LUND UNIVERSITY
School of Economics and Management

Does hedging increase firm performance? An empirical analysis of the shipping industry

Daniel Allan Nilsson

Paola Patiño Arévalo

Lund University

A thesis submitted for the degree of

Master of Science in Business and Economics

Lund Spring 2017

Seminar date:	May 30th 2017
Course:	BUSN79:Degree Project in Corporate Financial Management – Master Level, 15ECTS
Authors:	Daniel Allan Nilsson and Paola Patiño Arévalo
Advisor:	Niclas Andrén
Key words:	Hedging, Risk Management, Return on Invested Capital, Shipping, Operating Performance
Purpose:	The aim of this thesis is to analyze the effect that fuel cost hedging has on ROIC and how ROIC interacts with fuel cost hedging and investments undertaken by shipping firms headquartered in Europe and North America.
Methodology:	This study employs quantitative analysis by using the ordinary least squares regression method. The data used is organized as panel data with robustness checks for heteroskedasticity and cross-sectional and period heterogeneity.
Theoretical perspectives:	This thesis is based on existing risk management theories and relaxation of the Modigliani & Miller theorem assumptions. With this study we contribute to existing corporate risk management research regarding the relationship between firm operating performance and hedging activities adopted by firms.
Empirical foundation:	Publicly listed firms headquartered in Europe and North America classified as Marine Shipping or Marine Transportation by the Bloomberg Industry Classification System (BICS) and Global Industry Classification Standard (GICS). The final sample consisted of 186 observations with 31 companies during the period 2009-2014.
Conclusions:	Fuel cost hedgers showed a statistically significant lower Operating Cash Flow to Sales volatility and EBIT margin volatility. Fuel cost hedgers were also larger and less levered as measured by Long Term Debt to Total Assets. Multivariate tests showed no evidence that hedging fuel costs has any statistically significant effect on ROIC. Bunker fuel prices were negatively related to CAPEX and for those shipping firms that engage in fuel hedging, higher capital spending contributed positively to ROIC.

Acknowledgements

First and foremost we would like to express our deepest appreciation to our supervisor Niclas Andrén for all your help and support. Our outmost gratitude is also given to the reviewers of this thesis. In addition we would like to thank all of our friends and family for their continuous positive support, guidance and help.

Lund, May 2017

Daniel Allan Nilsson and Paola Patiño Arévalo

Abstract

In this study, we analyze the hedging activities for risk management purposes of 31 shipping companies headquartered in Europe and North America and its impact on ROIC, in the period between 2009 and 2014. We also study how ROIC interacts with hedging and investments undertaken by the firms in our sample. If some of the assumptions of the Modigliani & Miller (1958) framework are relaxed, hedging could be beneficial for companies. Given the large exposure to commodities volatility such as oil and bunker fuel, the shipping industry provides a potential benefit of using bunker fuel derivatives. Our results showed no evidence that hedging fuel costs has any statistically significant effect on ROIC. Regarding the interaction between investing and fuel costs and its effect on ROIC we found that bunker fuel prices are negatively related to capital expenditures. More importantly, our results showed that among shipping firms that engaged in fuel hedging, higher capital spending contributed positively to ROIC. Furthermore, our univariate results displayed that fuel cost hedgers had lower operating cash flow volatility and EBIT margin volatility. Fuel cost hedgers were also larger and less levered.

Table of Contents

1. Introduction

In a Modigliani & Miller (1958) world it is not beneficial for a firm to hedge. However, if some of the assumptions of the Modigliani & Miller (1958) framework are relaxed, there could be possible benefits to hedging. Firstly, reducing cash flow variability could help ensure access to internal funds to use for investing, an important factor if external funds are too expensive as proposed by Froot, et al. (1994). Secondly, if value is created by generating returns on investments greater than a firm's cost of capital then having internal funds available should enable a firm to take on more value creating projects. Several studies have investigated whether hedging increases firm value, however limited research has been done regarding the effectiveness of hedging and its relation to firm operating performance. This study aims to analyze if fuel cost hedging has any impact on firm operating performance for firms in the shipping industry, specifically on Return on Invested Capital (ROIC). We will also analyze whether there is any relation between ROIC and the interaction between hedging and capital expenditures.

Shipping firms are estimated to transport 75% of the world's traded commodities and finished goods making them a key part of world trade and heavily linked to global demand dynamics and commodity prices. Given these factors it is worth analyzing the sources of cash flow volatility for these firms and whether using risk management tools such as derivatives can mitigate this risk. In this study we will focus on fuel or oil price derivative use, given that fuel costs take up on average 21% operating costs for shipping firms. Due to the heavy exposure to commodities volatility such as oil, the shipping industry provides a clear potential benefit of using fuel derivatives for risk management, similar to other transport oriented industries such as airlines.

Shipping firms also have large investment needs in for example ships, reducing the variability of cash flows generated by assets in place should therefore benefit these firms in a Froot, et al. (1993) framework. Not reducing this variability can disturb both financing and investments in a way that is costly to the firm. One way to reduce cash flow variability would be to engage in hedging. We found that capital expenditures in the shipping industry were negatively correlated to bunker fuel prices. Therefore we believe that an additional valid research question is to investigate whether there is any relationship between cash flow generated by assets in place i.e. ROIC, Capital Expenditures and hedging.

Given the capital intensity of the industry, a major factor that should determine success and survival for shipping firms is their ability to generate cash flows from those investments. The financial performance measure chosen for this study is Return on Invested Capital (ROIC) as it is presented by Koller, et al. (2010). The authors state that the guiding principle of value creation is by investing capital raised from investors to generate future cash flows. If a firm can deploy more capital at higher rates of return, then more value should be created for the firm. ROIC is also a more reliable performance measure compared to other traditional financial ratios such as Return on Equity and Return on Assets. This is because ROIC is calculated by only including operating items from the income statement and balance sheet making it less distorted from accounting manipulation. Furthermore, ROIC has been empirically shown to be a driver of market values (Koller, et. al, 2010). The factors mentioned above in addition to the limited research related to ROIC makes it a ratio worth investigating further.

1.1. Purpose and Problem Statement

Existing theories have dealt with the rationales for engaging in hedging activities including factors such as that hedging should mitigate underinvestment problems, reduce bankruptcy and agency costs, as well as increase the value of tax shields. Froot, et al. (1994) explore the relationship between hedging and operating performance of firms in different industries in a theoretical context. Previous empirical research regarding risk management have focused on hedging and its effect on market values or Tobin's Q, see Allayannis & Weston (2001), Carter, et al. (2006) and Pérez-González & Yun (2013). Hedging and its effect on Gross Profit, Return on Assets (ROA) and Return on Equity (ROE) has been studied by e.g. Kwong (2016) and Brown, et al. (2006). Limited research has however been conducted on the effectiveness of derivative use for risk management purposes on ROIC, a measure of performance that is not as heavily influenced by accounting manipulation, choice of financing or stock market behavior. ROIC has also been shown to be a key driver for shareholder value which further highlights an important need for additional empirical research related to this performance measure. Furthermore to our knowledge there are currently no studies that look specifically at hedging and firm operating performance in the shippig industry which as previously mentioned should benefit from hedging fuel prices.

Previous studes have considered hedging and its effect on the level of investment undertaken by firms, see Carter, et al. (2006), Géczy, et al. (1997) and Graham & Rogers (2000). This study will not only focus on the effect hedging has on ROIC but also how ROIC interacts with hedging and investments undertaken by shipping firms headquartered in Europe and North America.

With this study, we hope to contribute to corporate risk management research. Firstly, we provide additional evidence regarding the relation between firm operating performance and hedging activities undertaken by firms. This is accomplished by studying the hedging decisions related to fuel prices undertaken by companies in the shipping industry in the U.S and Europe between 2009 and 2014. Secondly, we also hope to provide a better understanding for the potential value and benefits to shipping firms from engaging in fuel hedging. Lastly, we also wish to investigate the Froot, et. al. (1993) framework by contributing with empirical industry specific research related to investments and hedging.

This study is organized as follows. Section 2 contains an overview of existing theories related to risk management as well as previous empirical studies regarding rationales for hedging and the impact of hedging on firm value and performance. Section 3 covers our sample and period analyzed as well as the methodology and statistical specifications used in this study. In sections 4 and 5, the results and conclusion of our study are presented.

2. Theoretical Background and Literature Review

Being one of the oldest businesses in the world, shipping enables international trade of commodities, manufactured goods and finished products between ports and countries. With the design of faster, larger and more efficient ships, the total volume of world seaborne trade has increased over the last 50 years (Alizadeh & Komikos, 2009). It is estimated that shipping transports 90% of commodities and manufactured products globally (UN, 2017). This is partly related to overall world economic growth, the liberalization of international trade, the discovery of new sources of raw materials globally, as well as the development of new sources of demand as economies grow, increasing the volume of sea transportation (Alizadeh & Nomikos, 2009).

Given that shipping is a key part of world trade, it is worth analyzing the sources of volatility that could affect the expected net cash flows from operations of the companies within this industry. Some of the most important business risks for shipping firms are freight rate risks, interest rate risks, foreign exchange rate risks, credit risk, asset price risk (i.e. ships owned) and operating cost risks, where the price of fuel plays an important role.

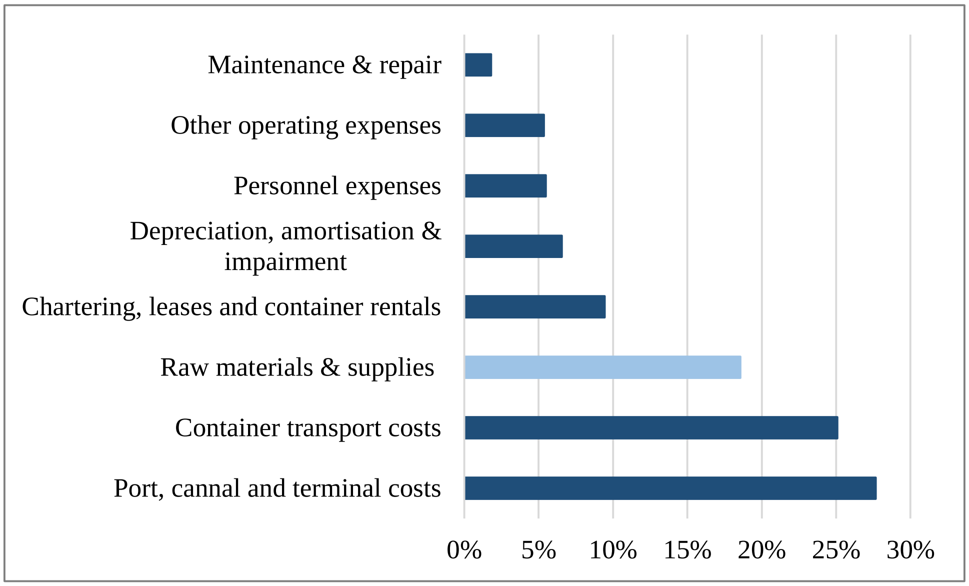
The costs faced by companies in the shipping industry can be divided into: capital costs, operating costs, cargo-handling costs and voyage costs. The mentioned costs depend on factors such as duration of the voyage; size, age, speed and type of ship; and how the vessel purchase is financed (Ibid). The capital costs involve the interest and capital repayments and depend on the mode of financing of the fleet as well as the level of interest rates. Operating costs or fixed costs include crew wages, maintenance and insurance. Cargo-handling costs are the costs involved in the loading, stowage, lightering and discharging of the cargo. Lastly, voyage costs or variable costs mainly include; fuel costs, port charges, pilotage and canal dues. After capital costs, operating and voyage costs are the two largest components of total costs for companies in this industry (Dafir & Gajjala, 2016).

It is important to mention that the allocation of costs vary depending on the type of shipping contract. For instance, in voyage-charter contracts, the party responsible for the voyage costs is the owner of the ship; while in time-charter contracts the charterer is responsible for the voyage costs.

This study will focus on risk management to account for the volatility of bunker fuel cost, also called bunker costs. Bunker fuel costs are one of the largest and most volatile components of shipping firms' operating expenses, which makes them an important source of risk. In 2013, a survey on income statements for shipping companies showed that fuel costs accounted for close to 21% of total operating expenses for major shipping companies (Ibid). Thus, one can infer that the profitability of companies within this industry could be significantly impacted by bunker fuel prices, creating an incentive for fuel hedging.

Below, the operative costs for one of the major companies in our sample were decomposed for the last year of study.

Figure 1. Decomposition of total operating costs for Hapag-Lloyd (fiscal year 2014).



The cost of raw materials and supplies refers to fuel expenses and effects from fuel hedging instruments.
Source: Hapag-Lloyd. Annual report, 2014.

The price of bunker fuel is closely related to world crude oil prices, since it is a derivative of petroleum (Dafir & Gajjala, 2016). Therefore, fuel prices can be volatile and depend on factors such as political and economic events around the world, supply and demand for oil and gas, war and turbulence in oil producing countries, regional production patterns, environmental concerns, and actions by OPEC and other oil and gas producers. In this sense, shocks in the crude oil market can be transmitted to the bunker fuel market. Figure 2 in section 3.1 shows the historical prices of bunker fuel and crude oil, where the average annual standard deviation between 2009 and 2016 was 21.6% and 29.1% respectively.

In order to minimize the exposure to bunker price fluctuations, during the early 1980s, shipping companies started to apply risk management techniques that had been used effectively in commodity and financial markets, such as hedging activities with futures, options and swaps. In the 1990s, a lack of reliable exchange-traded bunker futures contracts led to the development of over the counter (OTC) instruments for bunker price hedging. It is worth to mention that another way of managing fuel price risk used by shipping companies is to include a bunker adjustment clause in the shipping contract, known as the "bunker adjustment factor (BAF)"[1] (Alizadeh & Nomikos, 2009).

2.1. Rationales for hedging

Modigliani & Miller (1958) depart from the value maximization approach, where the ultimate goal of the firm and its investment decisions is to maximize value. How those investments are financed is irrelevant. The value of the firm is then determined by a firm's expected profit before interest and the risk of its underlying assets. This theory builds on the assumption that in equilibrium in a perfect capital market the price of a share is proportional to its expected return. The authors develop three propositions with respect to security valuation to demonstrate their theory. Proposition I states that the market value of the firm is determined by its expected profit and expected rate of return for its asset class, the capital structure of the firm is irrelevant. Proposition II states that the expected return is equal to the expected return on the firm's equity plus a premium to compensate for any financial risk associated with carrying debt. Proposition III states that a firm in a specific asset class will undertake an investment opportunity only if the rate of return on that investment is greater than the cost of capital. The cost of capital will also be unaffected by the type of security issued to finance the investment, assuming perfect capital markets with no taxes.

In the context of Modigliani & Miller (1958) there is no need for hedging by corporations. This is because firstly, the authors state that the variability in income streams can be neglected as it has no effect on the present value of the firm. Secondly, in a world with perfect capital markets with no information asymmetries, taxes, or transactions costs, hedging financial risk should not add value to the firm because shareholders can undo any risk management activities implemented by the firm at the same cost. If some of the assumptions in the Modigliani & Miller (1958) world are relaxed however, there could be benefits to be obtained from hedging. For example if hedging can reduce cash flow volatility it should enable a firm to invest more in times when cash flow is low, a theory posited by Froot, et al. (1993). If according to Modigliani & Miller (1958) value to shareholders is created through investments that generate a return greater than the cost of financing

[1] Bunker Adjustment Factor (BAF) can be defined as "an agreement between the ship operator and the shipper where the latter agrees to pay additional charges if there is significant change in bunker prices, according to a preset formula" (Alizadeh & Komikos, 2009).

the investment, then reducing volatility to invest more in positive NPV projects should create value to shareholders.

Building upon Modigliani and Miller's capital structure theorem, Smith & Stulz (1985) developed a theory to show that if certain assumptions of this theorem are relaxed then hedging can be beneficial to a value maximizing organization. Using a state preference model the authors show that if the effective marginal tax rate is an increasing function of pre-tax value then the after tax value of the firm is a concave function of its pre-tax value. Based on this relationship the authors demonstrate that the value of a hedged firm is greater than the same firm remaining unhedged. This relation does, however, depend on costless hedging. If hedging is costly then hedging will increase value as long as the costs of hedging do not outweigh the benefits.

Another aspect to consider is the tax structure that investors face. If investors face a non-linear tax structure such that hedging decreases tax liabilities for the firm but increases them for the investors then hedging is not beneficial. Furthermore, if excess tax profits or investment tax credits increase the convexity of the tax function then such a tax will induce firms to hedge more. To summarize, if hedging reduces the variability of pre-tax firm values, corporate tax liabilities are reduced and the expected post tax values are increased as long the cost of hedging is not too large.

Smith & Stulz (1985) also argue that there is a benefit to hedging from firms in that it can reduce financial distress costs. This is because by reducing the variability of the future value of the firm, the lower the probability of incurring bankruptcy costs. The lower the expected bankruptcy costs, the higher the expected payoffs to the firms claimholders. To exemplify, consider a firm with face value of debt equal to F, if the value of the firm is below F at maturity then bondholders will receive F less bankruptcy costs and shareholders nothing. If the value of the firm is greater than F at maturity then shareholders will receive firm value less taxes and F. The authors show that costless hedging decreases the present value (PV) of bankruptcy costs and increases the PV of the tax shield. The firm can reduce bankruptcy costs by holding an offsetting hedge portfolio that pays a positive amount in states of the world where bankruptcy would occur without hedging.

There are also two ways in which market forces make hedging policies attractive to shareholders. One is that the firm's reputation is affected positively by increasing the price for new debt, assuming the firm borrows frequently. The second reason is that hedging can reduce the probability of covenants becoming binding e.g. covenants that force a firm to alter its investment policy. This is due to the decrease in expected costs of financial distress (Smith & Stulz, 1985).

Froot, et al. (1994) and Froot, et al. (1993) developed a theory of why firms' hedge based on mitigating underinvestment and increasing a firm's debt capacity. Froot, et al. (1993) presented a rationale for hedging based on capital market imperfections that could make externally funds more expensive, thus making internally generated funds more attractive. To ensure to have internally funds available, hedging is necessary. The authors argue that hedging will reduce cash flow variability and hence reduce the variability in external funds raised or in investments made. Reducing investment variability is however contingent upon output being a concave function of investment and the marginal cost of funds as an increasing function of externally raised finances. Lack of cash would then be met with some raising of external funds as well as a reduction in investment, therefore cash flow variability affects both financing and investment decisions which is costly to the firm. To show the benefits of hedging Froot, et al. (1993) develop a general framework and how this framework corresponds to an optimal contracting model. The authors show that for hedging to be beneficial, two conditions need to be satisfied, marginal returns on investment must be decreasing and the level of internal wealth must be positively related to the level of investment.

These arguments are elaborated upon in Froot, et al. (1994), who developed a framework for how a corporation can implement a coherent risk management strategy. The authors build upon the pecking order theory, that firms prefer internally generated funds because external funds are too expensive. Based on this, the authors argue that the goal of risk management should be to ensure that a company has the cash available when they need it to make value-enhancing decisions. This is seen as vital for a company's success as investment volatility can threaten a company's ability to meet its strategic objectives. Furthermore, Froot, et al. (1993) and Froot, et al. (1994) argue that firms whose cash flows are more closely correlated to future investment opportunities will hedge less. For example if the oil price drops, the demand for oil exploration is also reduced.

Smith & Stulz (1985) state that managerial risk aversion and compensation schemes can be linked to hedging decisions by firms. Managers, employees, customers etc. are sometimes unable to diversify risks specific to their claims on the corporation and will require extra compensation to bear non-diversifiable risks.

Without proper incentives managers will not maximize shareholder wealth and therefore the manager's compensation should be designed so that when firm value increases so does their utility, therefore managers' compensation is occasionally tied to firm value. Assuming the manager's expected utility depends on the distribution of the firm's payoffs, changing this distribution through hedging also changes a manager's expected utility. This relationship has several implications on the level of hedging undertaken by a firm. If a manager's wealth is a concave function of firm value then the optimal hedge strategy would be to hedge completely. This conclusion is based on Jensen's inequality stating that the expected value of a concave function is smaller than the value of the function evaluated at the expected value of the random variable. If the manager's wealth is a convex function of firm value but their utility is a concave function of firm value, the optimal strategy would be to hedge some but not all risk. Finally if a manager's utility is a convex function of firm value the manager will choose to not hedge at all. This is the case if their compensation comes in the form of for example options or bonuses. Other aspects include the role of accounting and manager ownership. If a manager's compensation is tied to accounting earnings they will have more of an incentive to hedge accounting earnings variance even if it increases economic value variance. If the manager owns a significant fraction of the firm then more hedging is expected and closely held firms will hedge more as it is less likely that those managers hold diversified portfolios (Smith & Stulz, 1985).

Smith & Stulz (1985) also show that managers whose compensation is a concave function of firm value have incentives to reduce cash flow variability. Such managers might reject variance increasing NPV projects. Hence, if hedging costs are small then it could be beneficial to let managers hedge as they will then have an incentive to take on variance increasing NPV projects which would benefit shareholders. With costly hedging, however, shareholders have an incentive to devise compensation schemes that discourage managers from hedging.

2.2. Empirical evidence on rationale for hedging

There have been numerous empirical studies related to risk management practices in various industries that examine the rationale for hedging activities adopted by companies. Nance, et al. (1993) analyzed the determinants for corporate hedging using a survey consisting of 169 firms in the U.S. Their results of restricted logit regressions suggest that firms are more likely to hedge if: they have more investment tax credits; a larger portion of the firm's income is in the progressive region of the tax schedule; the firm is larger; if the firm has more growth options (i.e. higher R&D expenditures); and if the firm has higher dividend payout. Furthermore, they concluded that the hedging decision is made to reduce expected tax liabilities, lower expected transaction costs, and to control agency problems.

Tufano (1996) analyzed the risk management practices in the North American gold mining industry. The author found little empirical support for risk management being explained by the theories based on the maximization of shareholder value. Multivariate tests did not show any observable relationship between hedging and likelihood of financial distress, tax convexities or portion of investment program represented by acquisition programs. However, regarding the rationale for hedging associated with the maximization of manager's utility, support was found for the theory that managers who hold more options engage in less risk management than managers who hold stocks, suggesting that managerial risk aversion may affect corporate risk management policy. This finding provides support for the risk aversion theory developed by Smith & Stulz (1985). Moreover, Tufano (1996) concluded that firms with lower cash balances manage more risk, firms with large outside block holdings manage less risk and that risk management is negatively associated with the tenure of a firm's CFO.

Geczy et al. (1997) examined the determinants of corporate derivative use for 372 firms that had exposure to foreign exchange rate risk in the U.S. In their univariate tests, they found that foreign currency derivatives (FCD) user firms differed from non-user firms regarding variables related to growth opportunities. User firms were larger, had higher R&D/Sales ratios, smaller Book/Market ratios, lower quick ratios, larger managerial option holdings and lower LT debt ratios. Non-users did however exhibit less information asymmetry. FCD users and non-users were not statistically different with regards to managerial wealth, substitutes for hedging or tax preferences. Furthermore, the author's logit model showed that financing constraints create incentives for hedging. Higher quick ratios, indicating more internally existing funds, imply a lower probability of using derivatives. In this sense, firms hedge to reduce variance in cash flows that could impede firms from investing in growth opportunities. Géczy, et al. (1997) also found that potential underinvestment costs provide incentives for hedging. An increase in the ratio of R&D expenditures to sales lead to an increase in the probability of firms using currency derivatives. Finally, they suggested that the costs associated with implementing a hedging strategy could also play a role in a firm's decision to use currency derivatives.

Graham and Rogers (2000) studied the rationale for derivative holdings of firms facing interest rate and/or currency risk in the U.S for fiscal year 1995. The author's univariate analysis showed evidence that hedging increases with firm size, as in their sample, hedging companies were much larger than non-hedgers. This is also related to the theory of fixed costs of derivative instruments acting as a barrier for small firms. The authors also found that hedgers had lower book to market ratios, suggesting that hedgers have greater investment opportunities providing support for the underinvestment theories developed by Froot et, al. (1993). Furthermore, when analyzing the joint influence of the explanatory variables on corporate derivatives hedging, Graham & Rogers (2000) found evidence of firms hedging in response to large expected costs of distress, as the debt ratio and the interaction of debt with market-book were both positively related to interest rate hedging. Firms with lower ROA showed higher derivative holdings, consistent with the financial distress theory as a reason to hedge. These findings are in line with the hedging arguments brought forth by Smith & Stulz (1985). More importantly, net operating loss (NOL) carryforwards exhibited a negative coefficient, indicating that firms reduce hedging if they have recently retained losses. Finally, Graham & Rogers (2000) found a positive relation between R&D expenses and hedging, which is consistent with the underinvestment hypothesis of Froot, et al. (1993).

Adam, et al. (2007) developed a model to analyze the hedging decisions of firms based on the theory presented by Froot, et al. (1993). They considered the case in which firms must depend only on internal funds to finance their investments, assuming that companies have the flexibility to adjust their output in response to realized production costs after making their investment decisions. Due to this flexibility, a firm's profit function can be convex in investment, providing an incentive to hedge for financially constrained firms. Adam, et al. (2007) also analyzed how a firm´s risk management hedging decision is affected by the hedging choices of its competitors. They found that firms gain more from additional investments when other firms invest less, implying that a firm has an incentive to make risk management decisions that transfer cash flows to states in which its competitors are relatively cash constrained. Finally, their model predicts that in the most competitive industries there is more heterogeneity in the choice to hedge.

Campello, et al. (2011) and Pérez-González & Yun (2013) examined the implications on financing and investment from hedging. Campello, et al. (2011) found a positive relation between hedging and a firm's ability to invest. The authors' results showed that hedgers pay lower interest spreads and are less likely to have capital expenditure restrictions in loan agreements. Furthermore it was found that the average IR/FX hedger is able to increase investment spending by close to 13% of the sample mean level of investment. Hedgers were also larger and more leveraged, and exhibited lower cash flow and asset volatility. Similar results were found by Pérez-González & Yun (2013) who used a sample of 203 US electric and gas firms, examining the effect of using weather derivatives on investment and financing. They find that hedging leads to more aggressive financing policies and higher investment policies. Their results showed that smooth cash flows may allow firms to relax their borrowing constraints or to pursue valuable investments in low cash flow scenarios, providing support for the framework presented in Froot, et al. (1993) and Froot, et al. (1994).

Guay & Kothari (2002) examined the magnitude of risk exposure hedged by using financial derivatives for 234 large non-financial corporations. The results of their study showed that if interest rates, currency exchange rates, and commodity prices change simultaneously by 3 standard deviations, the median firm's derivatives portfolio, generates 15 million USD in cash and 31 million USD in value. Some evidence was also found for increased use of derivatives for larger firms and for firms with greater investment opportunities. The authors also observed increased derivatives use among more geographically diverse firms and among firms for which the CEO's sensitivity of wealth to stock price is relatively large. In the same study multivariate tests indicated that geographic diversification and investment opportunities have the greatest power to explain firms' hedging intensities. Guay & Kothari (2003) also observe increased derivatives use among more geographically diverse firms and among firms for which the CEO's sensitivity of wealth to stock price is relatively large. These findings provide further support for both the Froot et al. (1993) framework in that firms with greater investment opportunities should hedge more as well as the

Smith and Stulz (1985) argument that more closely held firms by managers also hedge more. Guay & Kothari (2002) also found that the magnitude of the derivative positions held by most firms is economically small in relation to their entity-level risk exposures.

2.3. Empirical evidence on hedging and firm value and performance

The empirical research regarding hedging and firm value has shown mixed results. Allayannis & Weston (2001) found a positive and significant relationship between Tobin's Q and foreign currency derivative (FCD) use. The authors' results showed that Tobin's Q for firms using FCD's was between 4.5% and 5.3% higher than for non-users. In addition, firms that began a hedging policy experienced an increase in value above those firms that chose to remain unhedged whereas firms that quit hedging experienced a decrease in value relative to those firms that chose to remain hedged.

Further evidence of how hedging positively affects firm value was found by Carter, et al. (2006) who analyzed the relationship between jet fuel hedging and Tobin's Q in the US airline industry. The hedge premium in this industry was found to be between 5% and 10%. The results also showed that the greater the percentage of the following years fuel requirements that were hedged, the greater the firm value. This hedging premium was also attributable to the interaction between hedging and investment. It was found that the main benefit of jet fuel hedging by airlines is the reduction of underinvestment costs. The value premium suggests that hedging provides airlines the ability to invest during periods of high jet fuel prices consistent with the Froot et al. (1994) and Froot, et al. (1993). This industry specific study is similar to the one conducted in this paper as there are several similarities between the airline industry and the shipping industry. For example, fuel costs take up a large part of operating expenses for firms in both industries.

Pérez-González & Yun (2013) found evidence that hedging using weather derivatives for a sample of US electric and gas firms was associated with higher firm values. The authors find that in the absence of weather derivatives, firms that are highly exposed to weather volatility exhibit significantly lower valuations and pursue more conservative financing policies. The use of weather derivatives lead to an economically important and statistically robust increase in firm value, the results showed an increase in market-to- book (M-B) ratios of at least 6% for derivative users.

In contrast to these findings, Li, et al. (2014) and Jin & Jorion (2006) found negative relationships between hedging and firm value. Li, et al. (2014) examined the effect that foreign currency derivative use had on Tobin's Q for listed non-financial firms in New Zealand for the year 2007. The authors found a significant negative relation between Tobin's Q and the use of foreign currency derivatives. Similar results were found by Jin & Jorion (2006) who examined the effect of hedging on firm values in the oil and gas industry. Using a sample of 119 US oil and gas firms between 1998 and 2001 they found no significant difference between Tobin's Q for hedging and non-hedging firms. The authors argue that this result was obtained because the oil and gas context is closer to the Modigliani & Miller theorem. Investors in the oil and gas industry can easily identify the commodity exposure and hedge on their own, therefore there is no value premium attached to firms who hedge.

Regarding research related to the possible contribution of derivatives hedging to firm performance, Kwong (2016) found that derivatives use contributes to a better ROA and ROE, in a study based on a sample of 680 non-financial firms in Malaysia. However, the author's multivariate model with firm market value as a dependent variable showed that capital markets also imposed a "discount" on derivative user firms. Furthermore, in univariate tests, derivative users exhibited smaller standard deviations for net profit and operating margin, providing evidence that hedging helps to reduce earnings volatility. Also, derivatives users were larger, had lower financing costs, better growth opportunities and had better asset turnover than non-users.

Brown, et al. (2006) analyzed the corporate risk management activities by US gold mining firms and its effect on firm operating and financial performance. The authors found that these firms attempt to time market prices with their risk management policies, referred to as selective hedging. The findings, however, suggest that the economic gains from selective hedging are small and there was no evidence of hedging leading to superior operating or financial performance. No significant evidence was found that active hedgers grow at a faster pace than non-active hedgers or that ROA is higher for active hedgers compared to non-active hedgers. Changes in EBITDA and changes in sales were also negatively correlated to changes in a firm's hedge ratio. The authors did however find that non-active hedgers have slightly better market performance (i.e. changes in market value) compared to active hedgers. Firms with greater growth opportunities, proxied by the market-to-book ratio, engaged in less selective hedging.

Taking into account the existing literature and characteristics of the shipping industry we believe that profitability of shipping firms should be negatively affected by increases in bunker fuel prices. If the hedging strategy for fuel derivative users is effective we expect a positive relationship between fuel price hedging and ROIC. Based on the Froot, et al. (1993) framework we also expect a positive interaction between ROIC, investment and hedging. When bunker fuel prices increase the firms who hedge should have more stable cash flows and therefore have more funds available for investments as well as being able to withstand abrupt changes in demand given the industry's close ties to world trade.

3. Research design

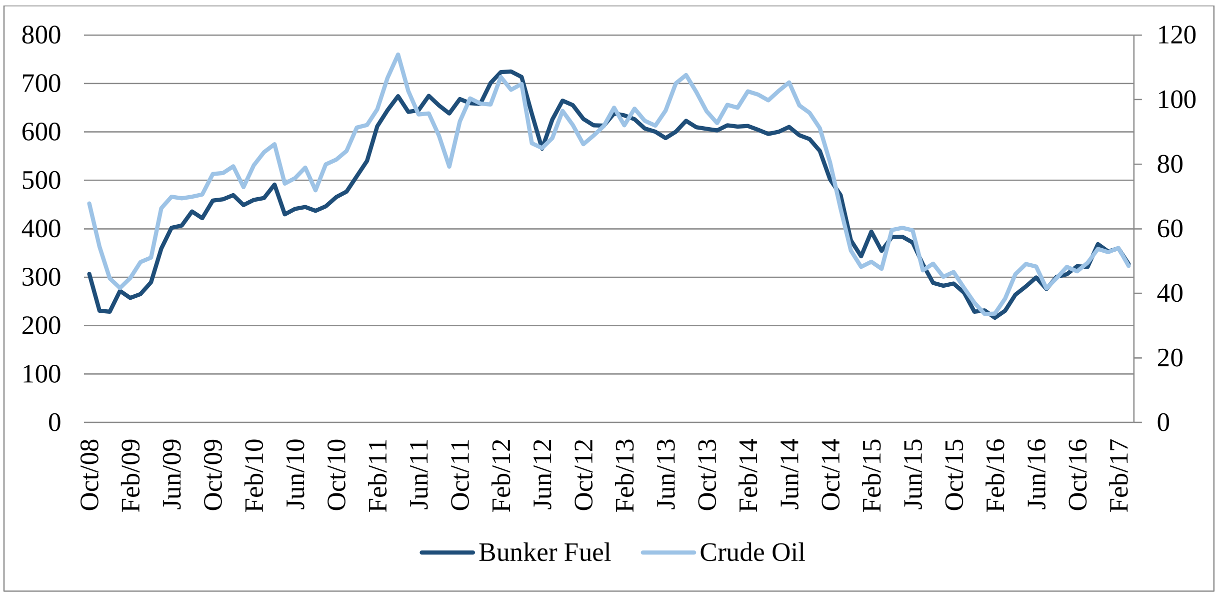
In this section we will present the methodology used in this study. The data collection methods, sample description and the period analyzed as well as specifications of our multivariate regressions will be brought forth.

3.1. Sample size and period

The Bloomberg (2017) equity screener was used to identify the shipping firms used for this study. We included only companies that had publicly traded common stock, were actively traded and classified as marine shipping or marine transportation by the Bloomberg Industry Classification System (BICS) and Global Industry Classification Standard (GICS) respectively. Further vetting was performed by reading each firms description about their operating activities. Only firms that explicitly engage in marine transportation activities were included. Firms not directly engaging in marine transportation activities were excluded such as firms only offering shipping consulting services, warehousing and other related services. Some firms included in our sample do however engage in other services apart from marine transportation, see appendix A. The study was conducted for the period between 2009 and 2014. The final sample was 25 shipping companies from Europe and 6 companies from North America, for a total of 31 companies and 186 observations. All data was retrieved in US dollars.

Certain extreme outliers were cut from our data, in total five firm-years were excluded from the sample. These observations displayed ROIC values of 55.96%, 34.03%, -233.27% and -38.5%. Running our regressions with these data points would distort our results. To exemplify, the company Newlead Holdings LTD experienced a substantial increase in operating losses for the years 2013 and 2014, which led to a ROIC of -233.27% and -38.5% respectively. In contrast, KDM Shipping PLC experienced a dramatic rise in its revenues in 2011 and 2012 due to a cyclical increase in the freight rates for dry bulk cargoes in the Black, Azov and Mediterranean Sea regions, and this led to a ROIC of 55.96% and 34.03% respectively. Also, ROIC for this company could not be calculated in 2009 due to missing financial data.

Figure 2. Historical crude oil prices vs. bunker fuel prices (2008-2017). Figures in USD.



Source: Bloomberg (2017)

As previously mentioned the period analyzed was 2009-2014, any company that did not have available financial statement data during these years were excluded from the sample. This specific period was chosen as during this time the price of crude oil was experiencing a recovery in the aftermath of the financial crisis. As can be observed in figure 2 the oil price experienced a sharp increase starting in 2009 and a period of stability between 2011 and 2014 before a sharp drop in the second half of 2014.

By the end of December in 2008 the price of crude oil was $44.2 per barrel, decreasing from $144.29 in July during the same year. The sharp drop in 2008 was partly brought on by then president George W. Bush lifting an executive ban on offshore drilling (CNN, 2008) , easing tensions between the US and Iran (The Age, 2008), a weaker US dollar versus the Euro and an expected weakening demand for oil and gas in Europe (CNN, 2008). In the five years following there were numerous geopolitical events that contributed to the oil price being kept at a relatively high level. These events included rising tensions in Gaza (BBC News, 2009), political and supply uncertainty in Oman, Libya and Iran (The New York Times, 2011), and expectations of higher demand for oil because of economic improvements in several European countries and the US (Yahoo Finance, 2011). There were also supply risks in Russia as well as the Texas oil spill that contributed to oil price increases during this period (US News, 2014). By the end of June in 2014 the price was $105.37 per barrel, however it decreased dramatically to $53.27 at the end of December of the same year.

A period of high bunker fuel prices such as the sharp increase during 2009 and 2010 should impact the cash flows of shipping firms negatively as their operating expenses increase. However, the economic recovery after the financial crisis in 2008 increased demand for goods and services and hence the transportation of various products possibly benefiting the revenues of shipping firms. Even though the price for crude oil and bunker fuel were volatile during our sample period, Figure 2 indicates that there were no significant shocks to the price of oil apart from the second half of 2014. Based on this one would expect this would be a period where shipping firms hedging the price of oil would experience higher and/or more stable profitability.

3.2. Method

In this study a multivariate linear regression was used with panel data to determine the relationship between bunker fuel and/or derivative holdings and firm performance in the shipping industry. This method was seen as appropriate considering our data is quantitative and has been used in several prior studies related to hedging and firm value and performance; see e.g. Carter, et al. (2006), Allayannis & Weston (2001), Kwong (2016) and Li, et al. (2014). To do this we use cross sectional tests that compare firm performance as a function of hedging decisions. The dependent variable in this study was ROIC as a proxy for firm performance. The notes to the annual reports of each company were used to determine whether the company engaged in hedging activities in a certain year for; bunker fuel or crude oil price, freight rates, interest rates, and exchange rates. A dummy variable equal to 1 was used if the firm hedged during a particular year and zero otherwise. This method is similar to that used in Allayannis & Weston (2001), Li, et al. (2014), Carter, et al. (2006) and Pérez-González & Yun (2013). Data was collected on an annual basis with financial data downloaded from Bloomberg (2017) to calculate the financial ratios used in our calculations. Several control variables believed to be related to both hedging and influence ROIC were included as independent variables.

We also wanted to determine if hedging activities are related to investment opportunities. To do this, the same regression as for ROIC was run with one additional independent variable; CAPEX over Total Assets multiplied by our fuel hedging dummy. This variable is intended to analyze ROIC and its relation to the interaction between fuel hedging and CAPEX, this method was also used in Carter, et al. (2006).

3.2.1. ROIC statistical model specification and description

Equation (1) was used to estimate our regression model. Let $Fuel_{it}$ denote the fuel hedge dummy for firm i, at time t. The regression over firm i and control variables j that belong to the set Ω enables use of $J = |\Omega|$ explanatory factors at the same time, i.e. $1 + |\Omega|$ regressors. The multiple linear regression model for firm i and the control variables in Ω are given by,

$$ROIC_{it} = \beta * Fuel_{it} + \sum_{i\in\Omega} \beta_{ijt} Control_{ijt} + \varepsilon_{it}, \qquad i = 1, \dots, I, \qquad t = T_1, \dots, T_N \qquad (1)$$

The dependent variable ROIC was calculated as,

$$ROIC_{it} = (EBIT_{it} * (1 - T_{it})) \,/\, Invested\ Capital_{it}$$

for company i in period t. T is the corporate tax rate in the country that each company is incorporated in, for a detailed description of tax rates see Appendix B. Beginning of year $(t-1)$ Total Assets, Cash & Cash Equivalents and Long Term Debt were used for all of our financial ratios. This is because the return on investments made in the previous year will be generally be reflected in ROIC for the following year. End of period assets are then a function of the previous year's ROIC causing potential endogeneity. Using the beginning of year total assets should help mitigate this problem. The denominator for the ROIC measure was defined as Invested Capital (IC),

$$IC_{it} = \ Total\ Assets_{it-1} - Cash\ \&\ Cash\ equivalents_{it-1} - Short\ term\ operating\ liabilties_{it-1}$$

where,

$$Short\ term\ operating\ liabilties_{it-1} = Current\ liabilities_{it-1} - Short\ term\ borrowings_{it-1}$$

In order to isolate the effect that fuel hedging has on ROIC several variables believed to also influence both ROIC and our fuel hedging dummy were controlled for. The control variables in this study were;

$CAPEX_{it}/Total\ Assets_{it-1}$: If firms invest more it should affect Invested Capital and therefore ROIC. The expected sign is ambiguous as it depends on the firm's ability to generate cash flows from these assets. Similar ratios has been used by e.g. Allayannis & Weston (2001), Jin & Jorion (2006) and Carter, et al. (2006) to control for investment growth opportunities on firm value. Firms with greater investment needs should also hedge more in order to have more stable cash flows to ensure availability of internal funds to finance these investments.

$Cash_{it-1}\ /\ Total\ Assets_{it-1}$: Firms with lower cash balances have been shown to manage more risk (Tufano, 1996). Related to firm performance, liquidity has shown to have ambiguous effects. In an agency theory context companies with higher liquidity should have lower levels of performance due to managers investing in negative NPV projects (Silva & Maçãs, 2008). Liquidity can however also have positive effects on performance as it gives firms greater capacity to face competitive changes in a firm's market segment (Silva & Maçãs, 2008).

$Long\ Term\ Debt_{it-1}\ /\ Total\ Assets_{it-1}$: Empirical research shows that firms that hedge more are also more leveraged (Tufano, 1996). Higher leverage can also reduce a firm's ability to raise funds to finance future positive NPV projects due to a higher financial risk and therefore reduce profitability (Fok, et al., 2004). However, debt commitments can force managers to manage resources more efficiently due to reduction in free cash flows (Silva & Maçãs, 2008).

$Size = LN(Total\ Assets_{it-1})$: Several previous risk management studies have found that hedgers are larger than non-hedgers, see e.g. Graham & Rogers (2000), Jin & Jorion (2006) and Campello, et al. (2011). Large firms may also have more market power, greater access to capital and have better capabilities to take advantage of economies of scale which could lead to higher cash flows and profitability (Fok, et al., 2004; Hardwick, 1997). However, once the company has reached maturity then an increase in size could have a negative impact on performance. This variable has also been used as a control variable in several other operating performance and firm value studies related to hedging, see e.g. Simpson & Kohers (2002), Ferrier & Lyon (2004) and Allayannis & Weston (2001).

Furthermore, additional hedging dummies were included indicating freight rate and foreign exchange (FX) rate derivative use, equal to 1 if the firm hedged that particular exposure in year t and 0 otherwise. Hedging dummies for interest rate hedging were excluded however as 28 out of 31 firms in our sample hedged for interest rates, including such a variable would therefore distort our results. A statistically significant and positive fuel hedging dummy coefficient can be interpreted as fuel hedging having a positive effect on ROIC. As fuel hedging should stabilize bunker fuel operating costs for shipping firms it should increase EBIT and ROIC. We therefore expect the fuel hedge dummy to be positive in sign.

$$Hypothesis: \beta_{fuel} > 0$$

3.2.2. Investment statistical model specification

To test the relation between hedging and investment and its combined effect on ROIC we ran two additional regressions. Firstly we want to identify if there is any relationship between bunker fuel costs and capital expenditures. Secondly we want to identify if for firms that hedge fuel prices there is any effect on ROIC stemming from the interaction between hedging and capital expenditures. The method used is similar to that in Carter, et al. (2006).

The dependent variable in our first regression was CAPEX / Total Assets denoted by $CAPEX$, the independent variables were; the 12 month average bunker fuel price for year t denoted by $Bunker$, Operating Cash Flow to Total Assets denoted by CF and Tobin's Q measured as Market Value of Equity + Total Liabilities / Total Assets. Including CF and Tobin's Q allows to control for cash flow and growth opportunities and their effect on capital expenditures, thereby isolating the effect of bunker fuel prices. The multiple linear regression model for firm i in year t is given by,

$$CAPEX_{it} = a + \beta * Bunker_{it} + \beta * CF_{it} + \beta * Tobin's\ Q_{it} \qquad (2)$$

A negative and significant coefficient for the $Bunker$ variable can be interpreted as bunker fuel prices having a negative impact on shipping firms' capital expenditures. A positive sign would imply that shipping firms invest more when bunker fuel prices are higher. Given that bunker fuel is a major component of shipping firms operating expenses, we would expect that increases in the bunker fuel price to have a negative impact on cash flows therefore leaving less funds available for investing. Given these factors we expect the $Bunker$ coefficient to be negative in sign and statistically significant.

$$Hypothesis: \beta_{Bunker} < 0$$

After running regression (2) we ran an additional model using ROIC as the dependent variable and the same independent variables as in equation (1) with one additional variable; the fuel hedging dummy multiplied by CAPEX to Total Assets denoted by $Fuel * CAPEX$. The multiple linear regression model for firm i and the control variables in Ω are given by,

$$ROIC_{it} = \beta * Fuel_{it} + \beta * Fuel * CAPEX_{it} + \sum_{i \in \Omega} \beta_{ijt} Control_{ijt-1} + \varepsilon_{it}, \qquad i = 1, \dots, I, \qquad t = T_1, \dots, T_N \tag{3}$$

A positive and significant coefficient for the $Fuel * CAPEX$ can be interpreted as for those firms that engage in fuel cost hedging, capital expenditures would contribute to a higher ROIC, the opposite would be true for a negative coefficient. We would expect the sign of the $Fuel * CAPEX$ coefficient to be positive and significant. This is because firms that opt to hedge against fuel cost risks should be able to generate more stable cash flows, therefore have more internally generated funds available to invest in positive NPV projects and have better performance.

$$Hypothesis: \beta_{Fuel*CAPEX} > 0$$

3.2.3. Robustness Checks

As panel data is used it is important to account for any possible heteroskedasticity. In this study a Breusch-Pagan test was implemented where the squared residuals from the OLS linear panel regression were used in a separate regression as a dependent variable with the same independent variables as in equation (1). If the F statistic from this test was significant, p-value < 0.05, we reject the null hypothesis of homoscedasticity indicating that heteroskedasticity is present, see appendix E for results.

A Redundant Fixed Effects test in Eviews was run to determine if there was any presence of fixed effects in the cross-section and/or period dimension. If the F-test statistic was significant for the cross-section dimension, period dimension or both, a regression model with the appropriate fixed effects specification was run, see appendix D for results. A Hausman test was then used to determine if a fixed effects or random effects specification would be more suitable for our data. If the p-value of the Chi-Squared Statistic from the Hausman test was < 0.05, a fixed effects specification is to be considered a more suitable specification, see appendix F for results.

In this study however, we rely mainly on the results from our fixed effects specification model. Fixed effects control for time invariant differences between the firms in our sample that can cause cross-sectional heterogeneity (Roberts & Whited, 2012). Examples of these individual differences could include managerial preferences, business practices or political systems in the countries that a specific firm operates in which could influence a firm's decision making. Based on this we expect that the estimated coefficients of the fixed effects model are not biased by omitted firm's individual characteristics that may influence the outcome. A random effects specification should be more efficient in that fewer parameters have to be estimated compared to a Least Squares Dummy Variable (LSDV) model as well as saving on degrees of freedom. It would also allow us to infer our results to a larger population outside of our sample. However, the requirements of the random effects model are stricter. Assuming u_i is the error term in a linear regression and $u_{it} = c_i + e_{it}$,

where $c_i = unobservable\ entitiy\ specific\ effect$

and $e_{it} = i.i.d\ error\ term$

The assumptions that must be fulfilled in a random effects model are then,

1) $c_i \sim N(0, \sigma_c^2), e_{it} \sim N(0, \sigma_e^2)$
2) $c_i\ are\ indpendent\ of\ e_{it}$
3) $both\ c_i\ and\ e_{it}\ are\ independent\ of\ the\ explanatory\ variable/s\ x_{it}$

Even if a Hausman test indicates that a random effects model is more appropriate it cannot be certain that these assumptions are fulfilled which would lead to endogeneity problems in our model. As the random effects model assumes that an entity's error terms are uncorrelated with our predictor variables, it allows for time invariant characteristics to act as explanatory variables. Controlling for this would then require specifying these individual characteristics which is difficult, leading to a higher probability of our model suffering from omitted variable bias.

In addition to this when estimating the panel data regression we also considered the results of the Breusch-Pagan heteroskedasticity test. If heteroskedasticity was present then White cross-sectional robust standard errors were used to mitigate this problem. Depending on the effect specification, White cross-sectional, period or diagonal standard errors were used.

4. Analysis and findings

In this section we will present and analyze the characteristics of our sample as well as the results of our multivariate regressions. The simulation environment is Microsoft Excel and Eviews. Excel was used for data storage, computation of financial ratios and construction of tables. Eviews was used to run the multivariate regressions and conduct any necessary statistical tests and specification adjustments related to these. T-tests for differences in means and F-tests for variance equality were conducted in Excel.

4.1. Descriptive statistics

Table 1 shows the means and medians of market value of equity, firm size and several performance, liquidity, investment, and leverage ratios. Table 2 shows the variance for performance ratios. Here we compare the characteristics of firms with and without bunker fuel hedging activities during the analyzed period.

It is worth to note that from the 31 analyzed companies, 29 companies made use of derivative contracts either to hedge bunker fuel price, freight rates, exchange rates or interest rates in any particular year. From our total sample, 8 companies had bunker fuel or crude oil derivative contracts during the studied period; 5 companies had freight rates derivatives; 16 companies hedged for exchange rates and 28 companies hedged for interest rates. Additionally, 4 out of the 8 firms that hedge for fuel prices also transport oil and other petroleum products.

Table 1. Sample characteristics. T-test for differences in means fuel hedgers and fuel non-hedgers (2009-2014).

Descriptive statistics ($ millions)	All firms	(1) Fuel hedgers	(2) Fuel non-hedgers	(3) Difference (1) - (2)	
MV equity					
Mean	1,779.9	7,157.4	351.6	6,805.8	***
Median	157.6	1,210.9	109.2		
Assets					
Mean	3,916.7	13,894.1	1,213.8	12,680.3	***
Median	761.2	3,728.2	544.0		
ROIC					
Mean	2.9%	2.3%	3.1%	- 0.00845	
Median	3.2%	3.3%	3.2%		
LT Debt / Total Assets					
Mean	35.5%	28.8%	37.4%	- 0.08549	***
Median	34.7%	29.2%	37.7%		
CAPEX / Total Assets					
Mean	7.9%	8.5%	7.7%	0.00805	
Median	6.2%	7.7%	5.0%		
Cash / Total Assets					
Mean	7.5%	8.2%	7.2%	0.00939	
Median	5.5%	6.2%	5.2%		
Operating CF / Sales					
Mean	22.6%	11.4%	25.7%	- 0.14251	***
Median	16.9%	11.3%	22.1%		
Net Income / Sales					
Mean	-40.3%	-6.4%	-49.9%	0.43506	
Median	4.0%	3.8%	4.3%		
EBIT / Sales					
Mean	11.0%	5.1%	12.6%	- 0.07504	**
Median	9.8%	7.6%	13.4%		

*** and ** denote statistical significance of the t-tests at a 1% and 5% level respectively.

Table 2. F-test for equality of variances between fuel hedgers and fuel non-hedgers (2009-2014).

	All firms	(1) Fuel hedgers	(2) Fuel non-hedgers	(3) Difference (1) - (2)	
ROIC					
Variance	0.0045986	0.0044071	0.0046684	-0.000261	
EBIT / Sales					
Variance	0.1072201	0.0110149	0.1333441	-0.122329	***
Net Income / Sales					
Variance	12.3881585	0.3329687	15.7685382	-15.43557	***
Operating CF / Sales					
Variance	0.0908074	0.0193169	0.1067304	-0.087414	***

*** denote statistical significance of the f-tests at a 1% level

Our tests of the differences in means show that non-hedgers have higher firm performance, as showed by the differences in our ROIC variables. This difference was not significant however, indicating that fuel hedging does not provide any considerable benefits to firm operating performance. Furthermore, we find that fuel derivative users are larger measured by both market value and total assets, this difference is significant at the 1% level. These results show similarities to previous risk management studies, see e.g. Graham & Rogers (2000), Jin & Jorion (2006) and Campello, et al. (2011). It should be noted that the average market value for fuel hedgers shown in table 1 of $7.157 is heavily influenced by one company, A.P. Møller-Mærsk. When removing this observation the average MV of Equity drops to $928 million, the difference between the two groups was still significant at the 1% level however.

It was also found that non-fuel hedgers are more highly levered than fuel hedgers. This is contradictory to results found in Campello, et al. (2011) and Tufano (1996) where a positive relationship was found between leverage and hedging. This could indicate that fuel hedgers are not taking advantage of the possible increased value of the tax shield obtained by incresaing debt holdings shown by Smith & Stulz (1985).

Fuel hedgers were shown to have lower Operating Cash Flow to Sales ratios and EBIT margin volatility. This result provides support for the theory put forth by Froot, et al. (1993) in that hedging should be used to reduce volaitility in cash flows to ensure access to cash in difficult times. These results are also consistent with the findings of Campello, et al. (2011) and Kwong (2016) showing that hedgers exhibit lower cash flow and earnings volatility respectively.

4.2. ROIC Multivariate Tests

Table 3. Fuel hedging and firm performance: cross-section results

Dependent variable: ROIC	**Pooled OLS (Model 1)**	**Random effects (Model 2)**	**Fixed Effects (Model 3)**
Observations	181	181	181
Adjusted R2	0.042	0.012	0.374
CAPEX / Total Assets	0.073	0.050	0.037
Cash / Total Assets	0.081	0.107*	0.082
Freight Hedge Dummy	-0.005	0.010	-0.003
Fuel Hedge Dummy	-0.037***	-0.019	0.022
FX Hedge Dummy	0.004	0.016*	0.025
LT Debt / Total Assets	0.004	0.036	0.055
Size	0.011**	0.003	-0.004

***, ** and * denote statistical significance of the t-tests at a 1%, 5% and 10% respectively.

In addition to our univariate tests we also conducted multivariate tests to further investigate the relationship between ROIC and fuel hedging. The results in table 3 were obtained using equation (1) in section 3.2.1. Model 1 was estimated with pooled OLS using robust standard errors that account for heteroskedasticity and clustered data. White cross-sectional standard errors were used for Model 2 (i.e. the random effects model) and White diagonal standard errors were used for Model 3 (i.e. the fixed effects model) to account for heteroskedasticity. Both period and cross-sectional fixed effects were used for the fixed effects model based on the results obtained from the redundant fixed effects test, see appendix D.

Table 3 shows the results for the multivariate regression where the dependent variable is ROIC. The results obtained from Model 1 and 2 show a negative relation between bunker fuel and/or oil hedging and ROIC. However, in Model 2 the coefficient for the binary fuel hedging variable is not statistically significant. These results are contrary to the positive jet fuel hedging coefficient found by Carter, et al. (2006) who studied the effect of jet fuel hedging on firm value in the US airline industry. In contrast to the results in Model 1 and 2, the fuel hedging dummy coefficient in Model 3 is positive in sign indicating that hedging for fuel has a positive effect on ROIC, the coefficient was not significant however. This finding is similar to that found by Allayannis & Weston (2001) who found that hedging with foreign currency derivatives had a positive but statistically insignificant effect on Tobin's Q by using a fixed effects model. The authors coefficient economic magnitude did not deviate greatly from the one obtained in this study, 0.045 compared to our fuel hedging dummy of 0.022. Furthermore, Kwong (2016) found a positive and statistically significant relationship between derivatives use for hedging and ROA as well as ROE for non-financial firms in Malaysia. Considering that we rely on the fixed effects model, there is no conclusive evidence based on our data that merely hedging fuel prices significantly influences ROIC for firms operating in the shipping industry.

The insignificant result of the fuel cost hedging dummy could be a result of the contracting practices in the shipping industry. Bunker adjustment factors (BAF) are frequently included in contracts between ship operators and shippers mainly by larger liner companies (Alizadeh & Komikos, 2009). This would eliminate the need for ship operators to hedge fuel prices as with this tool they can transfer bunker fuel price risks to the shipper. Furthermore, the party that bears the bunker fuel price risk can also vary depending on the type of charter.

Regarding our control variables, the two hedging dummies FX and Freight rates have a positive and negative sign respectively in the Fixed Effects model. However neither of these coefficients were significant. The coefficient for Cash to Total assets was positive in sign, indicating that higher liquidity is positively related to firm performance. This could mean that shipping firms with high cash balances are able to adapt better to changing market conditions and are less constrained financially making these firms better positioned to make strategically sound investments. Size is negatively related to firm performance suggesting that larger firms that have reached maturity, a further increase in size will negatively impact firm performance. CAPEX to Total Assets is positive in sign indicating that in the shipping industry, higher capital spending will contribute to better return on those investments. Leverage measured as Long Term Debt to Total Assets is positive in sign, showing that higher debt commitments could benefit ROIC positively by possibly forcing managers to make more efficient use of resources.

None of the control variables; Long Term Debt to Total Assets, Cash to Total Assets, Size and CAPEX to Total Assets were found to be statistically significant however in our Fixed Effects model.

4.3. Investment Multivariate Tests

Table 4. Bunker Fuel Costs and Capital Expenditures

Dependent variable: Capex_Total Assets	**Pooled OLS (Model 1)**	**Random effects (Model 2)**	**Fixed Effects (Model 3)**
Observations	185	185	185
Adjusted R2	0.0510	0.0499	0.0990
Bunker Fuel Price	-0.0001**	-0.0001**	-0.0001*
Operating Cash Flow / Total Assets	0.2289**	0.2231**	0.1783
Tobin's Q	0.0019	0.0017	0.0037

***, ** and * denote statistical significance of the t-tests at a 1%, 5% and 10% respectively.

According to Froot, et al. (1994) it is important to understand the relationship between a company's investment opportunities and economic variables, in our case bunker fuel prices. In this section we investigate whether bunker fuel prices affect investment decisions for shipping firms.Table 4 shows the results of regression (2) from section 3.2.2. As expected the bunker fuel prices coefficient is negative in sign and statistically significant in the three displayed models. This indicates that shipping firms invest less when bunker fuel prices increase and have greater investment opportunities when bunker fuel prices are lower. This is most likely because higher fuel prices decreases cash flows and leaves less funds available for investing activities. This result is opposite to the positive jet fuel cost coefficient found by Carter, et al. (2006). The results in Table 4 also indicate that shipping firms should benefit from fuel hedging in a Froot, et al. (1993) underinvestment framework in order to assure having funds available when needed.

Table 5. Firm performance and Interaction of CAPEX and Fuel Hedging

Dependent variable: ROIC	**Pooled OLS (Model 1)**	**Random effects (Model 2)**	**Fixed Effects (Model 3)**
Observations	181	181	181
Adjusted R2	0.065	0.052	0.405
CAPEX / Total Assets	0.061	0.033	0.025
Fuel hedge * CAPEX / Total Assets	0.395***	0.462**	0.476**
Cash / Total Assets	0.044	0.061	0.033
Freight Hedge Dummy	-0.014	0.003	-0.004
Fuel Hedge Dummy	-0.068***	-0.048*	0.004
FX Hedge Dummy	0.0004	0.014	0.030
LT Debt / Total Assets	0.008	0.042	0.060
Size	0.012**	0.002	-0.003

***, ** and * denote statistical significance of the t-tests at a 1%, 5% and 10% level respectively.

After determining that bunker fuel prices are negatively related to capital spending we wanted to investigate whether ROIC could be affected by higher CAPEX amongst firms that do hedge fuel costs. Table 5 shows the results from regression (3) in section 3.2.2. The coefficients of the control variables have not changed significantly from the results in Table 3 in terms of both sign and magnitude. Our variable of interest Fuel Hedge*CAPEX to Total Assets is positive in sign and significant at the 5% level in the Fixed Effects model. These results were as expected and could provide support for the Froot, et al. (1993) framework in that hedging is beneficial to the extent that it enables firms to obtain internally generated funds to invest in value creating projects. Furthermore, the results show that amongst the firms that engage in fuel cost hedging, those that have greater capital expenditures are able to generate higher returns on their investments. The positive sign could also suggest that hedgers are effective in their hedging strategies and investment choices, which is reflected in a higher ROIC. These results are similar to those obtained in Carter, et al. (2006) who conducted a similar test for firms in the airline industry and found that capital spending contributes to higher Tobin's Q for hedgers than non-hedgers.

Regarding the fuel hedging dummy, Model 1 and 2 showed a statistically significant and negative relation to ROIC. Model 3, however, showed a positive but statistically insignificant relation to ROIC, similar to those obtained in Table 3 in Section 4.2. The results obtained in this section in combination with the results in Section 4.2 also implies that hedging fuel costs alone does not influence ROIC, however the combination of both hedging for fuel costs and increased investing affects ROIC positively.

5. Conclusions

The research question in this study was whether fuel cost hedging has any impact on ROIC for firms operating in the shipping industry and if the interaction between investing and fuel cost hedging could affect ROIC.

Univariate tests showed that fuel cost hedgers had lower ROIC compared to non-hedgers although this result was statistically insignificant. Fuel cost hedgers showed a statistically significant lower Operating Cash Flow to Sales volatility and EBIT margin volatility. This was expected as hedging should lead to smoother cash flows and access to more internal funds in periods of high bunker fuel price volatility. Fuel cost hedgers were also larger and less levered as measured by Long Term Debt to Total Assets.

Similarly multivariate tests showed no evidence that hedging fuel costs has any statistically significant effect on ROIC based on a Fixed Effects linear regression model. None of the control variables Leverage, Size, Cash to Total Assets, CAPEX to Total Assets nor our binary freight and FX hedging variables were significant. Regarding the interaction between investing and fuel costs and its effect on ROIC we found that bunker fuel prices are negatively related to CAPEX to Total Assets. This indicates that shipping firms invest less when bunker fuel prices are higher which in a Froot, et al. (1994) framework should motivate hedging. The variable that captured the interaction between CAPEX and Fuel Cost Hedging was found to be positive and statistically significant showing that for those shipping firms that engage in fuel hedging, higher capital spending contributes positively to ROIC.

6. Limitations and future research

There was a lack of time to reorganize the financial statements for all the companies in our sample in order to obtain a ROIC measure was fully consistent with that put forth by Koller, et al. (2010). Had this been done it might have provided ROIC values that better represent the performance of the firms in our sample and less outliers in our dependent variable.

A similar study could have been made for the global shipping industry given its integral part in world trade. We initially identified a sample of 120 firms of which 53% was comprised of firms based in the Asia and Asia-Pacific regions. These firms were excluded because of difficulties in obtaining appropriate data in English. Differences in accounting standards made it difficult to measure the level of fuel costs that were hedged. If one can gain access to this information, a variable measuring the level of fuel costs hedged could be included in our models. Other statistical models or methods could also have been used e.g. two stage least squares regressions, however finding appropriate instrument variables for this type of model is difficult.

7. References

Adam, T., Dasgupta, S. & Titman, S., 2007. Financial Constraints, Competition, and Hedging in Industry Equilibrium. *The Journal of Finance,* 62(5), pp. 2445-2473.

Alizadeh, A. H. & Komikos, N. K., 2009. *Shipping Derivatives and Risk Management.* s.l.:Palgrave Macmillan.

Alizadeh, A. H. & Nomikos, N. K., 2009. *Shipping Derivatives and Risk Management.* London: Palgrave Macmillan.

Allayannis, G. & Weston, J. P., 2001. The Use of Foreign Currency Derivatives and Firm Market Value. *The Review of Financial Studies,* 14(1), pp. 243-276.

BBC News, 2009. *BBC News.* [Online]
Available at: http://news.bbc.co.uk/2/hi/7811043.stm
[Accessed April 2017].

Bloomberg, 2017. *Bloomberg Professional,* s.l.: s.n.

Brown, G. W., Crabb, P. R. & Haushalter, D., 2006. Are Firms Successful at Selective Heging?. *Journal of Business,* 79(6), pp. 2925-2949.

Campello, M., Lin, C., Ma, Y. & Zou, H., 2011. The Real and Financial Implications of Corporate Hedging. *The Journal of Finance,* 66(5), pp. 1615-1647.

Carter, D. A., Rogers, D. A. & Simkins, B. J., 2006. Does Hedging Affect Firm Value? Evidence from the US Airline Industry. *Financial Management,* 35(1), pp. 53-86.

CNN, 2008. *CNN Money.* [Online]
Available at: http://money.cnn.com/2008/10/06/markets/oil/index.htm
[Accessed April 2017].

CNN, 2008. *CNN Politics.* [Online]
Available at: http://edition.cnn.com/2008/POLITICS/07/14/bush.offshore/index.html
[Accessed April 2017].

Dafir, S. M. & Gajjala, V. N., 2016. *Fuel Hedging and Risk Management: Strategies for Airlines, Shippers, and Other Consumers.* s.l.:John Wiley & Sons Ltd.

Ferrier, W. J. & Lyon, D. W., 2004. Competitive Repertoire Simplicity and Firm Performance: The Moderating Role of Top Management Team Heterogeneity. *Managerial and Decision Economics,* September - November, 25(6/7), pp. 317-327.

Fok, R. C. W., Change, Y.-C. & Lee, W.-T., 2004. Bank Relationships and Their Effects on Firm Performance around the Asian Financial Crisis: Evidence from Taiwan. *Financial Management,* 33(2), pp. 89-112.

Froot, K. A., Scharfstein, D. S. & Stein, J. C., 1993. Risk Management: Coordinating Corporate Investment and Financing Policies. *The Journal of Finance,* 68(5), pp. 1629-1658.

Froot, K. A., Scharfstein, D. S. & Stein, J. C., 1994. A Framework for Risk Management. *Journal of Applied Corporate Finance,* 7(3), pp. 22-32.

Géczy, C., Minton, B. A. & Schrand, C., 1997. Why Firms Use Currency Derivatives. *The Journal of Finance*, 72(4), pp. 1323-1354.

Graham, J. R. & Rogers, D. A., 2000. *Does Corporat Hedging Increase Firm Value? An Empirical Analysis.* s.l.:s.n.

Guay, W. & Kothari, S., 2003. How much do firms hedge with derivatives?. *Journal of Financial Economics*, Volume 70, pp. 423-461.

Hardwick, P., 1997. Measuring cost inefficiency in the UK life insurance industry. *Applied Financial Economics,* Volume 7, pp. 37-44.

Jin, Y. & Jorion, P., 2006. Firm Value and Hedging: Evidence from U.S. Oil and Gas Producers. *The Journal of Finance,* 61(2), pp. 893-919.

Koller, T., Goedhart, M. & Wessels, D., 2010. *Measuring and Managing the Value of Companies.* 5th ed. s.l.:John Wiley & Sons, Inc..

Kwong, L. C., 2016. How corporate derivatives use impact firm performance?. *Pacific-Basin Finance Journal*, Volume 40, pp. 102-114.

Li, H., Visaltanachoti, N. & Luo, R. H., 2014. Foreign Currency Derivatives and Firm Value: Evidence from New Zealand. *Journal of Financial Risk Management*, Volume 3, pp. 96-112.

Modigliani, F. & Miller, M. H., 1958. The Cost of Capital, Corporation Finance and the Theory of Investment. *The American Economic Review,* 48(3), pp. 261-297.

Nance, D. R., Smith Jr., C. W. & Smithson, C. W., 1993. On the Determinants of Corporate Hedging. *The Journal of Finance*, 48(1), pp. 267-284.

Pérez-González, F. & Yun, H., 2013. Risk Management and Firm Value: Evidence from Weather Derivatives. *The Journal of Finance,* 68(5), pp. 2143-2176.

Roberts, M. R. & Whited, T. M., 2012. *Endogeneity in Empirical Corporate Finance.* [Online]
Available at: http://ssrn.com/abstract=1748604
[Accessed May 2017].

Silva, S. Z. & Maçãs, N. P., 2008. Performance and size: empirical evidence from Portugese SMEs. *Small Busniess Economics,* August, 31(2), pp. 195-217.

Simpson, G. W. & Kohers, T., 2002. The Link between Corporate Social and Financial Performance: Evidence from the Banking Industry. *Journal of Business Ethics,* January, 35(2), pp. 97-109.

Smith, C. W. & Stulz, R. M., 1985. The Determinants of Firms' Hedging Policies. *The Journal of Financial and Quantitative Analysis,* 20(4), pp. 391-405.

The Age, 2008. *Business.* [Online]
Available at: http://www.theage.com.au/business/oil-sags-to-6week-low-as-war-worries-ebb-20080718-3hop
[Accessed April 2017].

The New York Times, 2011. *The New York Times.* [Online]
Available at: http://www.nytimes.com/2011/03/02/business/02oil.html?ref=gasolineprices
[Accessed April 2017].

Tufano, P., 1996. Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold Mining Industry. *The Journal of Finance,* 71(4), pp. 1097-1137.

UN, 2017. *IMO (International Maritime Organization).* [Online]
Available at: https://business.un.org/en/entities/13
[Accessed April 2017].

US News, 2014. *US News.* [Online]
Available at: https://www.usnews.com/news/business/articles/2014/03/24/oil-near-99-after-china-manufacturing-drops
[Accessed April 2017].

Yahoo Finance, 2011. *Yahoo Finance.* [Online]
Available at: https://finance.yahoo.com/news/Oil-and-gasoline-prices-on-apf-2832043271.html?x=0
[Accessed April 2017].

8. Appendices

A. Firms included in the sample that engage in other services apart from marine transportation.

ID	Company Name	Other Services
1	AP MOLLER-MAERSK A/S-B	Operates industrial business and explores for and produces oil and gas
3	WILH WILHELMSEN HOLDING-B	Insurance services and maritime training services
12	DRYSHIPS INC	Offshore oil drilling
22	KDM SHIPPING PLC	River tourism, ship construction and ship repair
26	KIRBY CORP	Overhauls and services diesel engines employed in marine, power generation and rail applications

B. Corporate tax rates used for the sample firms.

ID	Company Name	Year/s	Country of Incorporation	Corporate Tax Rate	NOPLAT Tax Rate
1	AP MOLLER-MAERSK A/S-B	2009-2013	Denmark	25.0%	25.0%
		2014	Denmark	24.5%	24.5%
2	HAPAG-LLOYD AG*	2009-2014	Germany	15.0%	32.3%
3	WILH WILHELMSEN HOLDING-B	2009-2013	Norway	28.0%	28.0%
		2014	Norway	27.0%	27.0%
4	STOLT-NIELSEN LTD*	2009	Luxembourg	28.6%	8.4%
		2010	Bermuda	0.0%	6.8%
		2011	Bermuda	0.0%	12.5%
		2012	Bermuda	0.0%	11.4%
		2013	Bermuda	0.0%	12.5%
		2014	Bermuda	0.0%	6.7%
5	GOLDEN OCEAN GROUP LTD	2009-2014	Bermuda	0.0%	0.0%
6	D/S NORDEN	2009-2013	Denmark	25.0%	25.0%
		2014	Denmark	24.5%	24.5%
7	STAR BULK CARRIERS CORP	2009-2014	Marshall Islands	0.0%	0.0%
8	DIANA SHIPPING INC	2009-2014	Marshall Islands	0.0%	0.0%
9	ODFJELL SE-A SHS	2009-2013	Norway	28.0%	28.0%
		2014	Norway	27.0%	27.0%
10	SAFE BULKERS INC	2009-2014	Marshall Islands	0.0%	0.0%

11	NAVIOS MARITIME HOLDINGS INC	2009-2014	Marshall Islands	0.0%	0.0%
12	DRYSHIPS INC	2009-2014	Marshall Islands	0.0%	0.0%
13	GLOBUS MARITIME LIMITED	2009-2014	Marshall Islands	0.0%	0.0%
14	SLOMAN NEPTUN SCHIFFAHRTS AG*	2009	Germany	15.0%	32.5%
		2010-2012	Germany	15.0%	31.2%
		2013-2014	Germany	15.0%	31.9%
15	SOLVANG ASA	2009-2013	Norway	28.0%	28.0%
		2014	Norway	27.0%	27.0%
16	GLOBAL SHIP LEASE INC-CL A	2009-2014	Marshall Islands	0.0%	0.0%
17	NORDIC SHIPHOLDING A/S	2009-2013	Denmark	25.0%	25.0%
		2014	Denmark	24.5%	24.5%
18	WILSON ASA	2009-2013	Norway	28.0%	28.0%
		2014	Norway	27.0%	27.0%
19	VIKING SUPPLY SHIPS AB	2009-2012	Sweden	26.3%	26.3%
		2013-2014	Sweden	22.0%	22.0%
20	SEANERGY MARITIME HOLDINGS	2009-2014	Marshall Islands	0.0%	0.0%
21	EUROSEAS LTD	2009-2014	Marshal Islands	0.0%	0.0%
22	KDM SHIPPING PLC	2009-2012	Cyprus	21.0%	21.0%
		2013	Cyprus	19.0%	19.0%
		2014	Cyprus	18.0%	18.0%
23	MARENAVE SCHIFFAHRTS AG	2009-2014	Germany	15.0%	32.0%
24	HCI HAMMONIA SHIPPING AG	2009-2014	Germany	15.0%	32.3%
25	NEWLEAD HOLDINGS LTD	2009-2014	Bermuda	0.0%	0.0%
26	KIRBY CORP	2009-2014	United States	35.0%	35.0%
27	GENCO SHIPPING & TRADING LTD	2009-2014	Marshall Islands	0.0%	0.0%
28	EAGLE BULK SHIPPING INC	2009-2014	Marshall Islands	0.0%	0.0%
29	ALGOMA CENTRAL CORP	2009	Canada	33.0%	33.0%
		2010	Canada	31.0%	31.0%
		2011	Canada	28.3%	28.3%
		2012-2014	Canada	26.5%	26.5%

30	RAND LOGISTICS INC	2009-2014	United States	34.0%	34.0%
31	INTL SHIPHOLDING CORP	2009-2014	United States	35.0%	35.0%

The corporate tax rates were obtained from the Financial Annual Reports of each company.
*Adjustments were made as taxes paid were not in line with the corporate tax rate of the company's country of incorporation.

C. Correlation Matrix ROIC regression variables, Total Assets is abbreviated as TA.

	CAPEX / TA	CASH / TA	FREIGHT HEDGE	FUEL HEDGE	FX HEDGE	LT DEBT / TA	ROIC	SIZE
CAPEX / TA	1.00	0.22	0.03	-0.03	-0.02	-0.04	0.11	-0.01
CASH / TA	0.22	1.00	0.10	0.13	-0.01	-0.32	0.07	-0.02
FREIGHT HEDGE	0.03	0.10	1.00	0.33	0.11	-0.09	0.03	0.45
FUEL HEDGE	-0.03	0.13	0.33	1.00	0.48	-0.11	0.01	0.59
FX HEDGE	-0.02	-0.01	0.11	0.48	1.00	-0.13	0.06	0.51
LT DEBT / TA	-0.04	-0.32	-0.09	-0.11	-0.13	1.00	0.12	0.11
ROIC	0.11	0.07	0.03	0.01	0.06	0.12	1.00	0.11
SIZE	-0.01	-0.02	0.45	0.59	0.51	0.11	0.11	1.00

The table displays the correlation matrix including all the chosen explanatory variables that will be used for the ROIC regression in section 3.2.

D. Redundant Fixed Effects Test.
Equation 1
Equation: FIXED
Test cross-section and period fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	3.667345	(30,138)	0.0000
Cross-section Chi-square	106.112527	30	0.0000
Period F	2.976069	(5,138)	0.0139
Period Chi-square	18.534738	5	0.0023
Cross-Section/Period F	3.616721	(35,138)	0.0000
Cross-Section/Period Chi-square	117.814658	35	0.0000

The test showed that fixed effects in both the period and cross sectional dimension are significant for equation 1.

Equation 2

Redundant Fixed Effects Tests
Equation: EQ01
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	1.321756	(30,151)	0.1408
Cross-section Chi-square	43.137092	30	0.0570

In the Hausman Test, the Chi square T-statistic with a P-value >0.05 showed that Random Effects model should be used.

Equation 3

Redundant Fixed Effects Tests
Equation: FIXED
Test cross-section and period fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	3.931096	(30,137)	0.0000
Cross-section Chi-square	112.404507	30	0.0000
Period F	2.309597	(5,137)	0.0474
Period Chi-square	14.647806	5	0.0120
Cross-Section/Period F	3.808708	(35,137)	0.0000
Cross-Section/Period Chi-square	123.002034	35	0.0000

The test showed that fixed effects in both the period and cross sectional dimension are significant for equation 3.

E. Breusch–Pagan test.

Equation 1

Dependent Variable: RESID01
Method: Panel Least Squares
Date: 05/21/17 Time: 12:21
Sample: 2009 2014 IF FILTER=1
Periods included: 6
Cross-sections included: 31
Total panel (unbalanced) observations: 181

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008873	0.004240	2.092566	0.0378
CAPEX___TA	0.005979	0.004620	1.294338	0.1973
CASH___TA	0.010095	0.008905	1.133621	0.2585

FREIGHT_HEDGE	0.001409	0.001979	0.711701	0.4776
FUEL_HEDGE	0.002393	0.001979	1.209360	0.2282
FX_HEDGE	-0.000797	0.001535	-0.519427	0.6041
LT_DEBT___TA	0.001562	0.003570	0.437629	0.6622
SIZE	-0.001080	0.000647	-1.669224	0.0969

R-squared	0.053341	Mean dependent var	0.003816
Adjusted R-squared	0.015037	S.D. dependent var	0.008233
S.E. of regression	0.008171	Akaike info criterion	-6.733320
Sum squared resid	0.011550	Schwarz criterion	-6.591950
Log likelihood	617.3655	Hannan-Quinn criter.	-6.676006
F-statistic	1.392565	Durbin-Watson stat	1.014287
Prob(F-statistic)	0.211209		

The Breusch-Pagan showed an F-Statistic with a P-Value >0.05 showed that there is no presence of heteroskedasticity for regression 1.

Equation 2

Dependent Variable: RESID01
Method: Panel Least Squares
Date: 05/21/17 Time: 13:13
Sample: 2009 2014 IF FILTER=1
Periods included: 6
Cross-sections included: 31
Total panel (unbalanced) observations: 185

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.022568	0.006927	3.257751	0.0013
BUNKER_FUEL_PRICE	-2.40E-05	1.12E-05	-2.148480	0.0330
OP_CF_TA	-0.002169	0.018501	-0.117243	0.9068
TOBINS_Q	-0.002853	0.003177	-0.898096	0.3703

R-squared	0.031431	Mean dependent var	0.006773
Adjusted R-squared	0.015378	S.D. dependent var	0.015334
S.E. of regression	0.015216	Akaike info criterion	-5.511536
Sum squared resid	0.041907	Schwarz criterion	-5.441907
Log likelihood	513.8171	Hannan-Quinn criter.	-5.483317
F-statistic	1.957896	Durbin-Watson stat	1.771768
Prob(F-statistic)	0.121953		

The Breusch-Pagan showed an F-Statistic with a P-Value >0.05 showed that there is no presence of heteroskedasticity for regression 1.

Equation 3

Dependent Variable: RESID01
Method: Panel Least Squares
Date: 05/21/17 Time: 12:47
Sample: 2009 2014 IF FILTER=1
Periods included: 6
Cross-sections included: 31
Total panel (unbalanced) observations: 181

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008432	0.003970	2.123811	0.0351
CAPEX___TA	0.005851	0.004376	1.337100	0.1830
CAPEX_TA_FUEL_H EDGE	-0.037909	0.021340	-1.776418	0.0774
CASH___TA	0.012075	0.008574	1.408344	0.1608
FREIGHT_HEDGE	0.001489	0.001906	0.781140	0.4358
FUEL_HEDGE	0.004888	0.002479	1.971946	0.0502
FX_HEDGE	-0.000743	0.001450	-0.512645	0.6089
LT_DEBT___TA	0.001190	0.003347	0.355713	0.7225
SIZE	-0.001014	0.000606	-1.672913	0.0962

R-squared	0.066572	Mean dependent var	0.003705
Adjusted R-squared	0.023157	S.D. dependent var	0.007739
S.E. of regression	0.007649	Akaike info criterion	-6.860076
Sum squared resid	0.010063	Schwarz criterion	-6.701035
Log likelihood	629.8369	Hannan-Quinn criter.	-6.795598
F-statistic	1.533385	Durbin-Watson stat	1.035745
Prob(F-statistic)	0.148816		

The Breusch-Pagan showed an F-Statistic with a P-Value >0.05 showed that there is no presence of heteroskedasticity for regression 3.

F. Hausman test.

Equation 1

Correlated Random Effects - Hausman Test
Equation: RANDOM
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.

Cross-section random	9.116576	7	0.2444

In the Hausman Test, the Chi square T-statistic with a P-value >0.05 showed that Random Effects model should be used.

Equation 2

Correlated Random Effects - Hausman Test
Equation: EQ01
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	4.254388	3	0.2353

In the Hausman Test, the Chi square T-statistic with a P-value >0.05 showed that Random Effects model should be used.

Equation 3

Correlated Random Effects - Hausman Test
Equation: RANDOM
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	12.604002	8	0.1262

In the Hausman Test, the Chi square T-statistic with a P-value >0.05 showed that Random Effects model should be used.