Organisational growth and firm performance in the international container shipping industry

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Abstract

Firms buy factor inputs in the factor market and sell value-added outputs to customers in the product market. Firms also engage in economic exchanges along (vertically related exchange) and across the value chain (horizontally related exchange). The combination of these value-adding and exchange functions determine a firm's performance. Another important determinant affecting firm performance relates to organisational growth in terms of capacity. This paper examines how the factor and product markets are related to organisational capacity and firm performance in the container shipping industry. The findings revealed that the price on the product market (i.e. freight rate) is positively related to the production capacity of the industry, but the price on the factor market (i.e. charter rate) does not significantly influence liner shipping firms' decision on their fleet size adjustment. This study also illustrates the relationship between firm size and level of vertical expansion for carriers to own ships rather than chartering ships from the factor market. Successful firms tend to grow. Expansion can be a strategy for firms to achieve performance gains. To understand vertical expansion in this industry, a regression equation model is developed for the reference of managers to predict the level of ordering of new ships by ocean carriers. In addition, this study used objective data to empirically test the relationship between organisational capacity and firm performance, shedding light on the profitability of ocean carriers.

1. Introduction

Before the 1930s, business researchers focused on the production function of firms and their production efficiency, which is concerned with effective use of input resources to produce output (Lin and Shao, 2006). Their discussion was not extended to the valued-added activities of the firms and this situation persisted until the 1950s. The cost minimising and value maximising approach inter-linked with each other in business operations. Firms expand continually not only in their existing fields, but also into new products and markets as opportunity arises (Penrose 1956). Such expansion may require a combination of multiple business functions and activities, such as the exchange and value-adding functions that will determine a firm's performance (Dunning, 2003). In addition, firm performance is affected by the growth of existing firms (Dunning, 2003).

There are two key functions affecting firm performance in business operations: the value-added and the exchange functions. Firms buy factor inputs from the factor market and sell the value-added outputs to customers in the product market. In container shipping, carriers rent ships from the charter market to obtain inputs and deliver shipping services as outputs in the freight market. In addition, firms engage in economic exchanges along (vertically related exchange) and across the value chain (horizontally related exchange). Organisational growth is another key factor affecting firm performance. Container shipping is one of the world's most internationalised industries. Container shipping firms, also known as liner shipping carriers, provide scheduled, common-carrier type services over fixed geographical trade routes. The carriers have no cargoes of their own for transport. Instead, they offer shipping services and transport cargoes for different shippers. Containerisation in the 1970s brought a revolution in the patterns of sea transport. Containerisation led to a radically new design of containerships and cargo-handling facilities. Carriers also bring structural change to the container shipping industry through the formation of strategic alliance, enlargement of ship size, and development of global mega-firms (Lun et al., 2009[a]). All these changes prompt container shipping firms to move towards global operations. This transformation evolves further with the continuous trend of internationalisation.

The following research questions served to guide our investigation:

- What are the roles of charter rate and freight rate in the liner shipping industry?
- How does firm size affect horizontal expansion?
- How does firm size affect vertical expansion?
- What are the effects of organisational growth and capacity on firm performance?

2. Conceptualisation and hypotheses development

Firms buy factor inputs and sell value-added outputs. Buyers and sellers interact to determine prices and quantities for both inputs and outputs. The quantity supply of liner shipping services to shippers is determined by both the price of the factor market and the price of the product market. In liner shipping, the factor market is the charter market where carriers charter ships from ship owners while the product market is the freight market where carriers deliver shipping services. The product market in container shipping is a marketplace in which sea transport service is bought and sold (Lun and Quaddus, 2009). Container shipping operates according to a schedule of ports of loading and discharge adhering to a published time table on set conditions of carriage (Farthing and Brownrigg, 1997). Freight rate is the price on the product market. The quantity of transport services that carriers are willing to produce and sell depends on the freight rate. Freight rate plays an important role in the production of a container shipping service. If shippers need more shipping services, shipping demand will rise. When carriers find that shipping demand exceeds their service supply, they respond by increasing the freight rate, which in turn would stimulate an increase in their carrying capacity (Jansson and Shneerson, 1987). Hence, the following hypothesis is developed:

Hypothesis 1.1: Freight rate and total carrying capacity are positively correlated.

Table 1: Ownership of container fleet as of March 2008

Carriers	**Carrier-owned Capacity (in TEU*)**	**%**	**Chartered Capacity (in TEU*)**	**%**	**Total Capacity**
Maersk	1,030,456	52.5%	934,114	47.5%	1,964,570
MSC	712,512	57.4%	528,527	42.6%	1,241,039
CMA CGM	278,007	30.8%	624,735	69.2%	902,742
Evergreen	363,425	58.3%	260,294	41.7%	623,719
Hapag-Lloyd	256,581	51.5%	241,233	48.5%	497,814
China Shipping	251,195	58.2%	180,523	41.8%	431,718
COSCO	242,561	55.0%	198,453	45.0%	441,014
Hanjin Senator	126,821	35.8%	227,406	64.2%	354,227
APL	134,798	33.5%	268,059	66.5%	402,587
NYK	245,632	61.7%	152,645	38.3%	398,277
MOL	173,148	48.6%	183,318	51.4%	356,466
OOCL	204,915	58.3%	146,383	41.7%	351,298
K Line	169,306	54.3%	142,568	45.7%	311,874
CSAV	21,208	7.9%	246,581	92.1%	267,789
Zim	136,009	47.1%	153,008	52.9%	289,017
Yang Ming	172,825	63.0%	101,456	37.0%	274,281
Hamburg-Sud	110,309	39.2%	170,959	60.8%	281,268
Hyundai	76,465	33.7%	150,514	66.3%	226,979
PIL	103,358	59.5%	70,474	40.5%	173,832
Wan Hai	98,591	68.5%	45,352	31.5%	143,943
UASC	77,176	66.2%	39,415	33.8%	116,591
IRIS	47,268	63.0%	27,762	37.0%	75,030
MISC	40,151	42.0%	55,334	58.0%	95,485
Girmaldi	45,133	84.4%	8,345	15.6%	53,478
RCL	38,782	75.6%	12,507	24.4%	51,289

* TEU – twenty-foot equivalent unit

(Source: AXS-Alphaliner)

On the other hand, firms engage in economic exchanges both vertically and horizontally. An example of a horizontal exchange in container shipping is related to sharing of shipping space. Slot sharing is a way for container shipping firms to share shipping space with partner carriers to reduce financial risk on capital investment and achieve scale economy by deploying larger containerships. This practice allows carriers to place more new building orders for larger containerships (Lun et al., 2009[b]) due to their collaborative sharing in such areas as slot sharing and sailing arrangements (Sheppard and Seidman, 2001). An example of a vertical related activity takes place when a carrier owns their ships instead of chartering ships from the factor market. The decision for carriers to own their ships is influenced by a number of factors such as the financial background and risk taking behaviour. Hence, the use of vertical expansion strategy differs greatly from carrier to carrier. As shown in Table 1, some carriers (e.g. Girmaldi and RCL) own in excess of 70% of their entire fleet whereas others may only own a small percentage. Neither strategy is necessarily the best, but the ability to dip in and out of the factor market gives carriers a certain degree of flexibility. However, obtaining shipping space from the charter market could be subject to fluctuation of the charter rate.

In the factor market, the charter rate serves as a major signal to carriers on the supply and demand of ships to serve the sea transport market. When carriers find that demand for shipping service exceeds their capacity, they demand more ships from the charter market, which in turn would stimulate an increase in the charter rate. However, a high factor price reduces the demand for the factor input based on the 'law of demand' (Samuelson and Nordhaus, 1992). Carriers may reduce their capacity when the charter rate in the factor market is high. Hence, the following hypothesis is proposed:

Hypothesis 1.2: Charter rate and total carrying capacity are negatively correlated.

There are two ways in which economic activities coordinate: price mechanism and conscious planning (Richardson 1972). From the perspective of price mechanism, a high charter rate reduces the demand for inputs to deliver shipping services whereas a high freight rate encourages carriers to produce more outputs for shippers. On the other hand, inter-firm cooperation had its central core to elaborate the concept of conscious planning in economic activities. Inter-firm co-operation refers to a trading relationship between parties which is stable enough to make demand expectation more reliable, facilitating production planning. There is no specific rule in the container shipping industry to determine how to manage resources. Some carriers prefer to own their ships to ensure stability in the supply of their liner shipping services whereas others may rely on charter contracts with suppliers. For instance, CSAV obtains 92.1% of its capacity from the charter market whereas Girmaldi owns 84.4% of its carrying capacity.

Successful firms tend to grow. Tan et al. (2007) demonstrated a positive relationship between operations capability and firm performance. There is a strong tendency for firms possessing extensive resources to continually expand (Yin and Shanley, 2008). Opportunity for organisational growth is largely determined by the resource of the firm (Teece, 1982). One of the notable characteristics of organisational growth is concerned with the extent to which they change their product nature as they grow. The extent to which this process of expansion can continue depends upon the resource available to the firm. As long as there are openings in which the firm expects a rate of return on investment sufficient to justify its entry to the factor market, there is nothing in principle to limit its continued expansion (Penrose, 1956). Carriers possessing extensive resources tend to adopt the vertical expansion strategy. Such strategy allows carriers to control the input by owning their ships instead of chartering them from the factor market. Hence, the following hypothesis is developed:

Hypothesis 2: Larger carriers are characterised with a high level of vertical expansion.

Table 2: Evolution of carriers and their operated fleets from 2000 to 2007

Container Shipping Carriers	**January 2000 Capacity (in TEU)**	**January 2007 Capacity (in TEU)**	**Market Share (2007)**	**Rank**
Maersk	620,324	1,759,619	16.8%	1
MSC	224,620	1,026.251	9.8%	2
CMA CGM	122,848	685,054	6.5%	3
Evergreen	317,292	547,576	5.2%	4
Hapag-Lloyd	102,769	458,161	4.4%	5
China Shipping	86,335	399,821	3.8%	6
COSCO	198,841	387,690	3.7%	7
Hanjin Senator	244,636	348,235	3.3%	8
APL	207,992	339,036	3.2%	9
NYK	166,206	329,324	3.1%	10
MOL	136,075	281,807	2.7%	11
OOCL	101,044	281,113	2.7%	12
K Line	112,884	275,634	2.6%	13
CSAV	69,745	250,452	2.4%	14
Zim	132,618	241,951	2.3%	15
Yang Ming	93,348	240,305	2.3%	16
Hamburg-Sud	68,119	204,960	2.0%	17
Hyundai	102,314	164,700	1.6%	18
PIL	60,505	145,500	1.4%	19
Wan Hai	63,525	115,009	1.1%	20
UASC	74,989	86,608	0.8%	21
IRIS	19,920	59,900	0.6%	22
MISC	41,738	58,013	0.6%	23
Girmaldi	35,283	56,668	0.5%	24
RCL	26,355	46,466	0.4%	25
Others	1,306,388	1,677,643	16%	-
Total	5,150,000	10,467,496	100%	-

(Source: AXS-Alphaliner)

Organisation size plays a significant role in business research (Main et al., 1995; and Stuart, 2000). One of the most common size-based strategies cites low cost derived from scale economy as a source of competitive advantage (Porter, 2004). Large size leads to scale mechanism by which high production volume can be translated into cost efficiency (Dobrev and Carroll, 2003). Large size also serves as a strong entry barrier to deter new competitors (Porter, 1999). Scale economy in operations allows geographical expansion and facilitates the internationalisation of business and hence cost advantage as a result of decreasing the per unit operating cost. Due to the advantages of having scale operations, large carriers can leverage their capacity to attain continuous growth. As shown in Table 2, the capacity of the world's biggest carrier (i.e. Maersk) increased by 284% from 620,324 TEUs in 2000 to 1,759,619 TEU in 2007. Therefore, the following hypothesis is proposed:

Hypothesis 3: Larger carriers are characterised with a higher level of horizontal expansion than the smaller counterparts.

Regardless of whether the average profitability of the industry is high or low, some firms are more profitable than others (Bharadwaj et al., 1993). Firm size and performance is an interesting topic to explore (Audia and Greve, 2006). One of the most popular size-based strategies is the theory of low cost derived from scale economy as a primary source of competitive advantage (Barney, 1991; and Chandler, 1999). A firm can be viewed as a collection of resources.

According to Wernerfelt (1984), what a firm wants is to create a situation where its own resource position directly or indirectly makes it more difficult for others to catch up. In container shipping, capacity can be one of the resources for firms to reap potential high returns. Production processes with increasing returns to scale yield higher returns. Scale economy in the use of resources is one of the ample examples to illustrate product entry barriers. Nelson and Winter (1982) also noted that 'a firm that is already successful in a given activity is a particularly good candidate for being successful with new capacity of the same sort'. This routine-based view of growth suggests that expansion will be easier and favourable for performance gains. Hence, the last hypothesis of this study is developed:

Hypothesis 4: Larger carriers achieve better firm performance in terms of profitability.

3. Research design

In this study, objective data were used to test the hypotheses. To study the factor market, the data of charter rates (i.e. price on factor market) and total fleet size from 1996 to 2007 were extracted from the Clarkson Research Studies[1]. In addition, the data of freight rates (i.e. price on product market) from 1996 to 2007 were extracted from the U.S. Bureau of Labor Statistics[2] to examine the product market. The information relating to total fleet, prices on the factor market, and prices on the product market were used to develop a structural equation model (SEM) to evaluate hypotheses 1.1 and 1.2. To test hypothesis 2, information on the carrying capacity of the top 100 ocean carriers and their order of new ships are collected from AXS-Alphaliner[3]. In 2007, 45 out of 100 carriers ordered new ships indicating their level of vertical expansion. The data on carrying capacity and new order were used to examine vertical expansion. On the other hand, growth rate (between 2000 and 2007) and carrying capacity of the top 25 ocean carriers are used to evaluate horizontal expansion and test hypothesis 3. The last hypothesis examines organisational growth and firm performance. The data of ocean carriers' EBIT and net profit was collected from Drewry[4] to serve as performance indicators (as shown in Table 3). The variables on growth rate, firm size in terms of carrying capacity, and EBIT were used to develop a SEM to evaluate hypothesis 4. To predict firm performance, the variables on net profit and firm carrying capacity were used to develop a regression equation.

[1] Clarkson Research Studies is a research institute that provides statistical and research services.
[2] Source: http://www.bls.gov
[3] Source: http://www1.axsmarine.com/public/publicTOP100.php
[4] Drewry Shipping Consultants Limited provides commercial, economic and technical consulting and publishing services to the international shipping industry.

Table 3: Ocean carriers' performance

Carriers	EBIT (in million USD)	Net Profit (in million USD)
Maersk	1766.00	1513.00
MSC	N/A	N/A
CMA CGM	614.00	556.00
Evergreen	388.00	381.00
Hapag-Lloyd	405.00	378.00
China Shipping	621.00	485.00
COSCO	424.00	N/A
Hanjin Senator	792.00	624.00
APL	900.00	N/A
NYK	428.00	N/A
MOL	521.00	N/A
OOCL	729.00	670.6
K Line	1006.00	557.00
CSAV	145.00	207.00
Zim	176.10	171.80
Yang Ming	387.00	309.00
Hamburg-Sud	N/A	N/A
Hyundai	536.00	413.00
PIL	N/A	N/A
Wan Hai	131.00	214.00
UASC	117.60	127.30
IRIS	N/A	N/A
MISC	N/A	N/A
Girmaldi	N/A	N/A
RCL	99.00	87.30

(Source: The Drewry Annual Container Market, 2006)

4. Test results

A series of statistical techniques are used to test the hypotheses. To begin with, an SEM is developed to evaluate the significance of factor price and product price on the determination of capacity in the container shipping industry. To test the second hypothesis, regression analysis is used to examine the relationship between carrying capacity and ordering of new ships to examine vertical expansion. The objective of regression analysis is to predict a single dependent variable from the knowledge of an independent variable. A regression equation is therefore developed to predict the level of expected new orders in the container shipping industry based on firm capacity. Correlation coefficient is useful to indicate the strength of the association between any two variables. Therefore, Bivariate Correlation is used to test the relationship between firm size in terms of carrying capacity and its growth rate to evaluate hypothesis 3. SEM is used to examine the firm growth and its performance to validate the last hypothesis. Furthermore, a regression equation is generalised to predict the net profit based on the independent variable of carrying capacity. Generalisation of the results has also been discussed.

The exchange function

The first hypothesis attempts to examine the exchange function in container shipping. In this study, prices on the factor market are the charter rates for carriers to charter ships while prices on the product market are the freight rates for shippers to receive the shipping services. To evaluate how carrying capacity is affected by prices on the factor market and prices on the product market, this study uses path analysis as a method to examine the postulated relationships among the study variables. Path analysis is a special case of SEM that has been regularly used in empirical research. It enables the researcher to decompose the simple correlation between any two variables into the sum of the compound paths connecting these points.

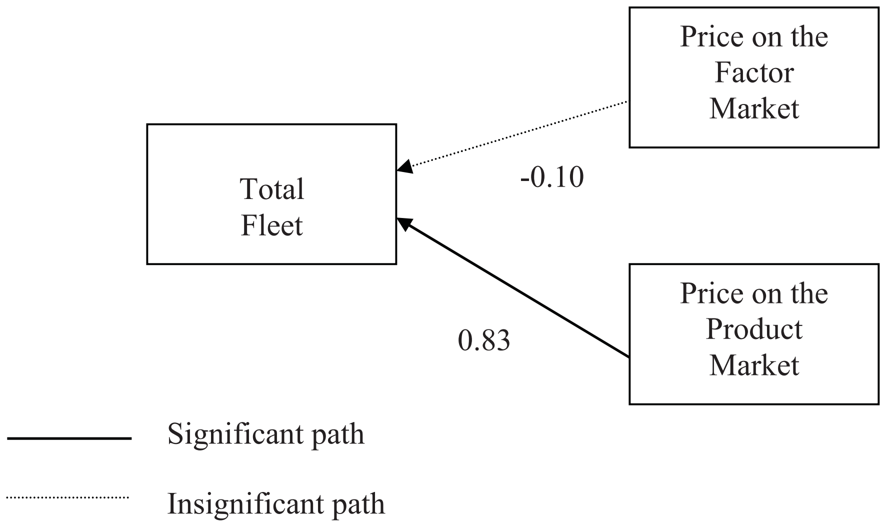
We used AMOS (Analysis of Moment Structure) to develop the SEM. The results showed that Chi-square (x^2) was 0.437 while the number of degrees of freedom (*df*) was 1.0. The corresponding probability was 0.509, which is greater than the conventionally accepted statistical significance level. A rule of thumb to assess the fit of the model is that an SEM is a good-fitting model when the ratio of the x^2 to the *df* is less than 2.0 (Tabachnick and Fidell, 2007). In our model, the value of x^2/df is 0.437 indicating that it is a good-fitting model. As shown in Table 4, the results suggest that the carrying capacity was positively affected by the freight rate with a β = 0.83 and the relationship was significant at the $p < 0.05$ level. On the other hand, the total fleet was negatively affected by the charter rate, but the relationship was not significant with a *p* value of 0.203.

Table 4: Results of the SEM on exchange function

Path	**Standard Coefficient**	***p***
Price on factor market → carrying capacity	-0.10	0.203
Price on product market → carrying capacity	0.83	0.001

A path diagram is fundamental to SEM because it allows the researcher to visualise the hypothesised set of relationships. The path diagram of the exchange function model and their corresponding path coefficients are summarised in Figure 1. In the exchange function, carriers buy factor input in the factor market by chartering ships and sell the output in the product market by charging shippers freight rates. The production of container shipping services is negatively affected by charter rates and positively affected by freight rates. The findings show that carrying capacity is significantly affected by freight rates. Carriers increase their capacity when the freight rates are higher. In addition, the empirical results showed that charter rates and shipping capacity are negatively correlated (with a β = -0.10) but the relationship was not significant with a p = 0.203 which is beyond the 0.050 acceptance level. Results of the SEM indicate that the freight rate is an important factor for shipping firms to determine their capacity. The higher the freight rates, the higher the capacity. However, the results suggest that charter rate does not have a significant impact on influencing the capacity decision.

Figure 1: Results of the exchange function model



The findings imply that the change in charter rate does not significantly affect the level of fleet size. In the factor market of container shipping, price (i.e. charter rate) is not a significant determinant to affect carriers' decision in adjusting their capacity. The findings suggest that ocean carriers tend to increase their capacity when the freight rate is at a high level. Price in the product market (i.e. freight rate) plays an important role in the production of shipping services. It indicates that container shipping is a market driven industry as the price of the product market significantly affects ocean carriers' production decision. Carriers adjust their carrying capacity based on the demand for shipping services. The demand for shipping services is a function of freight rates and the demand for shipping services per time period. The freight market creates a situation where freight rate moves to a level at which demand from shippers equates to the supply of shipping services from carriers (McConvill, 1999). Demand for shipping services depends on shippers' demand for sea transport of its goods. As a result, seaborne trade becomes a major determinant for sea transport. An increase or a decrease in seaborne trade volume would change the demand for sea transport which in turn influences the freight rate. If the seaborne trade volume increases, shippers demand more shipping services. When the shipping demand exceeds the shipping supply, the freight rate will go up. The freight rate coordinates the decision of carriers and shippers to transact for shipping services in the container shipping market. A high freight rate tends to encourage organisational growth in terms of carrying capacity. Such an association between freight rate and carrying capacity can be regarded as the existence of an invisible hand that regulates the container shipping market.

The growth of firms - vertical expansion

The second hypothesis of this study is to examine the relationship between firm capacity and vertical expansion in liner shipping. The firm capacity and new orders from carriers in 2007 were used to validate the relationship between vertical expansion and firm size. The statistical tool of regression analysis was used to test the hypothesis. According to Table 5, the result of the regression model shows that firm capacity and the ordering of a new fleet are positively related with a $R^2 = 0.628$ at the $p = 0.000$ level. The finding indicates that hypothesis 2 is supported.

Table 5: Relationship between firm capacity and new order

Equation	Model Summary		Parameter Estimates	
	R^2	P	Constant	β
Linear	0.628	0.000	37882.024	0.338

Dependent variable: New Order
Independent variable: Firm capacity

The coefficient of the independent variable is listed in the column labeled β in Table 5. Using the coefficient, the estimated regression equation[5] can be written as:

Expected New Order = Constant + Regression Coefficient x Firm capacity

i.e. NO = 37882.024 + 0.338 (FC)

where NO = new order and FC = firm capacity

The coefficient for the variable of firm capacity predicts the expected new order increases by 0.338 for a change of 1.0 in the value of firm capacity. Coefficient of determination (R^2) measures the percentage of variability in the dependent variable that can be explained through knowledge of the variability in the independent variable. R^2 can vary between 0 and 1.0. The higher the value of R^2, the greater the explanatory power of the regression equation, and the better the prediction of the dependent variable. The entry labelled R^2 in Table 5 tells that 62.8% of the observed variability in new orders is explained by the independent variable of firm capacity. The prediction accuracy of 62.8% indicates that the regression equation (NO = 37882.024 + 0.338FC) predicts fleet size very well.

Findings of this study indicate that there was a positive relationship between new order and carrying capacity in container shipping. It implies that larger firms prefer the strategy of vertical expansion, highlighted by 'a decision by the firm to utilise internal transaction rather than market transaction to accomplish its economic purpose' (Porter, 2004). In container shipping, larger firms find it advantageous to perform a significant proportion of the productive processes required to produce the shipping service in-house rather than acquiring shipping space from the charter market. Carriers tend to believe that it is cheaper, less risky, or easier to coordinate when the ships are owned internally. A vertically integrated decision is a 'make or buy' decision to consider strategic issues of integration or use of market transactions. There are important generic benefits to adopt the vertical expansion strategy. For instance, vertical expansion by acquiring more ships assures the carriers that they will have ships available during peak season for shipping

[5] In the regression equation, the regression coefficient for a variable tells how much the value of the dependent variable changes when the value of the independent variable adjusts. A positive coefficient means that the predicted value of the dependent variable increases when the value of the independent variable increases.

demand. Growth is related to a firm's requirements for certainty and survival (Pfeffer, 1972). Theories based on operating synergy (Galbraith and Stiles, 1984) can also be seen as a benefit for carriers to expand. In addition, economies of combined operations with regard to owning of ships and providing container services together can gain efficiencies. The shipping firms can also potentially save resources on negotiating the rate and transaction cost in the factor market to conduct economic exchange. Carriers possess a bundle of resource (Buckley and Casson, 1998) which can be allocated among various activities. To provide reference for a manager to determine the appropriate level of resource allocated for a new order context and to guide the decision on vertical expansion, we develop a regression equation model by using empirical data to estimate the level of vertical integration. The regression equation NO = 37882.024 + 0.338 FC indicates that the expected new order is 33.8% of firm capacity beyond the constant value of 37882.024.

The growth of firms - horizontal expansion

The third hypothesis examines the relationship between firm size and its growth rate. In this study, data on the firm capacity of the top 25 carriers and their growth rate were collected. The sample size of 25 is adequate to represent the liner shipping industry as the top 25 carriers control 84% of the world market share (source: AXS-Alphaliner). The summary statistics on the firm capacity and growth rate is presented in Table 6. According to the table, the mean value of firm capacity is 351,594 TEU with a minimum value of 46,466 TEU and a maximum value of 1,759,619 TEU while the mean value of growth rate is 155.24% with a minimum value of 15.00% and a maximum value of 458.00%.

Table 6: Descriptive statistics on firm capacity and growth rate

	N	Minimum	Maximum	Mean	Std. Deviation
Firm Capacity	25	46466.00	1759619.00	351594.52	366836.23
Growth Rate	25	15.00	458.00	155.24	117.97
Valid N	25				

To examine the relationship between firm capacity and growth rate, Pearson correlation matrix was conducted to examine the direction, strength and the significance of the relationship of the study variables. The results in Table 7 showed that there is a positive correlation between firm capacity and growth rate with a correlation coefficient of 0.418 at a statistical significance level of $p = 0.038$. The result suggests firms with high capacity enjoy higher growth rate.

Table 7: Correlations between firm capacity and growth rate

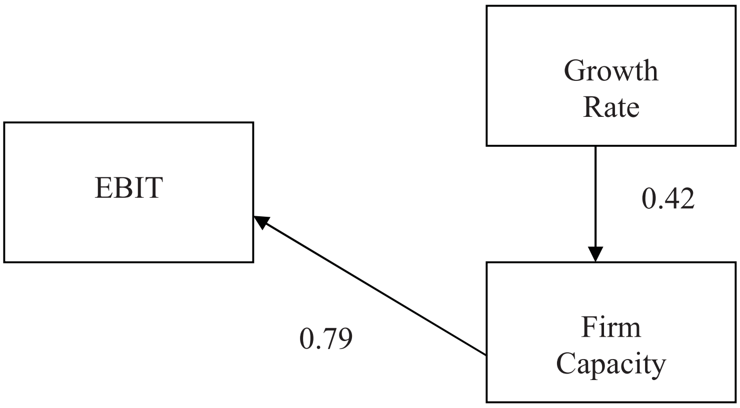
Variable	Firm Capacity	Growth Rate
Firm Capacity	1	
Growth Rate	0.418(*) ($p = 0.038$)	1

* Correlation is significant at the 0.05 level (2-tailed).

Growth and firm performance

The last hypothesis of this study proposes that larger firms attain better performance. The variables on growth rate, firm capacity and EBIT were used to test the hypothesis. To evaluate the postulated relationships among the study variables, path analysis was used to develop an SEM. The results showed that Chi-square (x^2) was 0.681 while the number of degrees of freedom (*df*) was 1.0. The corresponding probability was 0.409, which is greater than the conventionally accepted statistical significance level. In our model, the value of x^2/df is 0.681 indicating that it is a good-fitting model. The results of SEM and their corresponding coefficients are summarised in Figure 2. In the path diagram, growth rate of container shipping firms affect the firm size with a β = 0.42 (at the $p = 0.024$ level) and firm size influences container shipping firms' EBIT with a β = 0.79 (at the $p < 0.001$ level).

Figure 2: SEM on firm size and firm performance



The finings suggest that larger firms are associated with greater level of capacity expansion. An SEM is also developed to validate the relationships between these independent and dependent variables. The path diagram indicates that growth rate positively affects firm capacity, and firm capacity has a significant effect on firm performance.

Firm size and firm performance

In container shipping, firm capacity is positively associated with continued organisational growth. It is an interesting issue to explore how the firm capacity influences firm performance. In this section, the relationship between firm size and firm performance are examined by formulating a regression model. In doing so, the value of net profit is used as the dependent variable and the value of firm capacity in terms of TEUs is used as the independent variable, i.e. predictor. The regression analysis results are shown in Table 8.

Table 8: Relationship between firm capacity and net profit

Equation	Model Summary			Parameter Estimates	
	R^2	*df*	*p*	Constant (Intercept)	Regression Coefficient (β)
	0.810	13	0.000	150.217	0.001

Dependent variable: Net profit
Independent variable: Firm capacity

The result indicates that firm capacity and net profit are positively related with a $R^2 = 0.810$ at the $p = 0.000$ level. The coefficient of the independent variable is listed in the column labeled β in Table 8. Using the coefficient, the estimated regression equation can be written as:

Expected Net Profit = Constant + Regression Coefficient x Firm capacity

i.e. NP = 150.217 + 0.001 (FC)

where NP = new profit (in million USD) and FC = firm capacity (in TEU)

The coefficient for the variable on firm capacity predicts the expected new profit increases by 0.001 for a change of 1.0 in the value of firm capacity. It means that net profit increases by USD1000 for an increase of 1 TEU in firm capacity. The entry labelled R^2 in Table 8 indicates that 81.0% of the observed variability in net profit is explained by the independent variable on firm capacity. The prediction accuracy of 81.0% indicates that the regression equation (NP = 150.217 + 0.001FC) predicts net profit well.

In evaluating the fit of a statistical model, the issue on degree of freedom should not be neglected. The best regression model is the one with the highest predictive accuracy for the most generalisable sample. According the Hair et al. (2006), the degree of generalisability[6] is represented by the degrees of freedom, which provides a measure of how data are to reach a certain level of prediction. The degree of freedom[7] for this study sample is 13 (*df* = 13). It indicates that 13 data items are independent of one another and they carry unique pieces of information. Hence, the result can be generalisable. To determine the statistical power, sample size affects the generalisability of the result by the ratio of observations to independent variable. As a general rule, the minimum ratio to variable is 5:1 (Hair et al., 2006) meaning that five observations are made for each independent variable. In this study, 15 firm data (i.e. $n = 15$) and one independent variable (i.e. FC = firm capacity) were used to develop the regression equation to predict the dependent variable (NP = net profit). The ratio of observations to variable of this study is 15:1 indicating that the result of this study should be generalisable.

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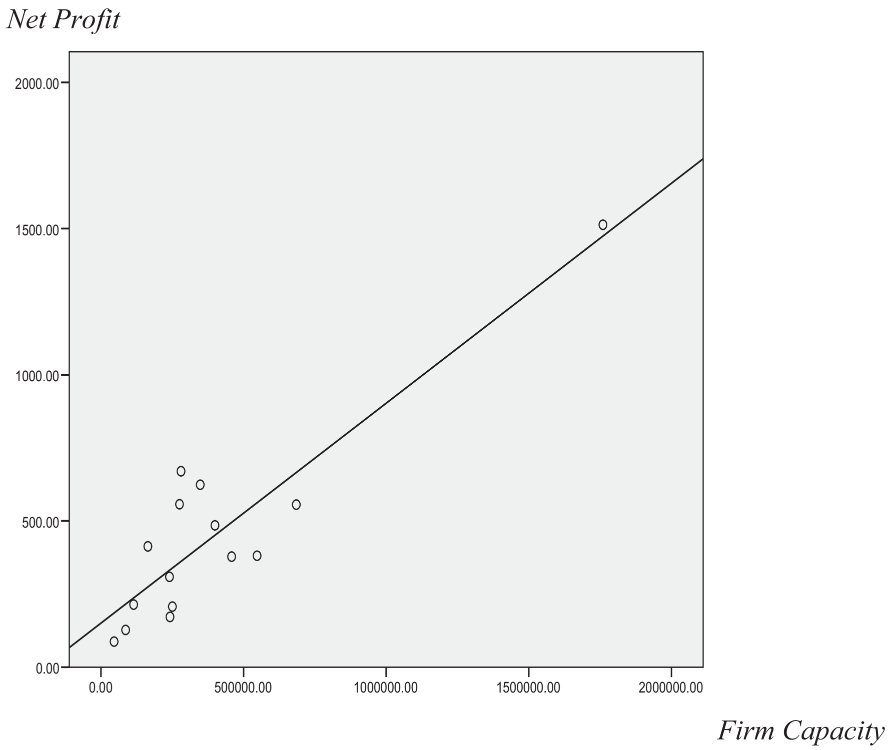
[6] Prediction accuracy of the regression equation could be very high if the sample is relatively small. A value of large degrees of freedom indicates the prediction is fairly robust. The larger the degrees of freedom, the more generalisable are the results. The concept of degrees of freedom can be indicative of the generalisability of the result and gives an idea of the overfitting of the regression model.

[7] In estimating a regression model with a single independent variable, we estimate two parameters, the intercept and regression coefficient for the independent variable. In estimating the random error, defined as the sum of the prediction errors (actual minus predicted dependent values) for all cases, we found (n-2) degrees of freedom.

Figure 3: Curve fit for net profit



To provide a visual presentation on the relationship between net profit and firm capacity, a curve fit graph is provided in Figure 3. The curve fit graph is a scatter plot of observed values of net profit expectancy and the line is derived from the regression equation. In the figure, the points (n=15) are reasonably distributed above and below the line. That is an indication that the regression model is a good choice and the regression equation predicts the net profit in container shipping.

The regression equation (NP = 150.217 + 0.001FC) indicates that annual net profit increases by USD1000 for an increase of 1 TEU in capacity. The results imply that capacity expansion is one of the most significant strategic decisions faced by carriers. Capacity expansion involving lead times and capacity is often long lasting. Capacity expansion requires carriers to commit resources based on the expectations about the condition of future demand. Hence, two types of expectations are essential in determining the level of capacity expansion: those about the market demand (Kogut, 1991) and those about the impact on the environment (Thompson, 1967). The former in capacity decision making is obvious. Demand for shipping service is derived from seaborne trade (Lun and Quaddus, 2009). Firms tend to employ a growth strategy to cope with the growth of seaborne trade. To avoid the negative effect from over capacity in the shipping market, accurate predictions about competitors' behaviour are crucial. Hence, the strategic issue in capacity expansion in container shipping is to add capacity to enhance firm performance and improve its market share while avoiding over capacity.

5. Conclusion

Several contributions are made by this study. First, we examined the exchange function in the container shipping industry. The findings indicate that the price on the factor market (i.e. charter rate) is negatively related to total production capacity while the price on the product market (i.e. freight rate) is positively related to the total production capacity of the industry. This study also demonstrates that the price of the product market affects the container shipping industry to adjust their production capacity. Second, findings of this study illustrate the relationship between firm size and the level of vertical expansion. In container shipping, large firms tend to have a higher level of vertical integration and hence larger carriers prefer to own their ships instead of renting ships from the charter market. To understand the level of vertical integration, this study develops a regression equation (i.e. NO = 37882.024 + 0.338 FC) as a useful reference for managers to predict the level of new orders by carriers. More importantly, objective data were used to validate the relationship between firm capacity and firm performance and in a regression equation (i.e. NP = 150.12 + 0.001FC) implying that net profit increases by USD1000 for an increase of 1 TEU in capacity. This empirically tested equation provides a useful guideline for managers to make a capacity decision.

We also provide an insight into the shipping cycle (Kirkaldy, 1914; and Fayle, 1933). The shipping market is driven by a competitive process in which supply and demand interact to determine the freight rate. Excessive demand leads to a shortage of ships, which in turn increases freight rates. On the other hand, excessive supply of ships leads to a reduction in freight rates. Shipping cycles are far more complex than a sequence of cyclical moves in freight rates. A shipping cycle starts with a shortage of ships. The increase in freight rates stimulates over-ordering of new ships. Finally, it leads to a market collapse and prolonged slumps. Shipping cycles are a mechanism to balance the supply of and demand for ships. Kirkaldy (1914) saw the shipping cycle as a consequence of the market mechanism. The market cycles create the business environment in which weak shipping firms are forced to leave and strong shipping firms survive and prosper. Our findings imply that larger firms tend to use a growth strategy to make them more competitive and prosperous on the one hand, and force their weaker rivals to exit the industry on the other hand. As bigger firms grow and prosper, the container shipping market becomes highly concentrated with a few mega firms controlling the majority of the market share (Lun and Browne, 2009).

Limitation of this paper can be viewed from the perspective of methodology. Methodologically, the data used to test the hypotheses were based on secondary sources. Although objective data are used, there is a lack of information to triangulate the data accuracy. Moreover, this study is limited to container shipping. It is desirable for future research to extend to bulk shipping and tanker shipping. Furthermore, a comparison between the container shipping, bulk shipping and tanker shipping can provide a more in-depth insight into the capacity decision in the shipping industry.

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