Market or hierarchy?

The effect of vertical integration on performance in the freight transport industry

Erasmus Universiteit Rotterdam

Erasmus School of Economics

Master programme Urban, Port, and Transport Economics

Name student: F. (Floris) Verweij

Name supervisor: dr. B. (Bart) Kuipers

Name second reader: M. (Martijn) Streng MSc

Date final version: 18-06-2019

Disclaimer: The views expressed in this thesis are solely the author's and cannot be assumed to be representative of the views of the Erasmus University Rotterdam, the Erasmus School of Economics, or Erasmus UPT.

Table of contents

List of figures and tables

List of abbreviations

3PL – Third-Party Logistics Provider

4PL – Fourth-Party Logistics Provider

EBIT – Earnings before Interest and Taxes

EBITDA – Earnings before Interest, Taxes, Depreciation and Amortization

ECB – European Central Bank

FE – Fixed Effects

M&A – Mergers and Acquisitions

NAICS – North American Industry Classification System

RBV – Resource Based View

RE – Random Effects

ROA – Return on Assets

ROE – Return on Equity

ROI – Return on Investment

ROS – Return on Sales

ROVA – Return on Value Added

SL – Shipping Line

TCE – Transaction Cost Economics

TOC – Terminal Operating Company

USD – United States Dollar

VI – Vertical Integration

VRIO – Business analysis framework related to the RBV and revolving around questions regarding four things: Value, Rarity, Imitability, and Organization

Executive summary

This thesis aims to provide a meaningful investigation of the effect of VI (VI) on performance in the freight transport industry. In theory, VI, as well as horizontal integration, provides significant advantages to firms, which seem to outweigh the disadvantages. In practice, however, the benefits of VI are less clear than the benefits of horizontal integration, which we see happening everywhere, also in the freight transport sector. In the nineties, there were quite some VI examples that failed, but in order to investigate whether today this is likely to happen again, more recent (2010-2018) data from shipping lines and freight forwarders in the Compustat Global and Compustat North America databases is used to investigate the effect.

Studies that addressed comparable (quantitative) questions differ in the following ways from this study. Firstly, they lack a clear measure that captures the total degree of VI of a firm. Secondly, they are not conducted on a firm level. Thirdly, they are conducted using other measures than the one used in this thesis. In the fourth place, they are only conducted on a subsector of the transportation sector. In the fifth place, they provide descriptive statistics rather than a meaningful investigation of the existence of an effect. In the sixth place, a limited number of companies is studied. Finally, they are not up-to-date.

This thesis aims to take these limitations into account. A clear measure of VI will be used, namely the ratio of value added to sales (developed by Adelman (1955)) with the adjustments proposed by Buzzell (1983) and Tucker & Wilder (1977). Performance is measured by return on assets. As said, the research will be conducted on a firm level by analysing company data from shipping lines and freight forwarders. By using recent, longitudinal data, a meaningful investigation of the existence of an effect is given. As robustness checks, two different variations on the VI measure are considered, the models are estimated for different subsamples (based on time period, data source and company type), and all models are estimated with and without two observations that had very different values for the two versions of the VI measure (to assess the effect of including these observations).

The results show that in general (using the full sample), the results show mixed evidence. This finding is robust across the Compustat Global, the shipping line, and the freight forwarder sample. In the Compustat North America sample and the subperiod samples (2010-2013 and 2014-2018), no effect was found. Next to the fact that the results are in line with some other studies, that also did not find an unambiguously positive effect, several explanations are given for these partly unexpected results.

A number of important conclusions emerge from the research. First, the data overall shows no evidence for a positive VI – performance relationship. Secondly, a positive effect is more plausible than a negative effect. A negative effect is not found in any model, while a positive effect is found in a number of models: the models that only used recent years (2014-2018) and one of the models using the freight forwarder sample. The former finding also supports the view that today is a better time to vertically integrate than a number of years ago. The latter finding shows that the evidence on the effect of VI on performance is mixed for freight forwarders. Implications of these findings for shipping lines, freight forwarders, policy makers and academics are discussed.

Thus, although data on the last couple of years shows a positive effect of VI on performance, the existence of a positive effect is not so clear from the results of this research, which is not very well supported by existing literature. Academics should therefore try to further develop theories about disadvantages of VI or develop new ones.

Preface

During my master specialization in Urban, Port, and Transport Economics, I developed an interest in the economics of vertical integration. In the course Economics of Governance, several theories on vertical integration with corresponding empirics were discussed. A question that was not covered in that course is the topic of this thesis, but which I found interesting, is the question that this thesis addresses: the effect of vertical integration on performance in the freight transport sector.

I would like to use this opportunity to thank a number of people. First, I would like to thank my supervisor dr. Bart Kuipers for his guidance and valuable comments. Also, I would like to thank my family for supporting me in various ways.

Floris Verweij

June 7, 2019

1. Introduction

For a long time already, the global freight transportation sector has been one of the most important sectors of the economy. Every firm active in the goods industry needs some kind of transport to get materials to the place where it needs them and/or to get their products to their customers. Especially since the end of the Fordist Era (1920-1970), the development of global transportation accelerated, because of major changes such as the development of telecommunications on a large scale, globalization of trade, more efficient distribution systems, and the substantial development of air transportation (Rodrigue, 2017). Also, containerisation enlarged the capacity of shipping lines considerably. In 2017, the revenues of the global transportation sector amounted to 6% of GDP (Plunkett Research, 2019). The large size of this market is one reason why many different parties emerged. In addition to shipping lines, trucking companies and terminal operating companies, different intermediaries exist that provide several services like supply chain management and customs clearance (forwarders). Motivated by the potential of economies of scale, in each of those subsectors, large companies emerged by different forms of horizontal integration, such as take-overs motivated by geographical expansion or capacity expansion, and alliances. While there is a large consensus about horizontal integration being profitable, the benefits of vertical integration (VI) are not so clear. Some companies in the freight transport sector significantly engaged in VI, while others did not. In the 90's, it appeared that quite some vertical M&A activity in the sector had failed. Frémont (2008) describes how in the 80's VI in the transport chain was perceived as being a good idea. Accordingly, vertical mergers and acquisitions took place. However, that did not always turn out well. Bilspedition, a Swedish transport company for transport over land, took over several shipping lines, but in 1994 completely stopped being involved in maritime transport. CSX, an American rail company, had taken over shipping line Sea-Land in the 80's, but in 1999 put an end to it, because of the very poor financial results that were achieved by the part of the company that was taken over. Furthermore, in 2004 shipping line Hapag-Lloyd stopped being involved in logistical activities (Frémont, 2008).

Still, many shipping lines and parties in the hinterland are not strongly integrated. Frémont (2008) notices that many companies claim to be a logistics service provider, while there are only limited shipping lines (or the groups they are part of) for which logistical activities account for a substantial part of the total turnover. The extent to which VI is present in the transport chain, is therefore less high than it sometimes seems to be. The fact that the term 'logistics' is used for too many different activities in the transport chain, also contributes to overestimation of the rate of VI in the transport chain. (Frémont, 2008).

Today, the 90's, in which several vertically integrated companies turned back a certain form of VI, are a number of years ago. Nowadays, activities in the transport chain are often viewed from a chain perspective. The recently developed concept of synchromodality is in line with this perspective. Van de Voorde & Vanelslander (2008) say the following about it:

"... operations are increasingly approached from the perspective of complex logistics chains, whereby each link must contribute to the constant optimisation of the chain as a whole." (p. 10)

This perspective might have made VI in the transport sector interesting again. The recent acquisition of Unifeeder by DP World might be a result of the development of this perspective. Another clear example of VI is the still existing vertical relationship between Maersk, APMT, and Damco.

Furthermore, CMA-CGM, COSCO, Evergreen, and ONE (which by then did not yet exist, but its predecessors did exist) are active in the terminal operating industry, amongst others (Song & Panayides, 2012).

These examples show that VI does not have to be disadvantageous, although the profitability of VI might also be dependent on the time it takes place. As Harrigan (1985) put it:

"The nature of competition evolves – and as competitive settings change, so will the need for vertical integration." (p. 398)

Anyway, the literature shows quite some theoretical support for VI. Many motives for VI have been put forward (e.g. in Frémont (2008), Heaver (2005), Buzzell (1983), Franc and Van der Horst (2010)), while it is harder to find disadvantages of VI (e.g. Buzzell (1983)). Thus, theory and practice might be moving towards each other again. Therefore, today is the right time to assess whether it is the right time to vertically integrate for companies in the freight transport sector. Earlier papers that did similar analyses have several shortcomings, which will become clear shortly.

Firstly, we should recognize that many papers about supply chain integration exist (for an overview, see for instance Fabbe-Costes & Jahre (2008)), but that in a large majority of the cases, process integration is meant. In fact, this can be viewed as a hybrid form, where neither VI nor vertical separation takes place, but where different firms cooperate. In this thesis, I aim to quantify the effect of 'real' VI on performance as this is what is captured by the measuring I use. When including that constraint, empirical research on the effect in the transportation sector in general is scarce. The relatively recent study of Song and Panayides notes "that it is widely accepted that the relationship between supply chain integration of shipping companies and performance has not been given the requisite attention in the literature" (p. 108). They further state that they therefore use case examples as a starting point for empirical research, which is also done, for instance, in Heaver (2005). However, some empirical papers exist. Some of them approach the VI-performance relationship in a qualitative way (e.g. Panayides, 2002; Franc and Van der Horst, 2010; Song & Panayides, 2012; Heaver, 2005. While such approaches provide some valuable insights, they fail to quantify the effect of VI on performance. Therefore, in this thesis, a quantitative approach is chosen. Some earlier papers did use a quantitative approach (Lam & Van de Voorde, 2011; Frémont, 2008; Andreou, Louca, and Panayides, 2012; Abbott and Cohen, 2017, Song & Panayides, 2012), but these papers have some limitations, as will be explained in more detail in the literature review. The limitations can be summarized as follows (each study has at least one of them).

Firstly, they lack a clear measure that captures the total degree of VI of a firm (Andreou, Louca, and Panayides, 2012; Mitra & Bagchi, 2008; Huo, Selen, Yeung, & Zhao, 2008). Secondly, they are not conducted on a firm level (Lam & Van de Voorde, 2011). Thirdly, they are conducted using other measures than the one used in this thesis (choice will be explained in literature review) (Frémont, 2008; Andreou, Louca, and Panayides, 2012; Lam & Van de Voorde, 2011; Mitra & Bagchi, 2008; Huo, Selen, Yeung, & Zhao, 2008; Abbott & Cohen, 2017). In the fourth place, they are conducted on a subsector of the transportation sector (Abbott & Cohen, 2017). In the fifth place, they provide descriptive statistics rather than a meaningful investigation of the existence of an effect (Frémont, 2008). In the sixth place, a limited number of companied is studied (Onghena, Meersman, & Van de Voorde, 2014). Finally, they are not up-to-date.

This thesis aims to take these limitations into account. A clear measure of VI will be used, namely the ratio of value added to sales. This measure is developed by M.A. Adelman. Although there has been some critique on this measure (e.g. by Adelman himself when he first wrote about it, in Adelman (1955), Maddigan (1981), Buzzell (1983)), it is often used by companies and is believed to give a reasonable approximation of the degree of VI of a company, which will be explained in more detail in the literature review. More precisely, this study uses the measure of value added to sales with the adjustments proposed by Buzzell (1983), and Tucker & Wilder (1977). Furthermore, both gross and net value added will be used as an additional robustness check (we use EBIT and EBITDA in the calculations). The research will be conducted on a firm level by analysing company data from freight forwarders. Also, because freight forwarders can have connections with various parties in the transport chain (e.g. shippers, shipping lines, trucking companies), the research is reasonably representative for the transportation sector as a whole. Furthermore, by using recent data for different companies and different years, a meaningful investigation of the existence of an effect is given.

In order to do this, this thesis conducts an empirical analysis on a number of companies in the freight transport sector, namely shipping lines and freight forwarders, in the period 2010-2018. Using data from the Compustat Global as well as the Compustat North America database, 575 firm-year observations were found for which all the variables needed were found. With these data, we can analyse the effect of VI on performance on the firm level and we can get a good indication of whether today is the right time to vertically integrate for companies in the freight transport sector. Also, the use of panel data helps to solve endogeneity issues. Based on the different measures that will be used, a number of Fixed/Random Effects models will be estimated. To reduce the risk of exogeneity even further, several control variables are added and several robustness checks have been done. Hereby a significant contribution can be made to the empirical literature on the effect of VI on performance in the freight transport sector. This is important for companies in this sector, and can help them in their decisions whether to vertically integrate.

As already became clear, several types of firms have been chosen in earlier research: shipping lines, port authorities/terminal operating companies/forwarders/logistics service providers/shippers. In this thesis, shipping lines and freight forwarders are studied because meaningful data were collectible easiest given the method chosen. The research question I aim to answer is as follows:

"Does vertical integration affect performance of international shipping lines and freight forwarders, and if it does, by how much?"

In addition to the analysis for the full sample, several robustness checks are performed. First, different VI and performance measures are considered, which will be explained later. Also, different subsamples (based on time period, data source, and type of company) are used.

The main findings of the research can be summarized as follows. First, the data overall shows no evidence for a positive VI – performance relationship. Secondly, a positive effect is more plausible than a negative effect. A negative effect is not found in any model, while a positive effect is found in a number of models: the models that only used recent years (2014-2018) and one of the models using the freight forwarder sample. The former finding also supports the view that today is a better time to vertically integrate than a number of years ago. The latter finding shows that the evidence on the effect of VI on performance is mixed for freight forwarders.

The remainder of this thesis is structured as follows. In chapter 2, a literature review will be given on VI in general, VI in the transport sector, and measures of VI used earlier. After that, in chapter 3, the data used will be discussed. The methodology for turning those data into results will be described in chapter 4. Those results are presented in chapter 5. Chapter 6 provides the main conclusions of the research, the answer to the research question, and recommendations for practitioners and policy makers. Finally, chapter 7 discusses limitations and suggestions for future research.

2. Literature review

In this chapter, a systematic overview of the relevant literature will be given. First, VI will be discussed in general, providing important theories and pros and cons. Secondly, VI will be discussed with respect to the freight forwarding industry. In the third place, relevant studies relating to the effect of VI on performance is discussed. Meanwhile, measures used in earlier studies for VI and performance are discussed, with shortcomings of the most closely related literature. Also, VI in the freight transport industry is related to VI in other industries. The general approach of this thesis to solve these problems, will be discussed in the final section.

2.1. Vertical integration in general

In almost all industries, companies are constantly looking for opportunities to achieve better results. This happens at the operational level, but also at the tactical and strategic level. VI is an example of pursuing improvement at the strategic level. It often involves huge investments and therefore, companies have to carefully think about such an option before they execute it. To support companies in those decisions, many scientific articles have been written about the benefits and costs of VI. However, it will first be outlined what VI exactly is.

According to Perry (1989), a firm is vertically integrated if 'it encompasses two single-output production processes in which either (1) "the *entire output* of the 'upstream' process is employed as *part or all* of the quantity of one intermediate input into the 'downstream' process, or (2) the *entire* quantity of one intermediate input into the 'downstream' process is obtained from *part or all* of the output of the 'upstream' process'" (p. 185).

From this definition we can learn that VI:

- is about relations between firms that perform different activities;

- excludes contractual or market exchanges. Therefore, when most of the upstream output as most of the downstream input is used, only partial integration takes place. Strictly speaking one can argue in favour of this, but for practical purposes, like in this study that aims to quantify the effect of VI on performance, in such cases it is assumed that VI takes place, be it partial.

The paper by Perry also notes that ownership and control is essential for VI to exist. In between VI and vertical separation, a number of other forms exist. Besanko, Dranove, Shanley, & Schaefer (2013) give an overview of those forms for a subform of VI, namely the make-or-buy decision, which will be explained later. This overview is shown in Figure 1.

Figure 1: Make-or-Buy Continuum

Arm's-length market transactions	Long-term contracts	Strategic alliances and joint ventures	Parent/subsidiary relationships	Perform activity internally
Less integrated		→ → →		More integrated

Source: Besanko, Dranove, Shanley, & Schaefer (2013)

The main lesson we can learn from this overview is that the other forms often mean that the firm does not have ownership over the party with which it cooperates, but only cooperates, while sometimes having some control over this party (long-term contracts, strategic alliances/joint

ventures). This distinction is important to distinguish the literature that is about the 'in-between forms' and the literature that is about 'real' VI.

In Fabbe-Costes & Jahre (2008), an overview of literature on supply chain integration is given, and in a large majority of cases, process integration is meant. This can be viewed as an in-between, or hybrid form.

VI can be divided in forward (downstream) and backward (upstream) integration. Customer and supplier integration mean the same, respectively, although one might say they only include synchronizing processes.

Theories regarding vertical integration

To better understand the economics of VI, it is useful to discuss some theories of VI. These theories can also be useful to identify control variables and to explain differences in the results of this study. Two important theories of VI, that are also applied to the freight transport sector in the literature, are the Transaction Cost Economics (TCE) approach of Williamson (e.g. 1973, 1989) and the Resource Based View (RBV) approach. Although not indisputable, Barney (1991) is believed to be the founder of the latter theory.

Transaction costs can basically be described as R.H. Coase put it: the costs of using the price mechanism. Buying goods or services on the market involves costs related to comparing alternative suppliers and choosing one. The central unit of analysis in transaction cost economics is the transaction. The question is how transactions can be organized most efficiently: via the market, via the firm/hierarchy (VI), or via hybrid forms, of which examples have been shown in the overview of Besanko et al. (2013) (Williamson, 1989). To answer that question, the characteristics of transactions are analysed in this approach. Three important characteristics to analyse are asset specificity, uncertainty surrounding transactions, and frequency of transactions. All of them are assumed to have a positive relationship with the degree of VI. This can be explained as follows for the various variables. The description is largely based on Williamson (1989).

Asset specificity. According to Williamson (1989), this is "the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value" (p. 142). A tailored suit, for example, is hard to sell to someone else if the buyer, after the suit has been made, suddenly decides to not buy it (given this is allowed by the clothing store) and therefore has a high degree of asset specificity. Printing paper, on the other hand, could easily be sold to someone else and therefore has a low degree of asset specificity. The point that transaction cost economics makes is that a high degree of asset specificity creates bilateral dependency between buyer and seller. Relationship-specific assets are then in place, which are worthless or decline significantly in value when the other party defaults. Therefore, it is attractive to engage in VI in order to eliminate this risk. In the freight transport industry, different types of ships exist, for instance. If a shipping line's primary business is container shipping, but the line owns and operates a few dry bulk ships for a particular customer, and this customer defaults, then the dry bulk ships can, at least temporarily, significantly decline in value (for the shipping line) because it is not used.

Uncertainty surrounding transactions. Different forms of uncertainty can be distinguished. The one that is most relevant is what is called behavioural uncertainty in Williamson (1989), which is uncertainty emanating from not disclosing or distorting information on purpose. In the case of vertical separation, suppliers might behave in such a way and therefore a high degree of tertiary

uncertainty is a reason to vertically integrate. This is very relevant in the freight transport industry, as the liner shipping industry is a highly volatile industry (Basak & Nebol, 2016; Danish Ship Finance, 2018; ING Wholesale Banking, 2019; Song & Panayides, 2012).

Frequency of transactions. How many times a certain firm needs to get a certain transaction completed, also determines the choice of governance mode[1]. If the frequency of the transaction is low, then it is probably better for a firm to organize it through the market. As Aubert, Rivard, & Patry (1996) state, then "the firm will prefer to bear the risk associated with opportunism and uncertainty rather than support the cost of creating a new governance mechanism or expanding an existing one" (p. 54). On the other hand, when the frequency is high, then hierarchy is probably a good option as producing in-house would allow the firm to produce as efficiently as the market because of economies of scale, while avoiding transaction costs. In the freight transport markets, transactions often occur frequent in a company, which is a reason to vertically integrate.

In the Resource Based View (RBV) the unit of analysis consists of the resources in the firm (Franc and Van der Horst (2010). In fact, it also includes capabilities, which are not the same as resources (Barney, 1991; Conner & Prahalad, 1996; Makadok, 2001). Resources are tradable and firm-specific, while capabilities are firm-specific and have the function of utilizing the resources within the firm (Makadok, 2001). These resources and capabilities create value for the firm and in the RBV the firms should obtain a valuable set of resources and capabilities and use them optimally. Therefore, in contrast to the TCE approach, the goal of the firm is to maximize value instead of only minimizing costs, which can be done either through cost minimization or product differentiation. To achieve this, firms should choose which resources and capabilities to keep within the firm on the basis of their strategic value for the firm, for which the RBV offers criteria (Franc and Van der Horst, 2010). The VRIO framework (Barney, 2001) is an important framework in this respect, because it offers criteria to make these choices. This framework assumes the following:

1) Resource heterogeneity. Firms have different combinations of resources and capabilities.

2) Resource immobility. Resources and capabilities are not easily transferable to other firms.

The value, rarity, and inimitability of resources, and the organisation of other policies and procedures of the firm determine which resources are the most profitable ones. When the firm's most valuable resources have a high overall score based on value, rarity, inimitability, and organisation, the firm should internalise these resources (Franc and Van der Horst, 2010). Therefore, the RBV approach can also be used to explain VI moves.

Pros and cons of vertical integration

Having discussed general theories of VI, we now move on to concrete pros and cons. Unlike the benefits of horizontal integration, the benefits of VI are not so clear in practice, rather the balance of the benefits and costs. In theory however, while it is true that VI has some costs, it also has many benefits. In general, benefits of VI are the following.

[1] Market, hierarchy and hybrid forms are often called 'governance modes'.

ADVANTAGES

+ To be better able to meet the needs of the customers (Frémont, 2008);

+ Less transaction costs;

+ More diversification;

+ More market power;

+ Greater visibility;

+ Economies of scope through the use of shared resources and expertise (Heaver, 2005);

+ Better coordination (Buzzell, 1983).

+ Performing different, for instance, logistical activities forms differentiation relative to companies that do not perform these activities (Frémont, 2008; Franc & Van der Horst, 2010; Heaver, 2005).

Furthermore, in transport, there are additional reasons to vertically integrate:

+ For shipping lines: cost savings through the use of bigger ships (economies of scale) are often compensated by lower freight rates, meaning that other sources of revenue are needed;

+ For shipping lines: maritime costs only form a small fraction of the costs of door-to-door transport (estimate: 23%). When the ship sizes continue to increase, this figure decreases even further because of economies of scale. By also performing other activities, shipping lines can influence the costs of these other activities (Frémont, 2008), which account for 40-80% of total costs (Song & Panayides, 2012). An important fact is that the company then has to pay no or less transaction costs.

+ Better knowledge of costs;

+ Security of capacity at peak times (Heaver, 2005).

+ Externalities can be dealt with more efficiently, so volumes and transportation times can be better balanced (Notteboom, 2002).

One study that analyses the benefits of VI in the maritime shipping industry is Song & Panayides (2012). In this study, the authors argue in favour of VI in the maritime shipping industry and use the following arguments:

+ Acquiring a customer can lead to other customers not being your customer anymore, because you started to compete with them.

+ Improved exchange of information and business knowledge, which improves logistics service quality.

+ Nowadays, customers increasingly demand just-in-time service provision. When a company is vertically integrated, this is often easier, because it is not dependent on other parties.

+ Developing a 'one-stop shop' service, where customers are offered all the services they need.

+ In the case a shipping company takes over a freight forwarder: reduced dependence on operations that require large investments.

+ In the case a shipping company acquires shares of a port/terminal: increased influence in a port which helps to tackle the capacity problem.

As said, VI also has some costs. Some cons of VI are the following.

DISADVANTAGES

- An important disadvantage of VI is that normally, the market is more efficient in production (economies of scale, specialism);

- VI requires a lot of capital, relative to not doing it. This can also mean higher interest costs;

- Unbalanced throughput. The Minimum Efficient Scale (MES) can be different for different stages in the value chain;

- Lower flexibility because adapting to changes in technology or the market is more difficult (Buzzell, 1983).

- Bureaucratic costs. VI normally leads to more administration work (Mahoney, 1992).

- Often relationship-specific assets are needed (see transaction costs economics approach discussed later), which increase sunk costs that can lead to excess capacity and low profitability (Chandler, 1962; Rumelt, 1974).

- Lower strategic flexibility due to high exit barriers, which also include psychological commitment and administrative costs of divestment (Duhaime & Grant, 1984).

More advantages and disadvantages could be listed, but the above list gives a representative image. A takeaway is that it is easier to make a long list of pros than to do the same for cons. Also, some of the most relevant cons (market is more efficient, sunk costs) decrease in significance when the companies that are studied are very large, which is often the case when talking about shipping lines and freight forwarders. At the same time, some of the most relevant pros, like a better balance between volumes and transportation times and better coordination, increase in significance when the companies are very large. In the cited book of Song and Panayides, the authors conclude that VI by shipping lines should positively influence performance. According to them, “liner companies integrate in order to be more resilient in a difficult industry environment that is characterized by high demand fluctuations, low profit margins and extensive capital (vessel) investments. Integration in the value chain supports the firm’s service quality and service range, and should therefore create a higher market value.”

2.2. Market overview and vertical integration within the freight transport chain

To clarify how VI takes shape in the freight transport and logistics chain, an overview of the freight transport and logistics market will first be given. The maritime freight transport and logistics chain could be depicted as in Figure 2. The maritime section could be replaced by an air section (including vessel loading & unloading and storage).

Figure 2: A typology of the maritime logistics chain

(1) (2) (3) (4) (5) (6) (7) (8) (9)

1 = production unit/raw materials site, 2 = hinterland transport, 3 = storage, 4 = vessel loading, 5 = maritime section, 6 = vessel unloading, 7 = storage, 8 = hinterland transport, 9 = destination.

Source: Van de Voorde and Vanelslander (2008)

Figure 2 shows the different activities that are undertaken to get goods from A to B, but does not clearly identify the actors that are active in the freight transport and logistics chain. In Nijdam and Van der Horst (2015), those actors and identified for the maritime and logistics chain. Those actors are (with in parentheses the corresponding place in the chain based on Figure 1[2]):

Deap-sea-terminal operator (or stevedore, terminal operating company). Main activity: loading and unloading ships and temporary storage of goods (3, 4, 6 and 7).

Shipping line. Main activity: operate ships and provide shipping services. They have to sell the capacity of the ship to customers, even though they sometimes do not own ships themselves (4). Prime examples are Maersk, MSC, COSCO, CMA-CGM, Hapag-Lloyd, ONE (established in 2017 by the integration of NYK, MOL, and 'K' Line), and Evergreen, together serving 76.4% of the market (Alphaliner, 2019). The concentration in this submarket is thus large.

Forwarder. Main activity: provide a door-to-door transport solution for the customer for a person of organisation that wants to ship goods (the shipper). It does so by providing a number of value-added services. Among his functions are selection of transport companies, negotiation about freight rates, consolidating small shipments from different shippers to be able to get discounts from shipping lines, and paperwork. Services like warehousing, pre-delivery inspection, and cross-docking can also belong to the tasks of a freight forwarder (2-8). Some of the largest forwarders are DHL, Kuehne & Nagel, DB Schenker and Sinotrans. In this submarket, the concentration is much lower; it is a fragmented market. The revenues of the top 30 companies are estimated to be lower than 70% of the total revenues of this subsector (Armstrong & Logistics, 2019).

Shipbroker. Main activity: take care of the business of a ship, which includes obtaining cargo from shippers and arranging (not doing it himself) port activities like (un)loading of cargo (4, 5, and 6).

Port-related transport companies for transport by rail, waterway, or road. Main activity: transport goods from the port to their destination in the hinterland (2 and 8).

Providers of nautical services: pilots, towage companies and mooring companies. Main activity: assist ships in safely manoeuvring in a port. They get paid by shipping lines (4 and 6).

[2] Note that sometimes, the actor is not depicted in Figure 1. What is meant, however, is that for instance a freight forwarder operates in the part of the transport chain that is depicted by figures 2-8, by providing door-to-door transport solutions.

Port authority. Main activity: take care of the planning, development and safety of a port. Could be either a public or a private institution (3, 4, 6 and 7).

This framework could be extended to also explicitly include the shipper. As was already mentioned actually, shippers are people/organisations that want to have goods exported. This could be either the sender or the receiver of the goods. In the case it is the sender, the shipper often is a producing company that wants to have its goods transported.

Furthermore, the framework can again be transformed to also include air freight transportation. Shipping lines are then replaced by air lines, terminal operators by transport vehicles and storage facilities at an airport, providers of nautical services by providers of taxiing services and shipbrokers by plane brokers.

The above overview is not complete, in particular with respect to air and ocean freight transport. Both air and ocean transport know a lot of support activities, as becomes clear from the overview of the North American Industry Classification System (NAICS). Codes starting with 48 or 49 represent companies related to transportation and warehousing. This group includes for example air traffic control, port harbour operations, marine cargo handling, and navigational services to shipping. Also, the above overview does not include some general tasks which are relevant for the freight transport industry, such as fuel provision and IT services. However, the overview shows the core tasks being carried out in the industry.

Based upon the place in the transport chain that was just identified for those actors, we can speak about forward and backward integration in the freight transport and logistics chain. However, as many activities in the freight transport and logistics chain take place both in the foreland and in the hinterland, involvement of an actor in a particular activity could mean forward integration as well as backward integration. A shipping line that engages in trucking in the foreland, would be implementing backward VI, but when it does the same in the hinterland, it would be implementing forward VI.

Due to the number of different parties, several VI moves are possible. Often, shipping lines are the companies that take over their suppliers or customers. A recent example is the takeover of Ceva Logistics by CMA-CGM. Zhu et al. (2019) provide an overview of vertical relations between shipping lines and terminals, which is shown in Table 1. Furthermore, Table 2 in the Appendix shows a more complete overview of vertical relations within the container shipping industry, although this overview is somewhat outdated. It appears that many different kinds of vertical relationships exist in the maritime shipping industry.

Table 1: Liner companies and their subsidiaries

Shipping company (Market share)	Terminal operator	Relation	Number of terminals
APM-Maersk (16.7%)	APM Terminals	Both (Maersk Line and APM Terminals) are owned by The Maersk Group	73
Mediterranean Shg Co (14.5%)	Terminal Investment Limited (TIL)	Established fully by MSC	34
CMA CGM (11.7%)	Terminal Link	Capital is held by CMA CGM (51%) and China Merchants Holdings International (49%).	27
	CMA Terminals	Fully owned CMA CGM subsidiary	
COSCO Shipping Co Ltd (8.5%)	COSCO Shipping Ports	Both (COSCO Container Line and COSCO Shipping Ports) are owned by The COSCO Group	31
Hapag-Lloyd (7.1%)	N.A.	N.A.	N.A.
Evergreen Line (5.0%)	N.A.	N.A.	9 (Incomplete statistics)
OOCL (3.1%)	Two affiliate companies	Fully owned OOCL subsidiaries	2
Yang Ming Marine Tansport Corp. (2.8%)	N.A.	N.A.	7
Hamburg Süd Group (2.6%)	N.A.	N.A.	N.A.
NYK Line (2.5%)	Ceres Terminals	Purchased in 2002	11
	Nippon Container Terminals	Established partly by NYK	
MOL (2.5%)	TraPac	Fully owned MOL subsidiary	10
	Joint ventures		

Source: Zhu et al. (2019)

However, shipping lines are not the only parties in the industry that pursue VI. Prime recent examples include the €660 mln. takeover of logistics solutions provider Unifeeder by DP World (DNB Alpha, 2018), the 10%, or $1.4 bln. investment of Alibaba in courier ZTO Express (Reuters, 2018), and Amazon that launched his own delivery service, *Amazon Logistics.* Other recent, somewhat less startling examples are the acquisition of 4th-party logistics provider Caroz by Nunner Logistica (Vakmedianet, 2019) and the planned acquisition of SCA Logistics by Matrans, to supplement their logistics services with, amongst other things, assets (warehouses, offices, cranes and vehicles) in the port of Rotterdam (Transport Online, 2019).

Intermezzo: VI in practice in the freight transport industry and the automotive industry
It is interesting to compare the freight transport industry to another important industry and investigate what are the differences when it comes to VI. The automotive industry is used for this purpose.

In the freight transport industry, VI was for a long time not really an option that was seriously considered. Every party in the transport chain focused on his own business, which was also feeded by the fact that before the eighties, ports were (almost) without exception state-owned and not much public investment was made in the terminals. Since the privatisation of ports, more (private) funds came available, while the shipping lines also started to invest in terminals (Cariou, 2008). It was not that no one ever thought about VI in the shipping industry before. In 1966, the chairman of the Swedish Association of Shipping Lines stated:

"The time has come when the activity of the shipping line is no longer restricted to maritime transport, but must also include inland transport (…). If we wish to limit our role to maritime transport, we will gradually find that we are relegated to the position of insignificant pawns in the enormous machinery of transport. We should consider ourselves from now on as transport

undertakings and not purely as maritime carriers. We should establish close links with the other parts of the transport chain." (Journal de la Marine Marchande, 1966, p. 1468)

However, companies in the freight transport sector only started to substantially engage in VI in the eighties (Fremont, 2009). When in the nineties some VI examples failed (some examples have been mentioned in the introduction), companies in the sector refrained from it for some years, but in the last couple of years, companies start to embrace VI again, of which also some examples have been mentioned (DP World – Unifeeder, CMA-CGM – Ceva, Alibaba – ZTO Express, Amazon – Amazon Logistics).

The automotive industry shows a very different pattern. Taking the time that the Ford Motor Company produced its Model T, the first automobile that was produced on a large scale, as the starting point, we see that in the first years, VI was very common. Henry Ford stated:

"If you want it done right, do it yourself." (Business Insider, 2015)

Thus, Ford wanted to do things right. However, in the eighties and the early nineties, the reduced need for quality was one of the reasons why auto manufacturers started to outsource component manufacturing. This was the result of new legislation that was aimed at giving financiers of American companies more control over these companies, which led to these companies placing a stronger emphasis on making money rather than making quality goods. Amongst the other factors that encouraged outsourcing in the eighties and early nineties, was the success of Toyota with its lean production system (The American Prospect, 2009). One of the implications of the lean system is to eliminate as much inventory as possible by using machinery and deploying personnel in a more flexible way. Outsourcing is a way to try to meet this goal. Therefore, many car producers started to apply this concept, too.

However, in the last couple of years, we witnessed a few notable examples of VI in the automobile industry. In 2015, Tesla Motors already was a very vertically integrated company (Business Insider, 2015). In that year, Tesla also decided to make the seats of their cars in-house (Automotive News, 2016). Another example is BMW, which is basically producing their own raw materials (Automotive Design and Production, 2014). Despite these prominent examples, the auto industry is still heavily outsourced. About 80% of production is carried out by suppliers and third-party companies (Supply and Demand Chain Executive, 2018).

Summarizing, the freight transport industry and the automotive industry show significantly different developments. In the former, the degree of VI was initially low, in the eighties started to become higher, then decreased/stayed on the same level, and now seem to increase again. In the latter, the degree of VI was initially high and then started to decrease in the eighties, although there are some recent prime examples of VI in this sector. The freight transport sector and the automotive sector thus show significant differences in the degree of VI. An explanation might be that service industries like the freight transport industry do not really fit in the lean system. Therefore, VI might be more profitable in the freight transport industry than in the automotive industry.

2.3. Effect of vertical integration in the freight transport industry

Now that we have a reasonable understanding of VI in the transport chain, also in relation to another important industry (the automotive industry), we move on to the discussion of literature that

investigates the effect on VI on performance. Because the relationship between supply chain integration in this sector and performance is underinvestigated (Song and Panayides, 2012), it is needed to first discuss literature about the effect in other sectors. However, before discussing that, it is useful to know something about the measurement of VI.

Measurement of vertical integration and the effect in other sectors

VI is a concept which is not easy to measure without disadvantages. A well-known measure, which is often calculated for companies is the ratio of value added to sales (Buzzell, 1983). However, the scientific literature does not connect it to performance in the freight transport industry, although it is true that the measure, often adapted, is used to investigate the effect in other industries (e.g. Buzzell, 1983; Reed and Fronmueller, 1990). As Panayides (2002) notes, mixed results were found: some studies found a negative effect, some found a positive effect and some found no effect at all. One explanation for these differences might be the different industries in which the studies are undertaken.

The measure is developed by M.A. Adelman, who published an article about it in 1955. Value added can be seen as the difference between sales and direct inputs (often materials in the case of goods) for a good/service. When compared with sales, it shows what part of the sales are earned by the activities of the company itself. Why backward as well as forward VI is captured by this measure (though forward integration gets a higher weight), is well explained in Tucker & Wilder (1977):

"… for a given firm or industry, backward integration will tend to reduce the purchases of material inputs while leaving sales of final outputs constant, with a resulting increase in the ratio of value added to sales. Similarly in forward VI, sales will tend to increase more than proportionally to purchased material inputs, also resulting in an increase in the ratio of value added to sales." (pp. 82-83)

The fact that backward integration gets a higher weight was already recognized by Adelman himself. He gives the example of a value chain that has three links that each contribute one-third of the total value added by the industry. That would produce initial ratios of 1.0, 0.5, and 0.33 (upstream to downstream). When the company 'in the middle' integrates backward, its ratio increases to 1.0, while it only increases to 0.67 when it integrates forward.

This is one of the examples of the disadvantages of this measure. However, it can be argued that this effect is less strong in service industries like the transportation sector, since the cost of trucking in the foreland does not have to be included in the price of ocean transport, like the cost of raw materials in intermediate or final products. Tucker & Wilder (1977) mention another disadvantage, namely that accounting profits are used in this measure. These profits often vary because firms have some freedom in assigning profits to fiscal years, and these differences have nothing to do with differences in VI. Thus, the measure has several disadvantages. However, these problems are believed to not be insurmountable. By using the right measure and applying adequate controls, which will be described later, the effect of these distortions will be minimized. Tucker & Wilder (1977) and Buzzell (1983) adjusted the aforementioned measure, but the latter was also criticized in Maddigan & Zaima (1985). R.J. Maddigan also developed a new measure on her own, based on input-output tables. And more measures have been developed, which can be found in Lajili, Madunic and Mahoney (2007), in which the authors give an overview of the empirical literature on VI.

In this thesis, VI is measured by the ratio of value added to sales. This ratio is not used in the earlier research on VI on performance in the freight transport sector. An advantage of the measure is that does not require extensive data gathering like some other measures. Also, because a quantitative ratio is used, this approach allows us to quantify the effect of VI on performance in the freight transport industry. Furthermore, this study is a meaningful contribution to the literature that empirically tests the relationship between VI and performance, which literature is not very extensive in the freight transport sector.

In Buzzell (1983), the author does investigate the effect of VI on performance. He proposes two measures: an adjusted version of the value added to sales ratio and a measure that compares the degree of VI of a company with the degree of VI of competitors. Regarding the first measure, he adjusted the value added to sales ratio by subtracting net income from both the numerator and the denominator, and added a 'normal profit' back (to both the numerator and the denominator), calculated as 20% of investment, which, for the data he used, closely resembled the average pre-tax, pre-interest rate of return, or EBIT/Turnover, for the companies in the database he used (over 4 years). He did this to deal with the endogeneity caused by net income being part of both the VI measure (independent variable) and the performance measure (dependent variable). This measure will also be used in this thesis, defining a normal profit as the average profit for the company for the years for which data is available. Although the endogeneity problem of EBIT being part of both the performance measure and the VI measure is not fully solved by this (as ROA will be used as a measure of performance, which will be explained later), this approach takes away a certain part of the bias. As said, Maddigan and Zaima (1985) criticized the measure by saying that Buzzell did not adjust for unequal returns to the factors of production and for the impact of different manufacturing stages (backward integration gets a higher weight). Therefore, it has to be noted that the measure still has some downsides. As measures of performance, Buzzell used return on investment (ROI) and return on sales (ROS). He undertakes the analysis at the business unit level. The most important conclusion is that companies should avoid to partly integrate. According to the analysis, very low or very high levels of integration are the most profitable. This is one of the few papers that explicitly discusses the effect of VI, measured by (adjusted or not) value added divided by sales, on performance. Other papers that use this measure use it for other things, such as depicting a trend (Laffer, 1969) or looking for determinants of VI (so VI is the dependent variable) (Tucker & Wilder, 1977).

Tucker and Wilder (1977) made another adjustment to the value added to sales ratio. As they do not relate VI explicitly to performance (VI is the dependent variable in their analysis), this is not done to solve endogeneity in the effect of VI on performance, but to remove the effect of "static differences and trends in profitability and effects of changing depreciation and other tax laws" (p. 87). However, it is also important for the effect of VI on performance, to limit the endogeneity between the degree of VI and performance. Tucker and Wilder adjusted the measure of value added to sales by subtracting net income including from both the numerator and the denominator, and by adding income taxes to both the numerator and the denominator. They do not add a 'normal' profit back to the numerator and the denominator, which would be a problem is they would have aimed to relate VI to performance, as, after that adjustment, the profit measure has only moved from the numerator

to the denominator (with a minus sign in front of it instead of a plus sign).[3] However, they did not aim to research that.

Reed and Fronmueller (1990) use a totally different approach. Using a taxonomical approach that classifies companies based on strategic posture, they measure VI. This is related to risk and performance of several types of companies. The last is measured by return on assets (ROA), gross profit margin and fixed asset turnover (ratio of sales to fixed assets). This is believed to remove some of the bias in the value added to sales ratio. To further reduce the risk of endogeneity, the effect is investigated by using matched pairs of companies. The results show that VI does not have an effect on performance.

There are also some papers speak about the effect of outsourcing on performance, which is actually the inverse of the effect of VI, because more VI by definition means less outsourcing. Therefore, when a positive effect of outsourcing is reported, it can be interpreted as a negative effect of VI.

In Kotabe & Mol (2009), the effect of the degree of outsourcing on financial performance is investigated, using data from manufacturing businesses. They find that an optimal degree of outsourcing exists, and that deviations negatively affect performance in a non-linear way. Franc and Van der Horst (2010) also note that the effect might be non-linear. This is also what is found in Buzzell (1983), but with one important difference, namely that extreme values of VI, which is the inverse of outsourcing, are the most profitable (two optima instead of one). Regarding the measurement of VI and performance, this study uses the ratio of industrial purchasing to sales for the degree of VI and the ROVA for performance.

However, Bustinza, Arias-Aranda, & Gutierrez-Gutierrez (2010), another paper that investigates the effect of outsourcing, is not in line with this. Using data of service firms, they show that outsourcing (in a linear way) positively influences business and organizational performance, which is measured using a wide variety of measures, including return on assets (ROA) and return on equity (ROE), via the effect on competitive capabilities. In particular, they identify flexibility, and ability to offer new services faster, on a broader scale and marketing wise more efficiently, as benefits of VI.

The literature which is referred to in the last two papers, shows that outsourcing sometimes has a positive effect, sometimes a negative effect, and sometimes no effect at all, which could be explained by the fact that the studies are undertaken in different industries and the level of analysis (individual firm vs. industry). However, studies that really investigate the effect in the transport sector are not among them.

The effect in the freight transport sector

In the freight transport sector, empirical research on the effect of VI on performance is scarce. The relatively recent study of Song and Panayides notes “that it is widely accepted that the relationship between supply chain integration of shipping companies and performance has not been given the requisite attention in the literature” (p. 108). Of the empirical papers, some approach the VI-performance relationship in a qualitative way (e.g. Song & Panayides, 2012; Franc and Van der Horst, 2010; Heaver, 2005).

In Song & Panayides (2012), actually both a qualitative and a quantitative analysis is given. With regard to the qualitative part, they give an overview of the vertical relations that exist in

[3] To better understand this, compare this statement with equations (1) – (5) in the third chapter.

international freight transportation, which is shown in Figure X. With regard to the quantitative part, they use firms as the unit of analysis and measure VI through two measures: one that measures the number of segments and an index that also incorporates the relative size of the segments. Performance is measured by 'excess value', which is the difference between market value of a firm and the estimated market value of the firm when all segments would be operating on their own. The second measure is found to positively influence market value.

A paper which is exclusively qualitative is Franc and Van der Horst (2010). The authors state that because of the new chain perspective (competition is between logistics chain rather than between individual actors), coordination has become highly important in logistics chains. This could be done in various ways (think of the framework of Besanko et al. (2013)), of which VI is one way. Using the TCE approach and the RBV approach, they search for explanations for VI moves by shipping lines (SLs) and terminal operating companies (TOCs) in the Hamburg-Le Havre range. They come up with three aspects that influence hinterland service integration: the geographical scale origins of industry incentives (local vs. global), the attributes of certain SLs and TOCs, and the institutional environment. They also give more specific aspects based on the approaches used. Based on the TCE approach, they conclude that uncertainty is an important reason for integration of SLs and TOCs. Based on the RBV approach, they reason that competitive advantage that TOCs obtain by VI, might be higher for TOCs that use the concepts of extended gates, and that VI might be less beneficial when the company is already strongly integrated. However, as argued in the 'advantages/disadvantages-section', the benefits of VI might also be larger for larger firms, and the costs lower for larger firms.

Like Franc and Van der Horst (2010), Heaver (2005) starts with the big picture of changing conditions, and analyse VI as an answer to such developments thereafter. The author investigates how companies in the transport and logistics industry can best respond to the requirements of shippers, which are constantly changing because of important changes in global conditions. In particular, he investigates the strategy of VI as an answer to the increasing attention to supply chain management as a strategy of companies. The unit of analysis are shipping lines, and most of the paper deals with shipping lines and their integration into the logistics business. Examples of vertical mergers and acquisitions are given, with pros and cons for such moves and possible effects on profitability, but concrete conclusions from these examples are not drawn really. No clear indication of the effect of VI on performance is given. However, the author's statement that container shipping 'is not as tightly bound to other logistics activities, as may be trucking or air transport for which the design and pricing of transport and logistics services may be done in an integrated service package', because of the length and uncertainty of time in transit in shipping, is very interesting. This might (partly) explain why VI failed in the 90's.

Furthermore, there has been some literature that takes freight forwarders as the unit of analysis in the VI-performance relationship (VI as is meant in this thesis, however to a limited extent). Examples are Mitra & Bagchi (2008) and Huo, Selen, Yeung, & Zhao (2008). They identify the variety of services offered by 3PLs as a driver of performance, amongst many others. Thus, in those papers VI only gets little attention and is therefore not discussed in detail. Moreover, variety of services is not a very good proxy for VI because it does not take into account the extent to which the company performs a certain activity. If a freight forwarder that operates in 50 different countries, but provides trucking services in only one of these countries, the variety of services increases, while the trucking services

only form a small fraction of the activities of the company. The measure used in this thesis (value added/sales) does not have this limitation.

While qualitative approaches provide some valuable insights, they fail to quantify the effect of VI on performance. Therefore, in this thesis, a quantitative approach is chosen. An analysis of the following papers together shows well what are the shortcomings of studies that did use a quantitative approach. Although they all use a quantitative approach, the specific approaches are quite different.

Lam & Van de Voorde (2011) present a scenario analysis in which they relate the degree of VI of shipping lines to areas of activities (e.g. customer service, inventory) on different levels (strategic, tactical, operational). They also relate performance to those activities and find that higher levels of supply chain integration lead to higher levels of performance. Their approach enables them to research the effect of VI on performance, but not on the level of the individual firm. Therefore, a shipping company, for instance, cannot easily attach conclusions to such analyses. Meersman, Van de Voorde and Vanelslander (2009) suggest that more research based on company data is needed. In Frémont (2008), which was cited before in this thesis, also a somewhat quantitative analysis can be found. This paper gives an idea about the extent of VI in the ocean freight transport industry (in 2007), especially the VI initiated by shipping lines, and shows that VI is not always successful in practice, but it lacks an explicit investigation of the effect of VI on performance. In Andreou, Louca, and Panayides (2012) the effect of integration (horizontal as well as vertical) on performance is measured by changes in the value of different freight transportation firms after an announcement of a merger or acquisition. They look at performance of targets and bidders after an announcement of a merger or acquisition. They find that bidders as well as targets profit from horizontal and vertical mergers and acquisitions, that targets however show a greater increase in value, and that this increase in value of targets is greater for vertical than for horizontal mergers. The last indicates a positive effect of VI on performance. This clearly relates to VI, but a measure of the total degree of VI of a certain company is not considered and therefore such an approach does not give very much information about the effect of VI on performance. Also, substantial attention has been given to the effect of VI of performance in the rail industry (passenger and freight transport). Abbott and Cohen (2017) provide an overview of empirical studies (some of which are quantitative) on this topic. Using cost items and variables measuring the quality of service, mixed results were found, which is not surprising in a literature overview, and therefore the authors try to explain these differences. They come up with the following conclusions: (1) vertical separation in freight transport is more beneficial than in passenger transport, (2) intensity of track use encourages vertical separation (although some papers they use state the opposite), and (3) vertical separation increases performance less when there is a high level of intermodal competition, because competition is also expected to increase efficiency. The disadvantage of only studying the railway industry, however, is that the results cannot easily be applied to the transportation sector in general. Lastly, the effect of VI on performance has been studied in the air freight business. Onghena, Meersman, & Van de Voorde (2014) estimate a cost function for FedEx and UPS, companies that have engaged in VI. Using time series data, they find that these companies exhibit strong economies of scale and density. A limitation of this study is the limited number of companies studied.

Measurement of performance and general approach of this thesis

In order to determine the performance measures to be used, it is useful to first summarize the performance measures used in the studies just discussed. They include market value of bidders and

targets (Andreou, Louca, and Panayides (2012)) and several cost items and variables measuring quality of service (Abbott and Cohen (2017)). Other measures to research the effect are qualitative (is VI a driver (Mitra & Bagchi (2008) and Huo, Selen, Yeung, & Zhao (2008)), what are explanations for certain VI moves (Franc and Van der Horst (2010); Heaver (2005)). Because in this paper a quantitative measure is used to be able to quantify the effect, and because the quantitative measures used in the freight transport industry are limited in amount, it is useful to know what quantitative measures studies in other industries have used.

In other industries, the most important measure of performance in this context is return on investment (ROI) (Panayides, 2002). However, also return on sales (ROS) (Buzzell, 1983), return on equity (ROE) (Bustinza et al., 2010), return on assets (ROA) (Reed & Fronmueller, 1990; Bustinza et al., 2010), gross profit margin, and fixed asset turnover are used (Reed & Fronmueller, 1990). All of them capture profitability in some way. In selecting one or more measures, it is important to think about possible endogeneity and about the availability of the data. For ROI, it is not fully clear how investment should be defined on a yearly basis for a company. Usually, this measure serves to calculate the profitability of projects and to choose between different projects. The measure of ROS has the disadvantage of having turnover in it, so it might lead to endogeneity concerns when relating it to VI. A similar problem occurs when we relate the measure of return on value added (ROVA), which is used in Kotabe & Mol (2009), to VI (in that paper, another measure for VI is used). Furthermore, Reed and Fronmueller (1990) proposed to use the gross profit margin. This is similar to value added and therefore would also lead to endogeneity concerns. Fixed asset turnover (ratio of sales to fixed assets) (Reed and Fronmueller, 1990) is not satisfying either because companies with few fixed assets but a large number of employees could have a high turnover compared to fixed assets, even when they make a loss. Then, using ROE and ROA would be better, because equity and assets are not used to calculate the degree of VI. However, equity has the advantage that it is sometimes negative, which is also the case in the dataset which in used in this study, leading to values of ROE that cannot or cannot easily be interpreted. Finally, the ROA measure also has a downside: although the amount of assets does not show up in the VI measure, and thus no direct endogeneity problem exists, turnover does, which is likely to be correlated with assets. However, as no direct endogeneity problem exists, the ROA measure is the best measure of the ones that are discussed.

Attention should be paid to the fact that profit, the numerator in the ROA measures and a component of the VI measure (how the bias arising from that can be handled, was discussed before), can be measured in different ways, the most important ways being EBIT and EBITDA. Both of these measures of profit are used, and when one of the measures is used in the performance measure, it is also used in the VI measure (and vice versa), because the effect of VI on performance should not be caused by a difference in the definition of profit.

In this literature review we saw that in other sectors, like the automotive industry in which VI is the exception rather than the rule, the effect is not so clear, as becomes clear from the results of Buzzell (1983) and Reed and Fronmueller (1990) Kotabe & Mol (2009). Bustinza, Arias-Aranda, & Gutierrez-Gutierrez (2010) is not in line with those studies, but they use data on service firms. In the freight transport sector, the empirical literature generally confirms a positive relationship (Song & Panayides, 2012; Lam & Van de Voorde, 2011; Andreou, Louca, and Panayides, 2012; Onghena,

Meersman, & Van de Voorde, 2014), but we also know that the desirability of VI can change over time, as VI in the shipping industry failed in the 90's, as discussed before.

Furthermore, it was argued that, in line with Song & Panayides (2012), in theory, the benefits of VI are larger than the costs. Because of this argument and the evidence for a positive effect, this study expects that VI will positively affect performance, using either of the measures:

H1: The degree of vertical integration (using EBIT) positively influences return on assets (ROA) (using EBIT).

H2: The degree of vertical integration (using EBITDA) positively influences return on assets (ROA) (using EBITDA).

Studies that addressed comparable (quantitative) questions differ in the following ways from this study. Firstly, they lack a clear measure that captures the total degree of VI of a firm (Andreou, Louca, and Panayides, 2012). Secondly, they are not conducted on a firm level (Lam & Van de Voorde, 2011). Thirdly, they are conducted using other measures than the one used in this thesis (Frémont, 2008; Andreou, Louca, and Panayides, 2012; Lam & Van de Voorde, 2011; Abbott & Cohen, 2017). In the fourth place, they are conducted on a subsector of the transportation sector (Abbott & Cohen, 2017). In the fifth place, they provide descriptive statistics rather than a meaningful investigation of the existence of an effect (Frémont, 2008). In the sixth place, a limited number of companies is studied (Onghena, Meersman, & Van de Voorde, 2014). Finally, they are not up-to-date.

This thesis aims to take these limitations into account. A clear measure of VI will be used, namely the ratio of value added to sales with the adjustments proposed by Buzzell (1983) and Tucker & Wilder (1977). The research will be conducted on a firm level by analysing company data from shipping lines and freight forwarders. By using recent, longitudinal data, a meaningful investigation of the existence of an effect is given. Finally, different robustness checks are performed. How this is operationalized, will be discussed in the next chapter.

3. Data and methodology

3.1 Sample and data sources

To answer the research question, a longitudinal dataset has been used. This has several advantages. Two of the most important ones are the following. First, they can easily correct for unobservable effects that are invariant over time. Secondly, using panel data increases the efficiency of the model compared to cross-sectional models or time series models. This is firstly because the dimensions of the data are often large, in any case larger than cross-sectional models, and secondly, because both cross-sectional differences and time-differences are used, which are two dimensions that can both provide insights, and thirdly, because the same individuals are observed, which often leads to higher efficiency compared to a lot of cross-sectional data of different individuals (Wooldridge, 2013). However, no method is without disadvantages. First, individuals can change reporting in different periods (panel effects), which in the case of companies can mean a different accounting policy. Secondly, they can change reporting because they are in the panel (panel conditioning) (Wooldridge, 2013). These disadvantages are dealt with as good as possible, but eliminating all bias arising from them with certainty is not possible.

In this thesis, the focus is on the freight transport industry. Therefore, a sample of a number of shipping lines and freight forwarders is compiled. Using the Compustat Global as well as the Compustat North America database, which contain only publicly listed companies, companies were selected based on the following North American Industry Classification Codes:

- *483111 Deep Sea Freight Transportation*

- *488510 Freight Transportation Arrangement*

At first, NAICS 541614 (Process, Physical Distribution, and Logistics Consulting Services) was also included in the sample, but since companies that have this code can perform logistics activities as well as other activities (e.g. manufacturing operations improvement), it cannot be assumed that these companies are representative for a subsector of the freight transport industry. Therefore, the final sample does not contain companies that have this code. Moreover, NAICS 481112 (Scheduled Freight Air Transportation), 481212 (Nonscheduled Chartered Freight Air Transportation), and 483113 (Coastal and Great Lakes Freight Transportation) were selected, but due to no or little data, these codes are not in the final sample.

Although a company could have several NAICS (because of VI), for each observation, the database displays the core NAICS for the company (NAICS Association, 2019a; 2019b). This allows us to recognize the core tasks of a company, and thus to operationalize the control variable 'Type of industry (core tasks)', which will be discussed further in section 3.2. Table 3 in the Appendix shows more detailed descriptions of the codes used.

This resulted in an unbalanced panel with 579[4] firm-year observations for shipping lines and freight forwarders were found, for which all variables needed (dependent variables, main independent

[4] Some duplicates (same company, same year) were found in the dataset. Although not all data was exactly the same for these 'duplicates', just deleting the first of observation of each duplicate seems to be a satisfactory strategy, as the main descriptive statistics (mean, standard deviation) of all

variables, and control variables) were available, except variables retrieved or calculated from another source. This other source is the European Central Bank (ECB) for exchange rates.

Because in this thesis, the question is whether today is a better time to vertically integrate for companies in the freight transport industry, the period studied is limited to the period 2010 till 2018. Data from the fiscal years are used. In the nineties, there were some clear examples that VI failed, as described in the introduction, but as was also mentioned there, the optimal degree of VI can change over time. Therefore, not using data which is too old, is important. Moreover, the dataset is still large enough to be able to make statistical inference.

As regards the units of measurement, the data are not all of the same currency. Therefore, the figures are standardized in USD using the exchange rates of the ECB. The User's Guide of Compustat notes that the standard way of dealing with income statement data in this respect is to use annual exchange rates, and to use daily data (end of fiscal year) for balance sheet data. The annual rates were available, but the ECB does not provide historical daily rates, so for balance sheet data the monthly rates are used. The average of December and January is taken (December 2008 and January 2009 if the data belong to 2008). This neglects the fact that fiscal year ends are different, but this is not expected to influence the results heavily.

3.2 Variables

In this section, the variables used will be described. Table 4 provides a summary of the data, and, if applicable, the effect of the variable on performance. One variable (the natural logarithm of total (net) turnover) that is described in this section, does not show up in Table 4, because it was deleted because of collinearity with the VI variables. This is explained in section 4.1.

Table 4: Summary of the data

Type of variable	**Variable**	**Variable name(s)**	**Description**	**Expected effect on performance**	**Data source**
Dependent variable	Performance	ROA_EBIT, ROA_EBITDA	Measure of performance, based on return on assets, which is based on either EBIT or EBITDA	Not applicable	Compustat
Main variable of interest	VI	VI_EBIT, VI_EBITDA	Measure of VI, see section 3.2 for calculations. Based on either EBIT or EBITDA.	+	Compustat

variables hardly change when this is done. Therefore, this strategy is implemented. The number of observations has therefore decreased to 579.

Control variables	Firm size	LN_Turnover	Measure of firm size, calculated as the natural logarithm of total assets	+	Compustat
	Uncertainty	Uncertainty	Measure of uncertainty, measured as the standard deviation of (net) turnover divided by the mean (by company) of (net) turnover	-	Compustat
	Capital structure	Debt_Assets	Measure of capital structure, defined as the ratio of debt to assets	-	Compustat
Other	Exchange rates	Not applicable	Annual and monthly nominal exchange rates	Not applicable	European Central Bank

Dependent variable

The dependent variable in this study is performance, which is measured by financial performance or profitability. Specifically, return on assets (ROA) is used as measure of financial performance. Reed & Fronmueller (1990) used ROA, while Bustinza et al. (2010) used both ROA and ROE. The numerator in these measures (profit) can be measured differently and that is why two different measures for profit (and thus also for ROA) are included, namely EBIT and EBITDA.

Main independent variable

The dependent variable in this study is the degree of VI, which is measured by the measure of value added to sales, introduced in Adelman (1955), with the adjustments proposed by Buzzell (1983) and Tucker & Wilder (1977). This is discussed in detail in the literature review. Value added is defined as follows, based on Scottish Enterprise (2017):

value added = profit + staff costs *(1)*

The exact measure of VI that is used in this study is as follows (in its general form):

VI = (value added - profit + average EBIT) / (sales – profit + average profit) = (value added + average EBIT) / (sales – profit + average profit) (2)

Inserting (1) in (2), we get:

VI = (profit + staff costs - profit + average profit) / (sales – profit + average profit) = (staff costs + average EBIT) / (sales – profit + average profit) *(3)*

Inserting either EBIT or EBITDA for profit, we get the following two measures for the degree of VI:

VI_EBIT = staff costs + average EBIT / (sales – EBIT + average EBIT) (4)

VI_EBITDA = staff costs + average EBITDA / (sales – EBITDA + average EBITDA) (5)

Like in the measurement of the dependent variable, profit is measured in two different ways: EBIT and EBITDA. This will be explained in section 3.5. Value added is measured as the sum of EBIT or EBITDA and total staff costs, following Scottish Enterprise (2017), an organisation that evaluates projects and programmes on their economic impact (Scottish Enterprise, 2019). Furthermore, the calculation of the measure requires sales data of the companies.

Control variables

In order to minimize the endogeneity between the main independent variable and the dependent variable, several control variables are used in the analysis. These factors are expected to influence profit and to be correlated to VI. They are firm size, uncertainty, capital structure, the world economy, demand for international transport, year effects and type of industry. The expected sign of the effect on the dependent variable is discussed below for each control variable.

Firm size/frequency of transactions. The size of a firm is a widely studied factor that may influence the profitability of a firm (e.g. Kakani, Saha, and Reddy, 2001; Majumdar, 1997; Doğan, 2013; Lun and Quaddus, 2011). Often, it is found to do so in a positive way (e.g. Kakani, Saha, and Reddy, 2001; Majumdar, 1997; Doğan, 2013; Lun and Quaddus, 2011). This can be explained by the argument of Wu (2006) who argues that larger firms have more resources available and thus can invest more easily, which can lead to higher performance. This argument especially holds when taking (the natural logarithm of) total assets as a measure of size, which is one of the most important measures of firm size (Dang, Li, & Yang (2018). Furthermore, the turnover of the firm is a measure of the number of transactions of a firm. Therefore, this measure also gives a proxy for frequency of transactions, which is expected to be positively related to the degree of VI, according to the transaction costs economics approach, while the positive relationship between sales growth and profit is also empirically confirmed, as shown in Lee (2014). Therefore, (the logarithm of) assets and turnover are proposed as control variables, while expecting them to have a positive relationship with performance. The data are transformed by taking the natural logarithm of total assets and total turnover, in order to reduce the variance. This is a very common way of measuring firm size (Dang, Li, and Yang, 2018).

Uncertainty. As discussed in the literature review, uncertainty is seen as a determinant of VI, which is confirmed empirically in the literature (Lafontaine and Slade, 2007). Furthermore, uncertainty can have an effect on performance. A common theory is that high uncertainty leads to less (profitable) investment and thus to lower growth/profit (Madhusoodanan, 2018). Therefore, uncertainty is expected to have a negative effect on performance. Following Gallagher and Andrew (2007), uncertainty is measured by the standard deviation of sales divided by the mean of sales, to account for the fact that companies have different means. As the procedure of obtaining means and standard deviations makes this a time-invariant variable, it is included only when a Random Effects Model is chosen. Fixed Effects models will be compared to Random Effects models and based on the consistency of the Random Effects model one of the models will be chosen.

Capital structure. Another variable that might distort the effect of VI on performance is capital structure. Corporate finance theory argues that higher risk should be compensated by a higher return. Equity has a higher risk than debt, because it is dependent on the profitability of a firm, while the return on debt consists of fixed payments. Therefore, a higher share of equity, or a lower share of debt, is expected to influence profit positively, which means a negative effect of the ratio of debt to assets. Also, the higher risk in case of a low debt-to-equity ratio could lead to a higher degree of VI, because uncertainty is limited by VI. It appears that this variable is related to the previous one. Therefore, it will be tested whether including them both leads to multicollinearity issues. This variable is measured by the ratio of debt to assets.

Type of industry (core tasks). The effect might be biased by different types of firms that are in the sample. Different industries might have different profit margins and also the optimal degree of VI (multiple optima might exist, see Buzzell (1983)) might differ for different industries. As freight forwarders are far less asset heavy compared to shipping lines, they are expected to show higher performance. The type of industry of a firm (its core tasks) in principle does not change over time. Therefore, in a Fixed effects model this effect is controlled for. However, when a Random Effects Model is estimated, this effect is not controlled for, and this factor can be included. When a Fixed Effects model is used, this factor, which is based on the core SIC code, is not included. The factor is based on the core NAICS code and is included by transforming these codes into dummies (e.g. $NAICS\_483111_{it}$ is equal to 1 when the company has NAICS code 483111, and 0 otherwise).

Year fixed effects. The effect of VI on performance can also be biased by aggregate trends in the degree of VI and performance, which can, in turn, be affected by other time-varying variables (such as the oil price, which is likely to have an impact on profit). Profit levels can vary over time (business cycles), while the optimal degree of VI can also vary over time (Harrigan, 1985). Therefore, time fixed effects are included. Based on the years of the observations, dummy variables for each year were created, which take the value of 1 if the data is from a certain year, and the value of 0 otherwise. The year fixed effects can also be included in a Fixed Effects model, because this model in itself only controls for *firm* fixed effects.

3.3 Descriptive statistics

To get a first impression of the data, it is useful to look at some descriptive statistics. To be able to calculate the variables needed, the basic data as displayed in Table 5 was obtained. All these data are measured in millions. The dataset includes some extreme values. However, as no evidence was found for the data being wrong, these values are not deleted because that would bias the sample. In all of the variables, we see a lot of variation.

Table 5: Descriptive statistics, basic data

Variables	Obs	Mean	Std.Dev.	Min	Max	Median	p1	p99
Assets	575	1626.06	4345.99	3.268	66824.05	522.9201	8.741	12388.37
EBIT	575	67.826	479.325	-1040.586	10667.83	6.10936	-181.178	878.708
EBITDA	575	132.354	744.683	-957.545	15962.59	22.21303	-66.413	1095.441
Liabilities	575	835.845	2191.308	.592	32413.29	249.0724	3.607	6041.293
Turnover	575	1190.893	3958.535	.019	56143.9	149.6941	1.578	18895.06
StaffExpense	575	152.017	620.703	-.4	6387.74	14.89109	.015	4029.286

Sources: S&P Global (2019a, 2019b), European Central Bank (2019)

Table 6 displays some descriptives for the variables that are used in the models. We see that companies in the sample on average have a positive ROA (2.3% based on EBIT and 6.4% based on EBITDA). The average degree of VI is 0.22 based on EBIT and 0.36 based on EBITDA. The variable Uncertainty has 9 observations less, because there were 9 companies for which only one year of data was available, thereby not allowing to calculate this variable, as it is partly based on the standard deviation of sales of a company, which then cannot be calculated. As a result, when this variable is included, the model has less observations. The mean of the uncertainty index is 0.35. Furthermore, companies in the sample on average are mainly financed by debt, as is reflected by the ratio of debt to assets, which amounts 0.54.

Table 6: Descriptive statistics, variables

Variables	Obs	Mean	Std.Dev.	Min	Max	Median	p1	p99
ROA_EBIT	575	.023	.087	-1.148	.298	.025356	-.241	.221
ROA_EBITDA	575	.064	.089	-1.147	.327	.0632686	-.173	.255
VI_EBIT	575	.215	.455	-4.774	5.33	.1807954	-.583	.889
VI_EBITDA	575	.36	.431	-4.094	4.976	.2878427	-.184	.957
DebtAssets	575	.539	.308	.017	4.204	.5249203	.048	1.662
LNTurnover	575	5.179	2.02	-3.965	10.936	5.008594	.456	9.847
Uncertainty	566	.351	.313	.062	1.993	.2524631	.062	1.993

Sources: S&P Global (2019a, 2019b), European Central Bank (2019)

Some values were found that caused some concern. After investigation of the observations in question, these observations were dropped because staff expenses were very high compared to the years thereafter for that company in the first case (about 7 times as high), and staff expenses were very high compared to total turnover in one case (about 10 times as high, while in subsequent years it was about 10 times as low for that company). This lowers the total number of firm-year observations to 577 (568 for Uncertainty). The number of firms is 105, so on average the number of data years is 5.5.

Furthermore, the often-used rule for detecting outliers, *Mean ± 3 * Standard deviation* (Oracle, 2019) is applied to the VI and ROA variables. This resulted in the values shown in Tables 7-10 in the Appendix. However, after an investigation of the underlying (basic) data, no reason was found to assume that the data are wrong. However, some of these observations had very different VI values for different definitions of VI (based on EBIT or based on EBITDA). Personally, I think that the analysis without these 'different' observations gives more reliable results, as it is hard to assess what is the correct degree of VI of a company at a given moment, if the values are so different only because of another definition. Therefore, these observations are dropped from the sample. This decreases the sample size to 575 observations. However, to investigate the impact on the results, the analysis is repeated using also the 'different' observations. The remaining observations that were investigated (see Tables 7-10 in the Appendix), are not dropped from the sample.

Table 6 does not describe the NAICS factor and the year factor, as these factors require other approaches. The distribution of the core NAICS codes is shown in Table 11. We can see that deep sea freight transportation (483111) make up the largest part of the sample, while freight forwarding activities (488510) account for about 19% of the sample. Note that Table 11 displays the number of firm-year observations, not the number of companies. The number of companies having code 483111 (shipping lines) is 84, while the number of companies having code 488510 (forwarders) is 21.

Table 11: Distribution NAICS

NAICS	Freq.	Percent	Cum.
483111	465	80.87	80.87
488510	110	19.13	100.00

Sources: S&P Global (2019a, 2019b)

Regarding the fiscal years for which data was obtained, in Table 12, we can see that for most years, the dataset has a comparable number of firm-year observations. The most recent years have less observations (2017 and 2018).

Table 12: Distribution data year

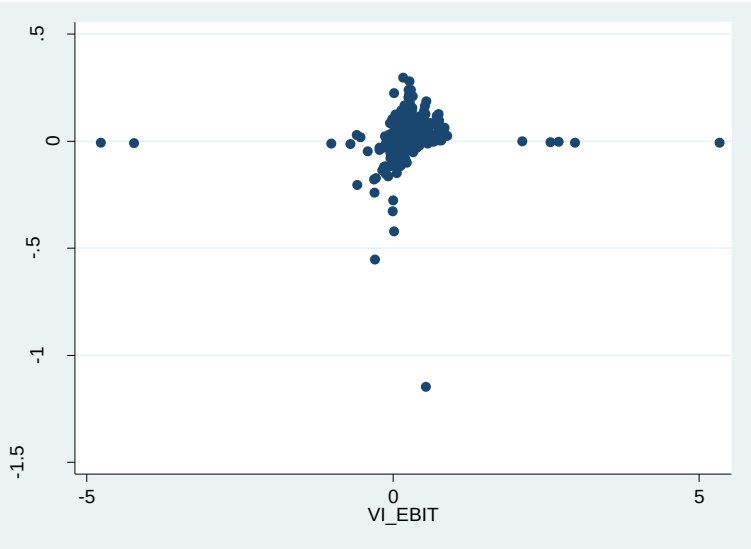
Data Year - Fiscal	Freq.	Percent	Cum.
2010	87	15.13	15.13
2011	84	14.61	29.74
2012	85	14.78	44.52
2013	86	14.96	59.48
2014	64	11.13	70.61
2015	77	13.39	84.00
2016	59	10.26	94.26
2017	30	5.22	99.48
2018	3	0.52	100.00

Sources: S&P Global (2019a, 2019b)

To conclude the division of the data in subsamples, 85.2% of the data is from the Compustat Global database (486 firm-year observations), which means that the remaining 15.8% (91 observations) is from the Compustat North America database.

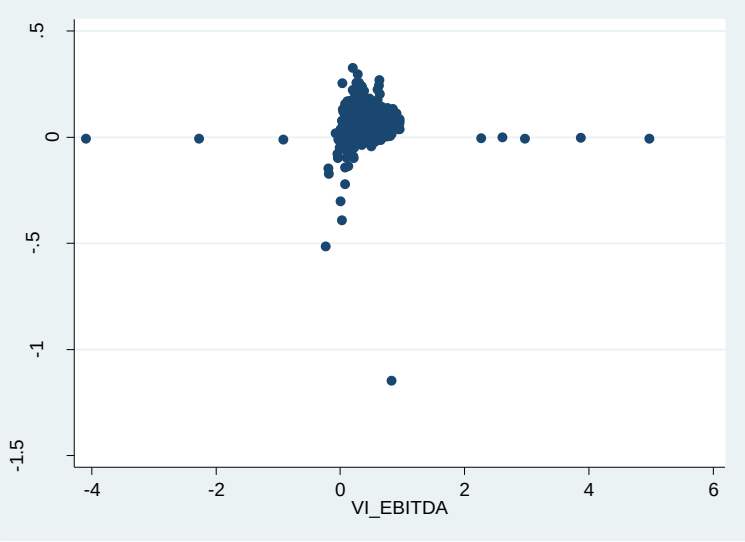
Also, Figures 1 and 2 show scatterplots with performance on the y-axes and the degree of VI on the x-axes. ROA and the VI measure do not show a clear pattern, but this might be due to the fact that in this figure, no variables are held constant.

Figure 3: Scatterplot ROA_EBIT and VI_EBIT



Sources: S&P Global (2019a, 2019b), European Central Bank (2019)

Figure 4: Scatterplot ROA_EBITDA and VI_EBITDA



Sources: S&P Global (2019a, 2019b), European Central Bank (2019)

3.4 Regression model

Two important regression models which can handle panel data are the Fixed Effects model and the Random Effects model. The Random Effects model is more efficient, but requires that the unobserved individual heterogeneity (α_i) is uncorrelated with the explanatory variables. If that is not the case, a Fixed Effects model is more appropriate.

One way to test this is to estimate the model by Random Effects and include the means of all explanatory variables in the regression (known as the Correlated Random Effects model), and test whether or not these means are jointly significant by means of an F-test. If they are significant, this indicates that α_i is correlated with at least one of the explanatory variables. Therefore, in that case, a Fixed Effects model is more appropriate. If not, the more efficient Random Effects model can be used (Wooldridge, 2013). This procedure to choose between Fixed Effects and Random Effects is repeated for each of the models.

In case a Fixed Effects model turns out to be most appropriate, then the regression model can be described by the following equation:

$$Performance_{it} = \beta_0 + \beta_1 VI_{it} + \beta_2 LNTurnover_{it} + \beta_3 Capital\_Structure_{it} + \beta_4 YEAR\_2011_{it} + \beta_5 YEAR\_2012_{it} + \beta_6 YEAR\_2013_{it} + \beta_7 YEAR\_2014_{it} + \beta_8 YEAR\_2015_{it} + \beta_9 YEAR\_2016_{it} + \beta_{10} YEAR\_2017_{it} + \beta_{11} YEAR\_2018_{it} + v_{it}$$

where (applies to both the Fixed Effects and the Random Effects model):

- The performance measure (ROA) can be based on either EBIT or EBITDA;

- VI can be either based on EBIT or EBITDA;

- v_{it} denotes the composite error term ($= \alpha_i + u_{it}$).

- *i* denotes the company, *t* the year.

If, on the other hand, a Random Effects model turns out to be most appropriate, several extra variables can be included, such that the regression model can be described by the following equation[5]:

$$Performance_{it} = \beta_0 + B_1 VI_{it} + \beta_2 LNTurnover_{it} + \beta_3 Cap\_Structure_{it} + \beta_4 Uncertainty_{it} + \beta_5 NAICS\_488510_{it} + \beta_6 YEAR\_2011_{it} + \beta_7 YEAR\_2012_{it} + \beta_8 YEAR\_2013_{it} + \beta_9 YEAR\_2014_{it} + \beta_{10} YEAR\_2015_{it} + \beta_{11} YEAR\_2016_{it} + \beta_{12} YEAR\_2017_{it} + \beta_{13} YEAR\_2018_{it} + v_{it}$$

To avoid perfect multicollinearity, one dummy of the NAICS (483111) and one year dummy (2010) have been removed. Furthermore, a significance level of 5% will be used in all significance tests, which is common in economic research. However, results that are significant at 10% are visible from the results, so that the reader can adjust the conclusions accordingly if he/she wants to.

3.5 Robustness tests

In order to take into account the fact that different definitions/specifications of the data/model could lead to different results, it is tested whether the results are robust to changes in definitions/specifications.

Firstly, it will be tested whether the results differ if we base the profitability and VI variables on EBITDA instead of on EBIT. As discussed earlier, when ROA is based on EBIT, the degree of VI is also based on EBIT and vice versa. Both measures can be theoretically supported, but there is no clear reason to expect the variables to show different results, so this is an appropriate robustness check. The measures can be theoretically supported as follows. Using a profit measure which is corrected for some costs (e.g. interest and taxes) has the advantage that changing conditions such as changing tax laws do not bias the effect. However, the more of these corrections are implemented, the more the measure of profit deviates from the 'real' profit. Hence, there is no single best measure. Net income which is not corrected for interest, taxes, depreciation and amortization could also be included, but data for this was hardly available in the Compustat database. Hence, the profitability and VI measures are based on either EBIT or EBITDA.

Secondly, different subsamples will be used. As stated earlier, the dataset is constructed using the Compustat Global and the Compustat North America database. To check whether the results are different for companies in the United States and Canada on the one hand, and other companies on the other hand, the analysis will be done separately for these groups of companies, in addition to the analysis for the combined dataset. Also, it will be tested whether the results differ using only data from the period 2014-2018, because in the years 2010-2013, the companies in the dataset probably still suffered from the effects of the financial and economic crisis which heavily impacted a lot of

[5] Actually, the equations given are the ones for a simple Ordinary Least Squares (OLS) model. The equations are slightly different for the Random Effects model and the Fixed Effects model. For the Random Effects Model, the equation would be: $Performance_{it} - Performance\_mean_i = \beta_0(1-\theta) + \beta_1(VI_{it} - \theta VI\_mean_i) + \cdots + (v_{it} - \theta v_i)$, where $\theta = 1 - \sqrt{(\sigma_u^2/(\sigma_u^2 + T\sigma_\alpha^2))}$. The specification of the Fixed Effects model is the same (except the variables that can only be included in the Random Effects model, but with one condition: θ is equal to 1.

sectors, including trade and thus freight transport. In 2014, the shipping market had recovered and experienced a very good year (Logistics Middle East, 2014). Furthermore, the analysis will be done for shipping lines (NAICS 483111) and freight forwarders (NAICS 488510) separately, to see whether the effect differs between these groups of companies. Frémont (2009) suggests that the effect of VI on performance might differ between different kinds of vertical mergers or acquisitions in this industry.

Thirdly, as said before, the analysis is repeated to see what is the effect of including two observations that showed very different VI values for different definitions of VI (based on EBIT or EBITDA).

All models that are estimated, partly as a result of the abovementioned robustness checks, are shown in Table 13. This table also includes the number of firm-year observations that are used in each model (N). The difference in N between Models 3 and 4 and between Models 5 and 6 is due to the fact that in both cases, one model is estimated by Random Effects and thus includes the Uncertainty measure, which has less observations (why the variable Uncertainty has less observations is explained in section 3.3).

Table 13: Taxonomy of models

	Profit measure used to calculate degree of VI and ROA	
Sample	**EBIT**	**EBITDA**
All data (N = 575)	Model 1	Model 2
2014-2018 (N = 233, 230)	Model 3	Model 4
2010-2013 (N = 336, 342)	Model 5	Model 6
Compustat Global (N = 484)	Model 7	Model 8
Compustat North America (N = 91)	Model 9	Model 10
Shipping lines (NAICS 483111) (N = 465)	Model 11	Model 12
Freight forwarders (NAICS 488510) (N = 110)	Model 13	Model 14

4. Results

4.1 Assumptions of the models used

Before running the regressions, it is important to check whether or not the assumptions of the models used hold, and to try to solve violations of the assumptions. In the panel data models that are used, in addition to other forms of endogeneity which this thesis aims to solve by including the appropriate control variables, possible problems which the models assume to be not present are: too much collinearity, autocorrelation, and conditional heteroskedasticity. All of these problems can bias the standard errors of the regression coefficients and thus the significance tests (Allen, 1997).

Regarding collinearity, Table 14 shows the correlation matrix of the variables used. The ROA variables are highly correlated with each other, as well as the VI variables, as was to be expected, but this is no problem because they are not used in the same model (VI_EBIT is used in combination with ROA_EBIT, for instance). What is important is whether the independent variables show collinearity between each other. This, however, is not really the case, as, apart from the correlations just mentioned, the highest correlation (in absolute value) is -0.35 for LNTurnover and Uncertainty, which is well below the threshold range given in Dormann et al. (2012), which is 0.5-0.7.

Table 14: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ROA_EBIT	1.000						
(2) ROA_EBITDA	0.963	1.000					
(3) VI_EBIT	0.108	0.070	1.000				
(4) VI_EBITDA	0.047	0.034	0.938	1.000			
(5) DebtAssets	-0.173	-0.100	-0.110	-0.076	1.000		
(6) LNTurnover	0.245	0.226	-0.146	-0.247	0.006	1.000	
(7) Uncertainty	-0.272	-0.328	0.054	0.126	-0.024	-0.352	1.000

Sources: S&P Global (2019a, 2019b), European Central Bank (2019)

Furthermore, in time series data and panel data, observations are by nature autocorrelated as a value in certain year often does not differ that much from the values in the years before and after that year in percentage terms. Therefore, the standard errors should be clustered at the level of the panel variable, which is the firm. This correction is performed in all models. This correction also corrects for potential heteroskedasticity.

4.2 Regression results

This section presents the results of the regressions that were run. For each definition of the independent variable, one model was estimated. This analysis was replicated for different subsamples, either based on year (2010-2013, 2014-2018), based on database (Compustat Global, Compustat North America), or based on type of company (shipping lines, freight forwarders). Also, all of this is replicated with the two 'different' observations included.[6] As explained in section 3.4, first, it was investigated for each model whether a Fixed Effects model or a Random Effects model was more appropriate. The results of the Correlated Random Effects models that were used to

[6] See section 3.3 for what I mean by 'different' observations.

investigate this, are shown in Table 15 (without 'different' observations) and Table 16 (including 'different' observations) in the Appendix. For some models, we could use the Random Effects estimator. For the other models, the Fixed Effects estimator was needed. All of these models are shown in Tables 17 (without 'different' observations) and 19 (including 'different' observations) in the Appendix.

Apart from the different subsamples based on period, data source, or type of company, the different number of observations stems from the fact that sometimes the variable Uncertainty is included and sometimes not (why the variable Uncertainty has less observations is explained in section 3.3).

In the next two sections, first, the main results of the models that do not use the two 'different' observations are presented, and secondly, the main results of the models that do use these observations are presented. Thereafter, the differences will be discussed. Finally, the results regarding the control variables will be discussed.

Main results of models not using 'different' observations

This section presents the results of the models that do not use the 'different' observations. The models I refer to in this section, are shown in Table 17 in the Appendix. Models 1 and 2 show the results of the models that used all data. Both models show no significant effect of VI on performance, which means that the result of 'no effect' is robust to several definitions of VI and performance. This result is not in line with the view expressed in the literature review that VI leads to higher performance. However, Frémont (2008) and Abbott and Cohen (2017) did also not find an unambiguous positive relationship of VI on performance in the transport sector.

Theoretically, the disadvantages of VI mentioned in the literature review can provide explanations. It might me that the lower flexibility in adapting to changes in technology or the market resulting from VI leads to significantly higher costs in the freight transport sector. Also, bureaucratic costs and the need for relationship-specific assets could explain why VI is overall not profitable. Furthermore, using the RBV approach, companies in the freight transport sector that pursue VI might integrate the 'wrong' resources (resources with low value, rarity, and inimitability), or that the resources of the acquirer are not easily transferable to the resources of the target (or vice versa) (resource immobility), so that synergies resulting from the merger or acquisition are limited. An additional argument is that, when considering that VI and horizontal integration are two completely different kinds of expanding the company, it might be in the company's best interest to choose either of these strategies, so that the company can focus on one of them (Zwakhals, 2018). As concentration (horizontal integration) in shipping is high, and shipping lines nowadays also start to vertically integrate again, this 'failure' to choose could explain why VI is not that profitable.

A more practical explanation for the result is that the shipping market is highly volatile (Basak & Nebol, 2016; Danish Ship Finance, 2018; ING Wholesale Banking, 2019; Song & Panayides, 2012). Because of this high volatility, which is surely (also) affected by other factors than VI, it is hard to distinguish an effect of VI on performance.

Looking at the other models, we can see the result of 'no effect' is also found in most other models, which means that this result is also robust to the use of several subsamples. However, there are some models that do show an effect of VI on performance: both models using the 2014-2018 sample (Models 3 and 4), and one of the models using the freight forwarder sample (Model 14). All of these

models show a positive effect. We can thus conclude that VI positively influenced performance in the period 2014-2018, while there is mixed evidence on an effect of VI on performance for freight forwarders. Both of these results deserve to be discussed.

The results for the 2014-2018 sample deserve special attention, as this sample is the only sample that shows a positive effect in both models. Therefore, the results show that VI positively influences performance in the period 2014-2018, but not in the period 2010-2013. This actually fits well with the note before that the desirability of VI can change over time (Harrigan, 1985). Also, it shows that, in the last couple of years, VI was likely to influence profit positively. This could mean 'good news' for the VI moves that took place in this period or in 2019 (DP World – Unifeeder (2018), CMA-CGM – Ceva (2019), Alibaba – ZTO Express (2018), Amazon – Amazon Logistics (2018)), and for future VI moves. However, whether it is a profitable strategy in the coming years is a question that the models do not directly answer, as they are not predictive models. Obviously, however, they can be used to support decisions regarding possible VI moves.

In contrast to the results for the 2014-2018 sample, for the 2010-2013 sample, in none of the two models, an effect was found, which was not expected. An explanation could be found in an important motivation for VI: to synchronize processes. As mentioned in the introduction, today

"... operations are increasingly approached from the perspective of complex logistics chains, whereby each link must contribute to the constant optimisation of the chain as a whole." (Van de Voorde & Vanelslander, 2008, p. 10)

VI could serve this purpose, as managing a chain becomes easier when you have more control over this chain. Although the paper cited is from 2008 and the idea even was already put forward by Robinson (2002), companies in the freight transport sector could have started to embrace this vision only in recent years; it did only in recent years translate into a positive effect of VI on performance.

As said, the freight forwarder sample shows an effect in one of the models, which is the model using EBITDA. The model using EBIT shows no effect. Several explanations can be given for this mixed result. A first explanation why Model 2 (using EBIT) shows no effect, not in line with expectations, while Model 1 (using EBITDA) shows a positive significant effect, in line with expectations, is that the measures are biased by different legislation regarding depreciation and amortization. Because of similar reasons, Tucker and Wilder (1977) calculated the VI ratio in a similar way. However, using a less strongly corrected measure, to put it that way, also is not without disadvantages: it leads to some bias in the VI and performance measures. They deviate to a certain extent from their 'real' values (e.g. 'real' profitability).[7]

As neither definition is perfect, though, it is hard to say which definition is best. This was why both measures were used, as a robustness check. Furthermore, although EBIT deviates less profit measure, to put it that way, it still deviates from 'real' profit, so this factor can still play a role. The explanation given assumes that the model showing no effect uses the 'wrong' version of profit and ROA, which does not need to be true. If an effect really does not exist, the model that does show an

[7] We could define 'real' profit as net profit, without adjusting for taxes etc. as in EBIT and EBITDA. However, as noted before, these values were hardly available for the companies in the sample and are therefore not included in the sample.

effect might actually use the wrong version. The only conclusion we can thus draw is that the evidence is mixed (though a positive effect is more likely than a negative effect).

Theoretically, a reason why VI influences performance of freight forwarders, but not performance of shipping lines (for freight forwarders, there is some evidence or an effect, while for shipping lines, there is no evidence for an effect), is the statement of Heaver (2005) that container shipping 'is not as tightly bound to other logistics activities, as may be trucking or air transport for which the design and pricing of transport and logistics services may be done in an integrated service package', because of the length and uncertainty of time in transit in shipping. This could explain why VI works better for freight forwarders than for shipping lines.

A number of important conclusions emerge from the above analysis. First, the data overall shows no evidence for a positive VI – performance relationship. Secondly, a positive effect is more plausible than a negative effect. A negative effect is not found in any model, while a positive effect is found in a number of models: the models that only used recent years (2014-2018) and one of the models using the freight forwarder sample. The former finding also supports the view that today is a better time to vertically integrate than a number of years ago. The latter finding shows that the evidence on the effect of VI on performance is mixed for freight forwarders.

Table 18 provides a summary of the most important results, including the coefficients of the VI measures, their significance, and (if significant) their interpretation. As most companies have a value between 0 and 1 (91.3% for VI_EBIT and 96.9% for VI_EBITDA), and an interpretation of the measure is what part of the sales are earned by the activities of the company itself, managers of shipping lines and freight forwarders can think about this as an increase in percentage points, where 0 means no VI and 1 full VI. As an increase of 1 in the degree of VI would then mean an increase of 100 percentage points, the coefficients are, as shown in Table 18, divided by 10 to arrive at the effect of an increase of 10 percentage points, which is easier to interpret.

Table 18: Summary of main results (excluding 'different' observations)

Sample	**Coefficient (standard error) VI_EBIT**	**Coefficient (standard error) VI_EBITDA**	**Effect of VI**	**Interpretation VI_EBIT (on average)**	**Interpretation VI_EBITDA (on average)**
All data	-0.000259 (0.00274)	0.00943 (0.00839)	0	Not applicable	Not applicable
2014-2018	0.00337** (0.00155)	0.00309** (0.00144)	+	VI_EBIT ↑ 0.1 (=1/10) → ROA_EBIT ↑ 0.00337/10 = 0,000337, or 0,0337 percentage points	VI_EBITDA ↑ 0.1 (=1/10) → ROA_EBITDA ↑ 0.00309/10 = 0,000309, or 0,0309 percentage points
2010-2013	0.0122 (0.0122)	0.00299 (0.00407)	0	Not applicable	Not applicable
Compustat Global	0.00136 (0.00197)	0.00755 (0.00635)	0	Not applicable	Not applicable

Compustat North America	0.0258 (0.373)	-0.142 (0.387)	0	Not applicable	Not applicable
Shipping lines (NAICS 483111)	-0.000502 (0.00280)	0.00881 (0.00817)	0	Not applicable	Not applicable
Freight forwarders (NAICS 488510)	0.192 (0.183)	0.381** (0.181)	0/+	Not applicable	VI_EBITDA ↑ 0.1 → ROA_EBITDA ↑ 0.00381/10 = 0.000381, or 0.0381 percentage points

Standard errors are robust and clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1

Main results of models also using 'different' observations

When we do not exclude the observations for which the degree of VI is very different for the different definitions, the results are as follows. The models I refer to in this section are shown in Table 19 in the Appendix, which shows the results of the models also using the 'different' observations. Models 1 and 2 show the results of the models that used all data. In the model using EBIT, the VI coefficient is positive and significant, which is in line with expectations. However, the model using EBITDA shows no significant effect. The models using all data thus show mixed evidence (although a positive effect is more likely than a negative effect) on the effect of VI on performance, which does not fully support the view expressed in the literature review that VI leads to higher performance. However, Frémont (2008), Abbott and Cohen (2017) did also not find an unambiguous positive relationship of VI on performance in the transport sector. In other sectors, Vesey (1978), Buzzell (1983), Maddigan and Zaima (1985) and Harrigan (1986) also did not find an unambigious positive relationship.

A first explanation why Model 2 (using EBIT) shows a significant positive effect, in line with expectations, while Model 1 (using EBITDA) shows no significant effect, is that the measures to a certain extent deviate from their 'real' values (e.g. 'real' profitability), as discussed before. Correcting for depreciation and amortization has advantages, as also mentioned before and discussed by Tucker and Wilder (1977); they wanted to remove the effect of 'static differences and trends in profitability and effects of changing depreciation and other tax laws' (p. 87). This was why Tucker and Wilder (1977) calculated the VI ratio in a similar way. However, it leads to some bias in the VI measure and performance measures.

As neither definition is perfect, though, it is hard to say which definition is best. This was why both measures were used, as a robustness check. Furthermore, although EBIT is a less strongly corrected profit measure, to put it that way, it is still corrected for interest and taxes, so different tax laws, for instance, could still play a role. The explanation given assumes that the model showing no effect uses the 'wrong' version of profit and ROA, which does not need to be true. If an effect really does not exist, the model that does show an effect might actually use the wrong version. The only conclusion we can thus draw is that the evidence is mixed (though a positive effect is more likely). This means that it is worthwhile to also consider alternative explanations why it might not be so clear that VI positively affects performance.

For theoretical and practical explanations for the partly unexpected results, I refer to the ones given in the section that uses the samples without the two mentioned observations.

Looking at the other models, we can sometimes notice a positive effect, and sometimes not. The samples that do show a positive effect in at least one of the models are the Compustat Global (Models 7 and 8) sample, the shipping line sample (Models 11-12) and the freight forwarder sample (Models 13-14). These models all are at least in line with Models 1 and 2 in that they show mixed evidence and no undisputed evidence. However, the other models show no effect when using either EBIT or EBITDA. One thing that strikes is that the models using the freight forwarder sample show the opposite pattern compared to the models using all data and the models using the shipping lines sample: an effect is found in the models using EBITDA, and not in the models using EBIT. However, knowing the Simson's Paradox, a well-known example of ecological fallacy (drawing wrong conclusions about individuals using aggregate data), it is not that strange. In this case, an explanation could be that the disadvantages of using a non-corrected measure of e.g. profit pointed out by Tucker and Wilder (1977) outweighed the disadvantages of using a corrected version (deviation from real profit). But, as pointed out before, such an approach assumes that the model showing no effect uses the 'wrong' measure; it might actually be the other way around. Therefore, the only conclusion we can draw from the results of the models using the freight forwarder sample is that the evidence is mixed (although a positive effect is more likely than a negative effect), and this is in line with the results of the models that use all data.

The other samples for which one time a positive and the other time no effect was found (Compustat Global, shipping lines), can be interpreted in a similar way. The results of these models might be influenced by the disadvantages of using EBIT or EBITDA, but since we cannot say which one is best, we can only conclude that the results show mixed evidence, which is in line with the models that use all data.

However, as the attentive reader has already inferred, there are some samples for which no effect at all is found (Compustat North America, 2010-2013, 2014-2018). Again, keeping in mind the Simpson's Paradox, we should not be too surprised by that. However, these results deserve to be discussed.

Regarding the Compustat North America sample (Models 9 and 10), first, we can notice that the number of companies in the Compustat North America sample is somewhat low: 15 companies (number of firm-year observations: 91). Therefore, we should be somewhat careful in interpreting these results. Another explanation is that the results differ from the results for other samples, including the full sample, is that the VI measure and ROA are influenced by North American and/or Canadian legislation (e.g. tax laws, accounting standards with respect to profit) (compared to legislation in other countries), so that this confounds the relationship. This is applicable to both the model using EBIT and the model using EBITDA.

Regarding the subperiod samples (Models 3-6), the fact that in both of these models no effect is found, while the results of the model using all data lean towards a positive effect, could mean that in a short period, the effects of vertical acquisitions on performance are not well distinguishable because it takes some time before the acquirer really starts enjoying the benefits of VI (think of synergies through for example knowledge sharing).

Four important conclusions emerge from the above analysis. First, the data shows mixed evidence on the VI – performance relationship. Secondly, a positive effect is more plausible than a negative effect.

A negative effect is not found in any model, while a positive effect is found in a number of models, including one of the models that use all data. Another conclusion, which holds for the models using the full sample and for some other models, but not for all models, is that no effect is equally plausible compared to a positive effect. Related to this, another conclusion is that in the models using the Compustat North America database and the models using the different subperiods (2010-2013 and 2014-2018), VI does not influence performance. Table 20 provides a summary of the most important results, including the coefficients of the VI measures, their significance, and (if significant) their interpretation.

Table 20: Summary of main results (including 'different' observations)

Sample	**Coefficient (standard error) VI_EBIT**	**Coefficient (standard error) VI_EBITDA**	**Effect of VI**	**Interpretation (on average)**	**Interpretation VI_EBITDA (on average)**
All data	0.00590** (0.00226)	-0.00216 (0.00201)	+/0	VI_EBIT ↑ 0.1 (=1/10) → ROA_EBIT ↑ 0.0059/10 = 0,00059, or 0,059 percentage points	Not applicable
2014-2018	0.00342 (0.00395)	-0.000173 (0.00189)	0	Not applicable	Not applicable
2010-2013	0.0122 (0.0122)	0.00299 (0.00407)	0	Not applicable	Not applicable
Compustat Global	0.00713** (0.00354)	-0.00147 (0.00162)	+/-	VI_EBIT ↑ 0.1 → ROA_EBIT ↑ 0.00713/10 = 0.000713, or 0.0713 percentage points	Not applicable
Compustat North America	0.0258 (0.373)	-0.142 (0.387)	0	Not applicable	Not applicable
Shipping lines (NAICS 483111)	0.00563** (0.00227)	-0.00232 (0.00207)	+/-	VI_EBIT ↑ 0.1 → ROA_EBIT ↑ 0.00563/10 = 0.000563, or 0.0563 percentage points	Not applicable
Freight forwarders (NAICS 488510)	0.192 (0.183)	0.381** (0.181)	-/+	Not applicable	VI_EBITDA ↑ 0.1 → ROA_EBITDA ↑ 0.00381/10 = 0.000381, or 0.0381 percentage points

Standard errors are robust and clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1

Discussion of differences

Comparing Table 18 to Table 20, without the two observations mentioned, a positive effect is found for the 2014-2018 sample, in both models, and for the freight forwarder sample, in one of the models. The other models do not show an effect. The results with the two observations mentioned are quite different: using all data, one of the models shows an effect, which is also the case using only data from Compustat Global, from shipping lines, and from freight forwarders. In the other models, no effect is found.

Therefore, it is clear that the 'different' observations had a large impact on the results. As mentioned before, personally, I think that the analysis without these values gives more reliable results, as it is hard to assess what is the correct degree of VI of a company at a given moment, if the values are so different only because of another definition. This means that the results shown in Table 18 are more reliable than the results shown in Table 20.

Results regarding control variables

Regarding the control variables, although the coefficients for these variables provide some evidence on the relationship of these variables with performance, these statistical relationships do not have to be causal. However, what is most important, is that is takes away bias in the relationship of VI on performance. The results with respect to the control variables are sometimes in line with expectations, and sometimes not. One variable that has at least the expected sign in all models, is the firm size variable (LNTurnover). However, the large majority of the models do not show a significant effect (the models using all data also do not), which is surprising at first sight, because it is quite plausible that economies of scale exist in the freight transport sector. This could be caused by the fact that total turnover is correlated with total assets, which has a tautological negative relationship with the performance measure, because it is in the denominator of this measure. This tautological relationship was the reason to refrain from using a measure based on total assets and use the natural logarithm of total turnover instead, but it could be the case that the problem has not disappeared completely. Another, theoretical explanation would be that not all costs in transport decrease with size. If we look at ocean transport, the average shipping costs (per TEU) decrease with larger ships, but the inland transportation costs per TEU and transhipment costs per TEU increase from a certain size**.** For inland transportation, diseconomies can arise because larger ships require more trucks, which can cause congestion in a port (Rodrigue, 2017). The increasing inland transportation costs can have influenced the freight forwarders, which often also provide inland transportation, while the increasing transhipment costs might have caused trouble for shipping lines, which often own terminals and otherwise the terminal operators could pass on these costs. If these increasing costs on average are approximately equal to the economies of scale used in e.g. shipping costs for the companies in the sample, this explanation is valid.

For the uncertainty measure, the models show similar results, although the uncertainty measure is only included in six models (Models 4 and 5), because of the other models being estimated by Fixed Effects. The similarity in comparison to the firm size measure is that the measure has the expected sign in all models, which is negative in this case, but that it is not significant in all models. In model 4 (2014-2018, EBITDA), no effect is found, while in Model 5 (2010-2013), a negative effect is found. This is not in line with the common theory that high uncertainty leads to less (profitable) investment and thus to lower growth/profit (Madhusoodanan, 2018). Again, one explanation is that in one

model EBIT is used and in the other model, but whether a model based on EBIT provides more reliable results than a model based on EBITDA or vice versa is unclear. Using the difference in the period that is used, another explanation is that companies in the last couple of years are reluctant to invest because they fear a new economic crisis and that VI is thus larger than what would be normal at the levels of uncertainty of the shipping lines and freight forwarders in the sample.

The results regarding another control variable, the measure of capital structure, are also not completely in line with expectations. Some negative effects were found, in line with expectations, but in most models, no effect was found, including the models using the full sample. The models using the Compustat North America sample are the only models that show a positive effect, which is against expectations, because a negative effect of the ratio of debt to assets on performance was expected, as suggested by the theory that a higher share of equity (or a lower ratio of debt to assets) should be accompanied by a higher return. These models thus consistently show a positive effect in for the companies in the North America database, but again, we should interpret the results of these models with caution due to the limited number of firms in the sample, which view is supported by the fact that no other model shows evidence for a positive effect. There are also other studies which did not confirm the negative relationship between the ratio of debt to assets and performance. In Harvey (1991), a negative risk-performance relationship (higher risk is implied by a lower ratio of debt to assets) was also found, for the OECD countries. Also, Turner, Startz, & Nelson (1989) find that the relationship between risk and performance changes from positive to negative from time to time. Also, the fact that total assets is used to calculate both the capital structure and the performance measure, could play a role. Theoretically, an explanation could be found in agency cost theory, which was introduced in Jensen & Meckling (1976). Agency costs arise because of imperfect alignment of the interests of owners (shareholders) and managers. Managers might thus take actions that are suboptimal or even disadvantageous to shareholders. This leads to a decrease in market value compared to the situation where the managers act in the shareholders' interest. This loss in market value, in combination with measures to prevent it, are both agency costs. This would mean that more equity is disadvantageous to firms, because it leads to higher agency costs. However, the mentioned agency costs are agency costs of debt, and agency of equity also exist, which are the result of different interests of shareholders and debtholders, and the possible preference of management for one of these groups of investors (Finance Train, 2019). However, the positive effects in Models 9 and 10 and the results of the models that show no effect might be explained by the fact that the agency costs of debt exceeded the agency costs of equity.

Regarding the year dummies, Table 21 in the Appendix shows the p-values of the joint significance of the dummies (Table 22 shows the p-values for the models using the sample including the 'different' observations). Joint significance of the year dummies can be interpreted as the existence of a trend in the dependent variable, ROA. The models using not all years are especially interesting here. The models using the 2014-2018 sample show no trend in ROA, while the models using the 2010-2013 sample show a trend in one of the models (EBIT). In the 2014-2018 period, there also few significant individual coefficients, while there are quite some significant negative coefficients for the 2010-2013 sample. Therefore, there are some signs of a trend in the period 2010-2013 but they are not undisputed. In the period 2014-2018, there was no trend in ROA. The result that a trend exists in one of the models (EBIT) is also found in the models using the full sample. In general, the year dummies are not in all models jointly significant, but they still take away some bias. Apart from the model using the full sample, most other models also used all years (the models not using only the years

2010-2013 or 2014-2018, but e.g. only freight forwarders). In half of the models that use all years, the year dummies are jointly significant, showing a trend, in and half of the models, they are not, showing no trend. Therefore, like for the 2010-2013 period, there are signs of a trend, but they are not undisputed. When this is the case, the 2010-2013 period possibly causes it, which can be explained by the negative effects of the last financial and economic crisis.

The remaining variable, the NAICS dummy, is only included in the Models 4 and 5, for the same reasons as the uncertainty measure. The dummy is one time significant (and positive), meaning that freight forwarders have a significantly higher average ROA than shipping lines (the reference category), which is in line with expectations, but one time not, meaning that freight forwarders have no significantly different ROA than shipping lines. The latter could be caused by the disadvantages of the EBITDA measures (deviates from e.g. 'real' profit), but again, it is not clear which measure is best. In any way, the results still show a positive coefficient, but the difference is not statistically significant. However, in general the results of the two models in which the industry dummy is included, lean towards a positive effect; a positive effect is more likely than a negative effect. However, no effect is equally plausible compared a to positive effect.

5. Conclusions and recommendations for practitioners and policy makers

In this chapter, the findings of the research will be summarized and recommendations for shipping lines and freight forwarders will be given based on these findings. Unless otherwise stated, the results relate to the models which I think are most reliable: the models that do not use the 'different' observations. The research question that was investigated is:

"Does vertical integration affect performance of international shipping lines and freight forwarders, and if it does, by how much?"

In the literature review, it was argued that, in line with Song & Panayides (2012), in theory, the benefits of VI are larger than the costs. Some of the most relevant cons (market is more efficient, sunk costs) decrease in significance when the companies that are studied are very large, which is often the case when talking about shipping lines and freight forwarders. At the same time, some of the most relevant pros, like a better balance between volumes and transportation times and better coordination, increase in significance when the companies are very large.

Studies that addressed comparable (quantitative) questions differ in several ways from this study, which is explained in the literature review. This thesis took these limitations into account. A clear measure of VI was used, namely the ratio of value added to sales with the adjustments proposed by Buzzell (1983) and Tucker & Wilder (1977). The research was conducted on a firm level by analysing company data from shipping lines and freight forwarders. By using recent, longitudinal data, a meaningful investigation of the existence of an effect is given. Finally, different versions of the VI and performance measures are considered.

Using all data, no evidence for the VI-performance relationship was found. This result of 'no effect' is also found in the models using the 2010-2013 sample, Compustat Global sample, the shipping line sample, the Compustat North America sample, the shipping lines sample. Several arguments can be given for these unexpected results.

Theoretically, the disadvantages of VI mentioned in the literature review, such as lower flexibility in adapting to changes in technology or the market resulting from VI, bureaucratic costs, and the need for relationship-specific assets, could have played a role. Furthermore, using the RBV approach, in examples of VI in the freight transport sector, firms might have integrated the 'wrong' resources, or the resources were not easily transferable from the acquirer to the target (or vice versa), so that synergies are limited. Also, the loss of focus, recognizing that horizontal integration is also common in shipping, could have played a role. A more practical reason is the high volatility of the shipping market, which is surely (also) affected by other factors than VI.

However, the freight forwarder sample showed a positive effect in the model using EBITDA, while the models using the 2014-2018 sample showed a positive effect in both models.

Regarding the results of the freight forwarder models, a first explanation why the model using EBIT shows no effect, not in line with expectations, while the model using EBITDA shows a positive significant effect, in line with expectations, is that the measures are biased by different legislation regarding depreciation and amortization. However, as neither definition is perfect, it is hard to say which definition is best. Another, theoretical, explanation can be found in the statement of Heaver

(2005) that container shipping 'is not as tightly bound to other logistics activities, as may be trucking or air transport for which the design and pricing of transport and logistics services may be done in an integrated service package', because of the length and uncertainty of time in transit in shipping. This could explain why VI works better for freight forwarders than for shipping lines.

The results for the 2014-2018 sample deserve special attention, as this sample is the only sample that shows a positive effect in both models. This result fits well with the note that the desirability of VI can change over time (Harrigan, 1985). Also, it shows that, in the last couple of years, VI was likely to influence profit positively. This could mean 'good news' for the VI moves that took place in this period or in 2019, and for future VI moves.

In contrast to the results for the 2014-2018 sample, for the 2010-2013 sample, in none of the two models, an effect was found, which was not expected. An explanation could be found in an important motivation for VI: to synchronize processes. As mentioned in the introduction, today

"... operations are increasingly approached from the perspective of complex logistics chains, whereby each link must contribute to the constant optimisation of the chain as a whole." (Van de Voorde & Vanelslander, 2008, p. 10)

VI could serve this purpose, as managing a chain becomes easier when you have more control over this chain. Companies in the freight transport sector possibly have started to embrace this vision only in recent years.

Although it is hard to formulate a precise answer to the research question, several important conclusions emerge from the research. First, the data overall shows no evidence for a positive VI – performance relationship. Secondly, a positive effect is more plausible than a negative effect. A negative effect is not found in any model, while a positive effect is found in a number of models: the models that only used recent years (2014-2018) and one of the models using the freight forwarder sample. The former finding also supports the view that today is a better time to vertically integrate than a number of years ago. The latter finding shows that the evidence on the effect of VI on performance is mixed for freight forwarders.

When the 'different' observations were included, the main conclusions were as follows. First, the data shows mixed evidence on the VI – performance relationship. Secondly, a positive effect is more plausible than a negative effect. A negative effect is not found in any model, while a positive effect is found in a number of models, including one of the models that use all data. Another conclusion, which holds for the models using the full sample and for some other models, but not for all models, is that no effect is equally plausible compared to a positive effect. Related to this, another conclusion is that in the models using the Compustat North America database and the models using the different subperiods (2010-2013 and 2014-2018), VI does not influence performance.

Looking at the differences between the results of the models that excluded the 'different' observations and the results of the models that did not, it is clear that those observations had a large impact on the results. Personally, I think that the analysis without these values gives more reliable results, as it is hard to assess what is the correct degree of VI of a company at a given moment, if the values are so different only because of another definition. This means that the results shown in Table 18 are more reliable than the results shown in Table 20, and I therefore refer to Table 18 for the size of the effect of VI on performance, if it exists.

For shipping lines and freight forwarders, the results in general can mean two things: a positive relationship between the degree of VI and performance (as is found for the last years), or no effect. A negative effect is unlikely. Furthermore, they should also understand that these results apply at the level of the group for which the models are estimated, and not at individual companies. However, they can use this information in to support their VI decisions. Furthermore, for freight forwarders, the existence of a positive effect is somewhat more likely, as VI influences performance in one of the freight forwarder models.

Furthermore, for policy makers the results can be even more meaningful as they operate on an aggregate level, in contrast to individual shipping lines and freight forwarders. Although using all data, no effect was found, for the sample covering the last couple of years, a positive effect of VI on performance of shipping lines and freight forwarders was found, and therefore they should not be too reluctant to stimulate this strategic choice by making it at least fiscally equally attractive compared to no VI and by being open to foreign investment. Also, they should limit the administrative tasks that are associated with a vertical merger or acquisition.

Regarding the control variables, they are not always significant, which was not in line to expectations, but, apart from the fact that these coefficients might be biased (we only want to control for them, not to estimate their effect!), several reasons can be put forward to explain these results. The most important thing, however, is that these variables take away bias in the VI-performance relationship.

6. Limitations and suggestions for future research

Despite all effort that has been made to make this thesis a valuable contribution to the existing literature, it is not without limitations.

First, some samples (Compustat North America, freight forwarders) only have a limited number of companies. More data was not available from Compustat, but other data gathering methods that lead to more data could provide results that are more reliable than the results that this study presents for the Compustat North America and the freight forwarder sample.

Secondly, the number of performance measures used is limited. ROA is measured based on both EBIT and EBITDA, but more measures of financial performance exist. It is true that some measures have their disadvantages (e.g. ROE, ROI, ROS), as mentioned in the literature review. However, it might be interesting to do apply the same methodology to other measures, such as Tobin's Q or firm value. Additionally, the methodology can be applied to organizational and environmental performance measures.

Thirdly, the VI measure can still be improved, in a number of ways. First, as discussed before, backward integration gets a higher weight than forward integration. Secondly, as also discussed before, EBIT or EBITDA is subtracted from the numerator and the denominator of the initial VI measure and a 'normal' profit is added back, which does solve some of the, but probably not the full problem of possible endogeneity of EBIT being part of both the VI measure and ROA. Next to that, the VI measure used is limited in that, although the amount of assets is only used in the ROA measure and not in the VI measure, turnover is used in the VI measure, which is correlated with the amount of assets (correlation coefficient = 0.79), possibly leading to a certain degree of endogeneity. Also, the fact that accounting profits are used (not economic profits) can have biased the profitability and VI measures to a certain extent. Lastly, the measure does not adjust for unequal returns to the factors of production (Maddigan and Zaima, 1985). It would be valuable to further develop the adjusted ratio of value added to sales, because it is a straightforward easy-to-calculate measure of VI with a clear idea: it shows what part of the sales are earned by the activities of the company itself.

Fourthly, there might be a problem of reverse causality. This is the case when VI is mostly pursued by high-performance companies. However, it is not clear that this is the case. Companies with a relatively high ROA might vertically integrate because they have the resources to do so, but companies having a low ROA might vertically integrate to improve their ROA in the long term. Finding an exogenous a relevant instrumental variable for the effect of VI on performance could solve this problem.

Lastly, a suggestion regarding theory development. The existence of a positive effect of VI on performance is not so clear from the results of this research, which is not very well supported by existing literature, which puts a stronger emphasis on the advantages of VI. Academics should therefore try to further develop theories about disadvantages of VI or develop new ones. That would contribute to a better understanding of a very fundamental question for shipping lines and freight forwarders: expand the service portfolio or not?

Appendix

Table 2: Overview of vertical relations within the shipping industry

Part 1

	Company	Shipping lines (container)	Terminal activities	Tankers and other shipping activities	Logistics/ Multimodal	Shipyard/ Container production	Others
1	AP Möller Group	Mearsk Line Safmarine og MCC Damco	APM Terminals	Maersk Tankers Maersk Drilling Maersk LNG Maersk FPS Svitzer (towing)	Mearsk Logistics	The Odense Steel Shipyard group Container Industry	Maersk Oil Supermarked Group Danske Bank Star Air Danbor Service
2	Mediterranean Shipping Company (MSC)	MSC Cargo					MSC Cruises
3	CMA CGM Group	Delmas ANL Mac Andrews OT Africa Line CNC Line Comanav U.S. Lines			River Shuttle Cont. LTI France Progeco CMA Rail CMA CGM Logistics TCX Multimodal Logistics		Compagnie du Ponant Partir en Cargo Tapis Rouge Int. The Traveller's Club (all tourism related)
4	Evergreen Line	EG Marine Corp. Italia Marittima SpA EG Marine (UK) Ltd. EG Marine (Hong Kong) Ltd. EG Marine (Singapore) Pte Ltd.	4 transhipments hubs 3 terminals operated				

Part 2

5	Hapag Lloyd AG	Hapag-Lloyd	Holding with minor shares in container terminals in Hamburg and Montreal				
6	CSAV Group	CSAV Norasia Container Lines Ltd. Companhia Libra de Navegacao/Navegacion CSAV Panama	COSAN SAAM	Transportation of vehicles, reefer cargo, solid and liquid bulks SAAM (tugboats)	SAAM (logistics activities)		
7	NOL Group	American President Line (APL)	APL Terminal Activities		APL Logistics APL Log Transp. Management Serv. APL Log Wh Management Serv. Vascor, Ltd.		
8	COSCO Group	COSCO Shipping Lines	COSCO Pacific Co.	Xiamen (bulk) Cosco Bulk Carrier Dalian (tanker) Guangzhou Ocean Shipp (specialized)	COSCO Logistics China Ocean Shipping Agency	COSCO Shipyard Group Nantong COSCO KHI Ship Eng. Co Dalian COSCO Shipbuilding CIMC (container manufacturing)	passenger shipping: Tianjin Jinshen Ferry Sino-Japan Int. Ferry Yingkou COSCO COSCO Finance Co COSCO Int. ship trading China Marine Bunker

Part 3

9	Hanjin Shipping	Hanjin Shipping	Hanjin Pacific Corporation (13 terminals) Hanjin New Port Company Hanjin Kerry Logistics Total Terminal Int.	Hanjin Overseas Bulk Hanjin Overseas Tanker Pte.	Hanjin Shipmanagement Hanjin Logistics HJLK (Transport. Agency) Shandong Hanjin Log. (ODCY)	ZESCO (ship repair yard)	Samol Co. (renewable energy)
10	CSCL	China Shipping Container Lines ShanHai Puhai Shipping Xiang Zhu	China Shipping Terminal Development Dalian Int. Container Terminal various other terminals	China Shipping Refrigeration Universal Shipping Co. Shanghai HaiXin YuanCang Int. Log. Various cargo agencies	Shanghai Yanshan Storage and Transportation Co. Dalian Vanguard Int. Logistics Universal Logistics		CSCL (Dalian) Data Processing International Computer Co. (IT)
11	Mitsui O.S.K. Line	Mitsui O.S.K. Liner Utoc Corp.	International Container Terminal	MOL Bulk Shipping - Tankers MOL LNG Transport Co. MOL Car Carriers	MOL Ship Management MOL Ferry Blue Sea Network (ferry and domestic transport) Tug-Boat and Towing	Minaminippon Shipbuilding Co.	MOL Information Systems MO Tourist Co. MO Marine Consulting MOL Finance
12	NYK Line	NYK Liner Trade	Yusen Terminals Inc.	Bulk Shipping	NYK Logistics Nippon Cargo Airline Co.		Yusen Real Estate Crystal Cruises Inc. NYK Cruise Co. Monohakobi Technology Inst. (Research)

Source: Song & Panayides (2012)

Table 3: Definitions NAICS codes

488510 - **Freight Transportation Arrangement**	**483111 - Deep Sea Freight Transportation**
This industry comprises establishments primarily engaged in arranging transportation of freight between shippers and carriers. These establishments are usually known as freight forwarders, marine shipping agents, or customs brokers and offer a combination of services spanning transportation modes.	This U.S. industry comprises establishments primarily engaged in providing deep sea transportation of cargo to or from foreign ports.

Source: NAICS Association (2019a, 2019b)

Table 7: Potential outliers VI_EBIT

Observation number	Value	Reason to investigate	Drop?
82	-4.774171	< (mean – 3 * standard deviation)	No
171	-4.229232	< (mean – 3 * standard deviation)	No
83	5.330085	> (mean – 3 * standard deviation)	No
463	10.48825	> (mean – 3 * standard deviation)	Yes (robustness check)
172	18.85335	> (mean – 3 * standard deviation)	Yes (robustness check)

Initial mean: .26503. Initial standard deviation: .9950477.

Table 8: Potential outliers VI_EBITDA

Observation number	Value	Reason to investigate	Drop?
172	-10.12156	< (mean – 3 * standard deviation)	Yes (robustness check)
82	-4.094424	< (mean – 3 * standard deviation)	No
171	-2.272317	< (mean – 3 * standard deviation)	No
463	-1.90257	< (mean – 3 * standard deviation)	Yes (robustness check)
80	2.266094	> (mean – 3 * standard deviation)	No
174	2.607795	> (mean – 3 * standard deviation)	No
85	2.968357	> (mean – 3 * standard deviation)	No
173	3.870489	> (mean – 3 * standard deviation)	No
83	4.976039	> (mean – 3 * standard deviation)	No

Initial mean: .3379155. Initial standard deviation: .6199238.

Table 9: Potential outliers ROA_EBIT

Observation number	Value	Reason to investigate	Drop?
138	-1.148409	< (mean – 3 * standard deviation)	No
384	-.5519809	< (mean – 3 * standard deviation)	No
418	-.4206757	< (mean – 3 * standard deviation)	No
168	-.3272788	< (mean – 3 * standard deviation)	No
233	-.2773469	< (mean – 3 * standard deviation)	No
503	-.2413051	< (mean – 3 * standard deviation)	No
484	.2977031	> (mean – 3 * standard deviation)	No

Initial mean: .0229413. Initial standard deviation: .0873185.

Table 10: Potential outliers ROA_EBITDA

Observation number	Value	Reason to investigate	Drop?
138	-1.147491	< (mean – 3 * standard deviation)	No
384	-.5155394	< (mean – 3 * standard deviation)	No
418	-.3908113	< (mean – 3 * standard deviation)	No
168	-.3011613	< (mean – 3 * standard deviation)	No
233	-.2205503	< (mean – 3 * standard deviation)	No

Initial mean: .0642542. Initial standard deviation: .0890138.

Table 15: Results of tests on joint significance of coefficients of Correlated Random Effects models (excluding 'different' observations)

Model number[8]	**Null hypothesis**	**P-value**	**FE/RE**
1	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0088	**FE**
2	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
3	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0427	**FE**
4	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0918	**RE**
5	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = 0	0.8254	**RE**
6	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = 0	0.0000	**FE**
7	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
8	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
9	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
10	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
11	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean =	0.0000	**FE**

[8] The models represent the Correlated Random Effects (CRE) models that were used to determine whether a Fixed Effects model or a Random Effects model was more appropriate. These models include all variables that are not time-invariant and the means of those variables. The numbers of these models correspond to the model numbers of the final models.

	Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0		
12	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
13	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
14	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**

Table 16: Results of tests on joint significance of coefficients of Correlated Random Effects models (including 'different' observations)

Model number[9]	**Null hypothesis**	**P-value**	**FE/RE**
1	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0055	**FE**
2	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
3	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0363	**FE**
4	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.1009	**RE**
5	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = 0	0.8251	**RE**
6	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = 0	0.0000	**FE**
7	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
8	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
9	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
10	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
11	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean =	0.0000	**FE**

[9] The models represent the Correlated Random Effects (CRE) models that were used to determine whether a Fixed Effects model or a Random Effects model was more appropriate. These models include all variables that are not time-invariant and the means of those variables. The numbers of these models correspond to the model numbers of the final models.

	Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0		
12	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
13	VI_EBIT_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**
14	VI_EBITDA_mean = DebtAssets_mean = LNTurnover_mean = Year2011_mean = Year2012_mean = Year2013_mean = Year2014_mean = Year2015_mean = Year2016_mean = Year2017_mean = Year2018_mean = 0	0.0000	**FE**

Table 17: Regression results (excluding 'different' observations)

VARIABLES	Model 1 ROA_EBIT	Model 2 ROA_EBITDA	Model 3 ROA_EBIT	Model 4 ROA_EBITDA	Model 5 ROA_EBIT	Model 6 ROA_EBITDA	Model 7 ROA_EBIT	Model 8 ROA_EBITDA	Model 9 ROA_EBIT	Model 10 ROA_EBITDA	Model 11 ROA_EBIT	Model 12 ROA_EBITDA	Model 13 ROA_EBIT	Model 14 ROA_EBITDA
VI_EBIT	-0.000259		0.00337**		0.0122		0.00136		0.0258		-0.000502		0.192	
	(0.00274)		(0.00155)		(0.0122)		(0.00197)		(0.373)		(0.00280)		(0.183)	
VI_EBITDA		0.00943		0.00309**		0.00299		0.00755		-0.142		0.00881		0.381**
		(0.00839)		(0.00144)		(0.00407)		(0.00635)		(0.387)		(0.00817)		(0.181)
DebtAssets	0.0105	0.0266	-0.103***	-0.0667***	-0.0555***	-0.0350	-0.0648*	-0.0514	0.130**	0.143***	0.0153	0.0311	-0.0420	-0.00705
	(0.0579)	(0.0585)	(0.0286)	(0.0206)	(0.0116)	(0.0257)	(0.0364)	(0.0327)	(0.0471)	(0.0357)	(0.0605)	(0.0612)	(0.0593)	(0.0631)
LNTurnover	0.0300	0.0327	0.0297***	0.0212***	0.00366	0.0139	0.00846	0.00922	0.108*	0.0948**	0.0309	0.0335	0.0256	0.0556*
	(0.0216)	(0.0225)	(0.00817)	(0.00638)	(0.00357)	(0.0105)	(0.0139)	(0.0134)	(0.0603)	(0.0414)	(0.0222)	(0.0231)	(0.0226)	(0.0268)
Year2011	-0.0313***	-0.0243**			-0.0276***	-0.0179*	-0.0318***	-0.0260**	-0.0172	-0.00428	-0.0387***	-0.0309**	0.00326	0.00464
	(0.0105)	(0.0105)			(0.0101)	(0.00957)	(0.0119)	(0.0119)	(0.0120)	(0.0146)	(0.0124)	(0.0125)	(0.0162)	(0.0160)
Year2012	-0.0149**	-0.00902			-0.0108**	-0.00593	-0.00702	-0.00264	-0.0387	-0.0296	-0.0177**	-0.0111	-0.00503	-0.00577
	(0.00709)	(0.00667)			(0.00543)	(0.00535)	(0.00576)	(0.00593)	(0.0234)	(0.0248)	(0.00853)	(0.00800)	(0.00863)	(0.00909)
Year2013	-0.0222***	-0.0183**			-0.0190***	-0.0145**	-0.0171**	-0.0122	-0.0370	-0.0422	-0.0268***	-0.0222**	-0.00327	-0.00725
	(0.00782)	(0.00813)			(0.00728)	(0.00717)	(0.00820)	(0.00825)	(0.0265)	(0.0335)	(0.00927)	(0.00962)	(0.00835)	(0.0102)
Year2014	-0.0173	-0.0136					0.00598	0.00970	-0.114*	-0.114	-0.0207	-0.0176	-0.00251	-0.00262
	(0.0196)	(0.0198)					(0.0110)	(0.0109)	(0.0637)	(0.0707)	(0.0240)	(0.0241)	(0.00665)	(0.00818)
Year2015	-0.00345	0.00178	0.00157	0.00312			-0.000651	0.00427	-0.0476	-0.0458	-0.00333	0.00304	-0.00524	-0.00939
	(0.00989)	(0.00982)	(0.00587)	(0.00622)			(0.0105)	(0.0103)	(0.0632)	(0.0706)	(0.0120)	(0.0119)	(0.00948)	(0.0114)
Year2016	-0.0120	-0.00596	-0.00543	-0.00323			-0.00906	-0.00444	-0.0695	-0.0635	-0.0116	-0.00379	-0.0162	-0.0246
	(0.00956)	(0.00999)	(0.00639)	(0.00659)			(0.0106)	(0.0108)	(0.0567)	(0.0702)	(0.0111)	(0.0116)	(0.0160)	(0.0156)
Year2017	-0.00855	-0.00428	-0.00526	-0.00362			0.00219	0.00284	-0.0999	-0.0911	-0.00291	0.00232	-0.0207*	-0.0313*
	(0.0107)	(0.0103)	(0.00717)	(0.00638)			(0.0111)	(0.0109)	(0.0659)	(0.0760)	(0.0113)	(0.0108)	(0.0119)	(0.0154)
Year2018	-0.0204	-0.0150	-0.0114	-0.00783			-0.0225*	-0.0177*	-0.0650	-0.0605	-0.0410***	-0.0266***	0.00263	-0.00971
	(0.0148)	(0.0136)	(0.00697)	(0.00582)			(0.0127)	(0.00891)	(0.0493)	(0.0518)	(0.00660)	(0.00680)	(0.0149)	(0.0180)
Uncertainty				-0.0584	-0.0737**									
				(0.0499)	(0.0370)									
NAICS_488510				0.0283	0.0411***									
				(0.0188)	(0.0147)									
Constant	-0.124	-0.113	-0.0697*	-0.00176	0.0585**	0.0165	0.0219	0.0463	-0.644	-0.466	-0.134	-0.122	-0.0968	-0.308
	(0.135)	(0.141)	(0.0380)	(0.0379)	(0.0233)	(0.0617)	(0.0729)	(0.0706)	(0.409)	(0.322)	(0.136)	(0.142)	(0.190)	(0.216)
Observations	575	575	233	230	336	342	484	484	91	91	465	465	110	110
R-squared (within)	0.083	0.088	0.199	0.1837	0.0659	0.056	0.096	0.077	0.537	0.558	0.097	0.101	0.092	0.123
R-squared (between)	0.0579	0.0465	0.0774	0.1007	0.3469	0.1077	0.1174	0.0703	0.4163	0.2796	0.0326	0.0389	0.5349	0.3119
R-squared (overall)	0.0612	0.0505	0.1111	0.1295	0.2469	0.0572	0.1029	0.0622	0.4475	0.3780	0.0253	0.0281	0.5148	0.3270
Number of companies	105	105	93	90	93	99	90	90	15	15	84	84	21	21

Standard errors are in parentheses. They are robust and clustered at the firm level.
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Regression results (including 'different' observations)

VARIABLES	Model 1 ROA_EBIT	Model 2 ROA_EBITDA	Model 3 ROA_EBIT	Model 4 ROA_EBITDA	Model 5 ROA_EBIT	Model 6 ROA_EBITDA	Model 7 ROA_EBIT	Model 8 ROA_EBITDA	Model 9 ROA_EBIT	Model 10 ROA_EBITDA	Model 11 ROA_EBIT	Model 12 ROA_EBITDA	Model 13 ROA_EBIT	Model 14 ROA_EBITDA
VI_EBIT	0.00590**		0.00342		0.0122		0.00713**		0.0258		0.00563**		0.192	
	(0.00226)		(0.00395)		(0.0122)		(0.00354)		(0.373)		(0.00227)		(0.183)	
VI_EBITDA		-0.00216		-0.000173		0.00299		-0.00147		-0.142		-0.00232		0.381**
		(0.00201)		(0.00189)		(0.00407)		(0.00162)		(0.387)		(0.00207)		(0.181)
DebtAssets	0.0210	0.0365	-0.00492	0.00907	-0.0555***	-0.0350	-0.0266	-0.0110	0.130**	0.143***	0.0246	0.0397	-0.0420	-0.00705
	(0.0421)	(0.0416)	(0.0252)	(0.0196)	(0.0116)	(0.0257)	(0.0286)	(0.0316)	(0.0471)	(0.0357)	(0.0433)	(0.0427)	(0.0593)	(0.0631)
LNTurnover	0.0297	0.0298	0.0172	0.0151**	0.00366	0.0139	0.00731	0.00533	0.108*	0.0948**	0.0306	0.0307	0.0256	0.0556*
	(0.0220)	(0.0230)	(0.0106)	(0.00772)	(0.00357)	(0.0105)	(0.0144)	(0.0139)	(0.0603)	(0.0414)	(0.0227)	(0.0237)	(0.0226)	(0.0268)
Year2011	-0.0315***	-0.0254**			-0.0276***	-0.0179*	-0.0326***	-0.0279**	-0.0172	-0.00428	-0.0389***	-0.0321**	0.00326	0.00464
	(0.0106)	(0.0107)			(0.0101)	(0.00957)	(0.0122)	(0.0123)	(0.0120)	(0.0146)	(0.0125)	(0.0127)	(0.0162)	(0.0160)
Year2012	-0.0149**	-0.0104			-0.0108**	-0.00593	-0.00773	-0.00471	-0.0387	-0.0296	-0.0177**	-0.0127*	-0.00503	-0.00577
	(0.00689)	(0.00639)			(0.00543)	(0.00535)	(0.00579)	(0.00596)	(0.0234)	(0.0248)	(0.00822)	(0.00760)	(0.00863)	(0.00909)
Year2013	-0.0232***	-0.0189**			-0.0190***	-0.0145**	-0.0194**	-0.0142*	-0.0370	-0.0422	-0.0279***	-0.0227**	-0.00327	-0.00725
	(0.00755)	(0.00776)			(0.00728)	(0.00717)	(0.00809)	(0.00819)	(0.0265)	(0.0335)	(0.00894)	(0.00917)	(0.00835)	(0.0102)
Year2014	-0.0174	-0.0157					0.00392	0.00523	-0.114*	-0.114	-0.0207	-0.0200	-0.00251	-0.00262
	(0.0188)	(0.0188)					(0.0108)	(0.0105)	(0.0637)	(0.0707)	(0.0229)	(0.0229)	(0.00665)	(0.00818)
Year2015	-0.00456	0.00170	-0.000890	0.00280			-0.00577	0.000197	-0.0476	-0.0458	-0.00437	0.00315	-0.00524	-0.00939
	(0.00924)	(0.00940)	(0.00706)	(0.00674)			(0.0110)	(0.0112)	(0.0632)	(0.0706)	(0.0112)	(0.0114)	(0.00948)	(0.0114)
Year2016	-0.0122	-0.00529	-0.00609	-0.00156			-0.00994	-0.00467	-0.0695	-0.0635	-0.0116	-0.00302	-0.0162	-0.0246
	(0.00968)	(0.0102)	(0.00666)	(0.00686)			(0.0106)	(0.0109)	(0.0567)	(0.0702)	(0.0113)	(0.0119)	(0.0160)	(0.0156)
Year2017	-0.00906	-0.00483	-0.00548	-0.00281			0.000347	0.000314	-0.0999	-0.0911	-0.00312	0.00187	-0.0207*	-0.0313*
	(0.0104)	(0.0102)	(0.00690)	(0.00636)			(0.0108)	(0.0105)	(0.0659)	(0.0760)	(0.0111)	(0.0109)	(0.0119)	(0.0154)
Year2018	-0.0197	-0.0169	-0.0111*	-0.00700			-0.0215**	-0.0200**	-0.0650	-0.0605	-0.0371***	-0.0307***	0.00263	-0.00971
	(0.0136)	(0.0138)	(0.00563)	(0.00575)			(0.00927)	(0.00772)	(0.0493)	(0.0518)	(0.00697)	(0.00759)	(0.0149)	(0.0180)
Uncertainty				-0.0638	-0.0737**									
				(0.0455)	(0.0370)									
NAICS_488510				0.0336*	0.0411***									
				(0.0188)	(0.0147)									
Constant	-0.129	-0.0987	-0.0573	-0.0107	0.0585**	0.0165	0.00749	0.0493	-0.644	-0.466	-0.139	-0.108	-0.0968	-0.308
	(0.131)	(0.137)	(0.0541)	(0.0473)	(0.0233)	(0.0617)	(0.0759)	(0.0733)	(0.409)	(0.322)	(0.132)	(0.137)	(0.190)	(0.216)
Observations	577	577	235	232	336	342	486	486	91	91	467	467	110	110
R-squared	0.090	0.088	0.069	0.0405	0.0659	0.056	0.079	0.046	0.537	0.558	0.104	0.103	0.092	0.123
R-squared	0.0536	0.0368	0.0897	0.1259	0.3469	0.1077	0.0914	0.0345	0.4163	0.2796	0.0294	0.0320	0.5349	0.3119
R-squared	0.0583	0.0445	0.1037	0.1381	0.2469	0.0572	0.0845	0.0394	0.4475	0.3780	0.0241	0.0250	0.5148	0.3270
Number of companies	105	105	93	90	93	99	90	90	15	15	84	84	21	21

Standard errors are in parentheses. They are robust and clustered at the firm level.
*** p<0.01, ** p<0.05, * p<0.1

Table 21: Results of tests on joint significance of coefficients of year dummies (excluding 'different' observations)

Model number	**Null hypothesis**	**P-value**
1	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0305
2	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.1000
3	Year2015 = Year2016 = Year2017 = Year2018 = 0	0.2269
4	Year2015 = Year2016 = Year2017 = Year2018 = 0	0.2251
5	Year2011 = Year2012 = Year2013 = 0	0.0215
6	Year2011 = Year2012 = Year2013 = 0	0.1531
7	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.1262
8	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0889
9	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0153
10	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0004
11	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0000
12	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0000
13	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.7074
14	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.3815

Table 22: Results of tests on joint significance of coefficients of year dummies (including 'different' observations)

Model number	**Null hypothesis**	**P-value**
1	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0405
2	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.1107
3	Year2015 = Year2016 = Year2017 = Year2018 = 0	0.2084
4	Year2015 = Year2016 = Year2017 = Year2018 = 0	0.5318
5	Year2011 = Year2012 = Year2013 = 0	0.0215
6	Year2011 = Year2012 = Year2013 = 0	0.1531
7	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0894
8	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0598
9	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0153
10	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0004
11	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0000
12	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.0000
13	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.7074
14	Year2011 = Year2012 = Year2013 = Year2014 = Year2015 = Year2016 = Year2017 = Year2018 = 0	0.3815

Reference list

Abbott, M., & Cohen, B. (2017). Vertical integration, separation in the rail industry: a survey of empirical studies on efficiency. *European Journal of Transport and Infrastructure Research, 17, 2.* doi: 10.18757/ejtir.2017.17.2.3191

Adelman, M. A. (1955). Concept and statistical measurement of vertical integration. In *Business concentration and price policy* (p. 281-330). Princeton University Press.

Andreou, P, C., Louca, C., and Panayides (2012). Valuation effects of mergers and acquisitions in freight transportation. *Transportation Research Part E: Logistics and Transportation Review, 48(6), 1221-1234.*

Aubert, B. A., Rivard, S., & Patry, M. (1996). A transaction cost approach to outsourcing behavior: Some empirical evidence. *Information & management*, *30*(2), 51-64.

Automotive News (2016). *Vertical integration rears its head.* Retrieved on June 6, 2019, from https://www.autonews.com/article/20160801/BLOG06/160809968/vertical-integration-rears-its-head

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120.

Barney, J. B. (2001). Is the resource-based "view" a useful perspective for strategic management research? Yes. *Academy of management review*, *26*(1), 41-56.

Basak, A. A., & Nebol, E. (2016). Strategic competitiveness of maritime companies in volatile shipping market conditions: keeping trade or tradition? *LM-SCM 2016 XIV. International Logistics and Supply Chain Congress.*

Besanko, Dranove, Shanley, & Schaefer (2013)

Business Insider (2015). *Tesla could learn something from Henry Ford.* Retrieved on June 5, 2019, from https://www.businessinsider.com/tesla-could-learn-something-from-henry-ford-2015-9?international=true&r=US&IR=T

Bustinza, O. F., Arias-Aranda, D., & Gutierrez-Gutierrez, L. (2010). Outsourcing, competitive capabilities and performance: an empirical study in service firms. *International Journal of Production Economics*, *126*(2), 276-288.

Bustinza, O. F., Arias-Aranda, D., & Gutierrez-Gutierrez, L. (2010). Outsourcing, competitive capabilities and performance: an empirical study in service firms. *International Journal of Production Economics*, *126*(2), 276-288.

Buzzell, R.D. (1983). Is vertical integration profitable? *Harvard Business Review. 61(1).*

Cariou, P. (2008). Liner shipping strategies: an overview. *International Journal of Ocean Systems Management*, *1*(1), 2-13.

Chandler, A. D. (1962). *Strategy and Structure: Chapters in the History of the American Industrial Enterprise.* Cambridge, MA: MIT Press.

Conner, K. R., & Prahalad, C. K. (1996). A resource-based theory of the firm: Knowledge versus opportunism. *Organization science*, *7*(5), 477-501.

Dang, C., Li, Z. F., & Yang, C. (2018). Measuring firm size in empirical corporate finance. *Journal of Banking & Finance*, *86*, 159-176.

Danish Ship Finance (2018). *Shipping market review*. Retrieved on May 31, 2019, from https://www.shipfinance.dk/media/1817/shipping-market-review-may-2018.pdf

DNB Alpha (2018). *DP World acquires leading port related logistics solutions provider in Europe.* https://www.dnbalpha.com/news/dp-world-acquires-leading-port-related-logistics-solutions-provider-in-europe/

Doğan, M. (2013). Does firm size affect the firm profitability? Evidence from Turkey. *Research Journal of Finance and Accounting*, *4*(4), 53-59.

Duhaime, I. M., & Grant, J. H. (1984). Factors influencing divestment decision-making: Evidence from a field study. *Strategic Management Journal*, *5*(4), 301-318.

European Central Bank (2019). *Exchange rates* [Dataset].

Fabbe-Costes, N., & Jahre, M. (2008). Supply chain integration and performance: a review of the evidence. *The International Journal of Logistics Management, 19(2), 130-154.* doi: https://doi.org/10.1108/09574090810895933

Finance Train, 2019. *Agency costs of equity and debt.* Retrieved on June 14, 2019, from https://financetrain.com/agency-costs-of-equity-and-debt/

Franc, P., and Van der Horst, M. (2010). Understanding hinterland service integration by shipping lines and terminal operators: a theoretical and empirical analysis. *Journal of Transport Geography, 18(4), 557-566.* doi: https://doi.org/10.1016/j.jtrangeo.2010.03.004

Frémont, A. (2008). *Empirical evidence for integration and disintegration of maritime shipping, port and logistics activities.* Retrieved on July 4, 2018, from https://www.econstor.eu/bitstream/10419/68780/1/58977994X.pdf

Frémont, A. (2009). Shipping lines and logistics. *Transport Reviews*, *29*(4), 537-554.

Harrigan, K. R. (1985). Vertical Integration and Corporate Strategy. *The Academy of Management Journal. 28(2), 397-425.*

Harvey, C. R. (1991). The world price of covariance risk. *The Journal of Finance*, *46*(1), 111-157.

Heaver. T. D. (2005). Responding to shippers' supply chain requirements. In H. Leggate, J. McConville, & A. Morvillo (Eds.), *International Maritime Transport: perspectives* (p. 178-189). Abingdon: Routledge.

Huo, B., Selen, W., Hoi Yan Yeung, J., & Zhao, X. (2008). Understanding drivers of performance in the 3PL industry in Hong Kong. *International Journal of Operations & Production Management*, *28*(8), 772-800.

Huo, B., Selen, W., Hoi Yan Yeung, J., & Zhao, X. (2008). Understanding drivers of performance in the 3PL industry in Hong Kong. *International Journal of Operations & Production Management*, *28*(8), 772-800.

ING Wholesale Banking (2019). *Sector volatility: Shipping.* Retrieved on May 31, 2019, from https://view.ingwb.com/sector-and-volatility-shipping

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of financial economics*, *3*(4), 305-360.

Journal de la Marine Marchande (1966). *Les armateurs suédois face à l'avenir* [The Swedish shipowners facing the future].

Kakani, R. K., Saha, B., & Reddy, V. N. (2001). *Determinants of financial performance of Indian corporate sector in the post-liberalization era: an exploratory study.*

Kotabe, M., & Mol, M. J. (2009). Outsourcing and financial performance: A negative curvilinear effect. *Journal of Purchasing and Supply Management*, *15*(4), 205-213.

Lajili, K., Madunic, M., & Mahoney, J. T. (2007). Testing organizational economics theories of vertical integration. In *Research Methodology in Strategy and Management* (pp. 343-368). Emerald Group Publishing Limited.

Lam, J. S. L. L, & Van de Voorde, E. (2011). Scenario analysis for supply chain integration in container shipping. *Maritime Policy & Management, 38(7), 705-725.* doi: https://doi.org/10.1080/03088839.2011.625988

Lee, S. (2014). The relationship between growth and profit: Evidence from firm-level panel data. *Structural Change and Economic Dynamics*, *28*, 1-11.

Logistics Middle East (2014). 2014: *A very good year for shipping and ports. Industry leaders share their thoughts on major maritime events of 2014.*

Lun, Y. 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 Systems with Applications*, *38*(6), 7227-7234.

Maddigan, R. J. (1981). The measurement of vertical integration. *The Review of Economics and Statistics*, 328-335.

Maddigan, R. J., & Zaima, J. K. (1985). The profitability of vertical integration. *Managerial and Decision Economics*, *6*(3), 178-179.

Madhusoodanan (2018). *How do investors respond to uncertainty?* Retrieved on May 7, 2019, from https://insights.som.yale.edu/insights/how-do-investors-respond-to-uncertainty

Majumdar, S. K. (1997). The impact of size and age on firm-level performance: some evidence from India. *Review of industrial organization*, *12*(2), 231-241.

Makadok, R. (2001). Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic management journal*, *22*(5), 387-401.

Meersman, H., Van de Voorde, E., & Vanelslander, T. (2009). *Zeehavens en maritiem transport: cruciale schakels voor logistiek succes.*

Mitra, S., & Bagchi, P. K. (2008, January). Key success factors, performance metrics, and globalization issues in the third-party logistics (3PL) industry: A survey of North American service providers. In *Supply Chain Forum: An International Journal* (Vol. 9, No. 1, pp. 42-54). Taylor & Francis.

NAICS Association (2019a). 483111 – Deep sea freight transportation. Retrieved on February 26, 2019, from https://www.naics.com/naics-code-description/?code=483111

NAICS Association (2019b). 488510 – Freight transportation arrangement. Retrieved on February 26, 2019, from https://www.naics.com/naics-code-description/?code=488510

Nijdam, M. and Van der Horst, M. (2015). Port definition, concepts and the role of ports in supply chains: setting the scene. In: H. Geerlings, B. Kuipers, & R. Zuidwijk (Eds.), *Ports and Networks: Strategies, Operations and Perspectives.* London, United Kingdom: Routledge.

Notteboom, T. E. (2002). Consolidation and contestability in the European container handling industry. *Maritime Policy & Management*, *29*(3), 257-269.

Onghena, E., Meersman, H., & Van de Voorde, E. (2014). A translog cost function of the integrated air freight business: The case of FedEx and UPS. *Transportation Research Part A: Policy and Practice*, *62*, 81-97.

Panayides, P. M. (2002). Economic organization of intermodal transport. *Transport reviews, 22(4), 401, 414.* doi: https://doi.org/10.1080/01441640210124523

Perry, M. K. (1989). Vertical integration: determinants and effects. *Handbook of industrial organization*, *1*, 183-255.

Reed, R., & Fronmueller, M. P. (1990). Vertical integration: a comparative analysis of performance and risk. *Managerial and Decision Economics*, *11*(3), 177-185.

Reed, R., & Fronmueller, M. P. (1990). Vertical integration: a comparative analysis of performance and risk. *Managerial and Decision Economics*, *11*(3), 177-185.

Reuters (2018). *Alibaba leads consortium $1.4 billion deal for stake in Chinese courier ZTO.* Retrieved on June 1, 2019, from https://www.reuters.com/article/us-zto-alibaba/alibaba-leads-consortium-in-1-4-billion-deal-for-stake-in-chinese-courier-zto-idUSKCN1IU1B8

Robinson, R. (2002). Ports as elements in value-driven chain systems: the new paradigm. *Maritime Policy & Management*, *29*(3), 241-255.

Rodrigue (2017). *Economies and diseconomies of scale in container shipping.* Retrieved on June 3, 2019, from https://transportgeography.org/?page_id=2773

Rodrigue, J. P. (2017). *The setting of global transportation systems.* Retrieved on March 22, 2019, from https://transportgeography.org/?page_id=1000

Rumelt, R. P. (1974). Strategy, structure, and economic performance.

S&P Global (2019a). *Compustat Global* [Dataset].

S&P Global (2019b). *Compustat North America* [Dataset].

Scottish Enterprise (2017). *Gross value added.* Retrieved on December 4, 2018, from http://www.evaluationsonline.org.uk/evaluations/Documents.do?action=download&id=802

Scottish Enterprise (2019). *What we do.* Retrieved on December 4, 2018, from https://www.scottish-enterprise.com/our-organisation/what-we-do

Song, D. W., & Panayides, P. M. (2012). *Maritime logistics: a complete guide to effective shipping and port management.* London, United Kingdom: Kogan Page Limited.

Standard & Poor's (2003). Compustat User's Guide. New York City, New York: The McGrawHill Companies.

Supply and Demand Chain Executive (2018). *Direction: outsourcing. Can the IT and automotive industries entwine?* Retrieved on June 6, 2019, from https://www.sdcexec.com/software-technology/article/21032238/direction-outsourcing-can-the-it-and-automotive-industries-entwine

The American Prospect (2009). *How Detroit went bottom-up.* Retrieved on June 5, 2019, from https://prospect.org/article/how-detroit-went-bottom

Transport Online (2019). *Matrans neemt SCA Logistics over.* Retrieved on June 3, 2019, from https://www.transport-online.nl/site/104077/matrans-neemt-sca-logistics-over/

Tucker, I. B., & Wilder, R. P. (1977). Trends in vertical integration in the US manufacturing sector. *The Journal of Industrial Economics*, 81-94.

Turner, C. M., Startz, R., & Nelson, C. R. (1989). A Markov model of heteroskedasticity, risk, and learning in the stock market. *Journal of Financial Economics*, *25*(1), 3-22.

Vakmedianet (2019). *Nunner neemt 4PL-er Caroz over.* Retrieved on June 3, 2019, from https://www.logistiek.nl/logistieke-dienstverlening/nieuws/2019/05/nunner-neemt-4pl-er-caroz-over-101168149

Van de Voorde, E., & Vanelslander, T. (2008). *Market power and vertical and horizontal integration in the maritime shipping and port industry.* Retrieved on July 18, 2018, from https://www.econstor.eu/bitstream/10419/68788/1/589780166.pdf

Vesey, J. (1978). Vertical integration: its effect on business performance. *Managerial Planning*, *26*(6), 11-15.

Williamson, O. E. (1973). Markets and hierarchies: some elementary considerations. *American Economic Review, 63 (2), 316-325.*

Williamson, O. E. (1989). Transaction cost economics. In: R. Schmalensee, & R. Willig, *Handbook of industrial organization*, 135-182. Amsterdam, The Netherlands: Elsevier.

Wooldridge, J.M. (2013). *Introductory Econometrics: A Modern Approach.* 5th Edition. Mason, Ohio: South-Western.

Zwakhals (2018). *The state of container shipping lines in 2050.* Master thesis.