken as an empirical case to study these issues at hand, based on a selected sample of 123 publicly-listed shipping companies, over 2006-2016. The sample includes companies belonging to the three main shipping sectors, i.e. tankers, containers and dry-bulk. We applied pooled regressions, based on ordinary least squares. Each model is run for each sample and each type of cost that we have considered in our model. We have gone through several tests of cost stickiness for some types of costs and their determinants. What we have found is the presence of stickiness both for the total cost of labor and the vessel operating costs.

Keywords

Cost behavior, cost stickiness, shipping firms, tankers, bulkers, containers

1. Introduction

An assumption made in cost accounting studies during the previous decade was that variable costs move proportionately with revenues. Recent studies argue that the scale of the change in the costs does not only depend on the scale of the change in the cost driver, but also of the direction of this change (ascending or descending). What have been shown by recent empirical studies on cost behavior is an asymmetrical variation on costs related to the actual activity volume. The magnitude of the cost-increase changes is greater than the magnitude of this variation equivalent to a reduction of potential revenue. A company with sticky costs shows a greater drop in income when its activity level drops when compared with companies with less sticky costs. In other words, one may refer to costs as "sticky", when they grow more with activity volume growth than they fall with a same amount of decrease (Dalla Via & Perego, 2014).

Even though throughout our research we have gone through several studies regarding explanatory factors of stickiness in country or firm level, as well as firm size level, we feel that this is the first study to interact with the shipping industry. Precisely, we investigate whether shipping companies appear to be cost sticky after implementing a model with different cost components. Secondly, this study contributes to the literature because apart from Selling, General and Administrative costs (SGA) that have been extensively investigated in previous studies (indicatively Banker et al., 2013; Chen et al., 2012) we extend the analysis to voyage costs, total labor cost and vessel operating costs. A paper close to ours would be that of Gavalas (2016) where he seeks whether financial risk assessment tools impact a shipping firm's performance, competitiveness and efficiency by implementing a Stochastic Frontier Analysis model. The influence of the risk assessment indicators on market and operational efficiency is subsequently determined by using a panel regression.

The empirical part of our study has been set after using data from the financial statements of listed shipping companies in the period 2006-2016. The sample includes companies belonging to the three main shipping sectors, i.e., tankers, containers and dry-bulk. For purposes of facilitating the setup of our model, we have included LNG-LPG sub-sectors to the tanker main sector. We have gone through several tests of cost stickiness for some types of costs and their determinants. What we have found is the presence of stickiness both for the total cost of labor and the vessel operating costs. Such findings come along to some previous research studies and differ with others.

The remainder of this paper has been organized as follows: Section 2 demonstrates the literature review upon same or similar scientific field. In Section 3, the empirical models, and methodology appear. Section 4 reveals the sample of our study. In Section 5 we demonstrate the results of this study. Section 6 contain the conclusions and suggestions for further research.

2. Review of the Literature

2.1 Cross-Country Analysis

He et al. (2010) test in their work whether Japanese managers changed their cost behavior after the stock market collapse in 1990. They find that similar to US firms, Japanese firms also demonstrate sticky SGA cost behavior. They also come up to the conclusion that there is a significant decrease in the scale of stickiness in Japan after the asset bubble burst. They translate such behavior as an adjustment of cost behavior in the post-bubble era. Porporato and Werbin (2010) show that sticky costs can be seen also in banks of Argentina, Brazil and Canada for the years 2004-2009. If the activity of the sector expands, the costs grow but less than proportional; the relation between an increase of 1% total income and increase of costs is positive (0.60% for Argentina, 0.82% for Brazil and 0.94% for Canada). The study results that total costs in this industry perform as sticky because the scale of the increase associated with an increase in the volume of activity or revenues (0.60%, 0.82% and 0.94%) is larger than the scale of the fall associated with a decrease of the volume (0.38%, 0.48% and 0.55%).

In 2014, Marques et al. (2014) used a 669 open companies' sample in nine countries of Latin America from 1995 to 2012. They applied several OLS log linear regressions for panel data and resulted that the behavior of SGA expenses moves asymmetrically with respect to changes in sales revenue. They found that (on average) when sales revenue increases by 1%, SGA 0.56% increase, but when the sales revenue decreases by 1%, SGA decrease only 0.45%. Some years later Bugeja et al. (2015) conduct a country level study upon Australian listed firms from 1990-2010. They argue that cost behavior in Australian firms is sticky on average, with a lower degree of stickiness than in United States firms. Costs increase by 0.885% with a 1% increase in sales revenues, but decrease by only 0.797% for a 1% decrease in sales. However, they do not find evidence of sticky cost behavior in the resources, construction and retail industries. It is argued that the degree of cost stickiness in Australia increases with a firm's asset and employee intensity, and when managers show strong incentives to obviate decreases in earnings or losses.

2.2 Corporate Governance Analysis

Another set of studies searched the magnitude of influence the corporate governance shows upon the SGA cost asymmetry. The managerial incentive theory suggests that the scale of cost stickiness is affected by managers' pursuit of self-interest. For example, Chen et al. (2012) find that costs are stickier when managers have a greater opportunity to overinvest. Dierynck et al. (2012) search for the influence of managerial incentives to accomplish the zero earnings benchmark on labor cost behavior of private Belgian firms. They argue that such policy will increase labor costs to a smaller extent when activity increases. After having used employee data, they show that managers of firms reporting a small profit focus on firing employees whom their firing cost (remuneration) is relatively low. Kama and Weiss (2013) focus on the impact of incentives to meet earnings targets on resource adjustments and the ensuing cost structures. They argue that when managers face incentives to avoid losses or earnings decreases, "they expedite downward adjustment of slack resources for sales decreases". Such strategy diminishes the scale of cost stickiness rather than induce cost stickiness. In another perspective, Balakrishnan et al. (2014) argue that "past decisions on cost structure, which determine the magnitude of costs controllable in the short-term, induce non-stationarity in the elasticity of SGA costs".

2.3 Industry Related Analysis

Another source of interest is related with industry focused studies. Argilés-Bosch and García Blandó (2011) after using a sample of farms, resulted in that small farms behave advantageously with respect to biggest farms in situations of operational flexibility. However, they argue that the increase in indirect costs with product diversification is higher in bigger farms than in smaller. While most farms seem elastic enough to avoid the stickiness of cost, the largest ones face considerable stiffnesses in downsizing indirect costs when working activity decreases. Furthermore, Cannon (2014) uses in his study US Air Transportation industry data to confirm that managers do retain idle capacity when demand falls. Moreover, he concludes that sticky costs “arise because managers lower selling prices to utilize existing capacity when demand falls, but add capacity (rather than raise selling prices) when demand grows”. The work also implies that sticky costs arise because managers incur more cost when adding capacity as demand grows than they incur when they add capacity as demand falls.

3. Methodology

First, we must clear out the sticky behavior of costs. We have relied upon the basic model that has been introduced by Anderson et al. (2003) and the one that has in the majority of the past researchers being used (at least during the time of complementing our research).

$$log \left[\frac{COST_{i,t}}{COST_{i,t-1}}\right] = \beta_0+\beta_1 * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right]+\beta_2 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \varepsilon_{i,t} \quad (1)$$

, where (*COST*) refers to costs used in the model, (*REV*) to revenues and coefficient $\beta 1$ measures the cost movement. If $\beta 2$ equals to zero this shows identical upward and downward movements in costs, and if the value is negative we consider a sticky behavior.

Our first cost variable is “SGA” which is reported on the income statement as the sum of all direct and indirect selling expenses and all general and administrative expenses of a shipping company. Namely, it includes the costs to sell and deliver products or services, in addition to the costs to manage the company. Our second cost variable will be “voyage costs” (or expenses). These are costs associated with the vessel’s employment, including costs of bunker fuel, canal tolls, light dues, port charges (including pilotage, towage, berth charges, agency fees, linesmen’s charges, etc.), passenger-handling costs, and cargo-handling costs. Namely, these are the costs incurred to earn the freight or other voyage revenue. Obviously, they vary with the length of the voyage and the number of port calls. We have chosen to add a third variable and that is “cost of employees” (total labor cost) which is the aggregate cost (direct and indirect) of the hours worked by all employees, plus all related payroll taxes and benefits. Our last cost variable is “vessel operating expenses” referring to the costs of operating a vessel, primarily consisting of insurance premiums, ship management fee, lubricants and spare parts, and repair and maintenance costs. Actually, this group of costs consist of the rest of the ones not included in the voyage costs basket.

In order to compare shipping companies between different sectors and firm’s size we have used ratios between current amount and value of the previous period for the four variables. We then log-transform all cost and revenue ratios to gain a better normal distribution. Dummy variable (*D*) refers to the sticky cost behavior. It takes value “1” when revenues of the current period are decreased when compared to the previous period and “0” in the opposite case. Moreover, according to Weiss (2010) another model to seek cost stickiness is the one that compares the costs movement scaled by sales being drawn by the most recent periods of sales decrease with the same measure drawn by the most recent periods of sales increase.

$$ST_{i,t} = log \left[\frac{\Delta COST}{\Delta REV}\right]_{i,\underline{\tau}} - log \left[\frac{\Delta COST}{\Delta REV}\right]_{i,\overline{\tau}} \quad , \underline{\tau} \ \& \ \overline{\tau} \in \{t,\ldots,t\text{-}3\} \tag{2}$$

, where we denote $\underline{\tau}$ as the most recent of the last four years having occurred a decrease in voyage revenue, and $\overline{\tau}$ as the most recent of the last four years having occurred an increase in voyage revenue. At this point, we try to search the dynamics of time inclusion in cost stickiness. We follow Dalla Via and Perego (2014) so that the revenues ratio at *t-1* is considered. This means that (1) shall be transformed to:

$$log \left[\frac{COST_{i,t}}{COST_{i,t-1}}\right] = \beta_0 + \beta_1 * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \beta_2 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] +$$

$$\beta_3 * log \left[\frac{REV_{i,t-1}}{REV_{i,t-2}}\right] + \beta_4 * D_{i,t-1} * log \left[\frac{REV_{i,t-1}}{REV_{i,t-2}}\right] + \varepsilon_{i,t} \tag{3}$$

Concerning the values of β_1, β_2, the expected values should be similar to (1). In case $\beta_3 > 0$ this means a lagged change of costs for adjustments in revenues. Furthermore, if $\beta_4 > 0$ but lower than β_2, this demonstrates a fractional inversion of the cost stickiness that pursues an incomes decline.

The relationship between cost stickiness and industry-level characteristics has been examined by several researchers, lightening this point of view, which contains a possible cause of cost stickiness. Important changes in sales revenues disturb the linear pattern of cost behavior. Subramaniam and Watson (2016) find that manufacturing industries exhibit the highest level of stickiness. Thereafter merchandising, service, and financial industries follow the lead. Specifically, Cost of Goods Sold (CGS) is sticky beyond a 15% absolute change in sales revenue for manufacturing firms. In parallel, concerning financial firms, CGS is sticky when interest revenue changes by >10%. The total cost results are like CGS results. Specifically, manufacturing and financial firms show that costs are sticky >10% and 15% fluctuations of revenue, respectively. Service firms' total cost is sticky for >20% fluctuations of revenue, while the authors do not find sticky cost behavior for merchandise firms when activity change is separated by its magnitude.

Furthermore, Caleja et al. (2006) show that operating costs are sticky as for changes in income. They utilize industry characterizations to control for industry attributes. They additionally find that the size of cost stickiness is more articulated for French and German firms than for UK and US firms. Specifically, their results show that the coefficients estimating the reaction of expenses to positive fluctuations in income, rises for most of the investigated countries although such rise in the span of the coefficients are generally small. They argue for a sticky reduction when firms show a reduction in income >10% in regards of US and UK firms; the level of stickiness for these firms reduces by around 4 ppts. Moreover, they examine levels of stickiness for larger fluctuations in income. The outcomes propose that sticky cost behavior happens when income decreases are little. At the point when the expansion in activity seems modest, firms have adequate limit and assets to meet the expanded action without the need of changing the current cost structure. When there is a slight decline in activity, the expense of redistributing assets, by means of agreement renegotiation, is higher than the expense of holding the excess, underutilized assets, and stickiness results. Then again, expansive reductions in income prompt a noteworthy decrease in stickiness for French and German firms proposing that, in such occurrences, the expense of conveying the surplus assets exceeds the expense of renegotiating the assets level and expenses are cut relatively.

Two other studies of interest are firstly Balakrishnan et al. (2014), who argue that cost structure fluctuates crosswise over industry subgroups inside every industry and secondly Cheung et al. (2014), who using a sample of Korean firms, they analyze the relationship between the asymmetric cost behavior of COGS and SGA and different industry qualities, for example, Hirschman-Herfindahl Index and Concentration Ratio. They argue that the level of competition is adversely connected with the extent of COGS stickiness and not fundamentally connected with SGA cost stickiness.

Finally, Dalla Via and Perego (2014) find a reduction regarding labor cost in the level of stickiness for larger decreases in sales revenue. They argue that the examination of individual industries, at macro- and microlevel affirms the lack of asymmetric behavior of cost in the Italian setting. Precisely, they argue that the SGA costs' coefficient decreases as the magnitude of revenues adjustment increases. Averaging between manufacturing and trading, when revenues change by <25%, they find a decrease in SGA costs of 0.70% for a 1% decrease in revenues. Regarding variations of >25% such expenses decrease by 0.58%. As far as operating costs are concerned, there seems to be an adverse situation. They decline by 0.97% for a 1% decrease in revenues if the magnitude of the variation is <25%, while they decrease by 0.99% if a change above 25% appears.

In general, these researches give some proof that outer components can be imperative determinants of the asymmetric cost behavior. Expanding upon earlier researches, we investigate whether outside competition factors influence the asymmetric cost behavior. We depend on competition factors derived from economic theories to look at whether item separation, section expenses, and market measure are related with cost stickiness.

To accomplish this, we use two different thresholds, at 10% and 25%. The candidate model has been formed under a similar sceptic with equation (1). We use four dummy variables in order for the income variations to be classified in intervals (Eq. 4). The values that these dummies may lie (in percentage change) between are:

- D_1 is 1 if the incomes' variation is between -25% and 25%, 0 otherwise;
- D_2 is 1 if the incomes' variation is between -50% and -25% or between 25% and 50%, 0 otherwise;
- D_3 is 1 if the incomes' variation is between -25% and 0%, 0 otherwise;
- D_4 is 1 if the incomes' variation is between -50% and -25%, 0 otherwise.

$$log \left[\frac{COST_{i,t}}{COST_{i,t-1}}\right] = \beta_0 + \sum_{k=1}^{4} \beta_k * D_{k,i,t}\, log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + \varepsilon_{i,t} \quad (4)$$

Regarding the firm characteristics, Anderson et al. (2003) examined firstly the asset intensity (ratio of total assets to sales revenue) of the firm. They argue that adjustment costs are advanced when SGA activities depend more on assets owned and people employed by the firm than services and supplies bought by the firm. Secondly, the employee intensity (ratio of number of employees to sales revenue) of the company. They find that the expenses of adjusting committed resources are advanced for firms that use more employees to support a standard volume of sales. Thirdly, the reduction of income in the previous period; managers consider an income reduction to be more lasting when it occurs in a second consecutive period of income losses. Increased likelihood of a lasting reduction might trigger managers to save resources, resulting in less stickiness. Under the same view, we assume in this study that a smaller amount of stickiness ensues in periods when income also declined in the prior period.

Moreover, Subramaniam and Watson (2016) tested the variables described above, adding inventory intensity, concentration ratio, interest ratio, advertising intensity, and R&D intensity. A few years later Calleja et al. (2006) added as variables the debt intensity, working capital intensity and Return on Equity. Dalla Via and Perego, (2014) relied upon the same path. Following the previous literature, the model applied in our study has kept assets and debt intensity and has been enriched by cash flow intensity, which reflects a vital issue of the shipping daily operation (Table 1).

Table 1. Firm Characteristics Determining Cost Stickiness

Variable	Description
Assets intensity	Ratio of the net book value of assets to sales revenue
Debt intensity	Debt to total assets ratio
Cash flow intensity	Ratio of the cash flow from operating activities to total assets

Our final model (Eq.5) is:

$$log \left[\frac{COST_{i,t}}{COST_{i,t-1}}\right] = \beta_0 + \beta_1 * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] +$$

$$+\beta_2 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] +$$

$$+\beta_3 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] * log \left[\frac{ASSETS_{i,t}}{REV_{i,t}}\right] +$$

$$+\beta_4 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + log \left[\frac{CASH_{i,t}}{REV_{i,t}}\right] +$$

$$+\beta_5 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] + log \left[\frac{TOT\_DEBTS_{i,t}}{REV_{i,t}}\right] +$$

$$+\beta_6 * D_{i,t} * log \left[\frac{REV_{i,t}}{REV_{i,t-1}}\right] * SD_{i,t} + \varepsilon_{i,t} \quad (5)$$

4. Sample

Our sample includes 10 years of annual data from Compustat Global database during the period 2006-2016. To endure in the initial sample, shipping firms must firstly be listed in any in any stock market in the world. After data extraction, these markets are New York, Nasdaq, Tokyo, Korea SE, Hong Kong, Taiwan, Bursa Malaysia, Shanghai, Oslo Bors and Copenhagen. In order not to becloud any shipping firms that also operate upon energy, drilling, bunkering and other activities, we have kept only the firms that over 55% of their revenue comes from freight transport (main activity). Finally, the gathered observations must have SGA, voyage revenue and cash flows from operating activities in the current and preceding year. In our analysis, we distinct shipping firms belonging into the three main sectors of the shipping industry, namely tankers, container and dry-bulk.

After the initial sample has been collected, we continue with the cleansing procedure. We omit observations (firm years) in which the SGA are higher than voyage revenue or annual voyage revenue changes by more than 40%. This way we try to remove the noise effects of bankruptcies mergers, acquisitions and divestitures. Additionally, we reduce the effect of outliers by setting each individual data element to the 1^{st} and 99^{th} percentile of the respective distribution. We also remove observations where SGA expenses move in the opposite direction to sales, as done in Chen et al. (2012).

To remove shipping firms that are relatively new or are not consistently reported by Compustat Global database, in our model sample firms must have at least three usable observations. All shipping firms with sales and total assets lower than $1 million have been excluded. This is done as it is doubtful that such “small” shipping firms have a well-defined cost structural plan and/or a business plan able to timely react to fluctuations in revenues. The two final steps of the procedure are from the one hand to extract missing data on either voyage revenue/costs or isolated data in the time-series and from the other hand following Dalla Via and Perego (2014) to poise the bottom and the top 1% of the sample, ordered by average of variable costs at the firm-level.

As soon as the procedure above has been accomplished, the final sample consists of 123 listed shipping companies (1.381 observations). The data are on an annual basis and converted into US dollars. Table 2 reports the number of shipping companies including firm-year observations according to their country of incorporation.

Table 2. Shipping Companies and Firm-Year Observations by Country

Country (alphabetically)	Firms	Firm-years
Belgium	3	32
Bermuda	7	124
Cayman Islands	1	11
Chile	2	26
China	6	79
Denmark	6	75
Finland	1	11
Greece	6	14
Hone Kong	2	38
India	6	51
Indonesia	3	31
Italy	2	16
Japan	10	143
Lavia	1	12
Malaysia	6	79
Marshall Islands	6	54
Norway	8	94
Philippines	2	31
Russia	2	12
Singapore	13	19
South Africa	1	18
South Korea	6	68
Sweden	3	41
Taiwan	9	101
Thailand	3	68
UAE	2	16
USA	6	117

Descriptive statistics of the samples are exhibited in Table 3. Panel A presents the statistics of the samples related to the tanker sub-sector, panel B presents the containers sub-sector and finally panel C, the dry-bulks.

Table 3. Descriptive Statistics

	Mean	Median	SD	Min	Max
Panel A-Tankers					
Voyage revenues	529.182	436.223	733.630	416.332	641.221
SGA costs	26.324	15.664	32.550	22.301	35.611
Voyage costs	113.403	98.663	128.644	96.331	142.309
Total labor cost	68.794	64.112	76.454	59.445	76.004
Vessel operating costs	173.864	122.546	201.333	171.005	201.366
Panel B- Containers					
Voyage revenues	2.508.080	2.406.332	2.631.114	904.556	3.216.633
SGA costs	147.560	121.550	168.993	101.330	651.300
Voyage costs	97.168	83.221	144.100	86.445	124.415
Total labor cost	236.197	201.336	254.699	198.856	321.564
Vessel operating costs	2.394.126	2.112.356	2.566.446	1.445.562	2.864.651
Panel C-Dry-bulks					
Voyage revenues	161.897	158.666	203.121	146.623	245.166
SGA costs	26.332	21.555	36.339	20.115	36.213
Voyage costs	8.617	7.113	13.236	7.003	16.445
Total labor cost	21.047	18.554	25.558	15.442	26.151
Vessel operating costs	90.358	85.666	101.542	82.311	101.554

Note. All figures expressed in thousands of US Dollars.

This analysis contains pooled regressions, based on Ordinary Least Squares (OLS) and conducted with software R. Each model is run for each sample and each type of cost that we have considered in our model. The standard conventions underlying the statistical models are checked; precisely the presence of multicollinearity between variables, the autocorrelation of residuals and the presence of heteroscedasticity. Taking into account the Durbin-Watson test statistic, we have concluded that the residuals are independent without presence of autocorrelation. The only exception is the variables containing "total labor costs" [similar results have been discussed in Dalla Via and Perego (2014) and in Anderson et al. (2003)].

5. Results

The tests driven from our model try to incorporate the sticky behavior, the effect of time, the relation with the magnitude of activity, the influence of other firm characteristics and eventually the relationship between shipping industry and stickiness. We have applied our model to the three panel data, namely tankers, containers and dry bulks.

Table 4 presents the results from running the models after applying the relevant equations.

Table 4. Sticky Behavior of Costs

	β_0	β_1	β_2	R^2
Panel A-Tankers				
SGA costs	0.0168*** (22.61)	0.6137*** (94.21)	0.0791*** (6.79)	0.31
Voyage costs	0.0001 (0.43)	1.0312*** (186.64)	0.0475*** (5.45)	0.64
Total labor cost	0.0341*** (68.12)	0.2766*** (67.64)	-0.0214*** (-2.46)	0.09
Vessel operating costs	0.0051*** (21.64)	0.8645*** (516.46)	0.0214*** (6.15)	0.86
Panel B- Containers				
SGA costs	0.0241*** (22.79)	0.4665*** (62.12)	0.0813*** (4.63)	0.28
Voyage costs	-0.0075*** (-14.21)	1.0144*** (375.56)	0.0048 (1.79)	0.84
Total labor cost	0.0411*** (57.12)	0.2455*** (38.38)	-0.0176 (-1.43)	0.13
Vessel operating costs	0.0013*** (9.34)	0.8664*** (612.15)	0.0146*** (3.03)	0.94
Panel C-Dry-bulks				
SGA costs	0.0043 (0.42)	0.7112*** (10.45)	-0.0463 (-0.34)	0.36
Voyage costs	-0.0013 (-0.24)	0.8436*** (13.54)	0.0845 (0.61)	0.43
Total labor cost	0.0002 (0.02)	0.6314*** (12.90)	-0.2943*** (-4.13)	0.27
Vessel operating costs	0.0027 (0.29)	0.7965*** (18.43)	-0.2152* (-2.19)	0.61

Notes. t-statistics are shown in parentheses. The value of the adjusted R^2 has been omitted because it is equal to R^2 at two-digit approximation. *, ** and *** indicate significance at the 5%, 1% and 0.1% levels based on two-tailed tests, respectively.

To start with, the value obtained for β_1 reveals that SGA costs increase, on average, by 0.60% for 1% increase in voyage revenue, the voyage costs increases by 0.96%, the total labor cost by 0.38% and the vessel operating costs by 0.84%. Estimations of β_2 are all positive, apart from total labor cost which shows a negative value. In particular, the value of 0.02 suggests that for a revenue decrease of 1%, total labor cost decrease by 0.25% which comprises an obvious indicator of sticky behavior of cost type. The other types of cost (SGA, voyage costs, vessel operating costs) considered in our model do not show sticky behavior. Precisely, our results show that for a 1% revenue decrease other types of cost drop more than they rise for an equal growth in revenue. We expected that there should be a non-sticky behavior among voyage costs in our findings; in terms of theory and practice there is an inelastic relationship between this type of cost and the levels of operation and revenue of sales (Shim, 2016).

We continue our study by investigating the effect of time on cost behavior, by applying Eq. 3 over different time-periods. Unfortunately, we obtain non-robust results, and it seems too risky to draw conclusions about the long-term stickiness behavior.

Afterwards, the results after running Eq. 4 are exhibited in Table 5. These are the changes in revenues and cost behavior, after applying the magnitude of activity.

Table 5. Sticky Behavior of Costs-Magnitude of Activity

	-25%<change<25%		-50%<change<-25% 25%<change<50%		
	β_1	β_3	β_2	β_4	R^2
Panel A-Tankers					
SGA costs	0.6895*** (83.45)	0.0544*** (3.12)	0.5766*** (107.78)	0.0411*** (4.99)	0.31
Voyage costs	1.1225*** (170.32)	0.0214 (1.63)	0.9455*** (201.33)	0.0314*** (3.11)	0.61
Total labor cost	0.3115*** (50.11)	-0.0544*** (-3.46)	0.2781*** (71.44)	-0.0211** (-3.85)	0.11
Vessel operating costs	0.8645*** (313.55)	0.0125*** (4.30)	0.9312*** (511.33)	0.0346*** (10.16)	0.85
Panel B- Containers					
SGA costs	0.5554*** (41.30)	0.0845*** (3.11)	0.4112*** (49.99)	0.0466*** (3.41)	0.24
Voyage costs	1.0421*** (284.33)	-0.0005 (-0.07)	1.0215*** (314.41)	-0.0014 (-0.36)	0.82
Total labor cost	0.3341*** (35.44)	-0.0986*** (-5.47)	0.2751*** (39.13)	-0.0041 (-0.24)	0.16
Vessel operating costs	0.9511*** (8.64)	0.0114***(2.39)	0.9111*** (613.75)	0.0219***(5.46)	0.95
Panel C-Dry-bulks					
SGA costs	0.4354*** (40.44)	0.0556*** (3.08)	0.4335*** (43.53)	0.0413*** (3.86)	0.13
Voyage costs	1.0200*** (271.33)	-0.0004*** (-0.07)	1.0511*** (280.43)	-0.0023 (-0.12)	0.73
Total labor cost	0.3291*** (31.00)	-0.0846*** (-4.36)	0.2311*** (29.64)	-0.0022 (-0.19)	0.13
Vessel operating costs	0.8135*** (7.64)	0.0178** (3.42)	0.8121*** (501.21)	0.0251*** (5.11)	0.93

Notes. t-statistics are shown in parentheses. The value of the adjusted R^2 has been omitted because it is equal to R^2 at two-digit approximation. *, ** and *** indicate significance at the 5%, 1% and 0.1% levels based on two-tailed tests, respectively.

Precisely, we demonstrate the results for variations <25% or >25%. Coefficients β_1 and β_2, which all show a significant positive value, reflect the variations in costs for affirmative changes in revenues. There seems to be a minor drop between the coefficient β_1, which corresponds to an increase in revenues of <25%, and the coefficient β_2 that is related to increase in revenues equal or more than 25%. The only exceptions to this downward trend are the vessel operating costs for all the shipping sub-sectors, which show a reverse movement. Pertaining to β_3 and β_4 coefficients, the results do not seem convincing. Looking only at the cases in which all values are significant, we find that the coefficient for the SGA costs decreases as the magnitude of revenues change increases. Averaging between tankers, containers and dry-bulks, when revenues alter by <25%, we observe a drop in SGA costs of 0.49% per 1% drop in revenues, while for changes >25% SGA costs decrease by 0.47%. A reverse movement occurs for vessel operating costs which decrease of 0.87% per 1% drop in revenues if the magnitude of the change is <25 per cent, while they decrease by 0.88% if the magnitude of alteration is above 25%.

Based on Eq. 5 we run the final regression model of this study (Table 6). We try to investigate the contribution of the shipping firms' characteristics by adding the following variables: asset intensity, cash flow intensity and debt intensity. As figured in Table 1, assets intensity is considered as the ratio of the net book value of assets to voyage revenue, debt intensity as the debt to total assets ratio and cash flow intensity as the ratio of the cash flow from operating activities to total assets.

Table 6. Sticky Behavior of Costs-Shipping Firms' Characteristics

	SGA costs	Voyage costs	Total labor cost	Vessel operating costs
Panel A-Tankers				
β_0	0.0186*** (21.41)	0.0010 (1.75)	0.0342*** (61.31)	0.0051*** (18.66)
β_1	0.6421*** (101.12)	1.0312*** (201.46)	0.2468*** (68.20)	0.8645*** (301.53)
β_2	-0.0810*** (-5.63)	0.0542*** (3.12)	-0.1645*** (-11.93)	0.0864*** (18.66)
β_3	-0.2184*** (-11.32)	-0.1240*** (-5.13)	-0.0016*** (-0.07)	0.0864*** (18.66)
β_4	0.1145*** (14.68)	0.0423*** (6.84)	0.0649*** (9.91)	0.0048 (1.34)
β_5	0.0155* (1.36)	0.0411*** (3.42)	0.0149 (1.76)	0.1346*** (21.36)
R^2	0.31	0.58	0.18	0.96
Panel B- Containers				
β_0	0.0161*** (21.01)	0.0042*** (11.21)	0.0463*** (51.31)	0.0014*** (7.63)
β_1	0.5312*** (55.10)	1.0152*** (256.12)	0.3648*** (41.79)	0.8652*** (333.14)
β_2	-0.0541* (-2.01)	0.0214** (2.11)	-0.1531*** (-4.64)	0.0247*** (3.97)
β_3	-0.0513 (-1.49)	-0.0059 (-0.52)	-0.0513* (-2.67)	-0.0741*** (16.43)
β_4	0.0241* (2.23)	0.0213*** (6.24)	0.0646*** (6.91)	0.0067*** (4.93)
β_5	0.0612** (2.46)	0.0011 (0.17)	0.0611** (3.84)	0.0643*** (9.07)
R^2	0.26	0.79	0.16	0.91
Panel C-Dry-bulks				
β_0	0.0155*** (19.01)	0.0033*** (10.16)	0.0416*** (49.61)	0.0007*** (5.64)
β_1	0.4310*** (43.11)	1.0136*** (143.32)	0.3649*** (42.63)	0.7645*** (945.33)
β_2	-0.0564* (-1.98)	0.0230** (1.67)	-0.1581*** (-5.62)	0.0219*** (2.24)
β_3	-0.0510 (-1.61)	-0.0049 (-0.33)	-0.0567* (-2.61)	-0.0564*** (13.33)
β_4	0.0232* (2.13)	0.0261*** (5.32)	0.0597*** (5.36)	0.0007*** (1.31)

β_5	0.0516** (2.45)	0.0029 (0.13)	0.0637** (3.99)	0.0522*** (7.81)
R^2	0.27	0.81	0.22	0.76

Notes. t-statistics are shown in parentheses. The value of the adjusted R^2 has been omitted because it is equal to R^2 at two-digit approximation. *, ** and *** indicate significance at the 5%, 1% and 0.1% levels based on two-tailed tests, respectively. β_3 refers to the "asset intensity" coefficient, β_4 refers to the "cash flow intensity" coefficient, β_5 refers to the "debt intensity" coefficient.

The attitude of SGA and total labor cost signals indication of stickiness, with a negative value of β_2, in all of the under investigation sub-sectors (tankers, containers, dry-bulks). In an effort to examine the factors of sticky behavior, we emphasize our analysis on samples where evidence of such behavior has been signaled. The total assets effect is appraised by the coefficient β_3, which seems significant and negative especially for SGA costs in tankers (-0.2184). A significant and positive sign is associated with the extent of employee intensity (β_4). In terms of the tankers sub-sector, it is equal to 0.1145 for SGA costs and to 0.0649 for total labor cost; at the same time, the relevant value is 0.0646 for the containers sub-sector and 0.0597 for the dry-bulks sub-sector.

6. Conclusions

According to previous studies, a firm with sticky costs shows a greater decrease in revenues, when operation level drops, when compared with firms with less sticky costs. Our study anticipates to contribute to this field of study by focusing on the shipping industry which is a capital-driven and a high-risk industry operating around a peculiar cyclical stance (Gavalas & Syriopoulos, 2016). Precisely, we investigate whether shipping companies appear to be cost sticky after implementing a model with different cost components. Secondly, this study contributes to the literature because apart from SGA costs that have been extensively investigated in previous studies, we extend the analysis to voyage costs, total labor cost and vessel operating costs.

The empirical part of our study has been set after using data from the financial statements of listed shipping companies in the period 2006-2016. The sample includes companies belonging to the three main shipping sectors, i.e., tankers, containers and dry-bulk. For purposes of facilitating the setup of our model, we have included LNG-LPG sub-sectors to the tanker main sector. We have gone through several tests of cost stickiness for some types of costs and their determinants. The estimations obtained with the basic model applied to tanker, containers, and bulk shipping firms reveals the existence of stickiness behavior of all type of costs analyzed, in different leverage. Our findings suggest that the shipping industry in total performs idiosyncrasies in terms of corporate governance with respect to other firms in the extended shipping industry (i.e., bunkering, manning, port reception facilities,) that possibly impact the behavior of costs. Regarding the relationship between cost stickiness and the magnitude of activity movement, our results show a decrease in the level of stickiness of total labor cost, for greater reductions in voyage revenue.

We suggest that future studies upon this scientific field should be conducted in a more direct way, namely having shipping managers to be interviewed, in order to obtain specific and business-oriented information of how their decisions affect cost behavior. One limitation of this study would be the voyage revenue variable used as a proxy for operation volumes; even though through our research we realized it seems a common use (found as "sales revenues" for the rest of the industries), the outcomes should be prudently analyzed because voyage revenue is subjective to variations in prices.

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