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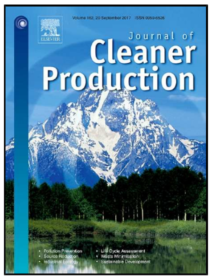

«Market orientation for sustainable performance and the inverted-U moderation of firm size: Evidence from the Greek shipping industry»

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Market orientation for sustainable performance and the inverted-U moderation of firm size: Evidence from the Greek shipping industry

Abstract

Sustainability, despite being a major concern for companies, has not been studied from a market-orientation perspective. Market-oriented companies can integrate sustainability activities into their business strategies but there is a gap in our knowledge to what extend this affects firm performance This paper analyses the sustainable performance differences and provides confirmation of the market orientation to performance relationship within the transportation (shipping) sector. In an attempt to fill the literature gap we examined, by employing Stochastic DEA and hierarchical regression analysis, the moderating effects of firm size on the relationship as well as the efficiency levels of the organizations to support the sustainable use of resources. We conducted a large-scale survey of the Greek shipping industry, which directly or indirectly controls 15.42% of the total world fleet. We surveyed the total population of 2,150 shipping firms of all types (ship owning, ship management, charterers etc.) and received 703 responses from managers of 397 shipping firms, which corresponds to an 18.5% response rate.

The findings show the effects of market orientation upon firm performance for shipping companies by disaggregating MO to its constituting factors, those of responsiveness, intelligence generation and dissemination. Further, we uncover the differences in the size of shipping companies on the MO-Performance (P) link. Findings indicate that there is an inverted U-shape effect of size on firm MO performance and identify where improvements are required.

Keywords: Sustainability, market orientation, firm size, shipping, firm efficiency, Inverted-U moderation

1. Introduction

Sustainability, or consumer consciousness for economically, environmentally and societally friendly products and services, was introduced as a term some 20 years ago to represent and reflect the responsibility of organizations not only towards their customers but to society as a whole (Matten and Moon, 2008). In this context major streams of sustainability research employ the theories of the firm, such as Aggregate Theory, Contractual Theory, Resource Based View, and Stakeholder Theory, in an attempt to interpret decisions and actions made by the organizations towards this direction (for an extended presentation refer to Lozano et al., 2015). One of the theories of the firm, the resource based view of the firm (RBV), supports that a firm is a collection of tangible (such as plant, equipment, land) and human (including skills and capabilities) resources (Peteraf, 1993). The RBV explains well *why* a firm can produce better products or services from another, *where* a sustainable competitive advantage can be developed and how the production costs can be reduced (Vlachos and Malindretos, 2012).

The RBV further supports that co-operation and dissemination of knowledge among individuals within the firm enhances the knowledge this firm can apply to business and provides a distinct source of competitive advantage (Vlachos and Siachou, 2016) as interrelated internal resources co-operate for the maximum result at the minimum cost (Lozano et al., 2015). Based on this theory of the firm we argue, in line with many scholars (e.g., Hunt and Morgan, 1995, Lafferty and Hult, 2001; Crittenden et al., 2011), that market-oriented firms are in a unique position to strategically align themselves with the needs and concerns of the customers and other stakeholders who are concerned with the organization's wider responsibilities to society and can, thus, achieve competitive advantage and superior long term performance in the way to develop a market-oriented sustainability framework.

Market orientation (MO), as a firm's resource, is still regarded as one of the first strategic frameworks to provide firms with sustainable competitive advantage and its contribution as a generic determinant to business performance is widely documented (Kirca et al., 2005). Despite the extensive literature contributing to the issue, the MO-Performance relationship remains largely unexplored or is ambiguous, as many have identified positive (Hau et al., 2013) while others report negligible (Kumar, et al., 2011) weak, non-significant (Langerak, 2003) or even negative effects (Lee et al., 2015). This ambiguity on the implications of MO to Performance is even more evident for firms operating globally under turbulent environments (Huhtala et al., 2014) forcing firms to develop managerial capabilities in rough times (Naidoo, 2010). Pelham (1997) stresses the need to further examine the reason behind MO is a less significant determinant on performance in markets in which cost cutting and economies of scale are the dominant sources of competitive advantage.

The shipping industry, on the other hand, is a unique multicultural industry. It operates globally with some 50,000 seagoing vessels of 1000 gross tones and more, of which 15.000 belong to the EU countries excluding U.K. (www.stats.unctad.org/maritime) and has been in the eye of the storm recently as in 2015 and 2016, most shipping segments, suffered historic low levels of freight rates. The container ship time charter index for example, felt from a high of around 700 points in 2012 to a yearly average of almost 360 points in 2016 whereas the Baltic Dry index dropped to 519 points in December 2015, 50% lower than its average in December 2014. Even the tanker market although stronger than the other two, presenting a slight increase of 5.6% from 2014, is almost half than its high in 2008. (UNCTAD, 2016) In an effort to deal with these low freight rates, companies consider alliances and mergers to form economies of scale (Tovar and Wall, 2012), new route-planning (Halvorsen-Weare et al., 2013) and structural or fleet changes (Xu et al., 2011). Further, abnormalities in the major shipping markets from mid-2012 to early 2015 have exposed shipping firms to higher risks and increased credit spreads (Kavussanos and Tsouknidis, 2014). The uniqueness of the shipping sector questions the generalizability of findings from previous studies on market orientation on shipping firms.

However, even though maritime is a main pillar of the word economy, empirical studies on marketing orientation are nowhere to be found. In fact, we can safely say that very little is actually known about the use of the marketing concept, market orientation or customer or society driven sustainable philosophy of shipping firms and organizations. Finally, literature is also inconsistent on the moderating effect of firm size on the MO–P relationship whereby some studies shows a positive effect (Hirsch et al., 2014) whereas others support a negative influence (Lee et al., 2015).

This study responds to the research gaps previously identified by providing two contributions to the transportation and marketing literature: First, it measures the effects of market orientation upon firm performance for shipping companies by disaggregating MO to its constituting factors, those of responsiveness, intelligence generation and dissemination. The second contribution is that this work examines the differences in the size of shipping companies on the MO–P link and assists on making meaningful comparisons on resources employed and performance results obtained. The study's contributions are based on empirical data collected via a large-scale survey, which increases the validity and reliability of the findings.

2. Literature Review and Research Hypotheses

The literature review first covers the concept of market orientation towards a sustainable competitive advantage, and then discusses market orientation and firm performance in the shipping sector; finally, the optimum shipping firm size and MO firm efficiency is discussed.

2.1 The concept of market orientation towards a sustainable competitive advantage

Market orientation conceptualizes a firm's tendency to implement the marketing concept. Since the early 1990s, diverse definitions of market orientation have been proposed to conceptualize and best describe its underlying theory. Kohli and Jaworski (1990) define MO as *"... the organization-wide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organization-wide responsiveness to it...*" (p. 6).

This market-oriented approach of the firm predicates on the understanding that it is connected to the organizational culture of the firm than rather simply focusing on the consumer and should - among other things - fit well within the sustainability framework as it builds upon the dynamic capabilities of the firm and intangible assets in order to encourage behaviors that affect organizational learning and achieve maximum results with minimum consumption of resources (Crittenden et al., 2011).

The dynamic capabilities of the firm have long been related to competitive advantage and superior performance (Hult and Ketchen, 2001) and represent a complex process within organizations that needs inter-functional and interdepartmental coordination; an issue that, by itself, has been identified as of major importance in every market oriented theory as the collection and dissemination of market and societal information within the organization is of major importance.

Crittenden et al. (2011) point out that sustainability is a major concern for marketers since marketing strategies and activities are inextricably linked to the future of the natural environment and developed a market-oriented sustainability framework based on this premise. Arshad et al (2012) hypothesize that corporate social responsibility (CSR) mediates the positive relationship between MO and firm performance, finding that market-oriented companies are integrating sustainability activities into their business strategies but not to an extent that creates a synergistic effect that can bolster firm performance. Green et al. (2015) find that market orientation both directly and indirectly (through green supply chain management practices) impacts environmental performance. Shams (2016) finds a consistent interrelationship between different sustainability indicators and market orientation in the global international education industry. Mitchell et al. (2010) propose a reconceptualization of MO and new corporate marketing model: sustainable market orientation; for example, gathering social and environmental intelligence, being responsive to sustainability needs and dissemination sustainability reports. Hult (2011) argues that an organization achieves market-based sustainability when it strategically aligns itself with the market-oriented product needs and wants of customers and the interests of multiple stakeholders concerned about social responsibility issues involving economic, environmental, and social dimensions. On the other hand, Darnall (2008) supports that weak internal coordination is one of the major obstacles for firms to undertake sustainable initiatives.

Therefore, it is apparent that a strong market orientation focus supports sustainability efforts by making managers and decision makers aware of the customer demands and sustainability concerns of their customers (Rehman and Shrivastava, 2011); it also produces a resource advantage for the firm (Crittenden et al, 2011) that leads to improved performance. Thus, market orientation is hypothesized to be an ancestor to the adoption of any sustainability strategy (Green et al., 2015).

2.2. Market orientation and firm performance in the shipping sector

The direct and positive impact of MO on firm performance is, overall, established in the literature in all sectors and firm sizes (Hau et al, 2013). However, empirical results are rather equivocal concerning the type, the magnitude of the impact of this relationship, and its direction (Langerak, 2003). Sittimalakorn and Hart (2004) criticize the linear relationship between market orientation and business performance whereas Langerak (2003) reports negative effects of market orientation on firm performance.

In the shipping literature, to the best of authors' knowledge, only three prior studies have explored the market orientation concept yet without developing a sector-specific rationale. Panayides (2004) examines a sample of logistics firms in the Asia pacific region, but concludes that market orientation is not significantly related to improved business performance. Using data from port logistics firms, Bae (2012) attests that the market orientation dimensions of intelligence dissemination and responsiveness, as well as coordination, capability, and exchange positively influence relationship commitment. Finally, a more recent study by Pantouvakis (2014) examines the relationship between MO, service quality and performance, by drawing evidence from a similar study to the present sample. However, in the correlation analysis that was followed, scores were averaged across components to arrive at a mean score for every construct under consideration. By relying on only one average observation per cluster in order to group firms no evidence is provided on the causality, type and strength of the relationship.

Based on the evidence provided above, one limitation seems obvious that justifies further examination of the market orientation concept and its impact on performance in the context of the shipping sector. The limitation regards the type and direction of the MO–P relationship in the shipping sector. Prior studies measuring the type of relationship of market orientation and shipping firm performance are not conclusive or consistent and exhibit notable variation regarding the potency and the significance of the MO–P association. Kohli and Jahorski (1990) identify the role of competition and market stability as factors affecting the kind and strength of the relationship and Ellis (2006) is among the first to highlight the role of the culture on this link. The shipping sector operates in an almost perfect competition, under severe cost-cuttings and is mainly characterized by unbranded products and providers (bulk shipping), unorganized sectors and production units (shipping firms) (Xu et al., 2011) which, according to Sheth (2011), limits the generalization of prior studies, questions the power of the MO–P relationship and calls for further research.

Thus, our first hypothesis is formulated as follows:

H1: Market orientation positively affects the performance of shipping firms.

2.3 Optimum shipping Firm Size and Market Orientation Firm Efficiency

The second argument is that the differences in the size of the organizations present unique differences in the way they employ personnel (i.e., smaller firms usually employ people on the basis of relationship or familiarity whereas larger firms employ people on the basis of skills) and hence they differ on the way they apply management and marketing techniques (Hausman, 2005). Those differences are important both on the sustainability level and, furthermore, they may produce varying performance results - the general assumption is that the larger the firm size the greater the outcomes - and calls for further research on the effect of size on sustainability are evident (Russo and Tencati, 2009).

Furthermore, the size of the firm presents clear moderating capacities on MO levels of any organization without, however, complete knowledge of the exact type of interaction (linear or non-linear) of the impact of size to the MO. For example, evidence suggests large and extra-large firms have the tendency to be more marketing-oriented than smaller firms (Grewal et al., 2013). This can be attributed to the fact that large and extra-large firms may benefit from both abundant resource reserves, which provide them with the opportunity to transform marketing knowledge into valuable performance outcomes, and due to economies of scale are better equipped, with expensive technological equipment and information systems, when compared with smaller firms (Hassan and Halbouni, 2013).

On the other hand, Coviello et al., (2000) suggest that extra-large firms may actually be less productive due to a number of factors such as excessive bureaucracy, slow adaptability, inability for prompt responsiveness to the external environment, communication impediments, high degree of formalization and high task specialization. Furthermore, going from large to extra-large size, it becomes more difficult to effectively diffuse market intelligence and customer knowledge across all organizational departments (Grewal et al., 2013) and may encounter difficulties in terms of managing human resources such as managerial control which, in turn, can adversely affect firm results (Marti et al., 2015, Grewal et al., 2013). All these difficulties imply a weak internal coordination, which is one of the major obstacles for firms to undertake sustainable initiatives (Darnall, 2008). Finally, Liu (1995) examines the differences in the level of market orientation between UK firms of different sizes, finding that medium-sized firms adopt a market orientation to a lesser extent than large and extra-large firms and that there are no differences in the level of market orientation between large and extra-large firms whereas Panayides et al. (2011), by using a sample of 26 major international shipping firms, conclude that shipping firms exhibit low to average market efficiency depending on their sector of business (tanker, bulk or container).These findings indicate that the type of size effects on the MO–P relationship is far from conclusive especially in the literature for the shipping sector and the direction and magnitude of this variation is not clear (Grewal et al., 2013).

Thus, the current study hypothesizes that the size–efficiency relationship is not monotonically increasing or decreasing, which also implies that an optimal firm size range may exist (Zschille, 2014). Specifically, the size-efficiency relationship may be U-shaped, which means that the highest levels of efficiency occur in small and large firms, while medium-sized firms display, on average, the greatest inefficiencies (Schiersch, 2013). In this way, the relationship between firm size and productive efficiency levels is non-linear and these levels are adversely influenced by size increases above a certain threshold (Lee, 2009). As a result, the relationship between productive efficiency and firm size may be an inverted U-shaped (Ajuzie et al., 2011). An inverted U-shape is a non-linear relationship where the effects of firm size on efficiency appear to increase to a maximum, and then decrease (Schiersch, 2013). Smaller firms can gain higher efficiency through the implementation of expansion strategies (Ajuzie et al., 2011) while larger firms should concentrate their efforts on divestment strategies, as gains in profitability decrease for larger firms (Lee, 2009).

Although existing research recognizes the critical role played by shipping firms' size towards influencing performance outcomes, such as profitability (Lun et al., 2010) or sales growth (Lun and Quaddus, 2011), no endeavors have been made so far to investigate optimum firm sizes in the context of shipping firms. Acknowledging the importance of determining optimal firm sizes towards achieving higher efficiency gains and sustainability, the following hypotheses are formulated.

H2: Firm size moderates the relationship between market orientation and firm performance of shipping firms

H3: There is an inverted U-shaped relationship between firm size and market orientation efficiency of shipping firms

3. Methodology

This sector discusses the research design, scales and operationalization of variables and, finally, stochastic Data Envelopment Analysis (DEA).

3.1. Research Design

To test our research hypotheses, we conducted a large-scale survey of the Greek shipping industry, which a leading shipping nation controlling directly or indirectly 15.42% of the total world fleet[1]. This study surveyed the total population of 2,150 shipping firms of all types (ship owning, ship management, charterers etc.) maintained in a university research center database. Before the survey, a panel of 30 managers from 15 shipping firms was invited to pilot the questionnaire. The target respondents were managing directors or other senior executives aware of the applied policies. Data collection was conducted in late 2014 by professional interviewers from a well-known research company contributing anonymously this way to this research. The authors following a detailed e-mail explaining the objectives of the study and requiring their contribution further trained those interviewers. Two weeks following the first email, a reminder was sent to non-respondents to arrange an appointment and we followed-up with non-respondents two weeks later. When other than the managing director responded -especially in very large firms- we addressed the questionnaire to at least two other senior members of staff. Replies received this way were summated at a firm level to better represent the opinion of the firm under examination. Finally, 703 managers from 397 shipping firms provided usable responses; this corresponds to an 18.5% response rate sufficiently representing the population. Non-response bias was tested by comparing the mean

[1] Greece is followed by Japan (13.62%), China (11.94%) and Germany (7.6%) of the total world fleet ownership according to UNCTAD 2014 statistics

differences in the responses between the two email batches and found no significant differences ($p<.05$), suggesting that the sample was free from non-response bias.

The demographics of the enterprises are as follows: 52.4% of the sample firms regard themselves as medium size; 18.6% and 19.9% as small and large, respectively; and 9.1% as significantly large. Regarding the number of employees, 36% of the firms employ less than 80 employees; 31% from 80 to 200 employees; 14.8% from 200 to 500; and, finally, 18.2% more than 500 employees[2]. The majority of the firms, almost 30%, are ship management firms of all types of operations [3], 13% belong to bulk and 19% to tanker industries, 20% have tankers and bulk, 6% to containers and, finally, approximately 12% are shipping brokers and agents.

3.2. Scales and Operationalization of Variables

In this study, a 32-item MARKOR scale was used to measure MO. Of these items, 10 pertained to market "intelligence generation" and "intelligence dissemination" and 14 to "responsiveness" (either as response design, or response implementation) at the business unit level. All items that tapped the three components were interwoven with issues related to the needs and preferences of customers and end-users, competitors' moves and regulatory trends. Each item was scored on a seven-point scale, ranging from "strongly disagree" to "strongly agree" as seen in Table A1 in Appendix A.

Each scale was refined according to the procedure described by Jaworski and Kohli (1993). Specifically, items exhibiting low inter-item correlations were eliminated, and negatively rated items had their values reversed in order to be consistent with the overall scoring system. Business performance, on the other

[2] Almost 90% of the employees ashore and onboard are multi-cultural belonging to other than the Greek nationality (Ukraine, Philippines, Egypt, etc.)

[3] Please note that it is common to all ship-owning firms to be legally represented as management firms as a matter of precaution against extreme liabilities

hand, was measured using judgmental measures that asked informants for their assessment of the overall performance of the business and its overall performance relative to major competitors, rated on a seven-point scale ranging from "poor" to "excellent".

Size is measured in four discrete clusters, as judged by the managers of the firms under consideration: small, medium, large and very large. Although the literature defines firm size as the organization's resources, turnover or workforce size (Lee and Xia, 2006) it is usual to describe it with the single item of number of employees (Leal-Rodríguez et al., 2015). In order to avoid arbitrary classification of the taxonomy of the different types of firms in size clusters we opted for the judgments on size from their managers. The correlation results reveal a 0.92 correlation of size dimension as stated by managers to the total number of employees employed by the firms and, thus, we proceeded with the subjective judgment of managers as a classification criterion. Management perceptions concerning concepts such as size and performance may actually be more valid indicators than objective data, since these measures are directly related to a vast number of variables, such as trends in the economy, industry factors, and other environmental factors. Therefore, self-reported rather than objective measures may, in some cases, represent more accurate descriptions (Day, 2003).

3.3 Stochastic DEA

Data Envelopment Analysis (DEA) is a widely used technique for measuring relative efficiency and performance of operational units employing the same type of resources to produce the same type of outputs. Since the seminal paper of Charnes et al. (1978) on DEA, thousands of papers, both theoretical and empirical, have been published (i.e. see review by Emrouznejad et al., 2008; Liu et al., 2013a; Liu et al., 2013b). The most popular industries where DEA has been used to measure efficiency and performance include banking, health care, agriculture and farm, transportation, and education (Liu et al., 2013a). DEA draws on the work of Farrell (1957) and constructs piece-wise linear frontiers, which envelop as tightly as possible, depending on the assumptions applied, the data. DEA uses mathematical programming to construct empirical production frontiers, distinguish benchmark units from dominated units, and define modifications needed in the production process of the dominated units in order to become benchmarks.

Acknowledging that conventional DEA is a non-parametric technique, the validity of DEA measurements is subject to the accuracy of the data set. In the case of noisy data, which is not unlikely in real-world data, such as the survey data we use in this study, a stochastic DEA program is more appropriate for measuring efficiency than conventional DEA programs. The stochastic DEA (SDEA) program, which draws on chance-constrained programming (Dyson and Shale, 2010) takes into account the possibility of noise in the data. To be more precise, the input-oriented SDEA program is formulated as presented in the Appendix.

In this study we take into account noise both in inputs and output as the measurement of these two types of variables drew on survey questions addressed to practitioners. In this context, stochastic inputs and output can capture the bias that may be present in the primary data we used in our analysis. Acknowledging that Dyson and Shale (2010) note that an SDEA program could become intractable if uncertainty is incorporated both in inputs and outputs, we formulated the SDEA taking into account stochastic inputs and outputs as this approach better expresses our case. Similar formulations of the SDEA program we applied to our study appear in Morita and Seiford (1999), Olesen (2006), Tsionas and Papadakis (2010), Wu and Lee (2010), and Udhayakumar et al. (2011). Moreover, in this work, we both apply input-oriented SDEA (i.e., program (3) and output-oriented SDEA, i.e., program (4)).

4. Results

4.1. Hypothesis 1 – Market Orientation Effect on Firm Performance

To explore the relationship between market orientation and firm performance (Hypothesis 1), a hierarchical regression analysis was used. We ran two multiple regressions, one for each firm performance variable, those of market and financial performance. We then entered variables in two steps and created the models. In Step 1, we entered only the control variables in the regression equation creating the control model, in Step 2 - named as the Independent model - we added the MO variables. Tolerance tests (Variance Inflation Factor - VIF) showed no significant collinearity among variables. Unobserved heterogeneity across firms may affect results substantially. One way to address the possibility of unobserved heterogeneity in these regressions is to include control variables. [4]

Table 1 reports the hierarchical regression results of MO impact on Firm Performance. The beta weights presented in Table 1 suggest that Response Implementation (β=0.47, $p<.1$), and Response Design (β=0.14, $p<.1$), are the most influential in predicting the Financial Performance in the Independent model (Step 2). The overall change in adjusted R square value (ΔR^2) was strongly significant with a value of .136, $p<.001$ (F=9.2, $p<.001$). This change shows that 13.6% of deviation of Financial Performance can be attributed to MO policies. The control model in Step 1 did not produce any statistical significant result (ΔR^2= .006). As a result, Response Implementation and Response Design contribute significantly to Financial Performance of shipping firms.

The beta weights presented in Table 1 also suggest that Response Design (β=0.17, $p<.1$), Intelligence Dissemination, (β=0.09, $p<.1$), and Intelligence Generation (β=0.07, $p<.1$), are the most influential in predicting the Market Performance in the Independent model (Step 2). The overall change in adjusted R square value (ΔR^2) was strongly significant with a value of .149, $p<.001$ (F=11.46, $p<.001$). The control model in Step 1 produced a very low statistically significant change (ΔR^2= .021) but no control variable had any significant beta value. As a result, Response Design, Intelligence Dissemination and Intelligence

4 Another way to deal with unobserved heterogeneity in surveys is to panel a constant set of shipping firms over time. This allows the use of dummy variables for each firm as controls. However, this approach has the limitation that a fixed set of survey respondents will not remain representative across time.

Generation contribute significantly to the Financial Performance of shipping firms. Therefore, Response Design is the only MO factor that contributes to both measures of shipping firm performance. As a result**,** we can partially accept hypothesis 1 that market orientation has an effect on overall firm performance**.**

Table 1. Hierarchical Regression Results of Market Orientation Impact on Firm Performance

	Financial Performance						Market Performance					
Step	**Step 1**			**Step 2**			**Step 1**			**Step 2**		
Variables	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**
Control Variables												
Gender	0.54	-0.1	1.117	0.70	-0.12	1.127	0.68	-0.1	1.117	0.97	-0.12	1.127
Age	0.22	-0.2	1.118	0.07	-0.05	1.153	0.22	-0.8	1.118	0.38	-0.67	1.153
Firm Type	0.93	-0.1	1.000	0.56	-0.24	1.029	0.17	-0.0	1.000	0.64	-0.12	1.029
Marketing Orientation												
Intelligence Generation				0.00	0.03	1.658				0.07	-0.00*	1.658
Intelligence Dissemination				0.00	0.01*	1.587				0.09	-0.00*	1.587
Response Design				0.14	-0.01*	1.143				0.17	-0.01*	1.143
Response Implementation				0.47	-0.03*	1.351				1.22	0.06	1.351
F Value	0.764			9.2***			2.856*			11.46***		
Adjusted R^2	-0.00			0.126			0.013			0.155		
ΔR^2	0.006			0.136***			0.021*			0.149***		
Durbin-Watson				0.72						1.038		

4.2. Hypothesis 2 – Firm Size Moderation on Market Orientation Impact on Firm Performance

Table 2 reports the hierarchical regression results of size moderation on market orientation impact on firm performance (Hypothesis 2). Regression analysis was run in three steps: In Step 1 (Control), the control variables were entered. In Step 2 (Moderation), the size variables were entered. In Step 3 (Interaction), the interactions between market orientation and size variables were entered. The dependent variables were financial performance and market performance. Regarding financial performance, the control model (Step 1) produced no significant results whereas the moderation model produced a significant overall change in adjusted R square value (ΔR^2) with a value of .107, $p<.001$ ($F=8.471$, $p<.001$). The interaction model also produced a significant overall change in adjusted R square value (ΔR^2) with a value of .147, $p<.001$ ($F=8.820$, $p<.001$). Similar results were achieved with market performance (Table 3) as a dependent variable but the statistical significance was lower than having financial performance as dependent variable. The control model produced no significant results, the ΔR^2 was significant in both the moderation model ($\Delta R^2=.032$, $p<.01$; $F=3.253$, $p<.01$) and interaction model ($\Delta R^2=.194$, $p<.001$; $F=7.971$, $p<.001$). For both performance variables, the number of employees had significant beta values compared to the firm type which showed no significant beta values except the interaction model in market performance ($\beta=0.17$, $p<.1$). This finding is against the Panayides et al. (2011) results that firm type moderates the MO efficiency levels and, therefore, is excluded from subsequent analysis.

The results indicate that firm size moderates the MO impact on firm performance; therefore, we accept Hypothesis 2**.**

Table 2. Hierarchical Regression Results of Size Moderation on Market Orientation Impact on Financial Performance

Step	**Step 1**			**Step 2**			**Step 3**		
Variables	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**
Control Variables									
Gender	0.04	0.88	1.001	0.05	0.97	1.002	0.04	0.95	1.037
Age	0.04	0.81	1.118	0.03	0.63	1.122	0.05	1.12	1.143
Firm Type	-7.6	-0.0	1.118	-0.02	-0.44	1.122	-0.07	-1.38	1.167
Size						2.146			
Employees				0.28	3.76***	1.002	-0.67	-3.28**	123.196
Firm Type				0.06	0.81	1.122	0.89	1.20	256.436
Interactions									
Intelligence Generation * Employees							0.84	1.66*	
Intelligence Generation* Firm Type							-0.35	-0.48	
Intelligence Dissemination* Employees									
Intelligence Dissemination* Firm Type							0.29	0.61	118.091
Response Design* Employees* Firm Type							0.36	0.55	246.092
Response Design* Firm Type							-0.39	-1.06	110.454
Response Implementation* Employees							0.12	2.19*	205.590
Response Implementation* Firm Type							0.28	2.60**	57.077
F Value	0.519			8.471***			8.820***		111.320
Adjusted R2	-0.00			0.098			0.229		94.003
Δ R2	0.004			0.107***			0.147***		185.882
Durbin-Watson							.854		

Standardized regression coefficients are reported. Within cells, first row figure is beta coefficients and second row the t-test values, significant at: *p < .10, **p <.01, ***p <.001.

Table 3. Hierarchical Regression Results of Size Moderation on Market Orientation Impact on Market Performance

Step	Step 1			Step 2			Step 3		
Variables	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**	**beta**	**t**	**VIF**
Control Variables									
Gender	0.02	0.37	1.001	0.02	0.40	1.002	-0.00	-0.12	1.037
Age	-0.0	-1.2	1.118	-0.07	-1.37	1.122	-0.05	-1.10	1.143
Firm Type	0.07	1.29	1.118	0.06	1.08	1.122	0.00	0.06	1.167
Size									
Employees				0.16	2.09*	2.146	-0.93	-5.68***	
Firm Type				0.02	0.28	2.146	0.10	2.80**	
Interactions									
Intelligence Generation * Employees							0.13	2.21*	123.196
Intelligence Generation* Firm Type							-0.14	-1.55	256.436
Intelligence Dissemination* Employees									
Intelligence Dissemination* Firm Type							-0.02	-0.06	118.091
Response Design* Employees* Firm Type							0.59	0.88	246.092
Response Design* Firm Type							0.54	1.46	110.454
Response Implementation* Employees							-0.33	-0.64	205.590
Response Implementation* Firm Type							0.64	3.29**	57.077
F Value	1.634			3.253**			7.971***		111.320
Adjusted R2	0.006			0.032			0.21		94.003
Δ R2	0.014			0.032**			0.194***		185.882
Durbin-Watson							1.127		

Standardized regression coefficients are reported. Within cells, first row figure is beta coefficients and second row the t-test values, significant at: *p < .10, **p <.01, ***p <.001.

4.3 Hypothesis 3 – Firm Size Effects on Market Orientation Efficiency

Acknowledging that there is high probability of noise in empirical data collected from a survey (i.e. input and output data), we applied SDEA to measure the efficiency of the market orientation of shipping firms. The efficiency scores of these firms appear in Table A2 in the Appendix B. For measuring the efficiency of market orientation of shipping firms we utilized three inputs: (a) responsiveness, (b) intelligence generation, and (c) intelligence dissemination, and one output for simplicity reasons: (a) total business performance (financial and market).

Our sample consists of 397 shipping firms, which are classified according to their size (i.e. Group 1: small firms; Group 2: medium firms; Group 3: large firms; Group 4: significantly large firms). The majority of our sample firms (i.e., 52.4%) is regarded as medium size, followed by large (i.e., 19.9%), small (i.e., 18.6%) and significantly large firms (i.e., 9.1%).

The validity of the efficiency scores presented in this section, which is associated with the minimum overestimation of the efficiencies, is ensured by the large sample size in conjunction with the low dimensionality of the production set. To be more precise, the size of our sample (i.e., 397 shipping firms) and the number of input and output variables (i.e., four variables) satisfy the "rules of thumb" established by Cooper et al. (2007) (i.e., $n \geq \max\{x \cdot y,\ 3 \cdot (x+y)\}$, where n represents the number of firms, and x and y the number of inputs and outputs, respectively) and Lin and Tseng (2007) (i.e., $n \geq 2 \cdot (x+y)$). In addition, our sample size is considerably larger than the minimum sample size defined by Smith (1997) (i.e., 80 firms) and Zhang and Bartels (1998) (i.e., 160 firms), which secure minimum distortion of the results. Our sample size is regarded as rather large because it approaches the milestone of 500 firms. Banker et al. (2010) considered as large any sample consisting of 500 units, and medium any consisting of 100 units. According to Banker (1993) and Banker and

Natarajan (2011), the possible distortion of the efficiency scores is eliminated for large samples.

By applying SDEA program (3) (see Appendix B) to the input and output data, we obtain the efficiency scores presented in Table 4. According to Table 4, the highest mean efficiency score (i.e., 0.7934) is assigned to the large shipping firms, followed by the efficiency score of the significantly large (i.e., 0.7859), medium (i.e., 0.7443) and small shipping firms (i.e., 0.6999). The efficiency scores assigned to the significantly large shipping firms are the least spread around the mean (i.e., standard deviation = 0.0892) compared to those assigned to firms of other size groups. Notably, none of the significantly large shipping firms in our sample has efficient market orientation, while six large and five medium sample shipping firms report efficient market orientation. In other words, large and medium groups have the highest percentage of 7.59% and 2.40%, respectively, of shipping firms with efficient market orientation among the four groups in our analysis. Across size groups, the percentage of shipping firms reporting efficient market orientation is 3.02%.

Table 4. Summary of Efficiency Assessment

Group	Firms' size	*n*	Efficiency scores				Efficient firms	Efficient firms (%)
			Mean	Min	Max	St. Deviation		
1	Small	74	0.6999	0.3609	1.0000	0.1245	1	1.35
2	Medium	208	0.7443	0.4080	1.0000	0.1131	5	2.40
3	Large	79	0.7934	0.4607	1.0000	0.1090	6	7.59

4	Significantly large	36	0.7859	0.6045	0.9647	0.0892	0	0.00
Total		397	0.7496	0.3609	1.0000	0.1165	12	3.02

Moreover, the size of shipping firms has a significant effect on efficiency (ANOVA, $F(3,393)=10.1952,\ p<.001$).

Post hoc analysis (i.e., the least-significant difference (LSD)) presents significantly different mean efficiency scores among large, medium and small shipping firms (Table 5). Significantly different mean efficiency scores are also present among significantly large, medium and small shipping firms; however, there is no significant difference between the mean efficiency scores of large and significantly large shipping firms.

Table 5. Multiple Comparisons of the Mean Efficiency Scores Classified by the Size of Shipping firms (post hoc test: LSD)

Groups (I)	Groups (J)	Mean difference (I-J)	*p*
Small	Medium	-0.0444	.004
	Large	-0.0935	<.001
	Significantly large	-0.0861	<.001
Medium	Large	-0.0491	.001
	Significantly large	-0.0417	.041

Large	Significantly large	0.0075	.742

Level of significance: .05

Taking into account the results obtained from program (3) (i.e. input orientation, see Appendix C), which are illustrated in Table 6, efficient large shipping firms have the most dominant market orientation among the efficient shipping firms of our sample. In particular, efficient large firms are regarded as benchmarks for 98.7% of the inefficient small, 97.6% of the inefficient medium and 100% of the inefficient large and significantly large firms. In addition, the impact of the market orientation of the efficient large firms on their inefficient counterparts is the highest among the efficient firms of the sample. In particular, the efficient large shipping firms are responsible for a mean decrease of 75.9%, 74.6%, 86.6% and 97.1% of all input levels of the inefficient small, medium, large and significantly large firms, respectively. The second most influential efficient shipping firms for the inefficient firms of the sample are the medium size.

Table 6. Benchmarking (Input orientation)

Source of benchmarks	Groups			
Firms	Small	Medium	Large	Significantly large
Small				
Dominated firms (%)	33.78	37.50	21.52	30.56
Mean improvement (%)	11.82	10.17	11.27	5.71
Medium				
Dominated firms (%)	81.08	89.90	82.28	86.11
Mean improvement (%)	18.05	23.18	20.08	14.65

Large				
Dominated firms (%)	98.65	97.60	100.00	100.00
Mean improvement (%)	75.88	74.61	86.55	97.12
Significantly large				
Dominated firms (%)	0.00	0.00	0.00	0.00
Mean improvement (%)	0.00	0.00	0.00	0.00

By applying program (4) (i.e. output orientation, see Appendix B), we identify the efficient large shipping firms as the most dominant for the inefficient firms among the other efficient firms of the sample (Table 7). When output orientation is selected for the measurement of efficiency, the impact of the market orientation of efficient large firms on the inefficient counterparts is higher than the impact of the large firms reported in Table 6. To be more precise, the efficient large firms are responsible for a mean increase of 110.3%, 102.8%, 110.2% and 124.4% of the business performance of the inefficient small, medium, large and significantly large shipping firms, respectively. The market orientation of the efficient medium shipping firms is the second most influential among the market orientation of the shipping firms of the sample.

Table 7. Benchmarking (Output orientation)

Source of benchmarks	Groups			
Firms	Small	Medium	Large	Significantly large
Small				
Dominated firms (%)	33.78	38.94	21.52	30.56

Mean improvement (%)	14.34	13.17	13.29	7.82
Medium				
Dominated firms (%)	81.08	89.90	82.28	86.11
Mean improvement (%)	26.12	30.01	26.01	17.89
Large				
Dominated firms (%)	98.65	97.60	100.00	100.00
Mean improvement (%)	110.25	102.78	110.15	124.42
Significantly large				
Dominated firms (%)	0.00	0.00	0.00	0.00
Mean improvement (%)	0.00	0.00	0.00	0.00

In the case that input-oriented SDEA approach is applied, intelligence dissemination (input 3) requires the highest average scale down that is 55.7% and simultaneously, intelligence generation (input 2) should be decreased by 40.2% and responsiveness (input 1) by 26.6% holding business performance (output 1) fixed so that an average inefficient shipping firm to become efficient (Table 8). When output orientation is applied, the average business performance (output 1) should be scaled up by 43.2%, without any adjustments to the input levels of the firms, so that the inefficient units to become efficient (Table 8). Once more, these findings are in total agreement with previously reported studies (Jaworski and Kohli, 1993; Kumar et al., 2011).

Table 8. Descriptive Statistics of Target Input or Output Improvements Towards Efficiency Attainment

Variables & Firms' size	Mean	St. Deviation	Min	Max
		Input orientation		
Input 1 (Responsiveness)				
Small	0.3160	0.1184	0.0538	0.6561
Medium	0.2802	0.1026	0.0333	0.5977
Large	0.2377	0.0953	0.0477	0.5823
Significantly Large	0.2310	0.0852	0.0507	0.4045
Input 2 (Intelligence generation)				
Small	0.4401	0.1131	0.0538	0.7449
Medium	0.4254	0.0949	0.0614	0.6793
Large	0.3788	0.0921	0.0329	0.6754
Significantly Large	0.3626	0.0996	0.1664	0.5575
Input 3 (Intelligence dissemination)				
Small	0.5766	0.0825	0.3752	0.8200
Medium	0.5767	0.0681	0.3913	0.7609
Large	0.5478	0.0643	0.4343	0.7935
Significantly Large	0.5249	0.0669	0.4054	0.6799
		Output orientation		
Output 1 (Business performance)				
Small	0.5632	0.3356	0.0859	2.0367
Medium	0.4506	0.2358	0.0590	1.6165
Large	0.3690	0.2149	0.0743	1.3284
Significantly Large	0.3457	0.1683	0.0762	0.7430

Results indicate that there is an optimum range of firm size, outside of which, firm size adversely affects the efficiency scores of the sample shipping firms.

According to the DEA literature, the efficiency scores – and consequently the percentage of firms deemed efficient – are inversely related to the sample size given the dimension of the input-output space (Banker, 1993; Grosskopf, 1996; Simar, 2007). The effect of sample size on the percentage of units that are efficient also applies to our case. To be more precise, by using scaled samples drawn from the overall sample of 397 shipping firms, we identify the number and percentages of efficient shipping firms (see Table A3 in Appendix C). Expression (1) presents a statistically significant negative but minor (i.e., -0.008) relationship between the sample size and the percentage of efficient firms as well as a statistically significant negative relationship between a dummy variable (i.e., *D*), which sorts data into a group incorporating up to 280 firms and a second group including samples of 290 firms or more, and the percentage of efficient firms.

$$\text{Percentage of efficient firms} = 7.466^{**} - 0.008^{*}\text{Sample Size} - 2.892^{**} D \qquad (1)$$

where $^{**}p < .01$, $^{*}p < .05$, $R^2 = 0.920$, adjusted $R^2 = 0.914$, $F(2,28) = 161.320^{**}$, number observations = 31.

Despite the results of expression (1), the negative relationship between the sample size and percentage of efficient firms does not apply to samples with 290 firms or more. According to expression (2), samples of 290 firms or more are not significant predictors of the percentage of efficient firms.

$$\text{Percentage of efficient firms} = 2.222^{**} - 0.001\ \text{Sample Size}^{L} \qquad (2)$$

where $^{**}p < .01$, $R^2 = 0.052$, $F(1,10) = 0.546$ and $p = .477$, number observations = 12. The Sample Size^{L} incorporates cases ranging from 290 firms to 397 firms.

In addition to model (2), we found no significant difference in the percentages of efficient firms for scaled samples of 290-397 units (see Table A3 in Appendix C) ($X^2 = 0.1374$, p > .99). Consequently, the results presented in Table 4 are robust as the percentage of efficient firms for a sample of 290 shipping firms or more is not affected by the sample size while the number of input and output variables are held fixed. This result is in line with the studies of Banker (1993) and Banker and Natarajan (2011), who revealed the limited effect of sample size on efficiency scores, and consequently on the probability of identifying efficient units, for large samples.

Based on the results of the analysis and the robustness of our findings, we can accept Hypothesis 3.

The inverted U-shape relationship between firm size and market orientation efficiency that applies to this study's sample shipping firms can be generalized. In particular, we incorporated randomly generated, normally distributed data in Monte Carlo simulations to test the effect of firm size on the market orientation efficiency of shipping firms. Drawing on Banker et al. (2010)'s study, we introduced a moderate noise level (i.e., noise ratio equals to 0.25) in our data set in order to randomly generate data for the three input and one output variables. We estimated the efficiencies as well as the probabilities of identifying efficient shipping firms on the basis of 1,000 simulations. A similar process, using 1,000 Monte Carlo simulations, was applied by Banker et al. (2010). Moreover, Morita and Seiford (1999) and Tsionas and Papadakis (2010) used simulations to estimate probabilities that firms are efficient.

According to Table 9, the highest mean efficiency estimations of 0.5446 and 0.5299 are found in large and medium shipping firms, respectively. Furthermore, large and medium shipping firms report the highest probability estimates of identifying efficient shipping firms – 3.22% and 2.94%, respectively – among the four groups in our study. These two probability estimates are higher than the overall mean probability estimate of a given shipping firm being efficient.

Table 9. Monte Carlo Simulation Efficiency Estimations

Group	Firm's size	Efficiency estimations				Prob. being efficient (%)
		Mean	Min	Max	St. Deviation	
1	Small	0.5070	0.2819	0.7022	0.0802	2.16
2	Medium	0.5299	0.2448	0.7965	0.0817	2.94
3	Large	0.5446	0.3486	0.7419	0.0720	3.22
4	Significantly large	0.5181	0.3880	0.7146	0.0816	2.56
Total		0.5276	0.2448	0.7965	0.0804	2.82

In addition, the Monte Carlo simulated efficiency estimators (see Table A4 in Appendix C) are normally distributed (K-S = 0.044, p = .068), and there is a statistically significant difference in the efficiency estimators among the four groups of shipping firms (ANOVA, $F(3,393)$ = 3.045, p = .029). Unlike the efficiency estimators, the normality of the probabilities that a given shipping firm has efficient market orientation fails (K-S = 0.2, p <

.001). From the Kruskal-Wallis test, we find that there is a statistical difference among the probability estimates of identifying efficient shipping firms in the four groups ($X^2 = 9.332$, p = .025).

5. Discussion

This study challenged a seemingly obvious assumption since the MO conceptualization has proven its applicability in many sectors and contexts globally:

Is the MO concept applicable to the shipping sector? This study contributes to sustainability literature highlighting the role of MO on firm performance. Market-oriented companies are more likely to integrate sustainability activities into their business strategies but it is unclear how this would improve firm performance (Arshad et al., 2012), particularly for some sectors like **shipping sector, which are considered less MO than others. Therefore, MO should be important for their** sustainable performance. This study contribution is to add evidence on the applicability of MO in industries characterized by a high degree of volatility and demand spikes due to economic crisis (Kirca et al., 2005) answering, the Kohli and Jarhorski (1990) concerns on MO level of applicability to non-stable environments.

- **Market orientation and firm performance in the shipping sector**

The findings from the first hypothesis affirm the positive impact of MO on Performance even when this relationship is challenged by intense competition and market turbulence. Moreover, it establishes a clear priority ranking on which MO constituting factors (responsiveness, intelligence generation and dissemination) should be pursued in turbulent environments. Response Design (β=0.17), Intelligence Dissemination, (β=0.09), and Intelligence Generation (β=0.07), were found to be the most influential in predicting the Market Performance (Table 1).

This disaggregated approach, by taking the sub-dimensions of MO, is found sporadically in existing MO literature apart from a few notable exceptions (Chung, 2012). As the majority of the studies apply an aggregated full MO construct approach with mixed results, the examination of its constituents is necessary especially in international environments (Murray et al., 2007).

In line with these suggestions, the response design dimension of MO, which is linked to organization's ability to modify strategies to respond to environmental changes, has been identified as the most influential factor in predicting both financial and market performance, whereas intelligence generation and intelligence dissemination follow in importance in explaining market performance. These results contradict studies made in domestic and stable environments, which indicate that intelligence generation and/or dissemination had no direct effect, but they are mediated from responsiveness dimension on performance (Chung, 2012).

- **Optimum shipping firm size and market orientation firm efficiency**

We further argue that firm size (i.e., small, medium, large and significantly large) non-linearly (i.e., inverted U shape) affects the MO impact on firm performance and thus the MO efficiency of firms. Results from the efficiency analysis using SDEA and SDEA with Monte Carlo simulations reveal that the highest MO efficiency scores are assigned to the large (i.e., mean efficiency score = 0.7934) and medium shipping firms (i.e., mean efficiency score = 0.7443). The inverted U-shape effect of shipping firms' size on MO efficiency applies beyond our sample. On the basis of 1,000 Monte Carlo simulations using randomly generated normally distributed input and output data, the highest mean efficiency and probability of MO efficient estimates are assigned to large (i.e., 0.5446 and 3.22%, respectively) and medium shipping firms (i.e., 0.5299 and 2.94%, respectively). SDEA concurs that considering the MO constituting factors of responsiveness, intelligence generation and dissemination, they should be scaled down on average by 27%, 41% and 57%, respectively, for the firms across the four size groups to become MO efficient.

6. Conclusions

In order to focus attention on the importance of MO to sustainability this work is framed within the context of a resource view of the firm and the role of MO, especially in the shipping sector. It is generally accepted that MO is an intangible resource yielding competitive advantage and this is the concept being proved here. We advocate that firms with a strong MO have a competitive advantage over firms that do not; however, we support that to achieve sustainable advantage careful use of available resources should be applied.

Accomplishing superior performance requires an integrated effort by every department to develop and maintain a strong market-oriented culture to more rapidly identify consumer needs in favor of eco-friendly services developed by eco- friendly processes. Market orientation is not inherently a sustainability strategy, especially in shipping. Sustainability addresses how a firm can decide on the optimum size of operation and thus avoid depleting resources and reduce its ecological footprint while, on the other hand, being efficient.

This study questions the linear and ubiquitous relationship between market orientation (MO) and firm performance (P) and provides empirical evidence on understanding its direction and the role of firm size. Specifically, we argue that shipping is a unique industry and results from previous studies need to be interpreted with caution. On the other hand, firm size, which is often used as a control variable in similar studies, may moderate the MO–P relationship aversely. As a result, the MO–P relationship could be not linear but inverted U in shape. This finding challenges the theoretical foundation of previous studies that assumed that size, mainly due to economies of scale, impacts the MO–P relationship in a linear way.

There is a number of novelties and contributions of this study. Specifically, this is the first study addressing the MO efficiency of shipping firms when moderated by their size, advocating that efficiency of small- and medium-size firms is significantly different from that of large and significantly large firms and that an inverted U- shape curve better depicts the MO efficiency of firms with very large firms being less efficient that large ones. This way an optimum size of firms to be market-oriented-efficient is established indicating that the inefficiency caused from excess marketing expense is the main reason for lower efficiency in sectors operating under market turbulence and shipping in particular. Further, the selection on shipping discerns this study from studies that examined the MO–P relationship in western cultures. Shipping is a competitive global industry and understanding the MO–P relationship needs evidence collected for this purpose. Empirical evidence verifies the positive MO-P link. Under unstable environments for firms operating globally, the response design dimension of MO should be pursued first, followed by intelligence generation and dissemination to achieve best results. This is an important contribution for firms allowing them to prioritize their resources and measure the effect of their operations to firm performance. (Kumar et al., 2011)

6.1. Practical Implications

Our findings suggest that to leverage the influence of the environment to achieve sustainable results simply investing in customer satisfaction policies through complicated MO strategies is not enough. Leaders and decision makers should take over with specific plans and authoritarian actions by focusing on the ways response is planned first at the top level of the organization. At a second stage this plan may be distributed and disseminated inside the organization as the emphasis is shifted from middle and lower level management to the top management on censoring critical competitor and market changes or needs. It is also imperative for decision-makers not to overspend on marketing if performance is the critical element of success. Moreover, very large but MO inefficient firms fostering performance outcomes may wish to consider some decentralization of marketing activities to lower levels in order to achieve better results. As this study reveals, and contrary to what was believed, there is an optimum range of firm size outside of which firm size adversely affects the MO efficiency of shipping firms. Therefore, there is a significant effect of the size of shipping firms on their efficiency.

The findings also support the view that a scheduled response to the changes of the turbulent environment in an alert and decisive way is a much better alternative than devoting time to talk with customers, undertake unnecessary market research or share information with employees. The emphasis lies on leaders and decision-makers' perceptions and behaviors, risk taking and centralized actions as the key drivers for firms to feature their market-oriented strategies to respond quickly and effectively to changes in the environment and thus improve firms' performance. Thus, in order to successfully implement a market orientation strategy, it is necessary to have a top management that is willing to take risks and decisions as market turbulence, competitive intensity and technological turbulence increase. In turbulent environments, firms move away from satisfying existing customer needs to satisfying latent needs; thus, top management need to identify possible disruptive innovations that may be more attractive to the marketplace in the future.

6.2. Limitations and Recommendations for Future Research

Further studies are needed to confirm and validate this U-type relationship in other sectors facing unstable or fast changing environments, like the hi-tech industry or other contexts. There is also an evident need to interrogate the validation of the MO constituting factors' contribution on performance in cross-industry studies and identify relationship patterns. A further contribution may come from the collection of objective data and make comparisons between objective and subjective data measures to identify possible differences. Finally, the role of cost as a determining factor of MO to performance is not examined here and may add to literature understanding.

References

References

1. Ajuzie, E., Bouras, A., Edoho, F., Bouras, D., Kaliba, A., Ike, R., Dutta, A., 2011. Productive Efficiency And Optimal Firm Size: The Case Of US Health Services Industry. Am. J. Health Sci. 2, 75–86.
2. Arshad, R., Mansor, S.M., Othman, R., 2012. Market orientation, firm performance and the mediating effect of corporate social responsibility. Journal of Applied Business Research. 28, 851–860.
3. Bae, H.S., 2012. The effect of market orientation on relationship commitment and relationship effectiveness of port logistics firms. The Asian Journal of Shipping and Logistics. 28, 105–134.
4. Banker, R. D. (1993), "Maximum-likelihood, consistency and data envelopment analysis: a statistical foundation", *Man. Sci*, Vol. 39, pp. 1265-1273.
5. Banker, R. D. and Natarajan, R. (2011) Statistical tests based on DEA efficiency scores, In: *Handbook on Data Envelopment Analysis*, Ed(s) W. W. Cooper, L. M. Seiford and J. Zhu, New York: Springer, pp. 273-295.
6. Banker, R. D., Zheng, Z. and Natarajan, R. (2010), "DEA-based hypothesis tests for comparing two groups of decision making units", **Eur. J. Oper. Res.** , Vol. 206, pp. 231-238.

7. Charnes, A., Cooper, W.W., Rhodes, E., 1978. Measuring the efficiency of decision making units. Eur. J. Oper. Res. 2, 429–444.
8. Chung, H.F., 2012. Export market orientation, managerial ties, and performance. Int. Market. Rev. 29, 403–423.
9. Coviello, N.E., Brodie, R.J., Munro, H.J., 2000. An investigation of marketing practice by firm size. J. Bus. Venturing. 15, 523–545.
10. Cooper, W. W., Seiford, L. M. and Tone, K. (2007), Data Envelopment Analysis: a comprehensive text with models, applications, references and DEA-solver software (2nd ed). New York: Springer.
11. Crittenden, V.L., Crittenden, W.F., Ferrell, L.K., Ferrell, O.C., Pinney, C.C., 2011. Market-oriented sustainability: a conceptual framework and propositions. J. Acad. Market. Sci. 39, 71–85.
12. Darnall, N., 2008. What the federal government can do to encourage green production, IBM Center for The Business of Government, Washington.
13. Day, N.E., 2003. Compensation Managers' Beliefs about Strategies that Affect Compensation Program Goals. J. bus. strateg. 13, 65–88.
14. Dyson, R.G., Shale, E.A., 2010. Data envelopment analysis, operational research and uncertainty. J. Oper. Res. Soc. 61, 25–34.
15. Ellis, P.D., 2006. Market Orientation and Performance: A Meta-Analysis and Cross-National Comparisons. J. Manage. Stud. 43, 1089–1107.
16. Emrouznejad, A., Parker, B.R., Tavares, G., 2008. Evaluation of research in efficiency and productivity: A survey and analysis of the first 30 years of scholarly literature in DEA. Socio. Econ. Plan. Sci. 42, 151–157.

17. Farrell, M.J., 1957. The measurement of productive efficiency. J. Roy. Stat. Soc. A. Sta., 120, 253–290.

18. Green, K.W., Toms, L.C., Clark, J., 2015. Impact of market orientation on environmental sustainability strategy. Management Research Review. 38, 217–238.

19. Grewal, R., Chandrashekaran, M., Johnson, J.L., Mallapragada, G., 2013. Environments, unobserved heterogeneity, and the effect of market orientation on outcomes for high-tech firms. J. Acad. Market. Sci. 41, 206–233.

20. Grosskopf, S, (1996), "Statistical inference and nonparametric efficiency: a selective survey", *Journal of Productivity Analysis*, Vol. 7, pp. 161-176.

21. Halvorsen-Weare, E.E., Fagerholt, K., Rönnqvist, M., 2013. Vessel routing and scheduling under uncertainty in the liquefied natural gas business. Comput. Ind. Eng. 64, 290–301.

22. Hassan, M.K., Halbouni, S.S., 2013. Corporate governance, economic turbulence and financial performance of UAE listed firms. Studies in Economics and Finance. 30, 118–138.

23. Hau, L.N., Evangelista, F., Thuy, P.N., 2013. Does it pay for firms in Asia's emerging markets to be market oriented? Evidence from Vietnam. J. Bus. Res. 66, 2412–2417.

24. Hausman, A., 2005. Innovativeness among small businesses: Theory and propositions for future research. Ind. Market. Manag. 34, 773–782.

25. Hirsch, S., Schiefer, J., Gschwandtner, A., Hartmann, M., 2014. The Determinants of Firm Profitability Differences in EU Food Processing. J. Agr. Econ. DOI: 10.1111/1477-9552.12061.

26. Huhtala, J.P., Sihvonen, A., Frösén, J., Jaakkola, M., Tikkanen, H., 2014. Market orientation, innovation capability and business performance: Insights from the global financial crisis. Balt. J. Manag. 9, 134–152.
27. Hult, G.T.M., Ketchen, D.J., 2001. Does market orientation matter? A test of the relationship between positional advantage and performance. Strategic Manage. J. 22, 899–906.
28. Hult, G.T.M., 2011. Market-focused sustainability: market orientation plus!. J. Acad. Market. Sci. 39, 1–6.
29. Hunt, S.D., Morgan, R.M., 1995. The comparative advantage theory of competition. J. Marketing. 59, 1–15.
30. Jaworski, B.J., Kohli, A.K., 1993. Market orientation: antecedents and consequences. J. Marketing. 57, 53–70.
31. Kavussanos, M.G., Tsouknidis, D.A., 2014. The determinants of credit spreads changes in global shipping bonds. Transport. Res. Part E: Logist. Transport. Rev. 70, 55–75.
32. Kirca, A.H., Jayachandran, S., Bearden, W.O., 2005. Market orientation: a meta-analytic review and assessment of its antecedents and impact on performance. J. Marketing. 69, 24–41.
33. Kohli, A.K., Jaworski, B.J., 1990. Market orientation: the construct, research propositions, and managerial implications. J. Marketing. 54, 1–18.
34. Kumar, V., Jones, E., Venkatesan, R., Leone, R.P., 2011. Is market orientation a source of sustainable competitive advantage or simply the cost of competing?. J. Marketing, 75, 16–30.
35. Lafferty, B.A., Hult, G.T.M., 2001. A synthesis of contemporary market orientation perspectives. Eur. J. Mark. 35, 92–109.

36. Land, K.C., Lovell, C.A.K., Thore, S., 1993. Chance-constrained data envelopment analysis. MDE Manage. Decis. Econ. 14, 541–554.

37. Langerak, F., 2003. An appraisal of research on the predictive power of market orientation. Eur. Manage. J. 21, 447–464.

38. Leal-Rodríguez, A.L., Eldridge, S., Roldán, J.L., Leal-Millán, A.G., Ortega-Gutiérrez, J., 2015. Organizational unlearning, innovation outcomes, and performance: The moderating effect of firm size. J. Bus. Res. 68, 803–809.

39. Lee, G., Xia, W., 2006. Organizational size and IT innovation adoption: A meta-analysis. Inform. Manage. 43, 975–985.

40. Lee, J., 2009. Does size matter in firm performance? Evidence from US public firms. Int. J. Econ. Bus.. 16, 189–203.

41. Lee, Y.K., Kim, S.H., Seo, M.K., Hight, S.K., 2015. Market orientation and business performance: Evidence from franchising industry Int. J. Hosp. Manag. 44, 28–37.

42. Lin, L. C. and Tseng, C. C. (2007), "Operational performance evaluation of major container ports in the Asia-Pacific region", *Maritime Policy & Management*, Vol. 34, No. 6, pp. 535-551.

43. Liu, H., 1995. Market orientation and firm size: an empirical examination in UK firms. Eur. J. Mark. 29, 57–71.

44. Liu, J.S., Lu, L.Y.Y., Lu, W.M., Lin, B.J.Y., 2013a. A survey of DEA applications. Omega. 41, 893–902.

45. Liu, J.S., Lu, L.Y.Y., Lu, W.M., Lin, B.J.Y., 2013b. Data envelopment analysis 1978-2010: A citation-based literature survey. Omega. 41, pp. 3–15.

46. Lozano, R., Carpenter, A., Huisingh, D., 2015. A review of 'theories of the firm' and their contributions to Corporate Sustainability. J. Clean. Prod. 106, 430–442.

47. Lun, Y.H.V., Quaddus, M.A., 2011. Firm size and performance: A study on the use of electronic commerce by container transport operators in Hong Kong. Expert. Syst. Appl. 38, 7227–7234.

48. Lun, Y.H.V., Pang, K.W., Panayides, P.M., 2010. Organisational growth and firm performance in the international container shipping industry. Int. J. Ship. Trans. Log. 2, 206–223.

49. Marti, C.P., Rovira-Val, M.R., Drescher, L.G., 2015. Are Firms that Contribute to Sustainable Development Better Financially?. Corp. Soc. Resp. Env. Ma. 22, 305–319.

50. Matten, D., Moon, J., 2008. Implicit and explicit CSR: a conceptual framework for a comparative understanding of corporate social responsibility. Acad. Manage. Rev. 33, 404–424.

51. Mitchell, R.W., Wooliscroft, B., Higham, J., 2010. Sustainable market orientation: A new approach to managing marketing strategy. J. Macromark. 30, 160–170.

52. Morita, H., Seiford, L.M., 1999. Characteristics on stochastic DEA efficiency: Reliability and probability being efficient. J. Oper. Res. Soc. Japan. 42, 389–404.

53. Murray, J.Y., Gao, G.Y., Kotabe, M., Zhou, N., 2007. Assessing measurement invariance of export market orientation: a study of Chinese and non-Chinese firms in China. J. Int. Marketing. 15, 41–62.

54. Naidoo, V., 2010. Firm survival through a crisis: The influence of market orientation, marketing innovation and business strategy. Ind. Market. Manag. 39, 1311–1320.

55. Olesen, O.B., 2006. Comparing and combining two approaches for chance constrained DEA. J. Prod. Anal. 26, 103–119.

56. Panayides, P.M., 2004. Marketing in Asia-Pacific logistics companies: a discriminant analysis between marketing orientation and performance. Asia Pacific Journal of Marketing and Logistics. 16, 42–68.

57. Panayides, P.M., Lambertides, N., Savva, C.S., 2011. The relative efficiency of shipping companies. Transport. Res. Part E: Logist. Transport. Rev. 47, 681–694.

58. Pantouvakis, A., 2014. Market orientation and service quality: opponents or colleagues. International Journal of Quality and Service Sciences. 6, 98–111.

59. Pelham, A.M., 1997. Market orientation and performance: the moderating effects of product and customer differentiation. J. Bus. Ind. Mark. 12, 276–296.

60. Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. Strategic Manage. J. 14, 179–191.

61. Rehman, M.A.A., Shrivastava, R.L., 2011. An innovative approach to evaluate green supply chain management (gscm) drivers by using interpretive structural modeling (ism). International Journal of Innovation and Technology Management, 8, 315–336.

62. Russo, A., Tencati, A., 2009. Formal vs. informal CSR strategies: Evidence from Italian micro, small, medium-sized, and large firms. J. Bus. Ethics. 85, 339–353.

63. Schiersch, A., 2013. Firm size and efficiency in the German mechanical engineering industry. Small Bus. Econ. 40, 335–350.

64. Shams, S.R., 2016. Sustainability Issues in Transnational Education Service: A Conceptual Framework and Empirical Insights. Journal of Global Marketing. 20, 139–155.

65. Sheth, J.N., 2011. Impact of emerging markets on marketing: Rethinking existing perspectives and practices. J. Marketing. 75, 166–182.

66. Simar, L. (2007), “How to improve the performances of DEA/FDH estimators in the presence of noise?”, *Journal of Productivity Analysis*, Vol. 28, pp. 183-201.

67. Sittimalakorn, W., Hart, S., 2004. Market orientation versus quality orientation: sources of superior business performance. J. Strat. Market. 12, 243–253.

68. Smith, P. (1997), “Model misspecification in data envelopment analysis”, *Annals of Operations Research*, Vol. 73, pp. 233-252.

69. Tovar, B., Wall, A., 2012. Economies of scale and scope in service firms with demand uncertainty: An application to a Spanish port. Marit. Econ. Logist. 14, 362–385.
70. Tsionas, E.G., Papadakis, E.N., 2010. A Bayesian approach to statistical inference in stochastic DEA. Omega. 38, 309–314.
71. Udhayakumar, A., Charles, V., Kumar, M., 2011. Stochastic simulation based genetic algorithm for chance constrained data envelopment analysis problems. Omega. 39, 387–397.
72. UNCTAD, 2014. Review of Maritime Transport, United Nations publication, Geneva.
73. Vlachos, I.P., Malindretos, G., 2012. Market Access and Sustainability effects on regional performance: Evidence from the Messinian Region-Greece. The Regional Science Inquiry Journal, IV, 137–153.
74. Vlachos, I.P., Siachou, E., 2016. Upgrading to lean operations: the role of training, knowledge acquisition, and organizational culture. 23nd EurOMA Conference, Operations Management for Sustainable Competitiveness, Interactions, June 17th–22 2016.
75. Xu, J.J., Yip, T.L., Marlow, P.B., 2011. The dynamics between freight volatility and fleet size growth in dry bulk shipping markets. Transport. Res. Part E: Logist. Transport. Rev. 47, 983–991.
76. Wu, D.D., Lee, C.G., 2010. Stochastic DEA with ordinal data applied to a multi-attribute pricing problem. Eur. J. Oper. Res. 207, 1679–1688.
77. Zhang, Y. and Bartels, R. (1998), "The effect of sample size on the mean efficiency in DEA with an application to electricity distribution in Australia, Sweden and New Zealand", *Journal of Productivity Analysis*, Vol. 9, pp. 187-204.
78. Zschille, M., 2014. Nonparametric measures of returns to scale: an application to German water supply. Empir. Econ. 47, 1029–1053.

Appendix

APPENDIX A

Table A1- Market Orientation Scales

Variables and Scales	Coefficient Alpha
Intelligence Generation	
We meet with our clients at least once a year to find out what services they will need in the future.	
Our staff interacts directly with our customers to learn how we can serve them better.	
In our company we perform (internally) a continuous market research.	
We are "slow" to detect changes in the preferences of our customers on our services.	
We often investigate (at least once a year) the opinions of our customers on the quality of the services we offer.	
We often talk or communicate with those who can influence our end-customers (brokers, carriers, etc.).	
We also collect market information from unofficial sources (e.g., conversation or dinner with members of the market, participation in special events, etc.).	.754
In our company all departments are involved in the generation of "knowledge" and gather information about our competitors.	
We are "slow" to detect major changes in our industry (e.g., changes in competition, technology, regulations, legislation, etc.).	
We periodically review the possible effects of the changes of the broader business environment to our customers (e.g., changes in financial condition, changes in legislation, etc.).	

Intelligence Dissemination	.752
A lot of informal discussions take place within the company for the tactics and strategies of our competitors.	
We often (at least every quarter) organize interdepartmental meetings to discuss market trends and latest developments.	
A large amount of time is dedicated to update all parts of the company for future needs of our customers and markets.	
Very often reports and newsletters with information about the market (specialized reports, gazettes, special forms, etc.) are distributed internally within our company.	
When something important happens to one of our major customers or in our market, all the departments of our company will be informed in a very short time.	
Data regarding the services we offer to our clients is available on a regular basis in all the departments of the company.	
Responsiveness (Response Design)	
It takes us forever to decide how to respond to our competitors' price changes.	
The division of the shipping market to customer segments and the development of the proper per segment specialization act as a "guide" to the development of our new services and the acquisition of productive resources.	
For various reasons we tend to ignore changes in our customers' needs.	
We frequently review the development efforts of our services to ensure that they are in line with our customers' needs.	
Our business plans are driven more by technological developments than by	

market research.	.739
All our departments work together regularly to plan a response to changes occurring in the market.	
Responsiveness (Response Implementation)	
If one of our competitors launches a new strategy to attract customers then we will respond immediately.	
The activities of different departments in the business (operations, chartering, etc.) are well coordinated.	
We do not pay much attention to our customer complaints.	
We immediately respond to significant pricing changes of our competitors.	
When we realize that our customers are unhappy with the quality of services we offer, we will take immediate corrective actions.	
Overall Performance	
The last 3 to 5 years we managed to increase even by little our market share (e.g., buying a new ship, we increased the total charter days, we achieved better prices, etc.).	
Compared to our major competitors, the last three years we think we do better.	
Compared to our major competitors, we think we manage our ships better.	.830
Compared to our major competitors we think we have better ROI (return on investment - Faster depreciation of assets).	

Variables	Coefficient Alpha
Performance	

The last 3 to 5 years we managed to increase even by little our market share (e.g., buying a new ship, we increased the total charter days, we achieved better prices, etc.).	
Compared to our major competitors, the last three years we think we do better.	
Compared to our major competitors, we think we manage our ships better.	
Compared to our major competitors we think we have better ROI (Return on investment - Faster depreciation of ships).	.830

Appendix B

Stochastic DEA mathematical formulation

$$\min \theta$$

$$s.t.\ \text{Prob}\left(\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io}\right) \geq p_i \qquad i = 1,\ldots,m$$

$$\text{Prob}\left(\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro}\right) \geq q_r \qquad r = 1,\ldots,s$$

$$\lambda_j \geq 0 \tag{1}$$

where p_i and q_r express the minimum probabilities that the input and output constraints are satisfied. Let the minimum probabilities set equal to the level of significance $\alpha = 0.05$. In addition, let $x_{ij} \quad N\left(E(x_{ij}), \text{var}(x_{ij})\right)$ and $y_{rj} \quad N\left(E(y_{rj}), \text{var}(y_{rj})\right)$ where $E(x_{ij})$ and $E(y_{rj})$ denote the expected values of inputs and outputs, respectively, and $\text{var}(x_{ij})$ and $\text{var}(y_{rj})$ express the variance of inputs and outputs, respectively. In this context, the expected values of inputs and outputs are $E(x_{ij}) = \sum_{j=1}^{n} \lambda_j E(x_{ij})$ and $E(y_{rj}) = \sum_{j=1}^{n} \lambda_j E(y_{rj})$, respectively. Moreover, the variance of inputs and outputs is $\text{var}(x_{ij}) = \sum_{j=1}^{n}\sum_{l=1}^{n} \lambda_j \lambda_l \,\text{cov}(x_{ij}, x_{pl}) \quad i, p = 1,\ldots,m$ and $\text{var}(y_{rj}) = \sum_{j=1}^{n}\sum_{l=1}^{n} \lambda_j \lambda_l \,\text{cov}(y_{rj}, y_{ql}) \quad r, q = 1,\ldots,s$, respectively. Then, program (1) becomes:

$$\min \theta$$

$$s.t.\ \text{Prob}\left(\frac{\sum_{j=1}^{n} \lambda_j x_{ij} - E(x_{ij})}{(\text{var}(x_{ij}))^{0.5}} \le \frac{\theta x_{io} - E(x_{ij})}{(\text{var}(x_{ij}))^{0.5}} \right) \ge p_i$$

$$\text{Prob}\left(\frac{\sum_{j=1}^{n} \lambda_j y_{rj} - E(y_{rj})}{(\text{var}(y_{rj}))^{0.5}} \ge \frac{y_{ro} - E(y_{rj})}{(\text{var}(y_{rj}))^{0.5}} \right) \ge q_r$$

$$\lambda_j \ge 0 \qquad (2)$$

After straightforward calculations on program (2), we obtain the input-oriented SDEA program

$$\min \theta$$

$$s.t.\ \sum_{j=1}^{n} \lambda_j x_{ij} + \sum_{j=1}^{n} \left(\text{E}(x_{ij}) - x_{ij} \right) \lambda_j + \zeta \left(\sum_{j=1}^{n} \sum_{l=1}^{n} \lambda_j \lambda_l \operatorname{cov}\left(x_{ij}, x_{pl} \right) \right)^{0.5} \le \theta x_{io}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} + \sum_{j=1}^{n} \left(\text{E}(y_{rj}) - y_{rj} \right) \lambda_j - \zeta \left(\sum_{j=1}^{n} \sum_{l=1}^{n} \lambda_j \lambda_l \operatorname{cov}\left(y_{rj}, y_{ql} \right) \right)^{0.5} \ge y_{ro}$$

$$\lambda_j \ge 0 \qquad (3)$$

where $\zeta = \Phi^{-1}(\alpha)$ and Φ denotes the standard normal distribution function.

Similarly, the output-oriented SDEA program is written as follows:

$$\max \varphi$$

$$s.t.\ \sum_{j=1}^{n} \lambda_j x_{ij} + \sum_{j=1}^{n} \left(\text{E}(x_{ij}) - x_{ij} \right) \lambda_j + \zeta \left(\sum_{j=1}^{n} \sum_{l=1}^{n} \lambda_j \lambda_l \operatorname{cov}\left(x_{ij}, x_{pl} \right) \right)^{0.5} \le x_{io}$$

$$\sum_{j=1}^{n}\lambda_j y_{rj}+\sum_{j=1}^{n}\left(\mathrm{E}(y_{rj})-y_{rj}\right)\lambda_j-\zeta\left(\sum_{j=1}^{n}\sum_{l=1}^{n}\lambda_j\lambda_l\,\mathrm{cov}\left(y_{rj},y_{ql}\right)\right)^{0.5}\geq\varphi y_{ro}$$

$$\lambda_j\geq 0 \qquad (4)$$

In programs (3) and (4), we assume that the variability is the same for all inputs (i.e. $\mathrm{var}(x_{ij})=c_i^2 \quad \forall\, j=1,\ldots,n$ where c_i stands for a constant, which is the within-inputs standard deviation, and $c_i<1$) and outputs (i.e. $\mathrm{var}(y_{rj})=c_r^2 \quad \forall\, j=1,\ldots,n$ where c_r stands for a constant, which is the within-outputs standard deviation, and $c_r<1$). Our assumptions also apply to the study of Land et al. (1993).

APPENDIX - C

Table A2. Efficiency scores

Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group
1	0.6401	1	86	0.4080	2	171	0.7900	2	256	0.6943	2	341	0.8649	3
2	0.5697	1	87	0.6098	2	172	0.6426	2	257	0.7826	2	342	0.7396	3
3	0.6879	1	88	0.6661	2	173	0.7514	2	258	0.8452	2	343	0.9073	3
4	0.6737	1	89	0.7791	2	174	0.8719	2	259	0.6234	2	344	0.8128	3
5	0.6574	1	90	0.8095	2	175	0.8863	2	260	0.8833	2	345	1.0000	3
6	0.5921	1	91	0.7015	2	176	0.7525	2	261	0.7470	2	346	0.8306	3
7	0.7731	1	92	0.6919	2	177	0.7659	2	262	0.5581	2	347	0.7527	3
8	0.7388	1	93	0.6401	2	178	0.7679	2	263	0.8072	2	348	0.8750	3
9	0.7348	1	94	0.7333	2	179	0.7595	2	264	0.7848	2	349	0.7796	3
10	0.5498	1	95	0.6329	2	180	0.8325	2	265	0.7785	2	350	0.7358	3
11	0.5817	1	96	0.7266	2	181	0.6838	2	266	0.5313	2	351	0.7164	3
12	0.9595	1	97	0.6918	2	182	0.8136	2	267	0.9359	2	352	0.8025	3
13	0.8509	1	98	0.6375	2	183	0.7241	2	268	0.6156	2	353	0.8232	3

Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group
14	0.7427	1	99	0.7223	2	184	0.8965	2	269	0.7656	2	354	0.8345	3
15	0.7629	1	100	0.6314	2	185	0.8225	2	270	0.7071	2	355	0.7589	3
16	0.8050	1	101	0.7402	2	186	0.9194	2	271	0.9054	2	356	0.7277	3
17	0.8238	1	102	0.8112	2	187	0.7014	2	272	0.8606	2	357	1.0000	3
18	0.5773	1	103	0.6670	2	188	0.7466	2	273	0.6114	2	358	0.5662	3
19	0.6854	1	104	0.9460	2	189	0.9404	2	274	0.6947	2	359	0.7199	3
20	0.6501	1	105	0.7647	2	190	0.5776	2	275	1.0000	2	360	0.8292	3
21	0.6053	1	106	0.6460	2	191	0.9682	2	276	0.6013	2	361	0.8247	3
22	0.7148	1	107	0.7227	2	192	0.8229	2	277	0.6877	2	362	0.7774	4
23	0.7648	1	108	0.6047	2	193	0.9494	2	278	0.5671	2	363	0.6942	4
24	0.4659	1	109	0.7971	2	194	0.6369	2	279	0.7539	2	364	0.8244	4
25	0.3609	1	110	0.5669	2	195	0.6455	2	280	0.8787	2	365	0.7115	4
26	0.7182	1	111	0.8918	2	196	1.0000	2	281	0.6371	2	366	0.6045	4
27	0.6976	1	112	0.7695	2	197	0.7272	2	282	0.7632	2	367	0.7566	4
28	0.6645	1	113	0.7041	2	198	0.7330	2	283	0.8361	3	368	0.9075	4
29	0.6135	1	114	0.8462	2	199	0.5740	2	284	0.9537	3	369	0.7933	4
30	0.7479	1	115	0.7328	2	200	0.6233	2	285	0.7810	3	370	0.6320	4

Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group
31	0.9193	1	116	0.7189	2	201	0.8393	2	286	0.7487	3	371	0.6093	4
32	0.6480	1	117	0.6559	2	202	1.0000	2	287	0.7760	3	372	0.9025	4
33	0.7843	1	118	0.8012	2	203	0.7074	2	288	0.7776	3	373	0.8304	4
34	0.7199	1	119	0.9822	2	204	0.6455	2	289	0.9477	3	374	0.8518	4
35	0.6202	1	120	0.6144	2	205	0.9149	2	290	0.4607	3	375	0.7859	4
36	0.3729	1	121	0.6816	2	206	0.8024	2	291	0.8532	3	376	0.6558	4
37	0.5751	1	122	0.7460	2	207	0.6982	2	292	0.7706	3	377	0.8179	4
38	0.7527	1	123	1.0000	2	208	0.5391	2	293	0.7950	3	378	0.8495	4
39	0.5714	1	124	0.6201	2	209	0.5463	2	294	1.0000	3	379	0.8380	4
40	0.7703	1	125	0.8433	2	210	0.8531	2	295	0.8032	3	380	0.9647	4
41	0.5667	1	126	0.7873	2	211	0.9075	2	296	0.7645	3	381	0.8392	4
42	0.7789	1	127	0.7132	2	212	0.8460	2	297	0.8723	3	382	0.8115	4
43	0.7398	1	128	0.8240	2	213	0.7633	2	298	0.7395	3	383	0.8514	4
44	0.9318	1	129	0.8792	2	214	0.7291	2	299	1.0000	3	384	0.8438	4
45	0.7261	1	130	0.6722	2	215	0.4872	2	300	0.8303	3	385	0.6586	4
46	0.8472	1	131	0.8029	2	216	0.6910	2	301	0.6943	3	386	0.6995	4
47	1.0000	1	132	0.6893	2	217	0.5824	2	302	0.8252	3	387	0.7785	4

Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group
48	0.9569	1	133	0.7492	2	218	0.8193	2	303	0.7992	3	388	0.9081	4
49	0.6734	1	134	0.7422	2	219	0.9192	2	304	0.6780	3	389	0.7041	4
50	0.6825	1	135	0.6183	2	220	0.6197	2	305	0.8582	3	390	0.9163	4
51	0.6193	1	136	0.7877	2	221	0.7888	2	306	0.8238	3	391	0.7474	4
52	0.6283	1	137	0.6211	2	222	0.7158	2	307	0.6409	3	392	0.7477	4
53	0.7906	1	138	0.7750	2	223	0.9057	2	308	0.8900	3	393	0.7557	4
54	0.7633	1	139	0.7278	2	224	0.6676	2	309	0.6664	3	394	0.7742	4
55	0.6794	1	140	0.7294	2	225	0.6984	2	310	0.8372	3	395	0.8441	4
56	0.7732	1	141	0.7400	2	226	0.7566	2	311	0.7900	3	396	0.8271	4
57	0.6261	1	142	0.6616	2	227	0.7357	2	312	0.8000	3	397	0.7794	4
58	0.5097	1	143	0.5300	2	228	0.7706	2	313	0.6880	3			
59	0.9547	1	144	0.7797	2	229	0.6546	2	314	0.7665	3			
60	0.5612	1	145	0.7292	2	230	0.5774	2	315	0.7484	3			
61	0.5737	1	146	0.7232	2	231	0.9474	2	316	0.6344	3			
62	0.7444	1	147	0.6268	2	232	0.7403	2	317	1.0000	3			
63	0.8583	1	148	0.9213	2	233	0.6141	2	318	0.7469	3			
64	0.7790	1	149	0.8589	2	234	0.6239	2	319	0.8517	3			

Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group
65	0.7255	1	150	0.6117	2	235	0.7288	2	320	0.6161	3			
66	0.8247	1	151	0.6737	2	236	0.5640	2	321	0.7035	3			
67	0.6953	1	152	0.7972	2	237	0.8904	2	322	0.8308	3			
68	0.6016	1	153	0.7787	2	238	0.6729	2	323	0.9295	3			
69	0.6101	1	154	0.7603	2	239	0.7993	2	324	0.6517	3			
70	0.6749	1	155	0.7020	2	240	0.9391	2	325	0.7975	3			
71	0.6989	1	156	0.7391	2	241	0.7862	2	326	0.8150	3			
72	0.7053	1	157	0.7658	2	242	0.8205	2	327	0.4718	3			
73	0.7293	1	158	0.7470	2	243	0.8101	2	328	0.8124	3			
74	0.6167	1	159	0.7805	2	244	1.0000	2	329	0.7337	3			
75	0.8194	2	160	0.7947	2	245	0.6896	2	330	0.6403	3			
76	0.6778	2	161	0.6828	2	246	0.7908	2	331	0.7289	3			
77	0.8215	2	162	0.8028	2	247	0.6511	2	332	0.9641	3			
78	0.7812	2	163	0.6226	2	248	0.6050	2	333	0.8371	3			
79	0.7971	2	164	0.8066	2	249	0.8105	2	334	1.0000	3			
80	0.5716	2	165	0.6622	2	250	0.7599	2	335	0.8345	3			
81	0.7813	2	166	0.8002	2	251	0.8856	2	336	0.8607	3			

Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group	Firms ID	Efficiency	Group
82	0.8830	2	167	0.7112	2	252	0.6821	2	337	0.8018	3			
83	0.5430	2	168	0.7344	2	253	0.8831	2	338	0.7160	3			
84	0.4597	2	169	0.7661	2	254	0.9350	2	339	0.7948	3			
85	0.7583	2	170	0.6748	2	255	0.6981	2	340	0.7873	3			

Group 1: small firms; Group 2: medium firms; Group 3: large firms; Group 4: significantly large firms

Table A3. Efficiencies obtained from scaled samples

Sample Size	Number of Efficient firms	Efficient firms (%)	95% Interval Lower	95% Interval Upper
100	8	0.080	0.027	0.133
110	8	0.073	0.024	0.121
120	9	0.075	0.028	0.122
130	9	0.069	0.026	0.113
140	9	0.064	0.024	0.105
150	9	0.060	0.022	0.098
160	9	0.056	0.021	0.092
170	9	0.053	0.019	0.087
180	10	0.056	0.022	0.089
190	10	0.053	0.021	0.084
200	10	0.050	0.020	0.080
210	10	0.048	0.019	0.076
220	10	0.045	0.018	0.073
230	13	0.057	0.027	0.086
240	14	0.058	0.029	0.088
250	14	0.056	0.027	0.085
260	16	0.062	0.032	0.091
270	16	0.059	0.031	0.087
280	17	0.061	0.033	0.089
290	6	0.021	0.004	0.037
300	6	0.020	0.004	0.036
310	6	0.019	0.004	0.035
320	6	0.019	0.004	0.034
330	6	0.018	0.004	0.033
340	6	0.018	0.004	0.032
350	6	0.017	0.004	0.031
360	6	0.017	0.003	0.030
370	6	0.016	0.003	0.029
380	7	0.018	0.005	0.032
390	8	0.021	0.006	0.035
397	8	0.020	0.006	0.034

Table A4. Monte Carlo simulation efficiency and probability of being efficient estimates

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
1	1	0.5617	0.020	134	2	0.5085	0.015	267	2	0.5721	0.040
2	1	0.5806	0.035	135	2	0.6026	0.055	268	2	0.5906	0.050
3	1	0.4713	0.015	136	2	0.6425	0.065	269	2	0.3524	0.015
4	1	0.4538	0.010	137	2	0.5627	0.035	270	2	0.4943	0.015
5	1	0.5517	0.030	138	2	0.5703	0.030	271	2	0.5030	0.020
6	1	0.5454	0.040	139	2	0.5337	0.020	272	2	0.6655	0.065
7	1	0.4116	0.005	140	2	0.4792	0.020	273	2	0.3957	0.005
8	1	0.5017	0.015	141	2	0.5093	0.010	274	2	0.5823	0.055
9	1	0.4719	0.015	142	2	0.4648	0.000	275	2	0.5748	0.055
10	1	0.6689	0.130	143	2	0.6404	0.040	276	2	0.5298	0.015
11	1	0.5616	0.040	144	2	0.6089	0.060	277	2	0.4469	0.005
12	1	0.3975	0.000	145	2	0.4141	0.000	278	2	0.5443	0.020

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
13	1	0.5472	0.030	146	2	0.4933	0.015	279	2	0.5060	0.005
14	1	0.5724	0.025	147	2	0.5701	0.035	280	2	0.5237	0.030
15	1	0.4683	0.005	148	2	0.5804	0.025	281	2	0.6472	0.085
16	1	0.5644	0.045	149	2	0.4600	0.015	282	2	0.5994	0.055
17	1	0.4182	0.005	150	2	0.5632	0.025	283	3	0.5461	0.035
18	1	0.3876	0.005	151	2	0.4383	0.005	284	3	0.6565	0.090
19	1	0.4971	0.020	152	2	0.5686	0.030	285	3	0.4916	0.005
20	1	0.5457	0.015	153	2	0.5566	0.025	286	3	0.6224	0.065
21	1	0.3290	0.000	154	2	0.5889	0.035	287	3	0.7326	0.150
22	1	0.5274	0.030	155	2	0.5154	0.015	288	3	0.4854	0.025
23	1	0.5389	0.040	156	2	0.5960	0.050	289	3	0.5938	0.035
24	1	0.5080	0.020	157	2	0.4957	0.010	290	3	0.4904	0.010
25	1	0.5739	0.040	158	2	0.6029	0.050	291	3	0.5200	0.030
26	1	0.2819	0.000	159	2	0.4882	0.015	292	3	0.5763	0.030

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
27	1	0.5565	0.030	160	2	0.5024	0.010	293	3	0.5162	0.020
28	1	0.4219	0.010	161	2	0.5477	0.015	294	3	0.5465	0.040
29	1	0.5026	0.005	162	2	0.4429	0.000	295	3	0.5933	0.040
30	1	0.3749	0.010	163	2	0.5149	0.025	296	3	0.4677	0.005
31	1	0.4834	0.000	164	2	0.2773	0.000	297	3	0.4138	0.005
32	1	0.5358	0.010	165	2	0.5647	0.045	298	3	0.6021	0.065
33	1	0.5069	0.010	166	2	0.5814	0.055	299	3	0.4493	0.000
34	1	0.4277	0.000	167	2	0.4765	0.010	300	3	0.5579	0.010
35	1	0.5600	0.020	168	2	0.4728	0.000	301	3	0.5108	0.015
36	1	0.5627	0.020	169	2	0.5614	0.045	302	3	0.3486	0.000
37	1	0.4941	0.015	170	2	0.4555	0.020	303	3	0.5003	0.020
38	1	0.4893	0.025	171	2	0.5659	0.030	304	3	0.5698	0.020
39	1	0.5411	0.025	172	2	0.4288	0.010	305	3	0.4522	0.000
40	1	0.3933	0.000	173	2	0.5553	0.020	306	3	0.5370	0.030

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
41	1	0.6533	0.050	174	2	0.6030	0.045	307	3	0.5762	0.045
42	1	0.4588	0.000	175	2	0.5127	0.015	308	3	0.5097	0.030
43	1	0.5252	0.030	176	2	0.5329	0.010	309	3	0.6440	0.045
44	1	0.6000	0.035	177	2	0.5331	0.035	310	3	0.4661	0.025
45	1	0.4456	0.000	178	2	0.6530	0.110	311	3	0.5193	0.005
46	1	0.5057	0.025	179	2	0.5741	0.035	312	3	0.4078	0.000
47	1	0.5048	0.005	180	2	0.4156	0.000	313	3	0.6133	0.090
48	1	0.4348	0.000	181	2	0.4600	0.010	314	3	0.6449	0.060
49	1	0.6990	0.100	182	2	0.5284	0.020	315	3	0.4878	0.015
50	1	0.5396	0.015	183	2	0.5115	0.015	316	3	0.5626	0.025
51	1	0.3263	0.005	184	2	0.4144	0.010	317	3	0.6271	0.050
52	1	0.5996	0.025	185	2	0.5459	0.010	318	3	0.5242	0.015
53	1	0.5296	0.020	186	2	0.5730	0.050	319	3	0.5131	0.005
54	1	0.5638	0.050	187	2	0.4643	0.005	320	3	0.6332	0.080

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
55	1	0.5732	0.010	188	2	0.5082	0.020	321	3	0.5867	0.010
56	1	0.4533	0.015	189	2	0.6174	0.060	322	3	0.3943	0.005
57	1	0.5773	0.040	190	2	0.5325	0.025	323	3	0.5785	0.065
58	1	0.5162	0.005	191	2	0.6177	0.045	324	3	0.4231	0.010
59	1	0.4188	0.005	192	2	0.5411	0.015	325	3	0.5106	0.010
60	1	0.5464	0.035	193	2	0.5427	0.050	326	3	0.6507	0.065
61	1	0.4786	0.010	194	2	0.3771	0.010	327	3	0.4865	0.005
62	1	0.5302	0.030	195	2	0.5612	0.040	328	3	0.5819	0.020
63	1	0.4804	0.005	196	2	0.5348	0.030	329	3	0.5463	0.015
64	1	0.5394	0.020	197	2	0.5426	0.025	330	3	0.7419	0.185
65	1	0.5896	0.035	198	2	0.6001	0.060	331	3	0.5688	0.040
66	1	0.5255	0.005	199	2	0.5757	0.060	332	3	0.4745	0.000
67	1	0.5305	0.010	200	2	0.4935	0.020	333	3	0.5541	0.025
68	1	0.7022	0.095	201	2	0.5640	0.020	334	3	0.5069	0.025

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
69	1	0.6108	0.065	202	2	0.5816	0.025	335	3	0.4504	0.000
70	1	0.4675	0.010	203	2	0.5289	0.015	336	3	0.5829	0.055
71	1	0.4533	0.005	204	2	0.5270	0.025	337	3	0.5918	0.065
72	1	0.4218	0.005	205	2	0.6208	0.040	338	3	0.5501	0.010
73	1	0.5024	0.015	206	2	0.5877	0.040	339	3	0.5397	0.015
74	1	0.4257	0.005	207	2	0.4703	0.020	340	3	0.6164	0.060
75	2	0.5666	0.030	208	2	0.6443	0.080	341	3	0.5018	0.010
76	2	0.5167	0.015	209	2	0.5679	0.020	342	3	0.6042	0.055
77	2	0.5490	0.025	210	2	0.4013	0.005	343	3	0.5580	0.030
78	2	0.4089	0.005	211	2	0.4814	0.015	344	3	0.6187	0.060
79	2	0.5910	0.025	212	2	0.5444	0.040	345	3	0.6579	0.070
80	2	0.5314	0.015	213	2	0.5228	0.025	346	3	0.5073	0.015
81	2	0.4734	0.015	214	2	0.6456	0.085	347	3	0.5060	0.010
82	2	0.6185	0.070	215	2	0.5304	0.030	348	3	0.5174	0.015

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
83	2	0.5694	0.030	216	2	0.5246	0.015	349	3	0.5894	0.030
84	2	0.5130	0.025	217	2	0.4348	0.005	350	3	0.4962	0.015
85	2	0.5025	0.035	218	2	0.4346	0.005	351	3	0.5406	0.035
86	2	0.4646	0.005	219	2	0.5708	0.030	352	3	0.5951	0.020
87	2	0.5627	0.020	220	2	0.6968	0.120	353	3	0.4465	0.020
88	2	0.5309	0.030	221	2	0.6165	0.035	354	3	0.5563	0.020
89	2	0.6717	0.075	222	2	0.6674	0.070	355	3	0.5991	0.045
90	2	0.4524	0.010	223	2	0.6555	0.055	356	3	0.5997	0.070
91	2	0.4662	0.005	224	2	0.6962	0.095	357	3	0.5916	0.055
92	2	0.3369	0.000	225	2	0.5744	0.035	358	3	0.5206	0.010
93	2	0.5352	0.030	226	2	0.6631	0.075	359	3	0.5304	0.010
94	2	0.6190	0.040	227	2	0.4668	0.015	360	3	0.5406	0.025
95	2	0.5463	0.025	228	2	0.4457	0.010	361	3	0.5021	0.005
96	2	0.7535	0.150	229	2	0.5313	0.025	362	4	0.4058	0.000

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
97	2	0.2448	0.000	230	2	0.6878	0.095	363	4	0.5372	0.015
98	2	0.5128	0.010	231	2	0.4916	0.010	364	4	0.5382	0.020
99	2	0.4443	0.005	232	2	0.6174	0.060	365	4	0.5462	0.020
100	2	0.4405	0.000	233	2	0.5114	0.010	366	4	0.5524	0.045
101	2	0.4336	0.000	234	2	0.4450	0.005	367	4	0.3880	0.000
102	2	0.5939	0.035	235	2	0.5088	0.015	368	4	0.6474	0.080
103	2	0.5359	0.020	236	2	0.5089	0.020	369	4	0.4244	0.005
104	2	0.5279	0.020	237	2	0.3949	0.005	370	4	0.5065	0.015
105	2	0.5040	0.035	238	2	0.5008	0.000	371	4	0.5573	0.015
106	2	0.7250	0.115	239	2	0.4197	0.000	372	4	0.4385	0.000
107	2	0.5644	0.025	240	2	0.5575	0.030	373	4	0.4352	0.000
108	2	0.4954	0.025	241	2	0.5840	0.020	374	4	0.6094	0.045
109	2	0.6227	0.060	242	2	0.6991	0.115	375	4	0.4824	0.010
110	2	0.4663	0.010	243	2	0.6317	0.040	376	4	0.5869	0.040

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
111	2	0.5404	0.020	244	2	0.5106	0.015	377	4	0.6827	0.115
112	2	0.4702	0.010	245	2	0.4389	0.005	378	4	0.5041	0.010
113	2	0.5021	0.015	246	2	0.4516	0.020	379	4	0.6182	0.055
114	2	0.5744	0.030	247	2	0.4526	0.010	380	4	0.3923	0.010
115	2	0.6087	0.040	248	2	0.6175	0.065	381	4	0.5991	0.050
116	2	0.5123	0.015	249	2	0.5542	0.035	382	4	0.4287	0.000
117	2	0.5640	0.065	250	2	0.4795	0.010	383	4	0.5070	0.025
118	2	0.5742	0.035	251	2	0.3828	0.000	384	4	0.7146	0.155
119	2	0.5243	0.020	252	2	0.3889	0.000	385	4	0.4258	0.015
120	2	0.4276	0.000	253	2	0.5999	0.025	386	4	0.5468	0.020
121	2	0.5629	0.020	254	2	0.6149	0.065	387	4	0.4859	0.010
122	2	0.4396	0.005	255	2	0.5905	0.035	388	4	0.4933	0.035
123	2	0.4892	0.020	256	2	0.4810	0.015	389	4	0.4968	0.005
124	2	0.4701	0.020	257	2	0.7965	0.250	390	4	0.6001	0.035

No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient	No.	Group	Efficiency	Prob. being efficient
125	2	0.5788	0.030	258	2	0.5671	0.035	391	4	0.4939	0.000
126	2	0.5424	0.035	259	2	0.5665	0.040	392	4	0.5148	0.005
127	2	0.5333	0.005	260	2	0.5308	0.030	393	4	0.5716	0.020
128	2	0.6121	0.050	261	2	0.3300	0.000	394	4	0.4072	0.000
129	2	0.5198	0.030	262	2	0.4553	0.005	395	4	0.5049	0.015
130	2	0.5372	0.030	263	2	0.4859	0.005	396	4	0.6106	0.030
131	2	0.4572	0.010	264	2	0.4166	0.005	397	4	0.4314	0.000
132	2	0.4500	0.000	265	2	0.5540	0.020				
133	2	0.3930	0.005	266	2	0.5333	0.035				

Group 1: small firms; Group 2: medium firms; Group 3: large firms; Group 4: significantly large firms

TITLE PAGE

«Market orientation for sustainable performance and the inverted-U moderation of firm size: Evidence from the Greek shipping industry»

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